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A

SYSTEM OF MINERALOGY.

A

SYSTEM

OF

MINERALOGY,

COMPRISING THE

MOST RECENT DISCOVERIES:

INCLUDING

FULL DESCRIPTIONS OF SPECIES AND THEIR LOCALITIES, CHEMICAL ANALYSES
AND FORMULAS, TABLES FOR THE DETERMINATION OF MINERALS,
WITH A TREATISE ON MATHEMATICAL CRYSTALLOGRAPHY
AND THE DRAWING OF FIGURES OF CRYSTALS.

ILLUSTRATED BY SIX HUNDRED WOOD CUTS.

By JAMES D. DANA, A. M.

Member of the Soc. Cæs. Nat. Cur. of Moscow, the Soc. Philomathique of Paris, the Geological Soc. of
London, the American Academy of Arts and Sciences at Boston, etc.
Silliman Professor of Natural History, Yale College.

"*Hæc studia nobiscum peregrinantur, rusticantur.*"

FOURTH EDITION,
REWRITTEN, REARRANGED, AND ENLARGED.

VOLUME I.

NEW YORK AND LONDON:
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PREFACE.

In the Preface to the last edition of this Treatise, the classification of Minerals then adopted was announced as only a temporary expedient. The system of Mohs, valuable in its day, had subserved its end; and in throwing off its shackles for the more consistent principles flowing from recent views in Chemistry, the many difficulties in the way of perfecting a new classification led the author to an arrangement which should "serve the convenience of the student without pretending to strict science."

A classification on chemical principles was however proposed in the latter part of the volume, in which the Berzelian method was coupled with crystallography, in a manner calculated to display the relations of species in composition as well as form, and prominently "exhibit the various cases of isomorphism and pleomorphism among Minerals." The progress of Science has afforded the means of giving greater precision and simplicity to this arrangement, until now it seems entitled to become the authorized method of a System of Mineralogy. Whether regarded from a physical or chemical point of view, the groupings appear in general to be a faithful exhibition of the true affinities of the species.

The mind uneducated in Science may revolt at seeing a metallic mineral, as galena, side by side with one of unmetallic lustre, as blende; and some systems, in accordance with this prejudice, place these species in separate orders. Like the jeweller, without as good reason, the same works have the diamond and sapphire in a common group. But it is one of the sublime lessons taught in the very portals of Chemistry, that nature rests no grand distinctions on lustre, hardness, or color, which are mere externals, and this truth should be acknowledged by the Mineralogist rather than defied. Others, while recognizing the close relations of the carbonates of lime, iron, zinc and manganese, (calcite, spathic iron, smithsonite and diallogite,) or of the silicates of lime, iron, manganese, (wollastonite, augite, rhodonite,) are somewhat startled by finding silicate of zinc, or silicate of copper, among the silicates of the earths or of other oxyds. But the distinction of "useful" and "useless," or "ores" and "stones," although bearing on "economy," is not Science.

The advantages which the arrangement of the last edition afforded those interested in mining and metallurgy, is secured in the present volumes by an index to the useful ores, in which their distinctive characters and their relative importance in the Arts are mentioned, and references are given to the pages where the full descriptions are to be found.

During the four years since the appearance of the last edition, the Science of Mineralogy has increased in species from 625 to 660; and this notwithstanding the bankruptcy of some 45 of the number. The important work of Rammelsberg on Chemical Mineralogy, has been continued in a fifth Supplement, issued in 1853. A similar review of the Progress of the Science by Dr. Gustav Adolph Kenngott, conducted with like thoroughness, though with less criticism, has appeared in Vienna, and already two large volumes have been issued, one reviewing the Science for the years 1844 to 1849, the other, for 1850 and 1851. During this period also, Professor Gustav Rose has published his Krystallo-chemische Mineral-System (1853); Professor Von Kobell, a work on Mineralogical Nomenclature (1853), and a new edition of his excellent Tables for the Determination of Minerals, (1853); Dr. Franz Leydolt and Professor Adolf Machatschek, of Vienna, their elements of Mineralogy based on the system of Mohs (1853); Dr. Kenngott of Vienna, "Das Mohs'sche Mineralsystem" (1853), and also a portfolio of plates of figures for the construction of Models of crystals (1854); Professor Quenstedt of Tubingen, the first part of a Treatise on Mineralogy (1854); Dr. C. F. Naumann, a revised edition of his invaluable Elements of Crystallography (1854); Dr. Friederich Pfaff of Erlangen, Elements of the Mathematical Relations of Crystals (1853); F. H. Schröder of Clausthal, Dr. Rammelsberg of Berlin, and Jos. Pecirka of Prague, smaller Manuals on the same subject, (1852, 1853); Dr. J. Zimmermann of Stuttgart, a small "Tashenbuch der Mineralogie" (1852); Nicolai von Kokscharov, the able Crystallographer of St. Petersburg, the first numbers of his "Mineralogie Russlands," in quarto, (1853, 1854); H. J. Brooke and W. H. Miller, a new and original Treatise under the title of Phillips's Mineralogy (1852); C. F. Plattner, an enlarged edition of his extended Treatise on the Blowpipe (1853): besides the great work of Dr. Gustav Bischof, on Chemical and Physical Geology, begun in 1846, now numbering 2950 pages, (the last issue in 1853), and yet wanting another part to be complete; also G. H. Otto Volger's Essays on the Development of Minerals, (Studien zur Entwicklungsgeschichte der Mineralien,) as the basis of Scientific Geology and a rational Mineral Chemistry, (Zürich, 1854); and von Waltershausen's Treatise on the Volcanic Rocks of Sicily and Iceland. Moreover, various valuable papers have been issued in Scientific Journals and Transactions abroad, by Haidinger, Rammelsberg, Breithaupt, Scheerer, von Kobell, Rose, Bunsen, Hermann, von Rath, Hausmann, Sandberger, Wöhler, Baer, Kenngott, Schabus, Kokscharov, Scacchi, Meneghini, Delesse, Damour, Deville, Descloizeaux, Senarmont, Chapman, Mallet, SCOTT, PERCY, and other able investigators. In this country have appeared FOSTER & WHITNEY's Report on the Geology and Mineralogy of the Lake Superior Region, (1851 and 1853); and J. D. WHITNEY's Mineral Wealth of the United States (1854). Moreover, Dr. J. LAWRENCE SMITH and G. J. BRUSH, have labored with important results in American Mineralogy, clearing away many doubtful species; and other researches have been published by T. S. HUNT, F. A. GENTH, J. C. BOOTH, J. D. WHITNEY, C. U. SHEPARD, J. W. MALLET, W. P. BLAKE, M. H. BOYE and T. H. GARRETT.

Of all these Publications, BISCHOF's "Lehrbuch" stands first in importance. Mineralogy was well nigh a lifeless Science, having only powers of increase by accretion, like the objects of which it treats,—the addition of a new Mineral now and then being the great event of interest in its progress. BISCHOF, by his elaborate researches and profound views, has given it a new impulse. He makes every analysis of a Mineral an important element in the study of Mineral history, showing the necessity of their multiplication, and well exposing the leanness of Chemical formulas when given as a substitute for analyses. The associations and collocations of Minerals, their changes from exposure to atmospheric and other agencies, and even the infinitesimal ingredients in their constitution, are all made to bear on the question of the origin and progress of Mineral and Rock Formations. A Mineral species is shown to have a history of its own,—its perfect state, its liabilities to alteration and decay, its successive changes, and again its renovation or its metamorphosis into a new species. These views taken in their wide extent, constitute the proper basis of the Science of Geology, and should have their full exposition in a work on that Science. But the elements of the subject are with propriety indicated in a Mineralogical Treatise. While dwelling with deserved emphasis on the researches of BISCHOF, we should not forget that others have labored in the same department, prominent among whom, are HAIDINGER, VOLGER, BREITHAUPT, BLUM, BUNSEN and DELESSE.

The work next in importance, more especially in its bearing on the crystallization of Minerals, is the "Elementary Introduction to Mineralogy," by BROOKE & MILLER. It stands preëminent for its original measurements, and its thorough revision of the angles of Crystals, and will remain a permanent source of information on these points.

In the preparation of the present edition, the author takes pleasure in making special acknowledgments to the work of BISCHOF, for facts and principles relating to the Chemistry of the alteration of Minerals; to RAMMELSBERG's Supplement to his Chemical Mineralogy, a work whose earlier parts contributed largely to the preceding edition of this Treatise; to KENNGOTT's and KOKSCHAROV's publications; and to the critical observations in the "Mineralsystem" of G. ROSE. Frequent use has also been made of the work of BROOKE & MILLER, in the crystallography of the species, from which the angles and planes of crystals have often been cited. The various Scientific Periodicals of Russia, Germany, Italy, France and Britain, some of them down to June last, have been searched for their facts, and every effort has been made to post the work up to the day of publication.

American Mineralogy owes much to the careful revision it has received at the hands of Messrs. SMITH & BRUSH; and the author would express his special personal obligations to each of these Chemists. From Dr. F. A. GENTH, of Philadelphia, he has derived generous aid both in suggestions and results of researches. Mr. T. S. HUNT has kindly contributed several new analyses throwing much light on the minerals of Canada; and valuable observations and analyses have been received from J. D. WHITNEY and Professor BOOTH. Many and various have been the favors, in the way of new facts, opinions and recent discoveries, which the author owes to Mr. LOUIS SÆMANN of Paris. He is also largely indebted to ROBERT P. GREG, Jr., of Manchester, England, for information respecting the Mineralogy of Great Britain, liberally furnished from a work by him and W. G. LETTSOM, now in the press.

The author would also express his gratitude to Messrs. T. S. HUNT, C. M. WHEATLEY, B. SILLIMAN Jr., L. WILDER, T. F. SEAL, W. T. VAUX, L. STADTMULLER, and G. J. BRUSH, for the privilege of figuring Crystals of American Species in their possession. Similar favors were received from the lamented J. E. TESCHEMACHER of Boston, who ever rejoiced to devote himself and his cabinet to the progress of the Science, and continued his communications with the author, until the day before his death in November last.

In the preparation of this edition, the subject of Crystallography has been revised and simplified. A system of notation for the figures of Crystals, both brief and simple, has been adopted; and many new and original figures have been introduced. The homœomorphous relations of mineral species have been worked out with considerable care, in order to arrive at their true fundamental forms, and trace the bearing of the subject on their composition and classification. The Table of atomic weights has been corrected according to the most recent results, and the percentages of the formulas have been recalculated to correspond with it. The subject of pseudomorphs is treated at some length, and along with the descriptions of the species, a paragraph is devoted to the altered forms which each presents. These changes, together with the remodeling of the classification, and the large additions throughout, render the Treatise more properly a new work, than a revised edition.

NEW HAVEN, Sept. 1, 1854.

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ABBREVIATIONS.

Act. Soc. Sci. Fenn.—Acta Societatis scientificæ Fennicæ : at *Abo*, Finland.

Afh. i Fys., or *Afhandl.*—Afhandlingar i Fysik, Kemi och Mineralogi, by Hisinger and Berzelius, 6 vols. 1806 to 1816. *Stockholm.*

Am. J. Sci.—American Journal of Science and Arts, commenced in 1819 ; conducted by B. Silliman—associated with B. Silliman, Jr., since 1838; and also with J. D. Dana since Jan. 1846. 1st series tri-monthly, vols. 1 to 49, with vol. 50, an Index to the preceding; 2d series bi-monthly, vols. 1 (1846) to 18 (close of 1854) ; the 10th containing an Index to the first 10 volumes of the series.

Ann. Chem. u. Pharm.—Annalen der Chemie und Pharmacie, by F. Wöhler and J. Liebig. In monthly numbers of about 130 pages, 4 vols. a year. Vol. xc. (or xiv of New Ser.), commenced with April, 1854.

Ann. Chim.—Annales de Chimie. 96 vols. 1789—1815. *Paris.*

Ann. Ch. Phys. [2] and [3].—Annales de Chimie et de Physique, 2d series, 1816—1840, 78 vols. (3 vols. a year); 3d ser. since 1841 ; with 1854, volume xl, began.

Ann. Lyc. N. H. New York.—Annals of the Lyceum of Natural History of New York. The 6th volume was begun with 1854.

Ann. d. M. (or *Mines*).—Annales des Mines, a monthly of 180 pages, now making 3 vols. a year; 1st ser., 13 vols., 1816—1826, *Paris;* 2d ser., 10 vols. ; 1827—1831, 2 vols. a year ; 3d ser., vols. 1832—1841 ; 4th ser. began in 1842 ; 5th ser. in 1852. Index to 4th ser. published in 1853.

Ann. des. M. Russ.—Annales des Mines Russes.

Ann. Phil.—Annals of Philosophy, by Th. Thomson. 16 vols. *London*, 1813—1820 ; new series, by R. Phillips, 12 vols. *London*, 1821—1826, (afterwards united with the Philosophical Magazine, edited by Taylor and Phillips.

Archiv. d. Pharm.—Archiv der Pharmacie, 8vo., Hannover.

Arsb. Berz.—Arsberättelse om Framstegen i Kemi och Mineralogie af Jac. Berzelius ; from 1821 to 1847. The *Jahresbericht*, etc., is the German translation.

B. u. H. Ztg.—Berg. und. Huttenmänsche Zeitung.

B. & M.—Brooke and Miller.—Elementary Introduction to Mineralogy, 700 p. 8vo. London, 1852.

Baumg. Zeitsch.—Zeitschrift für Physik und Mathematik, by Baumgartner and v. Ettingshausen, *Vienna*, 1826—1832 ; Zeitschrift für Physik und verwandte Wissenschaften, by Baumgartner and von Holger. *Vienna*, 1832.

Beck, Min. N. Y.—Mineralogy of New York, by L. C. Beck, 536 pp. 4to. *Albany*, 1842.

Berichte Mitth. Fr. Nat. zu Wien.—Berichte über die Mittheilungen von Freunden der Naturwissenschaften in Wien, (Vienna), gesammelt und herausgegeben von W. Haidinger, vols. I to VII, 1846 to 1851.

Berz.—Berzelius.

Berth. T. des Ess.—Traité des Essais par la voie sèche by Berthier. 2 vols. *Paris*, 1835.

Beud.—Beudant; Traité élémentaire de Mineralogie. 2d edit. 2 vols. 8vo. *Paris*, 1830.

Bischof Geol. (or *Lehrb.*)—Lehrbuch der chemischen und physikalischen Geologie von Dr. Gustav Bischof, 2vols., 1846–1854, (last part not yet issued), *Bonn.*

Bib. Univ. Gen.—Bibliothèque Universelle de Genève. 1st ser. 1816—1835; 2d ser. 1836—1845; 3d series, since 1846, with the literary and scientific parts separate, the latter under the title, "Archives des Sciences Physiques et Naturelles."

Bost. Jour. Nat. Hist.—Journal of the Boston Society of Natural History, since 1834. *Boston.*

Breit.—Breithaupt.—Handbuch der Mineralogie. 3 vols. *Leipzig.*

Brewst. J.—Edinburgh Journal of Science, by D. Brewster. *Edinburgh.* 1st ser., 10 vols., 1824—1829; 2d ser., 6 vols., 1829—1832.

Bull. Soc. Geol. de Fr.—Bulletin de la Société Géologique de France, since 1830, forming 1 vol. a year. New series begun in 1843. Tome xi, for the year 1854.

Bull. Soc. Nat. Mosc.—Bulletin of the Society of Naturalists of Moscow.

Chem. Gaz.—Chemical Gazette, or Journal of Practical Chemistry, conducted by Wm. Francis. Published twice a month in a pamphlet of 24 pages, 1 volume a year. *London.* Commenced Jan. 1843.

Compt. Rend.—Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences. *Paris.* Weekly, and forming two volumes annually in quarto; since 1835.

Crell's Ann.—Chemische Annalen by Crell. 40 vols., 1784—1804. Helmstädt and Leipzig.

Deville, Etudes.—Etudes Geologiques des Iles Canaries. Paris.

Duf.—Dufrénoy.—Traite de Mineralogie. 3 vols. 8vo. with a fourth volume of plates. *Paris,* 1844—1847.

Edinb. Phil. J.—Edinburgh Philosophical Journal, by Brewster and Jameson. 14 vols. *Edinburgh,* 1819—1826.

Edinb. N. Phil. J., or *Jameson's Jour.*, by Prof. Jameson, continued tri-monthly since 1826. 2 vols. a year. Vol. lvi, commenced with the year 1854.

Gilb. Ann.—Annalen der Physik, by Dr. L. W. Gilbert. 76 vols., 1799—1824. *Leipzig.* From vols. 31 to 60, a new series, (1809—1818); from vols. 61 to to 76, another series, (1819—1824), under the title, "Annalen der Physik und der physikalischen Chemie."

Glocker Min. Jahresh.—Mineralogische Jahreshefte by Glocker. 1 vol. 1835. Nürnberg; part of a volume in 1837.

H.—Haüy.—Traité de Mineralogie. 2d ed. 2 vols. and atlas. *Paris,* 1822.

Haid.—W. Haidinger, author of a Handbuch der bestimmenden Mineralogie, *Wien,* 1845; and also of the English translation of Mohs's Mineralogy.

Haid. Ber.—See Berichte, etc., on the preceding page.

Halle Zeitschr.—Zeitschrift für die gesammten Naturwissenschaften herausg. von dem Naturw. Vereine für Sachsen u. Thuringen in Halle, redigirt von C. Giebel u. W. Heintz; begun in 1853, 2 vols. a year.

Hausm.—Hausmann. Handbuch der Mineralogie, 2 vols. *Göttingen,* 1845.

His. Min. Schwed.—Mineralgeographie von Schweden by Hisinger; a translation by Wöhler. *Leipzig,* 1826.

Hitchcock Geol. Mass.—Geological Report of Massachusetts, by E. Hitchcock, pp. 830. 4to. *Boston,* 1833.

J.—Jameson.—System of Mineralogy. 4th edit. *Edinburgh,* 1824. Also Manual of Mineralogy from the Encyclopædia Britannica, 1837.

Jackson, Geol. Rep. N. H.—Geological Report of New Hampshire, by C. T. Jackson. 376 pp. 4to, with plates. Also author of a Report on the Geology of Maine, and another on the Geology of Rhode Island.

Jahrb. k. k. Geol. Reichs.—Jahrbuch der kaiserlich-königlichen geologische Reichsanstalt, vols. I—IV. *Wien,* 1850, 1851, 1852, 1853.

Jahresb.—Jahresbericht, etc.—Translation of Berzelius's Annual Scientific Report, by C. Gmelin, and afterwards by Wöhler. Commenced in 1822, and continued to 1847.

John Unters.—Chemische Untersuchungen der Mineralkörper, by John. *Berlin,* 1808—1816.

Jour. Acad. Nat. Sci. Philad.—Journal of the Academy of Natural Sciences of Philadelphia; since 1817. 8 vols. to 1842; new series begun in 1848.

Jour. des. Mines.—Journal des Mines, 38 vols., 1794—1815. *Paris.*

J. f. pr. Ch.—Journal für praktische Chemie, by Dr. O. L. Erdmann and R. F. Marchand; Leipzig, twice a month, in parts of 64 pages each, and 3 vols. a year. From 1834 to 1836, (vols. i to ix), under Erdmann and Schweigger-

Seidel; 1837, (vols. x, xi, xii), under Erdmann alone; 1838—1850 under Erdmann and Marchand; 1851, 1852, Erdmann alone; 1853 and since, Erdmann and Gustav Werther. The vol. lxi commenced with the year 1854.

Joy, Inaug. Dissert.—Miscellaneous Chemical Researches, Inaugural Dissertation, etc., 50 pp., 8vo. *Göttingen*, 1853.

Gel. Anzeig.—Gelehrte Anzeigen—etc., München (Munich).

Karsten Archiv.—Archiv für Mineralogie, Geognosie, Bergbau und Hüttenkunde. *Berlin*, since 1829.

Keller u. Tied.—Nordamerikanischen Monatsbericht für Natur- und Heilkunde, redigirt von Dr. W. Keller and Dr. H. Tiedemann; 4 vols., 1850, 1851. *Philadelphia.*

Klap. Beit.—Beiträge zur chemischen Kenntniss der Mineralkörper, by Klaproth. 6 vols. *Berlin*, 1795—1815.

K. V. Ac. H.—Konigl. Vetenskaps-Academiens Handlingar, (Transactions of the Royal Swedish Academy).

Kob.—Von Kobell.—Grundzüge der Mineralogie von Franz von Kobell. *Nürnberg*, 1838.

Lampadius Handb.—Handbuch zur chem. Analyse d. Mineralkunde. *Freiberg*, 1791; Nachtrag, 1818.

L'Institut.—L'Institut, Journal Universel des Sciences et des sociétés savantes en France et à l' étranger. 1 volume a year since 1833. *Paris.*

Leonh. Bronn, Jahrb.—Jahrbuch für Mineralogie, Geognosie, &c., by von Leonhard and Bronn, 1830—1832; Neues Jahrbuch, &c., since 1833; monthly; 1 volume a year. *Stuttgart.*

Lieb. u. Kopp.—Liebig und Kopp's Jahresbericht, 1847—1853.

Logan Geol. Rep.—Logan's Reports on the Geology of Canada, Montreal, 1849—1853.

Min. N. Y. by Beck.—Report on the Mineralogy of the State of New York. 1 vol. 4to. *Albany*, 1842.

M.—Mohs. Naturgeschichte des Mineralreiches, von F. Mohs. 2d edit., in 2 parts or volumes. *Vienna*, 1836—1838.

Nord. Bidrag.—Bidrag till närmare Kännedom af Finnlands Mineralier, by Nordenskiöld. *Stockholm*, 1820.

Ofv. K. V. Ak. Förh.—Ofversigt af Kongl. Vetenskaps-Akademiens Förhandlingar. *Stockholm.* (Bulletin of the Royal Academy).

Phil. Mag. [2].—Philosophical Magazine or Annals of Chemistry, by Taylor & Phillips, 11 vols. *London*, 1827—1832.—*Phil. Mag.* [3].—London and Edinburgh Philosophical Magazine and Journal of Science, by Brewster, Taylor and Phillips, (new and united series). *London*, 1832—1850.—*Phil. Mag.* [4], 1851; vol. vii, began with Jan., 1854.

Phil.—Wm. Phillips.—Elementary Treatise on Mineralogy, 8vo. *London*, 1823; also 1837; also by Fr. Alger, *Boston*, 1844.—See also, B. and M.

Phil. Trans.—Philosophical Transactions of the Royal Society of London since 1665.

Pogg. Ann.—Annalen der Physik und Chemie, by Dr. J. C. Poggendorff. Continued from 1824; monthly; 3 vols. a year. Published for a while at Berlin, and now at Leipzig. Vol. xci commenced with 1854. A general index is published for volumes 1 to 60, to the close of 1843; and another in 1854 for vols. lxi to xc.

Proc. Amer. Assoc.—Proceedings of the American Association for the Advancement of Science, vols. i to vi; i of meeting at Philadelphia; ii, at Cambridge; iii, at Charleston, S. C.; iv, at New Haven; v, at Cincinnati; vi, at Albany.

Quart. Jour.—Quarterly Journal of Science and Arts of Royal Institution. 30 vols. *London*, 1816—1830.

Quart. Jour. Chem. Soc.—The Quarterly Journal of the Chemical Society of London, edited for the Society by E. Ronalds. Commenced in 1848, and published tri-monthly, in parts, 96 pages each. Volume vii commenced with April, 1854.

Ramm. Handw.—Handwörterbuch des chemischen Theils der Mineralogie, von C. F. Rammelsberg. 3 vols., 1841. *Berlin.* Supplements 1, 2, 3, 4, 5, about August, in the years 1843, 1845, 1847, 1849, 1853.

Rec. Gen. Sci.—Records of General Science, by R. D. Thomson. 4 vols. *London*, 1835, 1836.

Rogers's Geol. Rep. N. J.—Geological Report of New Jersey, by H. D. Rogers, 300 pp. 8vo. *Philadelphia*, 1840.

Rose's Kryst.-Chem. Min.—Das Krystallo-Chemische Mineralsystem of G. Rose, 156 pp. 8vo. *Leipzig*, 1852.

Scheer. Jour.—Allgemeines Journal der Chemie, by Scheerer. 10 vols. *Leipzig*, 1799—1803.

Schweig. Jour.—Journal für Physik und Chemie by Schweigger, and afterwards with Schweigger-Seidel. 69 vols., 1811 to 1833, at Nürnberg and Halle.

Shep.—C. U. Shepard, Treatise on Mineralogy. 12mo. *New Haven, Ct.* 1st part, an Introduction to the Science, 1 vol., 1823; 2d part, 2 vols., 1835; 2d edit. (of 1st part), 1844; 1st half of 3d edition, 1852.*

Sitzungsb. Wien.—Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften; Math.-Nat. Classe. Wien (Vienna). Vol. xi began with June of 1853.

Skand. nat. S. i Stockholm.—Transactions of the Scandinavian Society of Natural Science at Stockholm.

Stromeyer's Unters.—Untersuchungen über die Mischung der Mineralkörper. *Göttingen*, 1822.

Suckow.—Die Verwitterung im Mineralreiche.

Thom. Min.—Outlines of Mineralogy, by Dr. Th. Thomson. 2 vols. 8vo. *London*, 1836.

Ullmann Syst. tab. Ueb.—Systematisch-tabellarische Uebersicht der mineralogisch-einfachen Fossilien, by Ullmann. Kassel and Marburg, 1814, with occasional issues of a later date.

Verh. Min. St. Petersb.—Verhandlungen der kaiserlich russischen mineralogischen Gesellschaft, zu St. Petersburg.

Volger, Entwick.—Studien zur Entwickelungsgeschichte der mineralien als Grundlage einer wissenschaftlichen Geologie und rationellen Mineralchemie, von G. H. Otto Volger, 548 pp., 8vo., with 1 plate. *Zurich*, 1854.

Waltershausen's Vulk. Gest.—Ueber die vulkanischen Gesteine in Sicilien und Island und ihre submarine Umbildung, von W. Sartorius von Waltershausen, 532 pp. 8vo. *Göttingen*, 1853.

Wolff, Foss. Ekeberg.—E. Th. Wolff de Compositione fossilium Ekebergitis, Scapolithi et Mejonitis; Dissertatio inauguralis Chemica, Berolini; 1843.

W.—Werner.

U. S., United States; *Ala.*, Alabama; *Ark.*, Arkansas; *C. E.*, Canada East; *C. W.*, Canada West; *Cal.*, California; *Ct.* or *Conn.*, Connecticut; *Del.*, Delaware; *Ga.*, Georgia; *Ill.*, Illinois; *Ind.*, Indiana; *Ky.*, Kentucky; *La.*, Louisiana; *Mass.*, Massachusetts; *Md.*, Maryland; *Me.*, Maine; *Mich.*, Michigan; *Miss.*, Mississippi; *Mo.*, Missouri; *N. C.* or *N. Car.*, North Carolina; *N. H.*, New Hampshire; *N. J.*, New Jersey; *N. Y.*, New York; *O.*, Ohio; *Pa.* or *Penn.*, Pennsylvania; *R. I.*, Rhode Island; *S. C.* or *S. Car.*, South Carolina; *Tenn.*, Tennessee; *Va.*, Virginia; *Vt.*, Vermont.

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* This new edition of Prof. Shepard's Treatise should have been honorably mentioned at the top of page 7, (Preface). It is greatly to be regretted, on account of Prof. Shepard's extensive acquaintance with American Mineralogy, that the work is still incomplete.

INTRODUCTION.

The productions of our globe naturally distribute themselves into three grand divisions, the Animal, the Vegetable, and the Mineral or Inorganic; and our knowledge of the various kinds of objects in these departments constitutes the natural sciences, Zoology, Botany, and Mineralogy.

The first two divisions include all beings possessed of vitality: beings which increase by an assimilation of nutritive substances taken internally; which arrive at maturity by a series of successive developments; whose parts are mutually dependent, and cannot be separated without destroying the perfection of the individual; which, after a certain period, lose the capability of continuing the usual functions of life, and consequently die. The powers of vitality being no longer present to counteract decomposition, death is soon followed by a complete destruction of the original living being.

The third division, on the contrary, contains those natural objects that are not possessed of life; objects which increase by accretion merely, or an external addition of particles unaltered by any powers of assimilation in the object; which are equally perfect in the embryo state or at the earliest commencement of their formation, and in the enlarged individual; whose individuality is not destroyed by a separation of parts; whose formation is originally the result of chemical attraction, and, consequently, they are not, from their nature, necessarily liable to decomposition.

There is thus a strong line of demarkation in nature between those bodies which live, grow, and die, and those which exist only by virtue of chemical and cohesive forces.

The whole range of inorganic substances, whether made by art or existing in the earth's crust, fall into the last division, for they are produced by the same laws, and by like modes of aggregation. They constitute the Inorganic Kingdom. Minerals, as the term is used, are those species of this vast kingdom, that occur ready-made in the earth's crust. They exist by no different forces from the compound that proceeds from the laboratory; for it matters not whether sulphuric acid and lime come together in the workshop of art or nature; whether the hand of man bring the materials into juxtaposition, a running brook, a mineral spring, or a volcanic fumarole: the result in both cases is gypsum, identical in chemical, physical, and crystallographic characters. In many cases art has not yet found out the methods of imitating nature, and some of the requisites, as indefinite time, unlimited mass, weak and prolonged electric forces, and peculiar juxtaposition of elements and compounds, are not readily commanded by the chemist. Still the forces are the same in kind, and in this respect the inorganic kingdom is single and undivided. The Science of Mineralogy hence treats of only a small part of the third kingdom of nature. It includes here and there a species from the system—that is, those species that happen to have been formed by outdoor processes. The limits of the department are not based on any grand points of difference between these and other inorganic compounds; they are assumed, in order to present together a collection of facts, which the student conveniently considers in one connection—facts relating to the natural productions of our globe.

It is important, at the outset, that the distinctions here laid down be fully appreciated; for very partial views of nature are received, when minerals are supposed to constitute a complete system in themselves. The explorer of some contracted territory might as well claim the species he finds to constitute exclusively a *kingdom*, as one who takes a wider portion or the whole of the earth's surface.

The scope of the word mineral is conventional. It is convenient to include under it, all *inorganic natural objects* which are proper chemical compounds, whether *solid*, *liquid*, or *gaseous;* and this convenience is a sufficient ground for the course. Moreover the physical conditions of solidity, liquidity, gaseity, are not even specific distinctions in the wide inorganic kingdom, and hence afford no reasonable or necessary limit to the mineral department.

Mineralogy is closely related to the Science of Geology. The former considers minerals as independent bodies; the latter, in their dependent relations, constituting soils and various rocks. It is the object of Mineralogy to describe the individual qualities of the several mineral species, while Geology treats of them only as associated in the structure of the earth.

To an intermediate department, Chemical Geology, belongs the discussion of the origin and formation of minerals, both as simple species and as aggregated in rock masses.

MINERALOGY:

SUBDIVISIONS OF THE SUBJECT ADOPTED IN THE FOLLOWING TREATISE.

The aggregation of inorganic matter depends on a power called crystallization, or crystallogenic attraction, by the action of which minerals receive a regular structure and take on certain forms called *crystals*. This power is universal, like vitality in the animal and vegetable kingdoms, and hence an inorganic species has as much its characteristic form as a plant or animal. Under the head of CRYSTALLOLOGY, or, *the Science of the Structure of Minerals*, this subject occupies Part I. of the following treatise. *Crystallology* includes two sections; 1. CRYSTALLOGRAPHY, or, descriptions of the crystalline forms of minerals; 2. CRYSTALLOGENY, or, the origin of the forms and structure of crystals.

The properties of minerals come next under consideration:—

First, those depending on the *transmission and reflection of Light* and *Heat*, on *Electricity*, *Magnetism*, *Gravity*, *Cohesion*, and also their relations to the senses of *taste* and *smell*, or their *Taste* and *Odor*. These, the *Physical Properties of Minerals*, constitute the subject of Part II.

Next follow:—

Part III. On *the Chemical Characters and Relations of Minerals.*

Part IV. On *Taxonomy*, or Classification.

Part V. *Determinative Mineralogy*, or Tables for the determination of Species.

Part VI. Full descriptions of the species, under the head of *Descriptive Mineralogy.*

In treating of the properties of minerals, a work on Mineralogy is necessarily brief. A full discussion of the relations of crystals to light, heat, and electricity, would lead us out of our proper science into Physics; for it is by means of crystals that many of the fundamental laws of light, heat, and electricity, are exhibited. These subjects are considered, therefore, only so far as they afford aid in discriminating among minerals, and throw light on the characters of species.

MINERALOGY.

PART I.

CRYSTALLOLOGY,

OR, THE SCIENCE OF THE STRUCTURE OF MINERALS.

SECTION I.

CRYSTALLOGRAPHY.

A crystal is an inorganic solid bounded by plane surfaces symmetrically arranged, and resulting from the forces of the constituent molecules.

In its original signification, this term was applied only to crystals of quartz, which the ancient philosophers believed to be *water* congealed by intense cold. Hence the term, from κρυσταλλος, *ice.*[*] It now includes all those regular solids that owe their formation to the attraction that produced the κρυσταλλος of the ancients, or which, like that, possess a regular form, whatever may be the color or the degree of transparency or opacity.

In brilliancy of lustre and symmetry of form, crystals, as they are found in nature, sometimes rival the most splendid gems from the hands of the lapidary. They occur of all sizes, from the merest

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[*] *Diodorus* II. p. 163, Wess.—*τοὺς γαρ κρυστάλλους λίθους ἔχειν την σύστασιν ἐξ ὕδατος καθαροῦ παγέντος, οὐχ ὑπὸ ψυχους, ἀλλ' ὑπὸ θείου πυρος δυναμεως.*

Seneca, Quest. Nat. III. 25: Unde autem fiat ejusmodi lapis apud Græcos ex ipso nomine apparet. *Κρυσταλλον* enim appellant æque hunc perlucidum lapidem quam illam glaciem ex qua fieri lapis creditur. Aqua enim cœlestis minimum in se terreni habens, quum induruit longioris frigoris pertinacia spissatur magis ac magis donec omni aëre excluso in se tota compressa est, et humor qui fuerat, lapis effectus est.

Plinius, Hist. Nat. XXXVII. 2: Murrhina—humorem putant sub terra calore densari. Contraria huic causa crystallum facit, gelu vehementiore concreto.

microscopic point, to a yard or more diameter. A single crystal of quartz now at Milan, is *three and a quarter* feet long, and *five and a half* in circumference; and its weight is estimated at eight hundred and seventy pounds. One of the gigantic beryls from Acworth, New Hampshire, measures *four* feet in length, and two and a half in circumference; and another at Grafton, is over *four* feet long, and *thirty-two* inches in one of its diameters, and does not weigh less than two and a half tons. But the highest perfection of form and transparency are found only in crystals of small size.

Variety and Constancy of Form.—Each mineral, as has been remarked, has its own mode of crystallization, by which it may be distinguished, just as we distinguish a plant by its characters and mode of growth. For example, a crystal of calc spar is known at once by its *angles*, wherever it may have been found, and also by a peculiarity of *internal structure.* The same is true for other species: consequently, measurement of angles and examination of structure have become important means of distinguishing minerals. The *constancy of angle* between similar planes in the same species, is a fact of the highest importance in the science: it is not absolutely perfect, owing to some causes hereafter to be stated, yet it admits of but little variation.

The variety of form presented by a single mineral, may be very great. *Calc spar* is found in double pyramids, in prisms, rhombohedrons, and many other forms; *pyrites*, in cubes, octahedrons, dodecahedrons; and so with other species. But however great the number, all the forms in each case are referable to a single type, and little skill is required to trace out extreme simplicity amid apparent complexness: for all the various modifications take place according to a simple unvarying law. Thus a multiplicity of crystalline shapes is produced for each species. It is the object of Crystallography to point out the number and relations of these forms, and their internal structure; and thence to explain the manner in which the study of them is available in science. All inorganic compounds—those of art as well as minerals—may take on a crystalline structure; and hence, this subject has the widest bearing, for it is the science of structure in the whole inorganic world. Even the shapeless mass has a regular internal structure in its minute grains, of the same identical character with that of the crystal of like composition and species.

In treating of the subject of Crystallography, we take up, first, the normal forms and structure of *simple crystals*, discussing (1) *the Systems of Crystallization;* (2) *the Modifications of form in Crystals;* (3) *Cleavage or internal structure;* (4) *Distortions and Irregularities;* (5) *the Modes of Measurement.* We next pass to *abnormal forms*—that is, (6) *Twin or Compound Crystals;* then (7) to *Mineral Aggregates;* and (8) to *Pseudomorphous Crystals.*

I. SYSTEMS OF CRYSTALLIZATION.

The internal structure of crystals—especially their cleavage—led early crystallographers to the recognition of *thirteen Primary Forms.* There are crystals, as those of *galena*, whose internal structure is *cubical*, the mineral affording cubes on dissection; there are others, as fluor spar, that afford the *regular octahedron* in a similar manner; and there are others, as *blende*, whose cleavages yield *dodecahedrons.* In view of this fundamental character, which is one of the most unvarying and profoundly essential of a species, all of these forms, the cube, octahedron and dodecahedron have equal claims to be regarded as primary in the inorganic kingdom. In the same manner we arrive at the other so-called primary forms.

But viewed without reference to structure, several of these forms are essentially identical; and they may all be included under *six Systems of Crystallization.* In many species no internal structure is apparent; and in many others it is ambiguous, or affords two or more distinct forms at the same time; so that often a *primary* form cannot be recognized. Whereas the *system* of crystallization is in each case distinct and certain, being based on simple mathematical relations of the planes. The subject of Crystallography is much simplified by this classification of crystalline forms, and greater precision is given to the description of species.

In treating of the subject of Crystallography, the parts of crystals especially considered, are as follows:—

1. *Faces or planes:* which are of various forms, *triangular*, *square*, *rectangular*, *trapezoidal*, *polygonal.* A series of three or more planes, making with one another parallel intersections, is called a *zone.*

2. *Edges:* formed by the meeting of planes, and either *rectangular*, *obtuse*, or *acute.* Edges are said to be *similar*, when the planes, by the meeting of which they are formed, are respectively equal, and equally inclined to one another, *unlike* or *dissimilar*, when not thus equal.

3. *Plane angles:* the angles of the faces.

4. *Interfacial angles:* the mutual inclinations of two planes.

5. *Solid angles:* the meeting of three or more planes, and either *trihedral*, *tetrahedral*, *polyhedral.* Solid angles are said to be *similar* when included by the same number of plane angles, equal each to each, and equally inclined to one another.

6. *Axes:* lines connecting points diagonally opposite, as the apices of opposite solid angles, the centers of opposite edges, or of opposite faces. In Crystallography there are three axes employed, (excepting for hexagonal forms), and these axes are either at right angles with one another, producing *orthometric* forms, or oblique, produ-

cing *clinometric* forms,* and they may be either all equal, or but two equal, or all unequal.

In order to illustrate the relations of the six systems of crystallization, we may briefly mention, by way of introduction, the characters of some of the simpler solids.

1. *Prisms having a 4-sided base.*—When the base is square and the prism erect, as in f. 2, the form is a *Right Square Prism*;† the four lateral planes are equal rectangles, either longer or shorter than the breadth, according to the height of the prism, and the basal edges are *unlike* the lateral. If these lateral planes equal the basal, and like them are squares, the form is a *cube*, (f. 1), bounded by six equal squares. When the base is a rectangle instead of a square, the prism is a *Right Rectangular Prism*, (f. 3). In each of the forms mentioned the solid angles are eight in number, and are equal and rectangular. The edges, which are *twelve in number*, vary with the shape of the base and the height of the prism. In the cube the twelve are equal; in the square prism the eight basal are equal, (four at each base), but they differ from the lateral; in the rectangular prism, two at each base differ in length from the other two, and hence there are three sets of edges, four in each.

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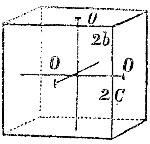

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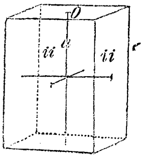

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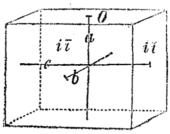

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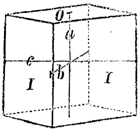

Again, the base may be a *rhomb*, a form in which the sides are equal; an erect prism with such a base is a *Right Rhombic Prism*, (f. 4). As two of the angles in the base are *obtuse*, and two *acute*, the solid angles corresponding differ in like manner, two at each base; and so also the lateral edges are two obtuse and two acute. But the four lateral faces, like the basal edges, will be equal.

If, instead of a rhomb, the base is a *rhomboid*, a figure in which

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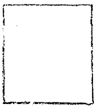
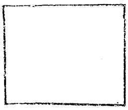
* Orthometric, from ορθος, *straight*, and μετρον, *measure*; clinometric, from κλινω, *to incline*, and μετρον.

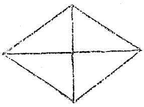
† The following figures represent the forms of bases alluded to:—



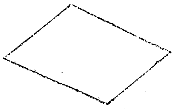
Square.



Rectangle.



Rhomb.



Rhomboid.

The square and rhomb have equal sides: the rectangle and rhomboid have only the opposites equal.

two opposite sides are unequal to the other two, the four lateral faces will correspond to the basal edges, and only the opposites be equal. This form is the *Right Rhomboidal Prism*, (similar to f. 4, or like f. 5, if placed on one of its lateral planes).

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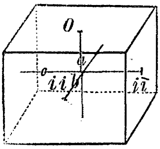

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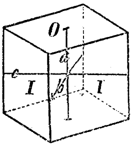

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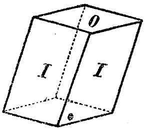

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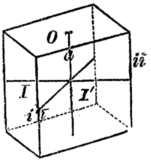

Again, the base may be a rhomb, but the prism stand *oblique* on its base. Thus we have, as another form, an *Oblique Rhombic Prism*, (f. 6, a front view, and 7, a side view). As in the right rhombic prism, the basal edges are equal in length; but from the inclination of the prism, two of these edges at each base are obtuse, and two acute.

Such a prism may be longer or shorter than its breadth. If equal in length to its breadth, and the lateral planes just equal the basal, the form is bounded by *six equal planes*, like a cube, but having *oblique* angles; it is called a *Rhombohedron.*

Again, an oblique prism may have a *rhomboidal* instead of a rhombic base, and is then an *Oblique Rhomboidal Prism*, (f. 8). The edges of each base are of four kinds, for two opposite are longer than the other two, and, of each pair, one is obtuse and the other acute. So also with the solid angles; the four are different at each base. In this solid, therefore, only diagonally opposite edges are *similar*—that is, are equal in length and in the included angles; and in the same manner, only opposite solid angles are equal, or consist of equal plane angles equally inclined. These particulars are readily understood from a model of the form.

2. *Prisms having a six-sided base.*—When the prism is a regular hexagon, and erect, it is called the *Hexagonal Prism*, (f. 9 or 10).

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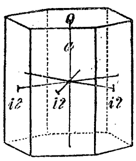

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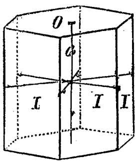

3. *Octahedrons.*—Octahedrons are 8-faced solids,—as the term implies, derived from οκταχις, 8-*times*, and ἑδρα, *face.* These faces are triangles, as in f. 11, 12, 13, and the form is like two 4-sided pyramids united base to base. Holding an octahedron with a solid angle uppermost, the upper and lower solid angles are called its *vertical solid angles;* the other four, its *lateral* or *basal* solid angles; and the horizontal plane in which the apices of the lateral solid angles lie, is the *base* of the octahedron.

In the *Regular Octahedron* (f. 11) the base is square, and the eight faces are equal equilateral triangles. The edges are twelve and all equal; the faces incline upon one another at an angle of 109° 28′ 16″, and have the plane angles all 60°. The solid angles are six, and mutually equal. Like the cube the solid is every way symmetrical.

When the base is square, and the vertical height greater or less than it is in the regular octahedron, (that is, the distance between the apices of the vertical solid angles greater or less than that between the apices of the lateral), the form is a *Right Square Octahedron*, (f. 12), having the faces *isosceles* triangles, but not *equilateral*. The four basal edges are equal and similar, but they differ in length from the eight equal pyramidal edges, and also in the angle of the including planes. The vertical solid angles also differ in the plane angles of which they consist from the lateral or basal.

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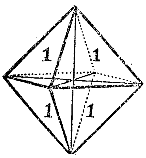

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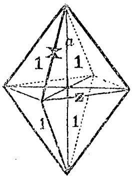

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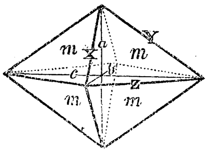

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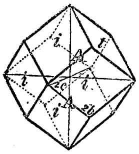

The base in other octahedrons is *rhombic*, and in this case the form is called a *Right Rhombic Octahedron*, (f. 13): the length may be less or greater than the breadth. The basal edges are alike in length and other respects; but as the plane angles of the base are of two kinds, two obtuse and two acute, so the pyramidal edges differ accordingly.

4. *Dodecahedrons.*—A dodecahedron is bounded by *twelve* faces; the name is from δωδεκα, twelve, and ἑδρα, *face*. In a common kind of dodecahedron, called the *Rhombic Dodecahedron*, these faces are equal rhombs, as shown in f. 14. Like the octahedron and cube, this solid is every way symmetrical. The interfacial angles are 120°; and the plane angles of the faces are 109° 28′ 16″ and 70° 31′ 44″. The edges are twenty-four and similar. The solid angles are fourteen in number, and of two kinds; eight obtuse, formed by the meeting of three obtuse plane angles, and six acute, enclosed each by four acute plane angles.

From these descriptions of the thirteen simplest forms among crystals, we pass to the systems of crystallization.

The *Systems of Crystallization* are based on certain relations in the axes of these forms. In forms belonging to the same system, the axes are alike in number, and in their mutual intersections and general relations as to length.

1. *Monometric or Tesseral System.*

In the Monometric system, the three axes are rectangular in their intersections and equal.

The cube, regular octahedron, and rhombic dodecahedron, which are here included, are alike in their perfect symmetry: the height, length, and breadth are equal, and their axes are equal and rectangular. In the cube (f. 1) these axes connect the centres of opposite faces; in the octahedron, (f. 11), the apices of opposite solid angles; in the dodecahedron, (f. 14), the apices of opposite acute solid angles. The relations of these forms, and the correspondence in their axes, will be understood after a brief notice of the transitions between the forms.

If the *eight angles* of a cube are sliced off evenly, keeping the planes equally inclined to the enclosing faces, we first obtain the form in f. 15, then that in f. 16, and finally a *regular octahedron*, and the last disappearing point of each face of the cube is the apex of each solid angle of the octahedron. Hence, the axes of the former necessarily connect the apices of the solid angles of the latter.

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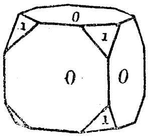

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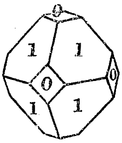

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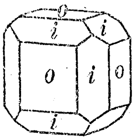

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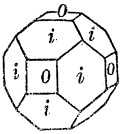

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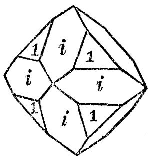

By cutting off as evenly the *twelve edges* of another cube, the knife being equally inclined to the faces, we have the form in f. 17; then f. 18; and finally, the *rhombic dodecahedron*, (f. 14), with the axes of the cube connecting the same points in each.

These forms are thus mutually derivable. Moreover, they are often presented by the same mineral species, as is exemplified in galena, pyrites, and the diamond.

The process may be reversed, and the cube made from the octahedron or dodecahedron, as will be readily understood from a comparison, in order, of f. 11, 16, 15, 1, and f. 14, 18, 17, 1.

The octahedron also is changed to a rhombic dodecahedron by removing its twelve edges, (f. 19), and continuing the removal till the original faces are obliterated, thus producing the dodecahedron.

The name *Monometric* alludes to the equality of the axes, and is from μονος, *one*, and μετρον, *measure*. *Tesseral* is from the Latin tessera, for cube or dice, and originally from the Greek word for *four*.*

2. *Dimetric System.*

In the Dimetric System, the three axes are rectangular in their intersections, and one, called the vertical, differs in length from the two lateral, which are equal.

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*[*Isometric* system of Hausmann; *Tessular* of Mohs and Haidinger; *Tesseral* of Naumann; *Regular* of Weiss and G. Rose; *Cubic* of Dufrenoy and Miller.

The right square prism, (f. 2), and square octahedron, (f. 12), are of this system. The axes of the prism connect the centres of opposite faces, and cross at right angles. The octahedron has the same relation to the prism as the regular octahedron to the cube; the axes connect the apices of opposite solid angles. A replacement of the angles of the prism, (f. 20), continued, leads to the octahedron. The vertical axis is a varying axis, and may be longer or shorter than the lateral. The name of the system alludes to the two kinds of axes, and is from δις, *two-fold*, and μετρον, *measure*.*

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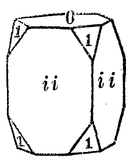

3. *Trimetric System.*

In the Trimetric System, the three axes are rectangular in their intersections, and unequal.

It includes the right rectangular prism, (f. 3), the right rhombic, (f. 4), and the rhombic octahedron, (f. 13). The three axes intersect at right angles, but are *unequal*. In the rectangular prism, the axes connect the centres of opposite faces; in the rhombic prism, the vertical connects the centres of the basal faces, the lateral the centres of opposite lateral edges; in the octahedron, the axes connect the apices of opposite solid angles.

By the transitions of these solids, it appears that these positions of the axes correspond throughout. If the lateral edges of a rectangular prism are removed parallel to a vertical diagonal plane, the form becomes finally a rhombic prism, as shown in f. 3, 21, 22, 4; and so if the lateral edges of a rhombic prism are in like manner removed, (f. 22, 21, 3), the result is a rectangular prism. This relation of these two forms is also shown by the rhombic prism within, f. 21; the lateral faces of one prism are opposite the lateral edges of the other; and the centre of the face of the rectangular prism, where the axis terminates, is a point identical with the termination of the corresponding axis in the rhombic prism. It is, hence, apparent that the positions assigned to the axes are not arbitrary, but depend on the actual relations of the forms. Both of these prisms occur often in the same mineral. The rhombic octahedron, (f. 13), moreover, is derived from the rectangular prism, by

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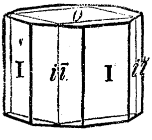

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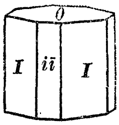

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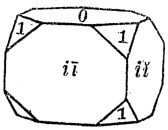

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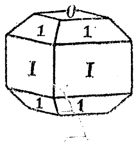

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* *Pyramidal* of Mohs; *Viergliedrige*, or *zwei-und-einaxige* of Weiss; *Tetragonal* of Naumann; *Monodimetric* of Hausmann; *Quadratic* of von Kobell.

removing the solid angles of the latter, a process begun in f. 23; and it comes from a rhombic prism by removing the basal edges of the prism, as shown in f. 24. The axes are the same points precisely in the three forms. The longer lateral axis is called the *macrodiagonal*, (from μακρος, *long*); and the other, the *brachydiagonal*, (from ϐραχυς, *short*). The name *Trimetric* alludes to the existence of axes of *three* kinds, (the three being unequal), and is from τρις, *three-fold*, and μετρον.*

4. *Monoclinic System.*

In the Monoclinic System, the three axes are unequal; one, called the vertical, (*a*), is inclined to one of the lateral, and at right angles with the other, (*c*); and the two lateral (*b*, *c*) are at right angles with one another.

It includes the right rhomboidal and oblique rhombic prisms. In the oblique rhombic prism, (f. 6), the vertical axis connects the centres of the bases, and the lateral the centres of opposite lateral edges; the lateral, *b*, *c*, intersect one another at right angles; the vertical is at right angles with *c*, but inclined to *b*. The axis *c*, which is at right angles with the other two, is called the *orthodiagonal*, (from ορθος, *straight*); and the axis *b*, which is inclined to the vertical, is the *clinodiagonal*, (from κλινω, *to incline*).

In the right rhomboidal prism the axes connect the centres of opposite faces. But they have the same relations as just explained: they are unequal, and there is one oblique intersection. To understand the relations of these solids, the rhomboidal prism must be placed on a rectangular plane for its base, as in f. 5, and then the vertical axes in the forms correspond, as shown in f. 25, in which both forms are combined. The removal of the lateral edges of one prism produces finally the other prism, the relation being the same as between the right rectangular prism and right rhombic.

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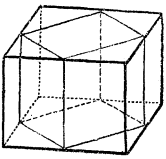

The name *monoclinic* is from μονος, *one*, and κλινω, *to incline*.†

5. *Triclinic System.*‡

In the Triclinic System, the three axes are unequal, and all the intersections (*a* to *b*, *a* to *c*, and *b* to *c*) are oblique.

It includes the *oblique rhomboidal prism*, (f. 8). The name of the system is from τρις, *three-times*, and κλινω.

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* *Prismatic* or *Orthotype* of Mohs; *Ein-und-einaxige* of Weiss; *Rhombic* and *Anisometric* of Naumann; *Binary* of Weiss; *Trimetric* and *Orthorhombic* of Hausmann.

† *Hemi-prismatic* and *Hemiorthotype* of Mohs; *Zwei-und-eingliederige* of Weiss; *Monoclinohedral* of Naumann; *Klinorhombic* of Kobell and Hausmann; *Augitic* of Haidinger; *Oblique* of Miller.

‡ *Tetarto-prismatic* of Mohs; *Ein-und-eingliederige* of Weiss; *Triclinohedral* of Naumann; *Klino-rhomboidal* of Kobell; *Anorthic* of Haidinger and Miller.

The *Diclinic* system has been indicated by Naumann, as occurring in an artificial salt. It differs from the triclinic in having two of the intersections (as *a* to *b*, and *b* to *c*) oblique, and one (*a* to *c*) rectangular. The prismatic form corresponding would be an *oblique rectangular prism*, resembling f. 8.

6. *The Hexagonal System.*[*]

In this system there are three equal lateral axes, intersecting at angles of 60°, and a vertical axis of varying length at right angles with the lateral.

It includes the hexagonal prism and rhombohedron. In the hexagonal prism the vertical axis connects the centres of the bases. The lateral axes connect the centres of the opposite lateral faces or opposite lateral edges, (f. 9, 10); in each case (as is seen from the character of a regular hexagon) the intersections are at angles of 60°.

In the rhombohedron two of the angles, diagonally opposite, consist of three equal plane angles; the line connecting the apices of these two angles is the vertical axis (*a*) of the rhombohedron, and the solid is said to be in position when this line is in a vertical position, (f. 26, 27, 28). The other six solid angles are similar, and are called the lateral angles. Placing the rhombohedron in position, the apices of the six lateral solid angles are at equal distances around the vertical axes. There are also six *lateral edges*, alike symmetrical in position, around this axis; and there are three *terminal edges* meeting at each extremity of the vertical axis. Looking down from above on a rhombohedron thus placed, the symmetry of arrangement in the lateral edges is at once perceived; and it is readily understood that lines connecting the centres of opposite lateral edges, will be three in number, like those of the hexagonal prism, and will intersect at 60°. If the lateral edges are replaced by planes parallel to the vertical axis, a regular hexagonal prism, terminated by a three-sided pyramid, is

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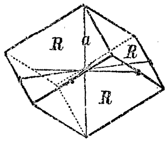

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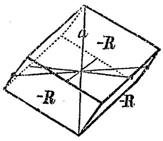

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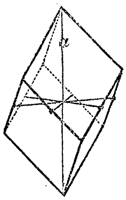

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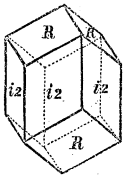

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[*] *Rhombohedral* of Mohs; *Sechsgliedridge* or *drei-und einaxige* of Weiss; *Hexagonal* of Naumann; *Monotrimetric* of Hausmann.

formed, as shown in f. 29; and if the lateral angles are removed in an analogous manner, another similar form is produced, (f. 30). The two differ in the form of the planes *R*, at their extremities. When at the same time the vertical solid angle is removed, the terminal plane of the hexagonal prism is formed, (f. 31).

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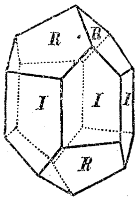

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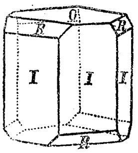

A hexagonal prism is reduced to a rhombohedron by removing alike three alternate edges of one base, and three edges of the other base alternate with these, (f. 31), and continuing the removal till the original form is obliterated; or again, by removing in a corresponding manner the alternate solid angles.

The hexagonal prism and rhombohedron are consequently closely related forms; both are presented by calc spar and many other species.

Rhombohedrons are *obtuse* when the angle at the terminal edges is greater than 90°, (f. 26, 27); and *acute* when it is less, (f. 28). In the former case, the terminal solid angles are made by the meeting of three equal obtuse plane angles, and the lateral by the meeting of one obtuse and two acute plane angles. In acute rhombohedrons the terminal edges are acute; the lateral obtuse; the terminal solid angles are made by the meeting of three equal acute plane angles, and the lateral by the meeting of one acute and two obtuse plane angles. The cube is the intermediate form, having angles of 90°; when placed with an octahedral axis vertical, it has a position corresponding with that of the rhombohedron; the axis a in a rhombohedron of 90° (or cube) $=\sqrt{\tfrac{3}{2}}=1{\cdot}224745$.

Under these systems of crystallization, and the forms described, the variety of possible forms or dimensions is unlimited. The cube, regular octahedron, and rhombic dodecahedron, are of unvarying relative dimensions. But the right square prism has one axis (the vertical) unequal to the other two, and it may be longer or shorter in any proportions. The right rhombic prisms may be indefinitely various in the angles between the lateral faces; and the oblique prisms may differ in other angles also. Rhombohedrons may occur of every angle; and the hexagonal prism, like the right square prism, may be indefinitely varied in the relation between the vertical axis and the lateral.

By these modes, and also by differences of structure hereafter to be explained, the actual fundamental forms of crystallization become exceedingly numerous, although they belong to a few simple types. However numerous the kinds of substances existing in the inorganic kingdom, there is no limit, owing to this possible variation of dimensions, to the crystallographic distinctions which may exist among them.

In each system there is a prism whose sides are parallel to the planes in which the axes lie, and whose edges equal the axes. Such is the square prism, f. 2, in the dimetric system; the rectangular prism, f. 3, in the trimetric; f. 5 in the monoclinic, etc.: such prisms are the type-prisms of the several systems. There is also in each system (excluding the monometric) another prism, like the rhombic prism, (f. 4), in the trimetric, or f. 6 in the monoclinic system, which has for its lateral faces vertical planes connecting the extremities of the lateral axes: these are distinguished as the axial or fundamental prisms. The *type-prisms* are diagonal to these, and are called also the *diagonal* prisms.*

II. MODIFICATIONS OF CRYSTALS.

In explaining further the laws of crystallography, we might adopt either the mathematical method of referring directly to the axes of the forms, or the less abstract mode of basing the statements of the laws and their explanations on the type-prisms. The latter mode, as it affords the mind distinct solids for contemplation and comparison, is much more simple to the learner, and is here adopted.

Moreover, as the edges of such prisms have the same directions and lengths as the axes, their relations to the derivative forms are more readily apprehended, than those of an assumed octahedron, or any other solid that might be taken as the type of the system.

As the number of forms among the crystals of a single species is often quite large, there is at first much apparent difficulty in tracing their connections, or distinguishing any symmetry of arrangement. The law governing these modifications is, however, of the utmost simplicity. In its application, it is necessary to have fully

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* The relations of the several forms of crystals are elegantly exhibited by means of models made of glass. They may be made from common window or plate glass, by cutting the glass in the form of the faces of the solid to be made, and then uniting them by means of glue. The author has generally found it convenient to have a small cord between two adjacent pieces of glass, as the adhesion between the glass and the cord, by means of the glue, is much stronger than between two pieces of glass and glue alone. The forms thus far finished, may be rendered much firmer, and, at the same time, the glue and cord concealed, by covering the edges with narrow strips of paper, cut for the purpose; colored glazed paper is preferable, as it is less easily soiled. The primaries, when completed, may be placed within a secondary, which afterwards can be closed up, and the edges papered. In this way, a primary may be enclosed within any of its secondaries so as to exhibit clearly the relations of the two solids. The plane angles of the faces in the monometric solids, are given in the following pages; by laying them off, a plane figure may be drawn, having the form of the desired face; by then placing the plate of glass over the figure, it may be cut with a diamond and a rule. Good glue is necessary for uniting the glass; gum arabic suffices for attaching the slips of paper. The axes may be made of colored thread. Mica may be employed in place of glass.

in mind what is understood by *similar* edges and angles, as explained on page 23. In the cube the edges are all similar in length, being equal and rectangular. In the right square prism, also, the edges are rectangular, yet the lateral are not equal to the basal in length, and therefore the two are dissimilar. In the right rhombic prism, the lateral edges are of the same length, but two are obtuse and two acute, and hence they are dissimilar; the basal edges are similar to one another, being all rectangular and of equal length, and also being included by planes respectively equal. This similarity of edges and angles is in each case a consequence of the similar axial relations of the planes.

I. LAWS OF SYMMETRY AND RESULTING FORMS.

The modifications of crystals take place according to the following simple laws:

I. *All the* SIMILAR *parts of a crystal may be simultaneously and similarly modified.*

II. *Half the* SIMILAR *parts of a crystal may be similarly modified independently of the other half.*

The forms resulting according to the first law are termed *holohedral* forms, from ὅλος, *all*, ἕδρα, *face*. All similar edges or similar angles of the type prisms, according to this law, will be alike in the number and positions of their planes.

The forms proceeding from the second law are termed *hemihedral*. According to it, half the similar parts are alike in their modifications, and unlike those of the other half; and the parts of either half thus modified are alternate or symmetrically related, so that the result is in general a symmetrical solid. The planes of one half are distinguished by the sign +, and those of the other by the sign —.

The examples under the law of hemihedrism may be classed as follows, referring them to the type prisms of each system.

I. Those forms in which half the similar angles or edges are modified independently of the other half, producing—

1. In the MONOMETRIC and DIMETRIC systems, *tetrahedral* and *sphenoidal* forms, by the independent replacement of the alternate angles; their opposite faces are not parallel, and they are hence called *inclined hemihedrons;* as in Boracite, Copper pyrites. The replacement in the dimetric system of two opposite basal edges at one base, and the other two at the opposite base, is of the same kind; as in Edingtonite.

2. In the TRIMETRIC system, *monoclinic* forms, by the replacement of half the similar parts of one base and the diagonally opposite of the other, unlike the other half; as in Datholite, Humite.

3. In the TRIMETRIC and HEXAGONAL systems, *hemimorphic* forms, by independent replacements at the opposite extremities of the crystal; as in Topaz, Calamine, Tourmaline.

4. In the RHOMBOHEDRAL system, by the replacements of the alternate basal edges or angles of the rhombohedron—forms usually called *tetartohedral* or quarter forms, on the ground that mathematically the rhombohedron is *hemihedral* to the hexagonal prism, which is the type of the hexagonal system.

II. Those forms in which all the similar angles or edges are modified, but by half the full or normal number of planes, producing—

1. In the MONOMETRIC system *pyritohedral* forms, by a replacement of the edges or angles; as in Pyrites. Such forms have opposite faces parallel, and are often called *parallel hemihedrons.*

2. In the DIMETRIC system, *pyramidal* and *scalenoidal* forms, by a replacement of the eight solid angles, according to two methods.

3. In the HEXAGONAL SYSTEM, *pyramidal* and *gyroidal* forms, by a replacement of the solid angles of the hexagonal prism, or the six lateral angles of the rhombohedron, according to two methods; as in Quartz and Apatite.

Explanations of these kinds of hemihedrism are given in the remarks which follow on the forms of the several systems of crystallization.

1. *Monometric System.*

1. *Holohedral.*—In accordance with the first law of symmetry, if a single edge of a cube, octahedron or dodecahedron, be truncated, all will be simultaneously truncated, (f. 17, 19, 43), for all are similar. If on an edge there is one plane inclined unequally to the adjoining faces, there will be two such planes, one inclined towards each face with like angles, as in f. 32; such edges are said to be *beveled;* moreover all the edges of these solids will be similarly beveled.*

a. Tetrahexahedron†.—A bevelment of the edges of a cube is represented in f. 32, and the result of a continuation of the process in f. 33. This form is bounded by twenty-four triangular faces.

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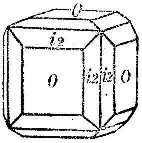

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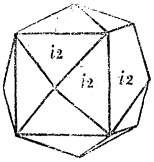

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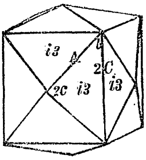

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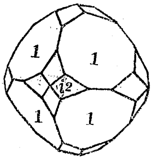

Figure 34 is a similar solid, proceeding from a different angle of bevelment. The above name indicates the general resemblance to the cube or hexahedron, and at the same time expresses the number of its faces. It is derived from τετρακις, *four times*, ἑξ, *six*, and ἑδρα, *face;* the 4×6-faced solid.

The planes *i*2 in f. 35, which are observed to replace the solid angles of the octahedron inclining at the same time on its edges, when extended to the obliteration of the primary faces, produce the same form as above, (f. 33). The replacement of the *six* acute solid

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* An edge is *beveled*, when replaced by two planes, which are respectively inclined at equal angles to the adjacent faces.

† Called *Fluoroid*, by Haidinger.

angles of the dodecahedron by *four* planes resting on its faces, (f. 36), if continued, results in the same solid.*

By varying the angle of bevelment of the cube, tetrahexahedrons of different angles may be produced.

b. Trisoctahedron.—The angles of the cube are represented as replaced by three planes in f. 37 and 47; in one, they incline on the primary faces; in the other, on the edges of the cube. The completed forms obtained by these replacements are seen in f. 39 and 49. Fig. 38 is an intermediate form, between 37 and 39, having also octahedral planes, (1). The resulting solids, though considerably unlike, have a general resemblance to octahedrons, with a three-sided pyramid substituted for each octahedral face. Like the octahedron, they are formed on the angles of the cube by a replacement by three planes instead of one, which accounts for their general resemblance to this solid. The name, trisoctahedron, is derived from τρις, *three-times*, ὀκτω, *eight*, and ἕδρα, *face*, 3×8-faced solid. The faces of one of these solids are four-sided, or *tetragonal*, those of the other, three-sided, or *trigonal;* they are, therefore, distinguished by the names *tetragonal trisoctahedron* and *trigonal trisoctahedron*. The usual name of the former is *trapezohedron*.

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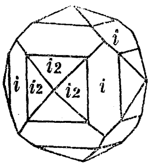

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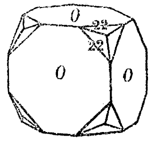

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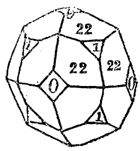

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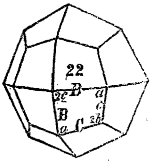

The *tetragonal trisoctahedron* or *trapezohedron*† (f. 39) may be derived from the octahedron, by replacing its angles by four planes, inclining on its faces, (f. 41 or 42); from the dodecahedron, by a truncation of its twenty-four edges, (f. 43, 44), or by replacing the solid angles, obtuse or acute, by planes inclined on the edges, (f. 45,

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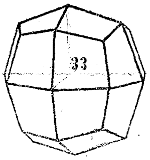

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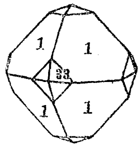

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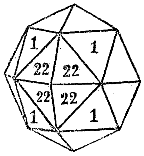

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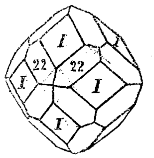

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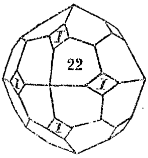
* The system of notation used in the figures is explained on a following page. It may be observed here that the expressions, 22, 33, and the like, are to be read as if written, 2-2, 3-3; that *i* stands for infinity; and that there is thus a correspondence between the mathematical symbols for the planes, and the lettering.

† *Leucitoid* of Haidinger, referring to its being the form of Leucite.

which represents planes of the trapezohedron, 33.) The planes 33, on f. 41 and 45, result in the trapezohedron of f. 40; and the planes

44



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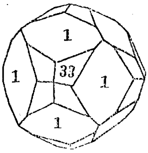

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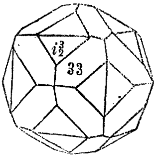
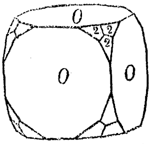


22, of f. 42 and 43, in that of f. 39. The truncation of the shorter edges of tetrahexahedrons produce trapezohedrons, (f. 46, 33 being the trapezohedral planes on the tetrahexahedron $i\ \frac{3}{2}$); and others proceed from planes on the angles inclined on the same edge.

The *trigonal Trisoctahedron* (f. 49) has been observed to proceed from a cube by a replacement of the angles by three planes, as in f. 47. It proceeds from an octahedron by beveling its twelve edges, (f. 48), and from a dodecahedron by a replacement of its eight obtuse solid angles, by three planes inclining on the faces.

47



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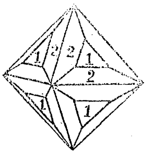

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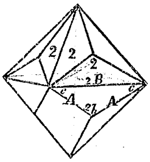
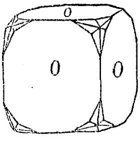


*c. Hexoctahedron.**—Figure 50 represents a cube, with six planes on each angle, and consequently forty-eight in all. The resulting solid is completed in f. 51. Here, for each face of the octahedron is substituted a low six-sided pyramid. The name of this solid is derived from the Greek, ἑξακις, *six-times*, ὀκτα, *eight*, and ἑδρα, *face*, the 6×8-faced solid.

50



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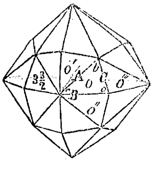

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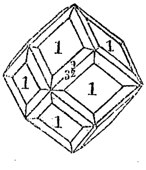


A replacement of the angles of the octahedron by eight planes, produces a similar solid. A bevelment of the *twenty-four* edges of

---

* *Adamantoid* of Haidinger, alluding to its being a form of the diamond.

the dodecahedron, (f. 52), also necessarily produces a *forty-eight-faced* solid. Others, differing in their angles, may result from a replacement of the *six* acute solid angles of the dodecahedron by *eight* planes, or the *eight* obtuse by *six* planes.

2. *Hemihedral.*

The exemplifications of the law of hemihedrism, are of frequent occurrence.

Figure 53 is an example of the first kind of hemihedrism, in which half the angles of the cube are modified, while the remaining half are unmodified.

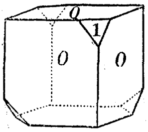
Figure 67 is an instance of the second kind. All the edges are similarly replaced, but by one of the two beveling planes represented in f. 32. The plane *i*2 is enlarged in f. 68. From this last figure, it will be observed, that the suppressed planes are those which were alternate, and that two planes, *i*2, incline on each face, *O*. The crystals have therefore a symmetrical character.

Another instance is observed in f. 73, in which each angle of the cube is replaced by three out of the six intermediaries in f. 50; that is, by half the number of planes which the first law would require.

A. *Tetrahedral hemihedrons.*

a. Tetrahedron or Hemi-octahedron.—If half the angles of a cube are replaced by a single plane, (f. 53, 54), the resulting form is a tetrahedron or hemi-octahedron, (f. 55, 56, one (+) resulting from the angles modified in f. 53, and the other (—) from a replacement of the other set of angles.) The same form may proceed from an octahedron by an extension of one half of its faces to the obliteration of the other half, (f. 57).

53



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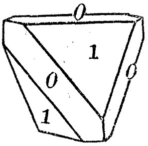

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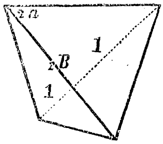

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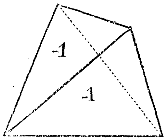
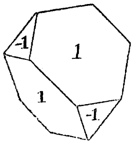


The plane angles of the tetrahedron are 60°; the interfacial 70° 31° 44′.

57



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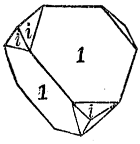

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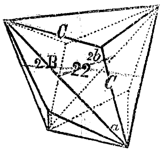

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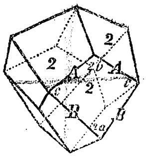
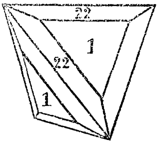


Figure 58 represents a combination of the faces of the tetrahedron with the faces *i*, (or those of a dodecahedron).

b. Hemi-trisoctahedrons.—The planes 22 in f. 37, when occuring on but half the angles, produce the solid in f. 59. The faces are *trigonal*, and the solid is called a *cuproid.*

61



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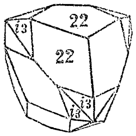

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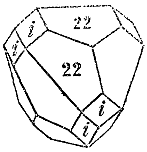

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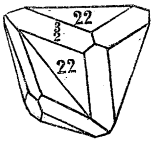
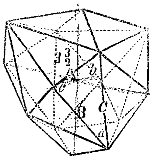


The planes 2 in f. 47, when occuring on but half the angles of the cube and enlarged, form the solid in f. 60; its faces are *tetragonal.* It is the *deltohedron* of Haidinger.

Figure 61 represents the cuproid combined with the tetrahedron; f. 62, the same with planes of a tetrahexahedron, *i3*; f. 63, with planes of a dodecahedron; f. 64, with planes of a deltohedron, similar to f. 60.

c. Inclined or *tetrahedral Hemi-hexoctahedron.*—A solid of this kind is represented in f. 65. It is formed by a replacement of half the angles of the cube, by six planes, similar to those in f. 50. As the opposite faces are not parallel, it is an *inclined hemi-hexoctahedron.* Figure 66 represents the same, with the faces of the tetrahedron.

65



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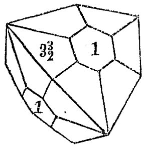
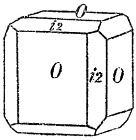


B. *Pyritohedral hemihedrons.*

d. Hemi-tetrahexahedron, or *Pentagonal Dodecahedron.*—A cube is represented in f. 67, with but one of the two beveling planes on each edge, given in f. 32. The same planes are enlarged in f. 68; f. 69 represents the completed solid; and f. 70 is the supplementary or — form. The second of the above names is commonly applied to this solid. It is the *pyritoid* of Haidinger.

67



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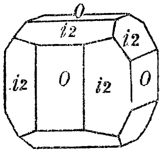

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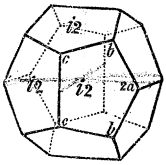

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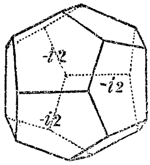

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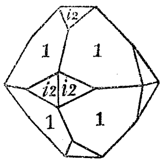

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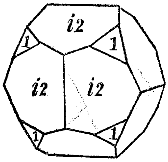
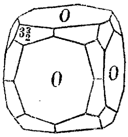


Figures 71, 72, exhibit the planes on the octahedron, which, extended, give rise to f. 69.

b. Parallel or *Pyritohedral Hemi-hexoctahedron.*—When all the solid angles of the cube are replaced by three alternate planes out of *six* intermediaries, (f. 73), a form like that in f. 74 is produced. It has *parallel* opposite faces. It is the *diploid* of Haidinger. Figure 75 shows the same planes on an octahedron.

73



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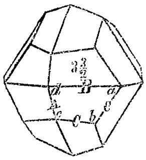

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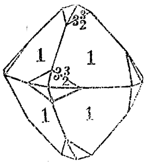


2. *Dimetric System.*

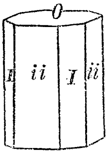
The modifications of the basal and lateral edges of a square prism, take place independently, owing to their dissimilarity. The lateral edges are included by equal planes, and, therefore, may be truncated or beveled, (f. 76, 78). The basal edges are similarly replaced; but being the intersections of unequal planes, they are never truncated or beveled. A plane on these edges, therefore, inclines unequally on the adjacent faces, (f. 80, 83).

The similar intermediary planes on each angle can be but two in number, (f. 88).

The production of a square octahedron from the replacement of the angles of the square prism, is explained on page 28, (f. 20, 12). By giving different inclinations to the plane on the angles, other octahedrons are obtained of longer or shorter vertical axes.

A truncation of the lateral edges of the *typical* square prism, gives rise to another square prism, (f. 77), the axial prism. Bevelment of the same lateral edges, (f. 78), affords eight-sided prisms, (f. 79), of different angles, according to the angle of bevelment.

76



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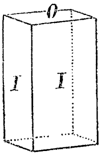

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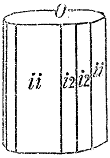

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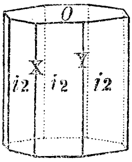
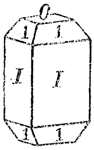


The fundamental octahedron (f. 12) proceeds from the axial prism, by a replacement of the basal edges, (f. 80, 81); the basal edges of this square prism corresponding to the angles of the other; (compare f. 80 and 20). Another series of octahedrons is formed on the angles of the axial square prism, (f. 82), or the basal edges of the diagonal square prism, f. 83; f. 84 represents the octahedron 1*i* of f. 83, and also within this, that of $\frac{1}{2}i$. The octahedrons of one series replace the pyramidal edges of the other, (f. 85), or are situated on the angles basal or vertical, and incline on these edges, (f. 86), 1*i* or 2*i* being octahedral planes of one series, and 1 of the other. Figure 87 represents the octahedron 1, combined with the lateral faces of the diagonal or type prism.

80



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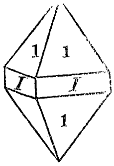

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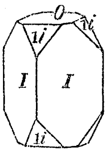

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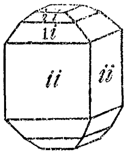

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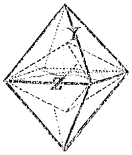

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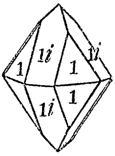

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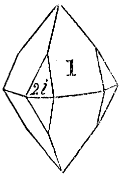

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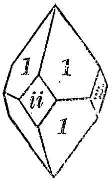
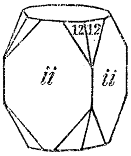


Two planes on each angle of a square prism, (as in f. 88), give rise to a double eight-sided pyramid, (f. 89), which may be of various proportions, according to the inclination. The same planes on the octahedron 1, either bevel the edges, (f. 90), or replace the angles by two planes corresponding to each terminal edge. In this solid the terminal edges are of two kinds, one, the axial, (*X*), terminating in the poles of the lateral axes; the other, the diagonal, (*Y*), intermediate in position.

88.



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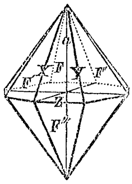

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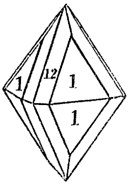
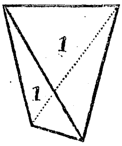


The *hemihedral* forms are as follows:—1. The *sphenoidal*, corresponding to the tetrahedral of the monometric system, the alternate angles being replaced alike. Half the planes 1, of f. 20, produce the scalene pyramid represented in f. 91; and the other half, that of f. 92; and two planes on half of the angles, afford the form in f. 93. Figure 94 represents the sphenoid with the vertical planes of the diagonal square prism; and f. 95 shows the combination of

f. 93, with the octahedron 1*i*. 2. *Pyramidal*, produced by the occurrence of one of the two planes on each angle, (see f. 88), the occurring plane at each extremity, about the edge of the prism, being on the same side of the edge, or in the same vertical line—as in f. 96. The resultant form is a square octahedron; occurs in Tungsten. Another kind of hemihedrism may occur, which is like the last, except that the plane at each extremity, about each edge of the prism, is on different sides of the edge, as in f. 97; the resultant form is represented in f. 98. In 96, the plane is the *left* of one base, and (the prism being inverted) the *right* of the other, (or the reverse); in f. 97, the plane is the *right* of each base, (or the *left*).

91



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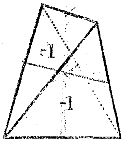

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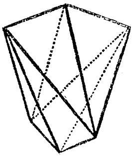

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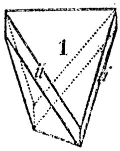

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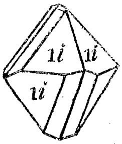

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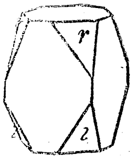

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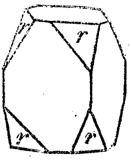

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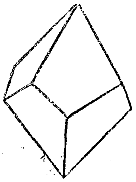


3. *Trimetric System.*

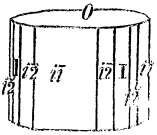
The edges of the right rectangular prism are of three kinds, (being different in length), and those of each kind are, according to the law mentioned, independently modified, (f. 99, 103, 105). Moreover, none of them can be truncated or beveled, in consequence of the inequality of their including planes.

Planes on the angles incline *unequally* on the three adjacent, *unequal* planes. The angles are similar, and therefore will be modified simultaneously, (f. 23).

The lateral edges of the right rhombic prism admit of truncation and bevelment, because of the equality of the lateral planes. The obtuse, however, are modified independently of the acute, (f. 101, 102). The obtuse solid angles, and the acute, are also independent in their modifications, (f. 107, 108). The replacements of the basal edges are similar and simultaneous, (f. 24).

On page 28 it is shown that a replacement of the lateral edges of the rectangular prism, (f. 21, 22), produces a right rhombic prism. By varying the inclination of the replacing planes, different rhombic prism are obtained. In f. 99, $i\bar{2}$, *I*, and $i\breve{2}$, are planes of three such prisms, *I*, being the prism represented in f. 4, and in the interior of f. 100, having the same axes as the rectangular prism; $i\bar{2}$ corresponding to the prism $i\bar{2}$ $i\bar{2}$, in f. 100,—(that is, having the same angle between the planes, as $i\bar{2}$ $i\bar{2}$, in f. 99); and $i\breve{2}$ corresponding to the prism $i\breve{2}$ $i\breve{2}$, in f. 100. Figure 101, represents the rhombic prism *I*, with the same planes $i\bar{2}$, and f. 102, with the planes $i\breve{2}$.

99



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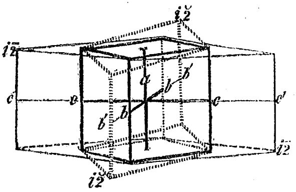

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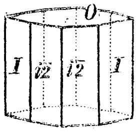

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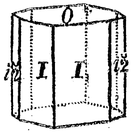
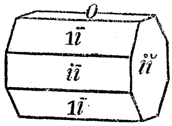


A replacement of the basal edges produces other rhombic, prisms, which are horizontal in position, and are called *domes*, (from δομη, or *domus*, house, or placed like the roof of a house). Figure 104 represents the dome corresponding to the planes $1\bar{i}$ in f. 103; it is parallel to the *longer* lateral axis, and is called a *macrodome*, (from μακρος, *large* and *dome*). Figure 105 contains planes ($1\breve{i}$, $2\breve{i}$) of two domes parallel to the *shorter* lateral axis, which are called *brachydomes*, (from ϐραχυς, *short* and *dome*). These brachydomes are presented completed in f. 106, the outer being $2\breve{i}$, and the inner $1\breve{i}$. The former has the vertical axis twice that of the latter. In f. 107, the planes $1\bar{i}$ and $1\breve{i}$, (f. 103, 105), are represented on a rhombic prism, the angles of which they replace.

103



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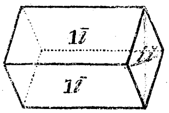

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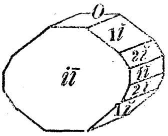

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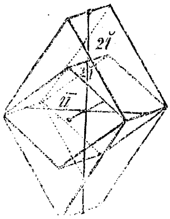
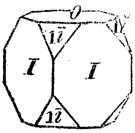


The production of a rhombic octahedron, by replacing the angles of a rectangular prism, or basal edges of a rhombic, is mentioned on page 28; (compare f. 23, 24, with 13). Other planes on the

107



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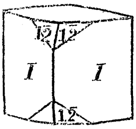

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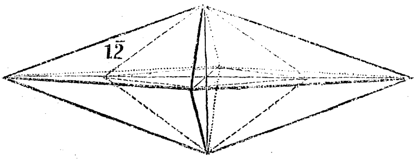
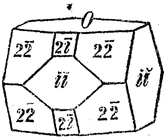


angles produce other octahedrons. The planes $1\bar{2}$, in f. 108, correspond to the octahedron of f. 109—(that is, have the same mutual inclinations as the faces of the latter); the longer lateral axis is twice that of f. 13, or that of the dotted figure in 109. The planes $2\bar{2}$, in f. 110, in the same manner correspond to the octahedron in f. 111, in which, both the vertical axis and one of the lateral are twice the same in f. 13. The planes $2\bar{i}$, in f. 110, belong to a macrodome different from that in f. 103, 104.

110



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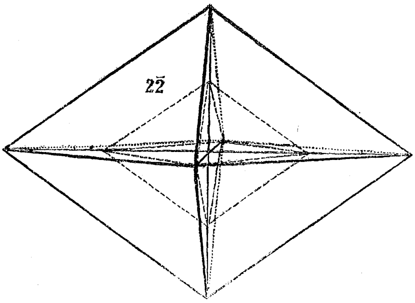


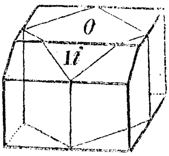
Hemihedrism, in the trimetric system, produces two kinds of forms. 1. *Monoclinic*, when the lower extremity of a crystal in front, and the diagonally opposite, differ in their modifications from the upper extremity in front; the forms resemble those of the monoclinic system, but differ in having the angle between the vertical and lateral axes 90°. An example is shown under datholite and humite. 2. *Hemimorphic*, when all the similar parts of one base are modified alike, but unlike the corresponding parts of the other, as in calamine and topaz, (q. v.)

In this system, the angle between *O* and the vertical prismatic planes, is 90°, and $\breve{i}i : \tilde{i}i=90°$.

4. *Monoclinic System.*

In the Monoclinic System the obliquity of the crystals (or of the vertical axis towards the clinodiagonal) makes the upper and lower parts in front different, one obtuse and the other acute, and they are independently modified, as in f. 112, 113. But the angle of the vertical axis with the orthodiagonal being right, and therefore alike on opposite sides, the planes on the four lateral angles

112



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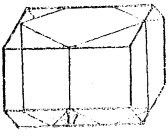

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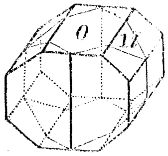

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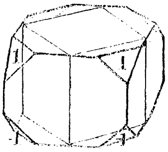
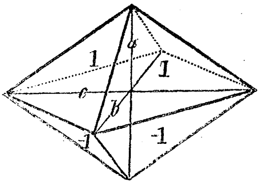


of the oblique rhombic prism are alike, as in f. 114. The four planes 1*i*, in the last mentioned figure, make a clinodiagonal prism, or *clinodome;* the plane 1*i*, in f. 112, is a hemi-orthodome; and the same with -1*i*, f. 113.

The lateral edges are replaced as in the trimetric system. The relation of the two forms, in f. 5 and 6, is shown in f. 25. Octahedrons may result in this system as in the trimetric; but they consist of two sets of planes, or hemi-pyramids, as shown in f. 115, in which 1, 1, are on the obtuse angles of the outer prism, or correspond to the obtuse basal edges of the inner, while -1 are on the acute angles or edges. The completed oblique octahedron corresponds to the planes 1, 1, -1, -1, as in f. 115, 116. The vertical axis *a* is oblique to *b*, the clinodiagonal, but at right angles with *c*, the orthodiagonal. The angle of obliquity is called the angle γ or *C*. Other octahedrons arise from planes of different inclinations.

116

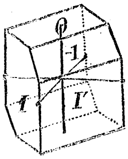


In this system, the angle between the plane *O* and *ii*, (f. 5), is 90°; *O* on other prismatic planes is an oblique angle; *ii* on the faces of different clinodomes is oblique: *ii* on *ii*, and all hemi-orthodomes, =90°. The particular plane to be taken as *O*, or as *I*, may be a question for particular species; the *O* will always be one of the planes in the clinodiagonal section; while any prismatic planes not parallel to either diagonal, or any octahedral planes, may be taken as *I*. When there is no very distinct cleavage to guide to a decision, (and even when such cleavage exists,) it is common, though not always best, to assume those planes as the fundamental form, which will render the calculations and symbols of the planes most simple.

5. *Triclinic System.*

As only diagonally opposite edges or angles (f. 8) are similar in the Triclinic System, there can be in a triclinic crystal but two planes of a kind, as in f. 117, 118. The inclination of *O* on *I*, differs from *O* on *I'*. The prism formed by planes on the prismatic edges of f. 8, parallel to the diagonals, has the same relation to the form in f. 8, as that of f. 5 to f. 6, of the monoclinic system; but unlike the prisms of the monoclinic system, *O* does not make

117



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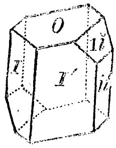

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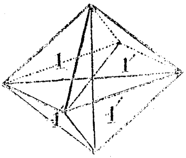


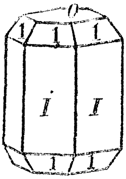
a right angle with any of the lateral planes; there are no right angles in triclinic forms. The replacement of the basal edges of the prism, in f. 8, by homologous planes, may produce an octahedron; but it will be included by four sets of planes, two of a kind, as represented in f. 119. These planes occur independently on crystals, and, owing to their independence, actual octahedrons are not met with in nature.

6. *Hexagonal System.*

1. *Holohedral.*

a. In the *hexagonal prism*, (f. 10), the basal edges are alike and have similar modifications, and the same is true of the lateral edges, and the solid angles. When a similar plane occurs on each basal edge, (f. 120), or each basal angle, (f. 121), the resulting solid is a double six-sided pyramid, (f. 122), called an *isosceles dodecahedron*, or a *dihexagonal pyramid;* it is the *Quartzoid* of Haidinger. Figure 121 represents planes of three different pyramids on the angles, viz., 12, $\frac{4}{3}2$, 22, which differ in the length of the vertical axis.

120



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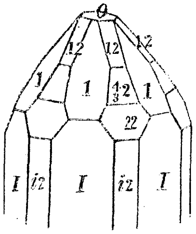

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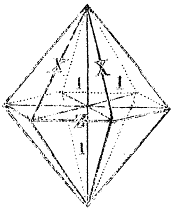
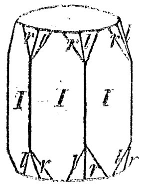


Each solid angle of the hexagonal prism, may be replaced by two similar planes, (as in f. 123), and the extension of such planes produces a double twelve-sided pyramid, (f. 124)—the *berylloid.* The berylloid has two kinds of terminal edges, one, *X*, the *axial;* the other, *Y*, the *diagonal.* The truncation of the lateral edges of the hexagonal prism leads to a secondary hexagonal prism, (f. 9), and (f. 121) diagonal to the first; and bevelment leads to different twelve-sided prisms.

123



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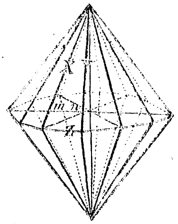


In the *rhombohedron*, the vertical solid angles, as they are formed by the meeting of three equal planes and equal plane angles, may be truncated, or replaced by three or six similar planes. The edges, for a similar reason, may be either *truncated* or *beveled.*

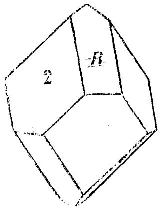
The terminal edges, however, are replaced independently of the lateral.

The lateral angles, six in number, are replaced simultaneously. Two like intermediary planes may occur on each.

The derivation of two six-sided prisms from a rhombohedron, has been explained on page 30; one, by a truncation of the six lateral edges, (f. 29); the other, by a replacement of the six lateral angles, by planes parallel to the vertical axis, (f. 30). The remaining parts of the primary faces on the first of the above prisms, are *rhombic;* those on the second, are *pentagonal.*

A truncation of the terminal edges of the rhombohedron, is observed in f. 125. Since these edges are six in number, three at one end of the crystal, alternating with three at the other, the solid formed by the extension of these planes, must be an oblique solid, contained under six equal faces: or, in a word, a rhombohedron. Moreover, because the *lateral angles* are six, and three alternate are nearer the lower extremity of the axis, and the remaining three near the upper extremity, the planes on these angles, if not parallel to the vertical axis, incline alternately above and below, (f. 126); and, therefore, by their extension, will give rise to rhombohedrons. These rhombohedrons will differ in the lengths of their vertical axes, as these planes vary their inclination. The nearer they approach to parallelism to the vertical axis, the longer the axis of the rhombohedron; and the six-sided prism formed on these angles may be considered a rhombohedron, with an infinite axis. Moreover, other rhombohedrons may be formed by replacing the terminal angles by three planes inclined on the faces or terminal edges; and as the planes of such secondary rhombohedrons approach horizontality, they approximate to the terminal or trunca-

125



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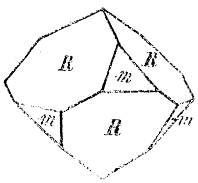

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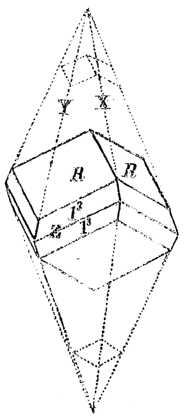

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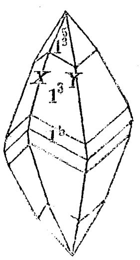

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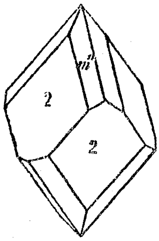

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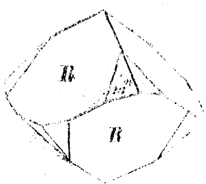
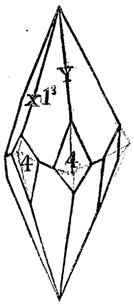


ting plane, *O*, which plane may be viewed as a rhombohedron with the axis=0.

In f. 127, the lateral edges of a rhombohedron are beveled; an extension of these beveling planes produces the solid represented in the dotted lines of this figure, which is called a *scalenohedron*. It is a solid included by twelve scalene faces. The twelve edges are of three kinds: 1, the longer terminal, *Y*; 2, the shorter terminal, *X*; 3, the basal, *Z*. By other beveling planes, (f. 128), other scalenohedrons are formed; and as the vertical axis increases, they pass into the diagonal hexagonal prism, *i*2, (f. 9). This prism may hence be considered a scalenohedron with an infinite axis.

Bevelments of the terminal edges (f. 129) give rise to other similar solids; and replacements of the lateral angles by two planes, (f. 130), afford still other scalenohedrons. Again, the replacement of the terminal edges of scalenohedrons, or of the angles, by planes inclined on these edges, gives rise to different rhombohedrons. In f. 131 there are planes of the rhombohedron, $4R$; in f. 132, planes of $-5R$; in f. 133, planes of $\frac{5}{2}R$; in f. 134, planes of $-2R$. A bevelment of the terminal edges, or a replacement of the angles by *two* planes inclined against each terminal edge, produces other scalenohedrons, (f. 133, 134).

131



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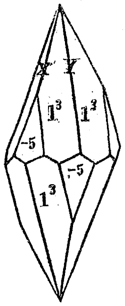

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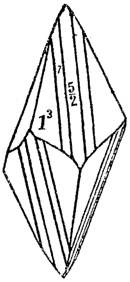

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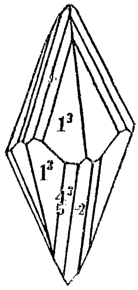


When a rhombohedron has its lateral angles replaced, as in f. 126, and the plane is inclined to the vertical axis at the same angle as *R*, a dihexagonal pyramid or quartzoid results. Such is the origin of the pyramids of crystals of quartz.

In crystallographic calculations, the rhombohedron, scalenohedron, and related forms, are regarded as hemihedral modifications of the hexagonal prism, and we proceed now to speak of them in this relation.

2. *Hemihedral.*

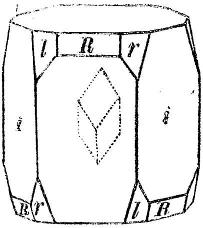
As the rhombohedron results from a hexagonal prism by a replacement of the *alternate* basal edges (f. 31) or angles, it is in this relation hemihedral; and since either set of alternate edges of the prism may give rise to a series of rhombohedrons, it is usual to distinguish one set by the sign +, and the other by the sign −. In the double pyramid of quartz, as just explained, we have a form in which both of these rhombohedrons, $+R$ and $-R$, are combined, producing a symmetrical solid.

The scalenohedrons have the same relation. To comprehend this form and other hemihedrons more fully, the holohedral form, in f. 123, may be again referred to. It is a hexagonal prism with two planes on the angles at either base, inclined on each face, one the *right*, (r), at the right upper angle of each face, the other the *left*, (l). In hemihedral forms, half of these planes are suppressed.

1. If, as in f. 135, the suppressed planes are those below, for the left face I, (f. 123), those above, for the middle I, those below, for the right, and so on, alternating around, the resulting forms are scalenohedrons; for each occurring pair, l, r, corresponds, as is seen, to a face (R) of the rhombohedron. This kind of hemihedrism is called the *rhombohedral*, by Naumann.

If the faces that are suppressed in f. 135, should be the occurring faces, and the others were suppressed, the same solid would result in an inverse position. If the rhombohedral plane R, in f. 135, is taken as $+R$, then the scalenohedron, in the same figure, will be +, and the inverse one, —; for, in f. 135, the planes l, R, r, belong to the same axial sector; while R would not be in the same sector with the planes of the inverse scalenohedron. Where various scalenohedral planes occur together, there may be among them both + and —, with + or — rhombohedral planes.

135



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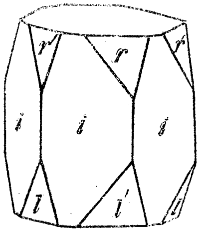

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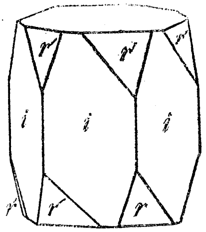

2. In another kind of hemihedron, the occurring planes of the two, r, l, in f. 123, may be the r on each angle at one base, and the l on each at the other base, as in f. 136. This variety is exemplified in apatite. It is called the *pyramidal* hemihedrism by Naumann, the resulting solid being a six-sided pyramid.

3. In another kind of hemihedron, the occurring planes may be the r of both bases, as in f. 137, or the l of both bases. This occurs in quartz, (see under that species), and is called the *trapezohedral* by Naumann, the resulting solid, made up of such planes extended, being a trapezohedral double pyramid. It is also called *gyroidal* hemihedrism, the planes gyrating to the right or left at each base.

A triangular prism, a hemihedral form of the hexagonal prism, and also hemihedrons of twelve-sided prisms, are of frequent occurrence in Tourmaline.

3. *Tetartohedral Forms.*

Tetartohedral forms are true hemihedral, if the rhombohedron under which they occur, is taken as the type of the crystal; but referred to the hexagonal system, as is conveniently done in calculations, they are tetartohedral forms, or contain only *one-fourth* the number of planes occurring under complete symmetry.

1. In one kind of tetartohedrism, the occurring planes are the alternate of those on the angles in f. 136—that is, only the alternate r's of one base, and the alternate l's, at the other. A form of this kind consists of six planes, and being oblique, is a kind of irregular rhombohedron. It is found in Titanic Iron, and is called rhombohedral tetartohedrism.

2. In a *second* kind—the *trapezohedral* tetartohedrism of Naumann, (also *gyroidal*),—the occurring planes are the alternate r's at both bases, (f. 137), (or the alternate l's). It is observed in Quartz. (See under that species).

3. There is also a *third* kind, in which the opposite extremities of a rhombohedrally modified prism are unlike in their modifications, as seen in Tourmaline. It is an example of hemimorphic tetartohedrism.

II. LAW OF NUMERICAL PROPORTION, IN THE MODIFICATIONS OF CRYSTALS.

This law gives a mathematical basis to the science, adding to symmetry of arrangement a numerical relation in the position of the planes. It is as follows:

The position of planes is related in some simple ratio to the relative lengths of the axes of a crystal.

For example.—In a cube the axes are equal. A plane on an edge, if extended to meet the axes, would cut two of these axes at some distance from the centre of the crystal. Now this distance for these axes will either be as 1 : 1, (i, f. 17), that is, a ratio of equality—a truncating plane; or a ratio of 1 : 2, (like $i2$, f. 32, 33), 1 : 3, (f. 34), 2 : 3, or some other simple ratio. There is no haphazard scattering of faces, but a complete subserviency to this simple law. If the axes are unequal, as in a trimetric form, then the ratio is of the same character, except that the relative lengths of the axes come into the consideration. Thus if a, b, are the axes, the ratios will be $1a : 1b$, ($1\bar{i}$, f. 103, or $1i$, f. 112), or $1a : 2b$, $1a : 3b$, and so on.

To explain more precisely, let AA, BB, CC, f. 138, be three axes crossing at right angles, as in the monometric, dimetric, and trimetric systems; a, b, c, may stand for the halves of these axes, or for AS, BS, CS, respectively. All planes of a crystal meet (or will meet if extended) one, two, or three of these axes. A plane may pass through A, and be parallel to BB, CC, or through B, and be parallel to AA, CC; or through C, and be parallel to AA, BB. Such planes meet one axis, at a distance 1, and the others only at an infinite distance, which is equivalent to being parallel to them. Hence the expression $1 : \infty : \infty$ describes, in a general manner, the position of such planes; and it becomes more special by adding the letters marking the particular axes that are meant in each case, as $1a : \infty b : \infty c$, when parallel to b and c, $\infty a : \infty b : 1c$, when parallel to a and b, etc. The faces of a cube, square prism, and rectangular prism, are of this kind. See also f. 5.

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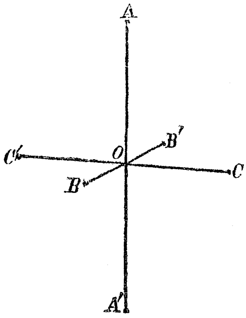

Again, a plane may pass through the points B and C, and be parallel to AA', or through A and C, and be parallel to BB', or through A and B, and be parallel to CC'. Such planes meet two axes at a distance 1, and are parallel to the third; and hence $1 : 1 : \infty$ is a general expression for them , (that is, for the first case, when the plane is parallel to AA, $1b : 1c : \infty a$, or what is the same, $\infty a : 1b : 1c$; and so for the others). Or the plane which is parallel to AA, and cuts BB' and CC', may meet BB' at a distance from the centre, equal to $2b$ ($=2BS$) while it meets CC at the distance $1c$, ($=1CS$). Then the expression $\infty a : 2b : 1c$ indicates the plane. If the ratio of $b : c$ equals $3 : 1$ instead of $2 : 1$, the expression becomes $\infty a : 3b : 1c$. In the same manner, $3a : \infty b : 1c$, would imply that the plane is parallel to BB', and meets AA at a distance $3a$, while CC' is met at a distance $1c$.

Again, if the plane passes through the points A, B, C, it has the parameters $1a : 1b : 1c$; or if a, b, c, are equal, it becomes $1 : 1 : 1$. But if A be removed to twice its distance from S, then the ratio would be $2a : 1b : 1c$; or if B be removed to twice its distance from S, the ratio would be $1a : 2b : 1c$; or if both A and C be so removed, it would be $2a : 1b : 2c$. Thus, in all cases, whatever the position of the plane, the ratio admits of being expressed in simple numbers. The planes may not actually meet the axes, but would meet them in each case, (when not parallel to them), if the plane and the axes were extended; and thus meeting them, the ratios of the parameters would be as indicated; for these ratios, for a plane of given inclination, are the same, whether the intersections are nearer to, or farther from S, on the principle that a line parallel to the base of a triangle cuts the sides proportionally.

$ma : nb : rc$ is a general expression for all planes, in which m, n, r, may have any value, from unit to infinity.

Figure 106 shows the relations to the axes of the planes $1\breve{i}$ and $2\breve{i}$ of f. 105. Figure 109 is made up of the planes of f. 108, and has the axes $1a:1b:2c$, the octahedron within being the fundamental octahedron, with the ratio $1a:1b:1c$. Figure 111 corresponds to the planes $2\bar{2}$ of f. 110, and has the axes $2a:1b:2c$. In f. 100, the inner prism has the ratio $\infty a:1b:1c$; $i\bar{2}\,i\bar{2}$ is the form $i\bar{2}$ of f. 101, having the ratio $\infty a:1b:2c$; and $i\breve{2}\,i\breve{2}$ is the form $i\breve{2}$ of f. 102, having the ratio $\infty a:2b:1c$, as the drawing of the axes shows.

The annexed figure (f. 139) will further aid in elucidating the principle above stated. It represents a rhombic prism with three planes on its basal edges; and for further illustration there are four planes on the angle to the right, besides two vertical planes, (the corresponding planes on the left side are not indicated). Within the rhombic prism there are the three axes, aa', bb', cc', crossing at S, the halves of which axes we call a, b, c, as above; b is the shorter lateral axis, and c the longer.

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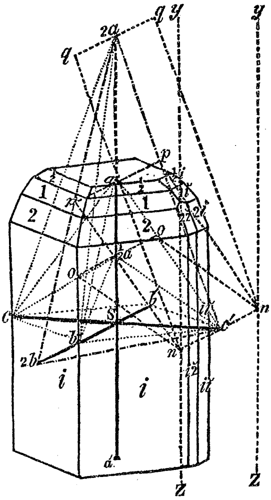

1. It is obvious that the vertical planes of the rhombic prism meet two of the lateral axes at the distance $1b$, $1c$, and are parallel to the vertical axis. Hence the expression for them is $\infty a:1b:1c$.

2. The terminal plane is parallel to the lateral axes, and meets only the vertical; or what is equivalent, it corresponds in position to the plane of the lateral axes, in which the vertical axis is zero. Hence it is designated $1a:\infty b:\infty c$; or $0a:1b:1c$.

3. The plane $i\breve{i}$ is parallel to a, the vertical axis, and also to b, the shorter lateral axis, and meets the axis c. Hence the expression $\infty a:\infty b:1c$. The parallelism to bb' is apparent in the fact that the upper and lower edges of the plane are parallel to this same axis bb'.

4. Consider next, $\frac{1}{2}$, 1, 2, which are planes of as many octahedrons. These planes are inclined towards the three axes; and being on the edges of the rhombic prism, they have the same ratio for the lateral axes as that prism, that is, $1b:1c$, and they differ in the length of the vertical axis, towards which they vary in inclination.

From b, c (which are connected by a dotted line) lines are drawn to points in the vertical axis; viz, to $\frac{1}{2}a$, a, $2a$; $\frac{1}{2}a$ bisects the axis a; a is the extremity of the axis; and $2a$ is at double the distance of a from S. Hence of these triangular planes, the plane $\frac{1}{2}a\,b\,c=\frac{1}{2}a:1b:1c$; $a\,b\,c=a:b:c$; $2a\,b\,c=2a:b:c$. These three planes correspond to the three planes on the left basal edge of the prism, being parallel to them. So, also, the three triangular planes having bc' at base, and $\frac{1}{2}a$, a, $2a$, respectively as the apices, correspond to the three planes on the other basal edge. Hence the expressions for the planes are,

For $\frac{1}{2}$, $\frac{1}{2}a : 1b : 1c$.
1, $1a : 1b : 1c$.
2, $2a : 1b : 1c$.

All those forms which have for the lateral axes the ratio of unity, are described as belonging to the *fundamental* series.

5. Take next the planes $\frac{1}{2}\breve{\imath}$, $1\breve{\imath}$, $2\breve{\imath}$. These planes are all parallel to the shorter lateral axis bb', because their mutual intersections, as well as the intersection of the last with $\breve{\imath}\breve{\imath}$, are parallel to this axis, for all are horizontal. The line nn is drawn through the extremity of the axis cc', parallel to bb'; and parallel to nn or bb' we draw oo, pp, qq, through $\frac{1}{2}a$, a, $2a$; and from nn we run parallel lines to oo, pp, qq. The planes $nnoo$, $nnpp$, $nnqq$, are parallel to the axis b, and each consequently corresponds to a plane of the same series with $\frac{1}{2}\breve{\imath}$, $1\breve{\imath}$, $2\breve{\imath}$; moreover they are respectively parallel to $\frac{1}{2}\breve{\imath}$, $1\breve{\imath}$, $2\breve{\imath}$, and therefore represent these particular planes, $2\breve{\imath}$ being parallel to $nnqq$, $1\breve{\imath}$ to $nnpp$, $\frac{1}{2}\breve{\imath}$ to $nnoo$. The expressions for the planes (horizontal prisms or domes) are therefore,

For $\frac{1}{2}\breve{\imath}$, $\frac{1}{2}a : \infty b : 1c$.
$1\breve{\imath}$, $1a : \infty b : 1c$.
$2\breve{\imath}$, $2a : \infty b : 1c$.

The fact of parallelism to these particular planes, in an actual crystal, would be shown, in this as in other cases, by a measurement of the inclinations of these faces. Calculation, the axes being given, would afford the inclination to the plane of the lateral axes of the planes $nnoo$, $nnpp$, etc., and the correspondence with the observed inclinations would prove the identity; or from the observed inclination, the position of the plane $nnoo$ could be determined, or what is equivalent, the length of the vertical axis.

But this parallelism of the planes, in the figure, is obvious, from the parallelism of certain lines. The planes $nnpp$ and abc', which have the same vertical axis, meet in the line ac', and this line is parallel to np. Moreover, a plane $ab'c'$ has the same intersection with $nnpp$. Consequently, the mutual inclinations of the planes abc', $nnpp$, $ab'c'$, will be parallel to one another. Now abc' is the plane 1; and $ab'c'$ another 1 on the back side of the crystal, meeting $1\breve{\imath}$. And if $1\breve{\imath}$ corresponds to $nnpp$, it must make parallel intersections with the two planes 1, which, in fact, it does. There is the same evidence that $\frac{1}{2}\breve{\imath}$ and $2\breve{\imath}$, are planes corresponding to $nnoo$ and $nnqq$, as above represented.

6. There remain the planes $2\breve{2}$ and $i\breve{2}$. We extend the axis bb' to twice the distance bS, (to $2b$); then connect $2b$ with c', and both with $2a$. The plane thus outlined has the vertical axis $2a$, one lateral $2b$, the other $1c$; and consequently is expressed by $2a : 2b : 1c$; and this is the plane $2\breve{2}$.

The triangular plane $2a\,2b\,c'$ intersects *nnqq*, in the line $c'\,2a$; and so also does the plane $2a\,b\,c'$. The same course of reasoning as the above, shows that the intersections of *nnqq* or $2\breve{i}$ with $2\,a\,b\,c'$ or 2, must be parallel. Consequently, if $2\breve{2}$ corresponds to $2a\,2b\,c'$, it must make parallel intersections with 2 and $2\breve{i}$, which it does. The same parallelism would happen, whatever the length of the axis b, and the above reasoning only determines the vertical axis. That the lateral axis b is, in this case, $2b$, is shown by a correspondence between calculation and measurement.

The plane $\breve{i}\breve{2}$, is parallel to the vertical axis, but not to either of the lateral axes. By doubling bS, extending it to $2b$, and connecting $2b$ with c', we have the position of the plane, it corresponding to $\infty a : 2b : 1c$. The intersection of the plane $2a\,2b\,c'$ with a vertical plane passing through $2b\,c'$, would be parallel to $2b\,c'$, and therefore horizontal, (in a right prism). Hence the intersection of $2\breve{2}$ with $\breve{2}$, if $2\breve{2}$ corresponds to $2a\,2b\,c'$, should be horizontal or parallel to $2b\,c'$; and as it is thus parallel and horizontal, $2b$ is correct for that plane.

ZONES.—*a. Oblique or Transverse Zones.*—In f. 140, $AA'(a)$, $BB'(b)$, $CC'(c)$, are the three axes of a crystal. By connecting the extremities of these axes, the plane ABC is formed, which corresponds to a ratio of equality for the axes—that is, $1a : 1b : 1c$. Make CD, DE, each equal OC; and connect A and B with D and E. Then the planes ABC, ABD, ABE, are alike in the ratio of the axes a and b, but differ in the axis c, they cor-

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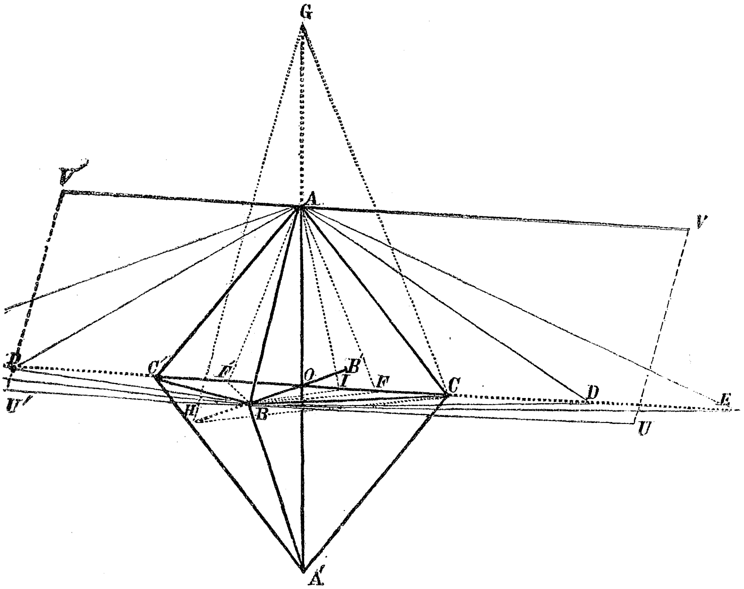

responding respectively to $1a : 1b : 1c$, $1a : 1b : 2c$, $1a : 1b : 3c$, CD being equal to $2OC$, and OE to $3OC$. So there may be any number of planes, in which the axis c shall increase until it reaches infinity; and, in this last case, the plane will be parallel to the axis c, as $ABUV$. Referring all these planes to the octahedron of the figure, the fundamental octahedron, *they replace the edge AB* at different inclinations, and all are alike in having the intersection with the face ABC, *parallel to the edge AB*, or to the edge of the vertical section through the axis b. Hence flows the following law:

I. *All planes, whose intersections with an octahedral plane are parallel to the edge AB, in that octahedron, have the same ratio of a to b; or if parallel to the edge AC, they have the same ratio of a to c.*

If the octahedron, instead of being the fundamental octahedron, is that expressed by the ratio $2a : 1b : 1c$, which differs from the fundamental octahedron in having the vertical axis twice as long, the ratio still holds; and the planes, if making parallel intersections to AB, would be $2a : 1b : 1c$, $2a : 1b : 2c$, $2a : 1b : 3c$, and so on to $2a : 1b : \infty c$, the last, the truncating plane, or that parallel to axis c. Or if they make parallel intersections to AC, so that the ratio a to c is constant, they may be $2a : 1b : 1c$, $2a : 2b : 1c$, $2a : 3b : 1c$, and so on to $2a : \infty b : 1c$, in which the last is parallel to the axis b.

Making OF half of OC, and connecting A and B with F, we have the plane AFB corresponding to $1a : 1b : \frac{1}{2}c$; or making OI a quarter of OC, we have AIB, corresponding to $1a : 1b : \frac{1}{4}c$; and so till c becomes zero, when the plane is identical with the axial plane $ABA'B'$, or is a plane parallel to it, and its ratio is $1a : 1b : 0c$. This last plane is a lateral plane of a rectangular or square prism.

There is thus a zone of planes indicated, lying between $1a : 1b : 0c$, on one side, and $1a : 1b : 0c$, on the other—that is, in the trimetric system for example, between a vertical plane parallel to axis b and its opposite. In like manner, there is another zone parallel to the edge AC, between $1a : 0b : 1c$, on one side, and $1a : 0b : 1c$, on the opposite, or between the other vertical plane of a rectangular prism and its opposite. And whatever the length of the axes of the octahedron, each edge may have its corresponding zone of planes. In the annexed figure, (f. 141), one of the zones of planes is represented: it lies between $\tilde{i}i$, (the smaller lateral plane of a rectangular prism), and its opposite; it is the same

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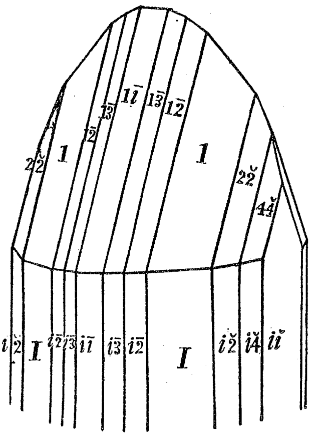

illustrated in the preceding figure, (f. 140), $1\bar{3}$ being plane *ABE;* $1\bar{2}$, *ABD;* 1, plane *ABC;* $2\breve{2}$, plane *ABF;* $4\breve{4}$, plane *ABI.* $1\bar{\imath}$ is the horizontal prism at the middle of the zone.

The fraction in $1a : 1b : \frac{1}{2}c$, is avoided by doubling all the terms, making $2a : 2b : 1c$, in which there is the same ratio for the axes. The plane *GCH*, (f. 140), is drawn to correspond to the expression $2a : 2b : 1c$, *OG* being equal to $2a$, (or $2OA$), and *OH* to $2b$, (or $2OB$); and it is seen that *GCH* and *AFB* are parallel planes in the figure, and therefore identical. So, in place of $1a : 1b : \frac{1}{4}c$, we may write $4a : 4b : 1c$, this being equivalent to $1a : 1b : \frac{1}{4}c$, the difference being that, while b is the unit axis in one, c is so in the other, and this difference is to be carefully observed. These planes on the octahedron, in f. 140, replace the angle *C*, and have the intersection with *ACB* parallel to *AB*. Hence the above law extends not only to planes about the edge *AB*, with parallel intersections, but to all planes making intersections parallel to the edge; and the same as to edge *AC*.

The expression $1a : 1b : 0c$, is equivalent to $\infty a : \infty b : 1c$, (a result of dividing each term by 0); and this last is the one usually employed for such vertical planes.

The zone (*B*) making intersections parallel to the edge *AB*, or the *brachydiagonal* section, in the octahedron $1a : 1b : 1c$, will hence be, beginning with $1\bar{\imath}$ and passing to $\breve{\imath}\breve{\imath}$, (f. 141), $1 : 1 : \infty$ . . $1 : 1 : 3$ . . $1 : 1 : 2$ . . $1 : 1 : 1$ . . $1 : 1 : \frac{1}{2}$ . . $1 : 1 : \frac{1}{4}$ . . $1 : 1 : 0$; or the equivalent, $1 : 1 : \infty$ . . $1 : 1 : 3$ . . $1 : 1 : 2$ . . $1 : 1 : 1$ . . $2 : 2 : 1$ . . $4 : 4 : 1$ . . $\infty : \infty : 1$. The latter is the form adopted.

In the same manner, there may be a zone for any octahedron, $ma : 1b : 1c$; and the series (the second of the above) becomes, under this general expression, $m : 1 : \infty$ . . . $m : 1 : 3$ . . . $m : 1 : 2$ . . . $m : 1 : 1$ . . $2m : 2 : 1$ . . . $4m : 4 : 1$ . . . $\infty : \infty : 1$. Any other values may be substituted for 3, 2, 4.

A corresponding zone, (*C*), making parallel intersections with *AC*, will be $1 : \infty : 1$ . . . $1 : 3 : 1$ . . $1 : 2 : 1$ . . $1 : 1 : 1$ . . $2 : 1 : 2$ . . . $4 : 1 : 4$ . . $\infty : 1 : \infty$; or for any octahedron $ma : 1b : 1c$, it becomes $m : \infty : 1$ . . . $m : 3 : 1$ . . . $m : 2 : 1$ . . $m : 1 : 1$ . . $2m : 1 : 2$ . . $4m : 1 : 4$ . . $\infty : 1 : \infty$. When m becomes infinite, the two zones form a single series of vertical prisms, as for example, $\infty : 1 : \infty$ . . $\infty : 1 : 3$ . . $\infty : 1 : 2$ . . $\infty : 1 : 1$ . . $\infty : 2 : 1$ . . $\infty : 4 : 1$ . . $\infty : \infty : 1$. When axis b is infinite, the zone *B* becomes a vertical series of horizontal planes parallel to axis b; and when axis c is infinite, the zone *C* becomes a similar vertical series, parallel to axis c. The basal plane falls into each of these series. These vertical zones are two out of the many series that may exist in crystals.

b. Vertical Zones.—The planes $\frac{1}{2}a\,b\,c$ and $a\,b\,c$, in f. 139, are parts of a vertical series having intersections parallel to bc, and varying in the vertical axis. This series, as the vertical axis diminishes, finally terminates in the top plane $0a : 1b : 1c$; and as it increases, ends in the vertical plane $\infty a : 1b : 1c$, or the vertical plane i. This is a *zone* of planes, having the general expression $ma : 1b : 1c$; it includes the terminal plane, and the faces $\frac{1}{2}$, 1, 2, i.

The planes $2\breve{2}$ and $i\breve{2}$ are in another zone. The fact of a horizontal intersection between them is proved as already explained, and it follows that all planes having, in like manner, the ratio for the lateral axes $2b : 1c$, will have horizontal intersections. This series is the zone $m : 2 : 1$, (or $ma : 2b : 1c$.)

It follows also, that whatever the ratio of b to c, all planes of like ratio will have horizontal intersections, (the planes of the axes $b : c$ being assumed to be horizontal), and consequently *there will be as many vertical zones as there may be values of $b : c$.*

Again, the planes $\frac{1}{2}\breve{i}$ $1\breve{i}$, $2\breve{i}$, $i\breve{i}$ (f. 139) are in a similar zone parallel to axis b, in which, therefore, $b = \infty$; the general expression is $m : \infty : 1$, (or $ma : \infty b : 1c$). As the vertical axis increases, m increases, and when $m = \infty$, the plane is vertical. *nnoo*, *nnpp*, *nnqq*, *nnyy*, illustrates the series; the last corresponds to the plane $i\breve{i}$. A similar series, on the other edge and solid angle of the rhombic prism, would have the general expression $m : 1 : \infty$, (or $ma : 1b : \infty c$.)

Hence, the second law:—

II. *Planes which have their mutual intersections horizontal, (the plane of the lateral axes being horizontal), are identical in the ratio between their lateral axes; and the converse.*

A tabular view of these vertical zones is here presented. The 0 stands for the basal plane, in which each zone terminates above. The first column corresponds to a vertical zone parallel to axis c; the second, to other zones with $1b : nc$ as the ratio of the lateral axes, in which n has a different value for each possible zone; the third, for the fundamental series, in which the ratio of the lateral axes is $1b : 1c$; the fourth, for other zones having the ratio of the lateral axes $nb : 1c$; the fifth, for the zone parallel to axis b. We have used l for any fraction less than a unit, m and n for numbers greater than a unit.

0				
$l : 1 : \infty$	$l : 1 : n$	$l : 1 : 1$	$l : n : 1$	$l : \infty : 1$
$1 : 1 : \infty$	$1 : 1 : n$	$1 : 1 : 1$	$1 : n : 1$	$1 : \infty : 1$
$m : 1 : \infty$	$m : 1 : n$	$m : 1 : 1$	$m : n : 1$	$m : \infty : 1$
$\infty : 1 : \infty$	$\infty : 1 : n$	$\infty : 1 : 1$	$\infty : n : 1$	$\infty : \infty : 1$

Expressions for planes in the different Crystallographic Systems.—The several systems of crystallization, since they differ in their axes, require each some peculiarity in the expressions used for their planes.

In the *Monometric* system, as the axes are all equal, there is correctly no vertical axis, and $a = b = c$. Either of the faces of a cube is hence expressed by $\infty : 1 : \infty$; the truncation of an edge (face of a dodecahedron) by $\infty : 1 : 1$; the truncation of an angle (face of an octahedron) by $1 : 1 : 1$; and $m : 1 : 1$; $m : m : 1$, $m : n : 1$, for other planes.

In the *Dimetric* system, the *vertical* is a varying axis; but $b = c$. The vertical faces of the prism (f. 2) will be expressed by the same symbol as the faces of the cube, $\infty : 1 : \infty$; the first term being considered here and elsewhere as referring to the axis a. The terminal plane is more conveniently considered as having the vertical axis reduced to zero, (0), as above illustrated. A prism diagonal with the prism just alluded to (or that truncating its edges, f. 77) will have the ratio $\infty : 1 : 1$. Planes parallel to either axis b or c, (on the basal edges, as in f. 83), will have alike the general expression, $m : \infty : 1$.

In the *Trimetric* system, the lateral axes differ from one another, as well as from the vertical. Hence one vertical face of the rectangular prism (f. 3) has the expression $\infty : 1b : \infty c$, and the other $\infty : \infty b : 1c$. This expression is made more concise by using in place of the letters, the mark $-$ for the longer lateral axis, and $\smile$ for the shorter. Thus, considering b shorter than c, the expression $\infty : 1b : \infty c$ becomes $\infty : \breve{1} : \bar{\infty}$; and $\infty : \infty b : 1c$, becomes $\infty : \breve{\infty} : \bar{1}$, which last means simply that the plane is parallel to the shorter lateral axis, this being *infinite*, (∞). So in all other cases, the general formula $ma : nb : rc$, becomes $m : \breve{n} : \bar{r}$, signifying that the plane has for its parameters, m times the vertical axis, n times the shorter lateral, and r times the longer lateral, whatever in any case may be the values of m, n, r. The lateral planes of the rhombic prism have the ratio $\infty : 1 : 1$.

In the *Monoclinic* system, one of the lateral axes is inclined to the vertical, and the other not. The expression $ma : nb : rc$, in this system, is abbreviated by using an accent for the inclined axis; thus the ratio becomes $m : \grave{n} : r$. In the prism, f. 5, the right hand lateral plane has the expression $\infty : \grave{\infty} : 1$; and the front plane, the expression $\infty : \grave{1} : \infty$; while the planes on the edges, or the lateral plane of 6, have the ratio $\infty : 1 : 1$, the same as for the right rhombic prism. Again, the planes on the angles of f. 114, as they are parallel to the clinodiagonal, come under the general expression $m : \grave{\infty} : 1$. Owing to the inclination of the vertical axis, the planes in front, above the plane of the axes *BB*, *CC*, differ from those below; and the two are distinguished by the signs for plus and minus, as in f. 112, 113.

The *Triclinic* and *Hexagonal* systems will be the subject of remarks on a following page.

System of Notation.—The ratios above given are inconveniently long for use in the descriptions of crystals, and have been abbreviated by Naumann. In all cases, one of the last two terms in these ratios may be a unit. Thus the ratio $6 : 3 : 2$ is equal to $3 : \frac{3}{2} : 1$. We may therefore indicate the ratio of b to c by simply a single figure. Thus, $\frac{3}{2}$, in this case, is as explicit as $\frac{3}{2} : 1$, when we wish only the general expression. Hence, $3 : \frac{3}{2}$ would express accurately the plane. Naumann writes the 3 (or number referring to the vertical axis) before a P, and the other figure after, thus, $3P\frac{3}{2}$; so also $\infty P\infty$; ∞P, (for $\infty P1$, the unit being implied); $3P$, (for $3P1$, as in the last); and generally mPn, for any plane. In the monometric system, the letter O, (initial of Octahedron), is adopted in place of P. The letter has no special meaning, and the expression is as explicit and more concise, when written without it, thus, 3-$\frac{3}{2}$, istead of $3P\frac{3}{2}$; 3 instead of $3P$; ∞-∞, instead of $\infty P\infty$; m-n, instead of mPn. In some cases, however, the use of the letter is convenient, and especially for hemihedral crystals.

In the *Trimetric* system, the expressions become $\infty : \breve{\infty}$, corresponding to $\infty : \breve{\infty} : 1$; 3-$\breve{2}$, corresponding to $3 : \breve{2} : 1$; m-$\bar{n}$ for $m : 1 : \bar{n}$, or m-$\breve{n}$, for $m : \breve{n} : 1$. Naumann writes $m\bar{P}n$, or $m\breve{P}n$. It is preferable to place the long or short mark over the figure referring to the longer or shorter, respectively, of the lateral axes, as $mP\bar{n}$, or $mP\breve{n}$.

In the *Monoclinic* system, $m : 1 : n$ becomes m-n, (or mPn); and $m : \grave{n} : 1$, becomes m-$\grave{n}$($mP\grave{n}$).

The symbol for a plane is used for the whole form which the planes of a kind constitute. Thus the general symbol for a plane of the regular octahedron (O or 1) is used to designate the octahedron; the general symbol of a face of the cube, ($\infty O\infty$, or ∞-∞), indicates the cube as a whole.

The *Zones* alluded to on a preceding page, are well exhibited through these symbols. Thus, if we write l for any number less than a unit, and m and n for any numbers greater, the series in the dimetric and trimetric systems will be as follows:

Dimetric System.

0		
l	l-n	l-∞
1	1-n	1-∞
m	m-n	m-∞
∞	∞-n	∞-∞

Trimetric System.

0				
l-$\bar{\infty}$	l-$\bar{n}$	l	l-$\breve{n}$	l-$\breve{\infty}$
1-$\bar{\infty}$	1-$\bar{n}$	1	1-$\breve{n}$	1-$\breve{\infty}$
m-$\bar{\infty}$	m-$\bar{n}$	m	m-$\breve{n}$	m-$\breve{\infty}$
∞-$\bar{\infty}$	∞-$\bar{n}$	∞	∞-$\breve{n}$	∞-$\breve{\infty}$

In the table for the *dimetric* system, the column 1 is a series of octahedrons ending below in a square prism; 2, different series of 8-sided pyramids, m-n, one for each possible value of n, and ending below in corresponding 8-sided prisms; 3, series of octahedrons diagonal to those of column 1, and ending in the diagonal prism. The basal plane 0 is the upper termination of each series or zone.

The table includes an eighth of an upper half of the crystal, the same planes occurring in each of the eight sections.

In the table for the *trimetric* system, column 1 is the zone parallel to the macrodiagonal, consisting of macrodomes, and ending below in the vertical plane; 3, the fundamental zone; 5, the brachydiagonal zone; 2 and 4, zones, *m-n*, either side of the fundamental zone. The table includes a *fourth* of an upper half of a crystal, the same being repeated in each fourth around.

The monoclinic system is similarly presented in the following table:

		0		
l-∞	*l*-*n*	*l*	*l*-*ǹ*	*l*-∞̀
1-∞	1-*n*	1	1-*ǹ*	1-∞̀
m-∞	*m*-*n*	*m*	*m*-*ǹ*	*m*-∞̀
∞-∞	∞-*n*	∞	∞-*ǹ*	∞-∞̀
−*m*-∞	−*m*-*n*	−*m*	−*m*-*ǹ*	*m*-∞̀
−1-∞	−1-*n*	−1	−1-*ǹ*	1-∞̀
−*l*-∞	−*l*-*n*	−*l*	−*l*-*ǹ*	*l*-∞̀

Column 1 is the orthodiagonal zone, or series parallel to the orthodiagonal; 3, the fundamental series of octahedrons, the ratio of the lateral axes being 1*b* : 1*c*, and containing also the fundamental rhombic prism; 5, the clinodiagonal series; 2 and 4, zones between the fundamental zone and the orthodiagonal series on one side, and the clinodiagonal on the other, each having its rhombic prism. The middle horizonal line of planes, ∞-∞, ∞-*n*, ∞, &c., is a series of vertical prisms; the planes above it are +, those below are —, excepting in the 5th column, in which those above and below are alike as they are clinodomes, (see page 43). The table comprises a fourth of the crystal, including the parts below as well as those above the middle section.

The various secondary planes of crystals often have a general relation among themselves, which is worthy of more study than it has yet received. Under Humite, figures are given, (taken, with a change in the notation, from a paper by M. Scacchi), which show a remarkable arithmetical progression in the series of planes. Thus in one zone, there are the octahedral planes $\frac{3}{10}$, $\frac{3}{8}$, $\frac{3}{6}$, $\frac{3}{4}$, $\frac{3}{2}$; in another figure, the planes $\frac{2}{7}$, $\frac{2}{5}$, $\frac{2}{3}$, $\frac{2}{1}$; in a third, the series, $\frac{4}{15}$, $\frac{4}{13}$, $\frac{4}{11}$, $\frac{4}{9}$, $\frac{4}{7}$, $\frac{4}{5}$, $\frac{4}{3}$, $\frac{4}{1}$; and other examples of similar character are seen in the same figures. It is evident that the planes of each type belong together in one system and have a mutual dependence.

In other species similar series may be observed, although they have not hitherto been as clearly made out. Among the concurrent crystals of the same locality, many different forms often occur, which are due to a simplification merely of a specific type, by a dropping of one and another plane; and such forms, however various, constitute therefore but one system. At other localities there is often a very different series of planes, many of which are peculiar to the place, or occur only in the combination there observed. The mutual dependence of the planes is such that they essentially belong together as much as the different parts of a curve of a given equation. It is customary to mention the known combinations of forms of a species, enumerating even those which are mere simplifications of a given type, and giving the whole equal importance. The distinction of the various forms of each species into separate types of dependent series remains to be studied out.

The fact that the axes of crystals have specific dimensions, is at the basis of the relation by multiples upon which the arrangement of the planes depends. In the monometric system, as the axes are equal, the positions of the planes are independent of any given length. Thus, if we find a plane on an edge of a cube inclined to its face at an angle of 153° 26′, as Rb on ba, (f. 142), the ratio of Pb to Pa (equivalent to the ratio of the axes of the plane ab) will be found to be 1 : 2, indicating that the plane has the ratio 1 : 2 : ∞. In the triangle Pba, the angle Pab=153° 26′ —90°=63° 26′; and then the ratio Pa (=1) : Pb : : R : tan 63° 26′=1 : 2.

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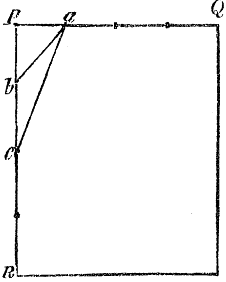

But in the dimetric and other systems, the inclinations of the planes afford the ratios not simply of m : n, as in the monometric system, but of ma : nb, (or ma : n, making b=1), etc., the lengths of one or more of the axes being included in the ratio. In deciding upon the planes to be considered those of the fundamental series, in a dimetric or trimetric crystal, and particularly upon the plane that will give the length of the fundamental vertical axis, or of the lateral axes, we may be, at times, guided by an octahedral cleavage, in which case the cleavage plane will be the face 1 : 1 : 1,—or 1 : 1 : ∞. In the trimetric system, there is often a vertical cleavage, parallel to the faces of a rhombic prism, which rhombic prism would be therefore the fundamental prism ∞ : 1 : 1; and when that is the case, the angle of the prism indicates at once the ratio of the lateral axes. If this angle, for example, is 100°, we have this angle of a rhomb to determine the ratio of the diagonals, (the lateral axes); the diagonals divide the rhomb into four right angled triangles, each having angles of 50° and 40°; and hence the ratio b (=1) : c : : R : tan 50°, which gives the value of c.

In the majority of cases, for one or more of the axes, some plane must be empirically assumed to be that based on the ratio of unity; and in deciding upon which, we may be guided often by finding some plane more frequent than others in occurrence; or by detecting analogies with some other species; or by the desirableness of having such a plane as will give the most simple expressions for the ratios of the other planes, an arbitrary criterion often convenient, rather than correct. We arrive in any case, at a ratio for the axes, upon which the whole structure of the crystal is based. If, for example, we obtain as the axial ratios of $a : b$, for a series of planes, 2·4 : 1, 1·2 : 1, 0·6 : 1, it matters little which plane is assumed as fundamental. If the first, then $a=2{\cdot}4$, $b=1$; and then the planes will be in order, $1:1:\infty$, $\frac{1}{2}:1:\infty$, $\frac{1}{4}:1:\infty$. But if we take the second as the fundamental one, (as would probably be done), then $a=1{\cdot}2$, $b=1$, and the ratios for the planes will be $2 : 1 : \infty$, $1 : 1 : \infty$, $\frac{1}{2} : 1 : \infty$. Both indicate the same general relation among the planes. The calculation of the axes in such a case, by plane trigonometry, would be similar to that above. The inclination of the plane on the base of a crystal, subtracted from 180°, (or diminished by 90°), gives the angles of the triangle Pba, and then working the triangle by the equation, $Pa\ (=1) : Pb :: R : \tan Pab$, we have, as the result, a ratio like one of the above. Pursuing the same with another plane as $a\,c$, another ratio will be obtained, which is some multiple of the first.

In the trimetric and triclinic systems either of the three axes may be called the *vertical*, and authors are not all agreed on this point with regard to particular minerals. So also in the monoclinic system, where there is no cleavage to determine the plane $0P$, or that of the lateral axes, this plane must be assumed from analogy or arbitrarily as the case may be. Still, in comparing the angles of different species, it is necessary to ascertain, by some facts or analogies, which are actually the *homologous* axes, as only such are properly related.

It is convenient to remember that when RPQ is a right angle, the sum of the angles Rca, Qac, is 270°; or whatever the angle, RPQ, $Rca+Qac=180°+RPQ$. If RPQ is 100°, then $Rca+Qac=280°$. Another elementary fact in geometry of frequent use in crystallography is, that the sum of the two angles cPa and caP of the triangle cPa, equals the external angle Rca. So that Rca being known, Pac is found by subtracting aPc, the angle of the edge, from Rca.

Plane and spherical trigonometry may be used also for determining the axes from any given planes, and for ascertaining the angles from the axes. But the calculations by means of equations derived from analytical geometry are the most complete, and most general in their application; and to these we now proceed, presenting more in detail many points barely glanced at in the preceding pages.

I. ORTHOMETRIC SYSTEMS.*

I. GENERAL FORMULAS.

1. *Inclinations between planes of different forms, or unlike planes.*

1. The parameters of any plane have been stated to be an expression of the position of this plane with reference to the axes. Thus, in f. 40, the parameters of a plane ABC, are AO, BO, CO, or $a : b : c$, AA', BB', CC' being three rectangular axes, each bisected at O. The plane ABC' is similar in its parameters, except that the axis $C'O$ is on the opposite side of O. Hence the ratio is $a : b : -c$.

For a like reason, the parameters of $AC'B'$ are $a : -b : -c$.
" " $AB'C$ " $a : -b : c$.
" " $A'BC$ " $-a : b : c$.
" " $A'BC'$ " $-a : b : -c$.
" " $A'C'B'$ " $-a : -b : -c$.
" " $A'B'C$ " $-a : -b : c$.

In the employment of general formulas, and substituting the values of the parameters in the equations, the signs should be carefully regarded. In most cases that come up for calculation, the planes are in the same octant and are then of the same signs.

2. Representing the parameters of any plane by $a : b : c$, and also of any other plane by $a' : b' : c'$, and placing W for the supplement of their mutual inclination,

$$\text{Cos } W = -\frac{aa'bb'+cc'aa'+bb'cc'}{\sqrt{(a^2b^2+c^2a^2+b^2c^2)}\sqrt{(a'^2b'^2+c'^2a'^2+b'^2c'^2)}}$$

In using this equation, the actual values of the parameters are to be substituted for the letters. For the planes m-n, m'-n', in the same octant, in which the parameters would be $ma : b : nc$, and $m'a : b : n'c$,

ma, b, nc are substituted severally for a, b, c.
$m'a$, b, $n'c$ " " " a', b', c'.

2. *Equations for determining the Parameters of planes by their intersections.*

3. When in a zone of planes, a plane $m'' : n'' : r''$ makes parallel intersections between two planes $m' : n' : r'$ and $m : n : r$, the relation of m, n, r, for either one of these planes may be ascertained, if their values for the other two planes are known, by means of the equation

$$\frac{1}{mn'r''}+\frac{1}{nr'm''}+\frac{1}{rm'n''}=\frac{1}{mn''r'}+\frac{1}{nr''m'}+\frac{1}{rm''n'}.$$

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* The following pages are a condensed abstract from Naumann's very elaborate treatise on Crystallography.

In using the equation, the values of m and n, (or m, n, r), in two of the planes, are to be substituted for the letters, (not neglecting to note the signs as above explained, when the planes belong to different octants), and the equation then reduced. If r, r', r'', each equals 1, the equation becomes for the planes $m\text{-}n$, $m''\text{-}n''$, $m'\text{-}n'$:—

$$\frac{1}{mn'}+\frac{1}{nm''}+\frac{1}{m'n''}=\frac{1}{mn''}+\frac{1}{nm'}+\frac{1}{m''n'}.$$

This equation is simplified for other forms in the following table: the plane of which the relation for m'' and n'' is required, is supposed to make parallel intersections between a plane mentioned on the margin of the table and another over the column of formulas. For the first of the equations, the simplification consists in substituting m' for the n' in the general equation, since $m'\text{-}m'$ is substituted for $m'\text{-}n'$; in the third, 1 is substituted for n'; in the fourth ∞ for n', and so on, the equation being reduced after the substitution. Several of these equations are deducible from the explanations on pages 53 to 56.

When ∞ enters into the equation, on reducing it, all the terms not containing ∞ as a coefficient are expunged, a result that follows necessarily, from dividing the whole equation by infinity; and if ∞^2 occurs, all but the terms containing ∞^2 are for a like reason dropped.

a. Form $m\text{-}n$.

$m'\text{-}m'$, $(n'=m')$	1. $m''(m-m')n+n''(m'-n)m-m''n''(m-n)=0.$
$m'\text{-}2$, $(n'=2)$	2. $m''n''(m'n-2m)+2m''(m-m')n+n''(2-n)mm'=0.$
m', $(n'=1)$	3. $m''n''(m'n-m)+m''(m-m')n+n''(n-1)mm'=0.$
$m'\text{-}\infty$	4. $m''(m-m')n+n''(m'-m'')m=0.$
$\infty\text{-}n'$, $(m'=\infty)$	5. $m''(n''-n')n+n''(n'-n)m=0.$
$\infty\text{-}2$	6. $m''(2-n'')n-n''(2-n)m=0.$
∞	7. $m''(n''-1)n-n''(n-1)m=0.$
1	8. $m''(m-1)n-n''(n-1)m-m''n''(m-n)=0.$
$\infty\text{-}\infty$	9. $\frac{m''}{n''}=\frac{m}{n}$
0 (basal plane)	10. $n''=n.$

b. $m\text{-}m$, in which $n=m$.

m', $(n'=1)$	1. $m''n''(m'-1)+m''(m-m')-n''(m-1)m'=0.$
$m'\text{-}\infty$	2. $m''(m-m')m+n''(m'-m'')m=0.$
$\infty\text{-}n'$, $(m'=\infty)$	3. $m''(n''-n')+n''(n'-m)=0.$
∞	4. $m''(n''-1)-n''(m-1)=0.$
1	5. $m''=n''$, $m''<m.$
$\infty\text{-}\infty$	6. $m''=n''$, $m''>m.$

c. $m\text{-}2$, in which $n=2$.

m'	1. $m''n''(m-2m')+2m''(m'-m)+nm'n''=0.$
$m'\text{-}\infty$	2. $2m''(m-m')+n''(m'-m'')m=0.$
$\infty\text{-}n'$	3. $2m''(n''-n')-n''(2-n')m=0.$
∞	4. $n''(2m''-m)-2m''=0.$

d. m, in which $n=1$.

$m'\text{-}\infty$	1. $m''(m-m')+n''(m'-m'')m=0.$
$\infty\text{-}n'$	2. $m''(n''-n')+n''(n'-1)m=0.$
$\infty\text{-}2$	3. $2m''-n''(m''+m)=0.$
∞	4. $n''=1,\ m''>m.$
1	5. $n''=1,\ m''<m.$
$\infty\text{-}\infty$	6. $\frac{m''}{n''}=m.$

e. $m\text{-}\infty$, in which $n=\infty$.

$\infty\text{-}n'$	1. $n''(m''-m)-m''n'=0.$
∞	2. $n''(m''-m)-m''=0.$

f. $\infty\text{-}n$, in which $m=\infty$.

1	1. $m''(n''-n)+n''(n-1)=0.$

g. $\frac{(m\text{-}n)}{2}$ (in the Monometric System.)

$\frac{(m'\text{-}n')}{2}$	$m''n''(m'n+mn')-m''(m+m')nn'+n''(n'-n)mm=0.$
$\frac{(m')}{2}$	$m''n''(m'n+m)-m''(m+m')n-n''(n-1)mm'=0.$
$\frac{(1)}{2}$	$m''n''(m+n)-m''(m+1)n-n''(n-1)m=0.$

h. $\frac{(m\text{-}m)}{2}$.

$\frac{(m'\text{-}m')}{2}$	$2m''n''-m''(m+m')+n''(m'-m)=0.$
$\frac{(m')}{2}$	$m''n''(m'+1)+m''(m+m')-n''(m-1)m'=0.$
$\frac{(1)}{2}$	$2m''n''-m''(m+1)-n''(m-1)=0.$

3. *General relation of Planes of Orthometric forms, in the same vertical zone.*

4. The angles between the planes of any vertical zone, ($m\text{-}n$, m or $m\text{-}\infty$), and the basal plane (0) of the type-prism being given, subtract each from 180°; then the tangents of the resultant angles will vary as the values of m in the zone. That is, calling this angle for $m\text{-}n$, I, and for $m'\text{-}n$ in the same zone, I', then—

$$\text{Tan } I : \tan I' = m : m'; \text{ or if } m=1,\ \tan I' = m' \tan I.$$

The law holds for the *hexagonal system*, as well as the monometric, dimetric, and trimetric.

Either face of the type-prism in the rectangular systems, may be taken as the basal; and the planes of the zones which in this new position become vertical, (or their intersections horizontal), have essentially the same relation. In this case, the angle I is the inclination on the assumed base, and m is the coefficient of the axis at right angles to this base, which axis becomes for the time the vertical.

II. MONOMETRIC SYSTEM.

1. *Inclinations between planes of different forms.**

5. In the monometric system, since the axes are equal, ($a=b=c=1$), the values of m, n, in equations, stand for the axes. m-n is a general expression for holohedral planes or forms; $\frac{(m\text{-}n)}{2}$ for inclined hemihedrons, (as in f. 53 to 66), $\frac{[m\text{-}n]}{2}$ for parallel hemihedrons, (as f. 67 to 75).

6. The general equation for the mutual inclination of two planes m-n, m'-n', is

$$\text{Cos } Q = \frac{mm'\ (nn'+1)+nn'}{\sqrt{(m^2\ (n^2+1)+n^2)}\ \sqrt{(m'^2\ (n'^2+1)+n'^2)}}$$

7. The following table contains this equation simplified for particular cases:

$M=\sqrt{m^2\ (n^2+1)+n^2}$, and (next page) $M'=\sqrt{m'^2\ (n'^2+1)+n'^2}$

	∞-∞	1	∞-n'	m'-m'
m-n	$\frac{mn}{M}$	$\frac{m\ (n+1)+n}{M\sqrt{3}}$	$\frac{m\ (nn'+1)}{M\sqrt{n'^2+1}}$	$\frac{m\ (m'n+1)+n}{M\sqrt{(m'^2+2)}}$
∞-n	$\frac{n}{\sqrt{n^2+1}}$	$\frac{n+1}{\sqrt{3}\sqrt{(n^2+1)}}$	$\frac{nn'+1}{\sqrt{(n^2+1)\ (n'^2+1)}}$	

The angle between m-n and ∞-n' is obtained by means of the equation opposite m-n and under ∞-n'; and by making $n'=1$, this becomes the expression for m-n on ∞, or the face of the dodecahedron.

From this table, the inclinations of any form on a face of the cube, octahedron, or dodecahedron, may be calculated.

8. For *inclined hemihedrons*, when the planes are both *plus* or both *minus*, the formula is the same as for holohedral forms; but when one is plus and the other minus, the formula becomes for $\frac{(m\text{-}n)}{2}$ on $-\frac{(m'\text{-}n')}{2}$

$$\text{Cos } Q = \frac{mm'\ (nn'+1)-nn'}{\sqrt{m^2\ (n^2+1)+n^2}\ \sqrt{m'^2\ (n'^2+1)+n'^2}}$$

---

* Besides the logarithms usually given in published tables, the following are required in using the formulas beyond. Log. $\sqrt{3}=0{\cdot}2385606$; log. $\sqrt{\tfrac{1}{3}}=9{\cdot}7614394$; log. $\sqrt{2}=0{\cdot}1505150$; log. $\sqrt{\tfrac{1}{2}}=9{\cdot}8494850$.

and for $\frac{(m\text{-}2)}{2}$ on $-\frac{(1)}{2}$ or a tetrahedal face,

$$\text{Cos } Q = -\frac{m\,(n+1)-n}{M\sqrt{3}}.$$

9. In *parallel hemihedrons*, for planes of like signs, the formula is the same as for holohedral forms; for analogous planes of unlike signs, $\frac{[m\text{-}n]}{2}$ on $-\frac{[m'\text{-}n']}{2}$.

$$\text{Cos } Q = -\frac{m'n\,(mn'+1)+mn'}{MM'}$$

For $\frac{[m\text{-}n]}{2}$ on $-\frac{[\infty\text{-}n']}{2}$ $\quad \text{Cos } Q = -\frac{n\,(mn'+1)}{M\sqrt{(n'^2+1)}}$

For $\frac{[\infty\text{-}n]}{2}$ on $-\frac{[\infty\text{-}n']}{2}$ $\quad \text{Cos } Q = -\frac{nn'}{\sqrt{(n^2+1)}\ \sqrt{(n'^2+1)}}$

2. *Inclinations between planes of the same form.*

10. For *m-n*, using the letters *A B C* for the edges on which they are placed in figure 51, and *N* for $m^2n^2+m^2+n^2$,

$$\text{Cos } A = -\frac{mn\,(mn+2)}{N} \qquad \text{Cos } B = -\frac{m^2\,(n^2+1)\ -n^2}{N}$$

$$\text{Cos } C = -\frac{n\,(2m^2+n)}{N}$$

For ∞-*n*, (f. 34), $\quad \text{Cos } A = -\frac{n^2}{n^2+1} \qquad \text{Cos } C = -\frac{2n}{n^2+1}$

$$\text{Tan } \tfrac{1}{2}C = \frac{n+1}{n-1}$$

For *m-m*, (f. 39), $\quad \text{Cos } B = -\frac{m^2}{m^2+2} \qquad \text{Cos } C = -\frac{2m+1}{m^2+2}$

$$\text{Tan } \tfrac{1}{2}B = \sqrt{m^2+1}$$

For *m*, (f. 49), $\quad \text{Cos } A = -\frac{m^2+2m}{2m^2+1} \qquad \text{Cos } B = -\frac{2m^2-1}{2m^2+1}$

$$\text{Tan } \tfrac{1}{2}B = m\sqrt{2}$$

11. In *inclined hemihedrons*, as $\frac{(m\text{-}n)}{2}$, f. 65, A' and C', are dedetermined by the same formulas as above.

$$\text{Cos } B' = -\frac{mm\,(mn-2)}{N}$$

12. In *parallel hemihedrons*, as $\frac{[m\text{-}n]}{2}$, f. 74, B'' is determined by the same formula as above.

$$\text{Cos } A'' = -\frac{m^2\,(n^2-1)+n^2}{N} \qquad \text{Cos } C'' = -\frac{mn\,(m+n+1)}{N}$$

For ∞-n, as in figure 69,

$$\operatorname{Cos} A''=-\frac{n^2-1}{n^2+1} \qquad \operatorname{Cos} C''=-\frac{n}{n^2+1}$$

3. *Determination of* m *and* n *by inspection.*

13. The following table gives data for determining the parameters of planes in monometric crystals by inspection. The first line would read, if written out in full, m-n has edge A truncated by m'-m' when $m'=\frac{2mn}{m+n}$ and if m-n=4-2, then $m'=\frac{2\times4\times2}{4+2}=\frac{16}{6}=\frac{8}{3}$ and m'-m', therefore, equals $\frac{8}{3}$-$\frac{8}{3}$. The same explanation answers for the rest of the table.*

a. m-n, (f. 51).	1. Edge A truncated by m'-m', when	$m'=\frac{2mn}{m+n}$
	2. Edge C truncated by m',	$m'=\frac{m(n+1)}{2n}$
	3. Edge B truncated by ∞-n',	$n'=n$
	4. Solid angle a truncated by rhombic plane ∞, (f. 52),	$n=\frac{m}{m-1}$
	5. Solid angle b truncated by 1,	$n=\frac{2m}{m+1}$
b. m-m, (f. 39).	S-A. a repl. by 4 pl., I-E. parallel to symmetrical diagonal of face,	$\frac{1}{3}m=\frac{m'n}{m'+n'}$
	2. Edge C truncated by m',	$m'=\frac{m+1}{2}$
	3. S-A. a repl. by 2 pl. m', incl. on edge C, I-E. par. to edge B of m-m,	$m'=m$
	4. Edge B truncated by ∞-n'	$n'=m$
	5. S-A. a repl. by 2 pl. ∞-n', incl. on edge B; I-E. of opposite pl. with the same face of m-m parallel, (f. 46),	$n'=\frac{1}{2}m$
	6. S-A. c repl. by 4 pl. ∞-n', incl. on B; I-E. par. to C,	$n'=m+1$
	7. S.A. a truncated by ∞; I-E. of opposite pl. with same face of m-m parallel; f. 43, 44, planes I,	$m=2$
c. m. (f. 49).	1. S-A. c repl. by 8 pl. m'-n'; I-E. of 2 pl. incl. on same face of m parallel,	$2m=\frac{m'(n'+1)}{n'}$
	2. S-A. c repl. by 4 pl. m'-m' incl. on edge A; I-E. of two pl. with same face of m parallel,	$m'=2m-1$
	3. Edge A truncated by m'-m',	$m'=\frac{2m}{m+1}$
	4. S-A. c repl. by 4 rbc. pl. m'-m', incl. on A of m,	$m'=m$
	5. S-A. c repl. by 4 rbc. pl. ∞-n' incl. on B,	$n'=\frac{m}{m-1}$

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* The following abbreviations are used in this and similar tables: *Trunc.* truncated; *Repl.*, replaced; *Bev.*, beveled; *A.*, angle; *S-A.*, solid angle; *E.*, edge; *I-E.*, edge of intersection of two planes; *Par.*, parallel; *Pl.*, planes; *Inc.*, inclined; *Rbc.*, rhombic; *Term.*, terminal.

	6. S-A c repl. by 4 pl. ∞-n' incl. on B; I-E. with a face of m par. to edge A,	$n=\frac{m'^2-1}{m'^2-m'}$
	7. Edge B truncated by ∞.	
d. ∞-n.	(f. 33, 34). 1. S-A. b repl. by 6 pl. m'-n'; I-E. of pl. incl. on same face of ∞-n parallel,	$n'=n$
	2. Edge A truncated by m'-m', incl. on edge A,	$m'=2n$
	3. S-A. b repl. by 3 rbc. pl. m'-m', incl. on edges A,	$m'=n-1$
e. ∞	(f. 14). 1. Edges bevelled by m'-n'.	$n'=\frac{m'}{m'-1}$
	2. Edge truncated by m'-m', (f. 43),	$m'=2$
	3. Obtuse S-A. repl. by 3 pl. m', incl. on faces of ∞.	
f. 1.	(f. 11). 1. S-A. repl. by 8 planes m'-n'.	
	2. S-A. repl. by 4 pl. m'-m', incl. on faces of 1, (f. 41).	
g. ∞ - ∞.	(f. 1). 1. S-A. repl., by 6 pl. m'-n', (f. 50).	
	2. S-A. repl. by 3 pl. m'-m', incl. on O, (f. 37).	
	3. S-A. repl. by 3 pl. m', incl. on edge, (f. 47).	
h. $\frac{(m\text{-}m)}{2}$	(f. 59). 1. Edge C′ trunc. by $+\frac{(m')}{2}$ (f. 64),	$m'=\frac{m+1}{2}$
	2. Acute S-A. by 6 pl. ∞-n'; I-E. par to edge, C′, (f. 62),	$n'=m+1$
	3. Acute S-A. repl. by 3 rbc. pl. ∞; I-E. of two planes on face of $\frac{(m\text{-}m)}{2}$ parallel,(f. 63).	$m=2$
	4. Edge B′ trunc. by ∞ - ∞.	
	5. Obtuse S-A. trunc, by $+\frac{(1)}{2}$ (f. 61).	
	6. Acute S-A. trunc. by $-\frac{(1)}{2}$.	
i. $\frac{[m\text{-}n]}{2}$	(f. 74). 1. Edge B″ beveled by $\frac{[m'\text{-}n']}{2}$	$n'=n$, $m'>m$
	2. Edge A″ beveled by do.	$m'=''$, $n'>n$
	3. Edge B″ trunc. by $\frac{[\infty\text{-}n']}{2}$	$n'=n$
	4. Edge A″ trunc. by $-\frac{[\infty\text{-}n']}{2}$	$n'=m$
	5. Edge A″ beveled by m'-m',	$m'=m$
	6. Edge C″ repl. by m'-m',	$m'=\frac{(mn-1)mn+(m-n^2)m}{(m^2-n)n}$
k. $\frac{[\infty\text{-}n]}{2}$	(f. 69). 1. Inequilateral S-A. c'' by pl. $-\frac{[\infty\text{-}n]}{2}$ incl. on Edge A″; I-E par. to transverse diagonal,	$n'=n$
	2. Equilat. S-A. trunc. by 1 (f. 71, 72).	

4. *Determination of* m *and* n *by calculation.*

14. In the following formulas,

ν=half the inclination of B on B over angle c, (fig. 51).

δ=half the inclination of B on B over angle a.

δ' = the inclination of C on the horizonal basal section.

ε = the inclination of C on the diagonal connecting S-A. b and its opposite. Tan $\varepsilon=\frac{(n-1)\sqrt{3}}{n+1}$.

1. In m-n,

a. Cos $\nu=\frac{\cos\frac{1}{2}A\sqrt{2}+\cos\frac{1}{2}B}{\sin\frac{1}{2}B}$; $n=\tan\nu$; $m=\tan\frac{1}{2}B\sin\nu$.

b. Cos $\varepsilon=\frac{2\cos\frac{1}{2}A+\cos\frac{1}{2}C}{\sin\frac{1}{2}C\sqrt{3}}$; $\delta'=144^\circ\,44'-\varepsilon$; $\tan\delta=\sin\delta'\tan\frac{1}{2}C$;

$n=\tan(135^\circ-\delta)$; $\frac{m(n+1)}{n}=\tan\delta'\sqrt{2}$.

c. Cos $\delta=\frac{\cos\frac{1}{2}C}{\cos\frac{1}{2}B}$; $\nu=135^\circ-\delta$; $n=\tan\nu$; $m=\tan\frac{1}{2}B\sin\nu$.

From H (angle between face of cube and the form m-n) and A, B, or C,

Sin $h'=\frac{\cos\frac{1}{2}A}{\sin H}$; $h=45^\circ+H$; $n\ \frac{\cot H}{\sin h}$.

Sin $\nu=\frac{\cos H}{\sin\frac{1}{2}B}$; $n\tan\nu$; $m=\tan\frac{1}{2}B\sin\nu$. $\frac{n-1}{n}=\frac{\cos\frac{1}{2}C\sqrt{2}}{\cos H}$;

$\sin h=\frac{\cot H}{n}$; $m=n\tan h$.

From O (angle between face of octahedron and form m-n) and A or B,

Cos μ $(=\alpha-35^\circ\,16')=\frac{\cos O}{\sin A\frac{1}{2}}$; $\cot\beta=\frac{\cot\frac{1}{2}A}{\sin\alpha}$; $m=\frac{\sqrt{2}}{\cot\alpha-\cot\beta}$;

$n=\frac{\sqrt{2}}{\cot\alpha+\cot\beta}$.

Cos $\delta=\frac{\cos O\sqrt{3}-\cos\frac{1}{2}B}{\sin\frac{1}{2}B\sqrt{2}}$; $n=\tan(45^\circ+\delta)$; $m=\tan\frac{1}{2}B\sin(45^\circ+\delta)$.

2. In m-m,

Cos $\nu=\cot\frac{1}{2}B$; $m=\tan\nu$; $\frac{1}{2}A=90^\circ$.

Cos $\varepsilon=\cos\frac{1}{2}C\sqrt{\frac{1}{3}}$; $\delta'=144^\circ\,44'-\varepsilon$; $m+1=\tan\delta'\sqrt{2}$.

Also, $m=\cot H\sqrt{2}$; $m=\tan(O+35^\circ\,16')\sqrt{2}$.

3. In m,

$m=\tan\frac{1}{2}B\sqrt{\frac{1}{2}}$. $\frac{1}{2}C=90^\circ$.

Cos $\varepsilon=2\cos\frac{1}{2}A\sqrt{\frac{1}{3}}$; $\delta'=144^\circ\,44-\varepsilon$; $m=\tan\delta'\sqrt{\frac{1}{2}}$.

Cot $H=\sin h$, and $m=\tan h$. $m=\tan(O+54^\circ\,44')\sqrt{\frac{1}{2}}$.

4. In ∞-n,

Cos $\nu=\cos\frac{1}{2}A\sqrt{2}$; $n=\tan\nu=\tan(135^\circ-\frac{1}{2}C)$.

$n=\cot H$. Cos $O\sqrt{\frac{3}{2}}=\cos\delta$, and $n=\tan(\delta+45^\circ)$.

15. The following are angles of many of the known monometric forms. *A*, *B*, *C*, stand for the angles named *A*, *B*, *C*, (or, in some cases, 2 *A*, 2 *B*, 2 *C*); H, O, are the inclinations of the forms on the face of a cube (hexahedron) or octahedron.

I.—HOLOHEDRAL FORMS.

	A.	*B.*	*C.*	*H.*	*O.*	
	° ′	° ′	° ′	° ′	° ′	
∞-∞ (f. 1)			90		125 16	
1 (f. 11)		109 28		125 16		
∞ (f. 14)	120			135	144 44	
∞-$\frac{5}{4}$	127 34		167 19	141 20	144 15	Perofskite.
∞-$\frac{4}{3}$	129 47		163 44	143 8	143 56	Diamond, Perofskite.
∞-$\frac{3}{2}$	133 49		157 23	146 19	143 11	Diamond, Perofskite, Blende.
∞-2 (f. 31)	143 8		143 8	153 26	140 16	Fluor, Salt, Garnet, Magnetite, Red Copper, Gold, Percylite, Copper, Silver.
∞-$\frac{5}{2}$	149 33		133 36	158 12	138 38	Fluor, Copper.
∞-3 (f. 34)	154 9		126 52	161 34	136 54	Fluor, Gray Copper, Amalgam.
∞-4	160 15		118 4	165 58	134 26	Silver.
∞-5	164 3½		112 37	168 41	132 48	Red Copper Ore.
$\frac{3}{2}$-$\frac{3}{2}$		121 58	160 15	136 35	168 41	Galena.
2-2 (f. 39)		131 49	146 27	144 44	160 32	Sal-Ammoniac, Fluor, Analcime, Sodalite, Leucite, Pyrochlore, Pyrites, Franklinite, Dufrenoysite, Amalgam.
$\frac{9}{4}$-$\frac{9}{4}$		135 48	119 38	147 15	157 25	Perofskite, Galena.
3-3 (f. 40)		144 54	129 31	154 36	150 30	Fluor, Spinel, Perofskite, Pyrochlore, Pyrites, Magnetite, Galena, Gold, Silver.
$\frac{3}{2}$	162 39½	129 31		115 15	169 49	Garnet.
2 (f. 49)	152 44	141 3½		109 28	164 12	Diamond, Fluor, Spinel, Franklinite, Perofskite, Magnetite, Cube Ore, Pyrites, Hauerite, Red Copper, Amalgam, Skutterudite, Galena.
3	142 8	153 28½		103 16	158	Fluor, Red Copper Ore, Galena.
3-$\frac{3}{2}$ (f. 51)	158 13	149	158 13	143 18	157 47	Diamond, Garnet, Magnetite, Red Copper, Amalgam.
4-2	162 15	154 47½	144 3	150 48	151 52	Fluor, Gold.
5-$\frac{5}{3}$	152 20	160 32	152 20	147 41	151 25	Magnetite.
7-$\frac{7}{3}$	158 47	165 2	136 47	155 42	145 46	Fluor.
$\frac{11}{3}$-$\frac{11}{5}$	166 57	152 7	140 9	152 4	151 47	Fluor.

PLANE ANGLES.

	a.		*b.*		*c.*	
	°	′	°	′	°	′
∞-$\frac{3}{2}$	50	14			79	31½
∞-2	48	11			83	37
∞-3	46	30½			86	59
2-2	82	15	117	2	78	28
3-3	81	26	112	53	84	16
2			118	4	30	58
3-$\frac{3}{2}$	86	56	56	15	36	48½
4-2	85	50	54	21½	39	48

II.—HEMIHEDRAL FORMS.

1. *Tetrahedral.*	*A.*		*B.*		*C.*		
	°	′	°	′	°	′	
1 (f. 55, 56)			60				Blende, Tennantite, Gray Copper, Boracite.
$\frac{3}{2}$	162	39½	82	10			Gray Copper.
2 (f. 60)	152	44	90				Diamond, Blende, Gray Copper.
3	142	8	99	5			
$\frac{3}{2}$-$\frac{3}{2}$			93	22	160	15	Tennantite.
2-2 (f. 59)			109	28	146	26½	Boracite, Tennantite, Gray Copper Bismuth Blende.
3-3			124	7	134	2	Gray Copper.
3-$\frac{3}{2}$	158	13	110	55½	158	13	Diamond, Gray Copper.
4-2	162	15	124	51	144	3	
2. *Pyritohedral.*							
∞-$\frac{3}{2}$*	112	37			117	29	Pyrites.
∞-2 (f. 69)	126	52			113	35	Pyrites, Cobaltine, Gersdorffite.
∞-3	143	8			107	27½	Pyrites, Hauerite.
∞-4	151	56			103	36½	Cobaltine.
3-$\frac{3}{2}$ (f. 74)	115	23	149		141	47	Pyrites, Hauerite, Cobaltine.
4-2	128	15	154	47½	131	49	Pyrites.
5-$\frac{5}{3}$	119	3½	160	32	131	5	Pyrites.

III. DIMETRIC SYSTEM.

8. *Inclination between planes of different forms.*

16. In the *dimetric* system, for the inclination of m-n on m'-n', in which (as the axes b, c, are equal, and may be taken each as 1)

$$a : b : c = \text{respectively } ma : n : 1,$$
$$a' : b : c = \quad \text{“} \quad m'a : n' : 1,$$

---

* In these pyritohedrons, *A* is the interfacial angle at the longer edge, and *C* that at either of the others.

Cos Q(the inclination sought)$=-\frac{mm'a^2(nn'+1)+nn'}{\surd(m^2a^2(n^2+1)+n^2)\ \surd(m'^2a^2(n'^2+1)+n'^2)}$

17. By substituting 1, ∞, or 0, for m or n in different forms, we have the following more simple formulas for certain cases. In the table, $M=\surd[m^2a^2\,(n^2+1)\,+n^2]$.

	0	∞-∞	∞-n'	$m'\,\infty$
m-n	$\frac{n}{M}$	$\frac{mna}{M}$	$\frac{ma(nn'+1)}{M\surd(n'^2+1)}$	$\frac{(mm'a^2+1)n}{M\surd(m'^2a^2+1)}$
m	$\frac{1}{\surd(2m^2a^2+1)}$	$\frac{ma}{\surd(2m^2a^2+1)}$	$\frac{ma(n'+1)}{\surd(2m^2a^2+1)\surd(n'+{}^21)}$	$\frac{mm'a^2+1}{\surd(2m^2a^2+1)\surd(m'^2a^2+1)}$
m-∞	$\frac{1}{\surd(m^2a^2+1)}$	$\frac{ma}{\surd(m^2a^2+1)\surd2}$	$\frac{mn'a}{\surd(m^2a^2+1)\surd(n'^2+1)}$	$\frac{mm'a^2+1}{\surd(m^2a^2+1)m\surd('^2a^2+1)}$
∞-n	0	$\frac{n}{\surd(n^2+1)}$	$\frac{nn'+1}{\surd(n^2+1)\surd(n'^2+1)}$	

18. The inclination of m-n on 0 (or basal plane) will be obtained by making cos $Q=-\frac{n}{M}$: so in other cases.

2. *Inclinations between planes of the same form.*

19. In the dimetric system, the forms m-n are double 8-sided pyramids, (f. 89); m and m-∞ are octahedrons, like f. 12 and 84; ∞-n are 8-sided prisms, (f. 79); ∞ and ∞-∞ are 4-sided prisms, (f. 77 and 2).

For X, Y, Z, in m-n, (see f. 89, in which the edge X is that connecting the vertical axis and a lateral axis),

$$\begin{array}{ll} \text{Cos } \tfrac{1}{2}X=\frac{ma}{M} & \text{Tan } \tfrac{1}{2}X=\frac{n\surd(m^2a^2+1)}{ma} \\ \text{Cos } \tfrac{1}{2}Y=\frac{ma(n-1)}{M\surd2} & \text{Tan } \tfrac{1}{2}Y=\frac{\surd(m^2a^2(n+1)^2+2n^2)}{ma(n-1)} \\ \text{Cos } \tfrac{1}{2}Z=\frac{n}{M} & \text{Tan } \tfrac{1}{2}Z=\frac{ma\surd(n^2+1)}{n} \end{array}$$

20. The formulas become for

m-m;	Tan $\tfrac{1}{2}X=\frac{\surd(m^2a^2+1)}{a}$	Tan $\tfrac{1}{2}Y=\frac{\surd(a^2(m+1)^2+2}{a(m-1)}$	Tan $\tfrac{1}{2}Z=a\surd(m^2+1)$.
m;	Tan $\tfrac{1}{2}X=\frac{\surd(m^2a^2+1)}{ma}$	$\tfrac{1}{2}Y=90°$	Tan $\tfrac{1}{2}Z=ma\surd2$.
m-∞;	$\tfrac{1}{2}X=90°$.	Tan $\tfrac{1}{2}Y=\frac{\surd(m^2a^2+2)}{ma}$	Tan $\tfrac{1}{2}Z=ma$.
∞-n;	Tan $\tfrac{1}{2}X=n$.	Tan $\tfrac{1}{2}Y=\frac{n+1}{n-1}$	$\tfrac{1}{2}Z=90°$.

21. Putting T for the angle of inclination of two planes of m-n, over the axial angle of the base, (F' on F''', f. 89), and U for

the inclination of two planes over the next basal angle, (F'' on F'''),

$$\operatorname{Tan}\tfrac{1}{2}T=\frac{man}{\sqrt{(m^2a^2+n^2)}} \qquad \operatorname{Tan}\tfrac{1}{2}U=\frac{ma(n+1)}{\sqrt{(m^2a^2(n-1)^2+2n^2)}}$$

3. *Determination of* m *and* n *by inspection.*

22. Under this head, it should be noted, that planes with horizontal intersections (the lateral axes being in a horizontal plane) have $n=n'$.

That planes truncating or beveling the terminal edges of any form $m'P$, or the edge X of any $m'Pn'$, have $m=m'$.

We again refer to the general laws on pages 53 to 56, which include many of the particular equations below.

The following table reads in the same manner as that under the monometric system; the first line, for example, is, m-n has its edge Y truncated by the plane m', when $m'=\frac{m\,(n+1)}{2n}$.

a. m-n	(f. 89). 1. Edge Y truncated by plane m', when	$m'=\frac{m\,(n+1)}{2n}$
	2. Term A. repl. by 4 rbc. pl. m', incl. on edge Y,	$m'=\frac{m}{n}$
	3. Basal A. at Y repl. by 2 pl. m', incl. on Y; I-E. par. to X, (f.90),	$m'=m$
	4. Edge X trunc. by m'-∞,	$m'=m$
	5. Term-A. repl. by 4 rbc. pl. m'-∞, incl. on X,	$m'=\frac{m\,(n-1)}{n}$
	6. Basal A. at X repl. by 2 pl. m'-∞, incl. on X, I-E. par. to Y,	$m'=\frac{m\,(n+1)}{n}$
	7. Basal edge trunc. by ∞-n',	$n'=n$
b. m'	(f. 62). 1. Term. edge bev. by m'-n', (f. 90),	$m'=m$
	2. Basal A. repl. by 4 pl. m'-n', I-E. par. to term. edges,	$\frac{m'}{n'}=m$
	3. Term. edge trunc. by m'-∞, (f. 85),	$m'=m$
	4. Basal A. repl. by 2 pl. m'-∞, incl. on Term. E., I-E. of two pl. with same face of m parallel, (f. 86),	$m'=2m$
c. m-∞	1. Term. E. bev. by m'-n', (sim. to f. 90).	$m=\frac{m'\,(n'+1)}{n'}$
	2. Basal A. rep. by 2 pl. m' incl. on Term-E.; I-E. of 2 pl. with same face of m-∞ par. (sim. to f. 86),	$m'=m$
	3. Term-E. trunc. by $m'P$, (f. 86).	$m'=\frac{1}{2}m$
	4. Basal E. bev., or Term-A. repl. by 4 pl. m'-∞ with horizontal intersections.	
d. $\frac{(m)}{2}$	(f. 91, 92). 1. Middle edges bev. by $\pm\frac{(m'\text{-}n')}{2}$	$\frac{m'}{n'}=m$
	2. Angles rep. by a pl. $-\frac{(m')}{2}$ I-E. par. to middle edges.	$m'=m$

3. Ang. repl. by 2 pl. m'-∞; I-E. of 2 pl. with same face of $\frac{(m)}{2}$ parallel, $m'=2m$
4. Angles repl. by ∞.
5. Middle edges truncated by ∞-2, (f. 94).

4. *Determination of* m *and* n *by Calculation.*

23. Let $\nu'=$ the inclination of X on base of pyramid m-n.
$\delta'=$ " Y " "
$\nu=$ half the angle of the base which edge X meets.
$\delta=$ " " " " " Y "

Tan ν (angle $\frac{1}{2}X$ of ∞-n) $=n$. Tan δ (angle $\frac{1}{2}Y$ of ∞-n) $=\frac{n+1}{n-1}$.

Tan $\nu'=ma$. Tan $\delta'=\frac{ma\,(n+1)}{n\surd 2}$.

a. In m-n,

$$\frac{\operatorname{Cos}\frac{1}{2}X}{\operatorname{Sin}\frac{1}{2}Z}=\frac{1}{\surd(n^2+1)}=\cos\nu.$$

$$\frac{\operatorname{Cos}\frac{1}{2}Y}{\operatorname{Sin}\frac{1}{2}Z}=\cos\delta. \qquad \operatorname{Tan}(\delta+45^\circ)=n.$$

$$\frac{\operatorname{Cos}\frac{1}{2}Z}{\operatorname{Sin}\frac{1}{2}Y}=\cos\delta'. \qquad ma=\frac{n\surd 2}{n+1}\tan\delta'.$$

$$\frac{\operatorname{Cos}\frac{1}{2}Y\surd 2}{\operatorname{Cos}\frac{1}{2}X}=n-1. \qquad ma=\frac{n}{\surd(\tan^2\frac{1}{2}X-n^2)}.$$

Designating the inclination of m-n on face of the fundamental prism (∞) by p; and on that of the diagonal prism (∞ - ∞) by q, we have

$$\frac{n+1}{n}=\frac{\cos p\surd 2}{\cos q} \qquad \text{or } \frac{\cot q}{n}=\cos\beta,\ \text{and } ma=\frac{\cot q}{\sin\beta}$$

$$\operatorname{Sin}\nu=\frac{\cos q}{\sin\frac{1}{2}Z} \qquad n=\tan\nu \qquad ma=\tan\tfrac{1}{2}Z\sin\nu.$$

$$n+1=\frac{\cos p\,\surd 2}{\cos\frac{1}{2}X} \qquad \sin\nu'=n\cot\tfrac{1}{2}X \qquad ma=\tan\nu'.$$

$$\frac{n+1}{n-1}=\frac{\cos p}{\cos\frac{1}{2}Y} \qquad \sin\delta=\frac{\cos p}{\sin\frac{1}{2}Y} \qquad ma=\frac{n\surd 2}{n+1}\tan\delta'.$$

b. In m-m,

$$\operatorname{Cos}\nu'=\frac{1}{a}\cot\tfrac{1}{2}X. \qquad ma=\tan\nu'.$$

$$\operatorname{Cos}\nu=a\cot\tfrac{1}{2}Z. \qquad m=\tan\nu=\frac{\tan\frac{1}{2}T\surd(a^2+1)}{a}.$$

$m=\tan\frac{1}{2}T\times\cot\frac{1}{2}T'$, T', (and in the following cases, U' and Z'), being the corresponding angle of the fundamental octahedron, 1.

c. In m-$\frac{m}{m-1}$,

$$\operatorname{Cos}\delta'=\frac{1}{a}\cot\tfrac{1}{2}Y\surd 2. \qquad 2m-1=\frac{1}{a}\tan\delta'\surd 2.$$

$\text{Cos}\ \delta = a\sqrt{\tfrac{1}{2}}\cot\tfrac{1}{2}Z.$ $\qquad \dfrac{m}{m-1} = \tan\ (\delta + 45^\circ).$

$2m-1 = \dfrac{\sqrt{(a^2+2)} \times \tan\tfrac{1}{2}U}{a}.$ $\qquad 2m-1 = \tan\tfrac{1}{2}U \times \cot\tfrac{1}{2}U'.$

d. In m,

$ma = \cot\varepsilon.$ $\qquad \cos\varepsilon = \cot\tfrac{1}{2}X.$

$ma\ \tan\tfrac{1}{2}Z\sqrt{\tfrac{1}{2}}.$ $\qquad m = \dfrac{\tan\tfrac{1}{2}Z.}{\tan\tfrac{1}{2}Z'.}$

e. In m-∞,

$ma = \cot\varepsilon.$ $\qquad \cos\varepsilon = \cos\tfrac{1}{2}Y\sqrt{2}.$

$ma = \tan\tfrac{1}{2}Z.$ $\qquad m = \dfrac{\tan\tfrac{1}{2}Z}{\tan\tfrac{1}{2}Z'}.$

f. In ∞-n, $n = \tan\tfrac{1}{2}X.$ $\qquad \dfrac{n+1}{n-1} = \tan\tfrac{1}{2}Y.$

The angles of the different vertical prisms, in the dimetric system, are the same as those of the forms ∞-n in the monometric system, as given on page 70—(forms ∞-$\tfrac{5}{4}$ to ∞-5).

IV. TRIMETRIC SYSTEM.

1. *Inclinations between planes of different forms.*

24. In the *trimetric* system the forms mPn are octahedrons; that is, for any particular plane mPn on a crystal there will be eight in all, and these extended, produce an octahedron like f. 13.

The inclination of a plane mPn, on another $m'Pn'$, may be ascertained by means of the general formula, p. 62, by substituting (b being the longer lateral axis) when the forms are

m-$\bar{n}$ and m'-$\bar{n}'$,	$ma,\ nb$	for $a,\ b.$
	$m'n,\ n'b,\ c$	for $a',\ b',\ c'.$
m-$\breve{n}$ and m'-$\bar{n}'$,	$ma \qquad nc$	for $a \qquad c.$
	$m'a,\ b,\ \ n'c$	for $a',\ b',\ c'.$
m-$\bar{n}$ and m'-$\breve{n}'$	$ma \qquad nc$	for $a \qquad c.$
	$m'a,\ n'b\ c$	for $a',\ b',\ c'.$

25. *a.* For m-$\bar{n}$ on m'-$\bar{\infty}$, having the parameters $a : b : c$ and $a' : \infty : c'$, the formula becomes

$$\text{Cos}\ W = -\frac{b(aa'+cc')}{M\sqrt{(a'^2+c'^2)}}.$$

b. For m-$\bar{n}$ on ∞-$\bar{\infty}$, the formula becomes

$$\text{Cos}\ W = -\frac{ab}{M}.$$

c. For m-$\bar{n}$ on ∞-$\bar{n}'$,

$$\text{Cos}\ W = -\frac{a(bb'+cc')}{M\sqrt{(b'^2+c'^2)}}.$$

A plane m-$\bar{n}$ may also be designated $\dfrac{m}{n}$-$\dfrac{\breve{1}}{n},$ the two expressions being equivalents, (p. 55); and in calculating the relations of one plane with another, or their interfacial angles, it is often convenient to make the change from one expression to the other, in order to have the same lateral axis referred to in both.

2. *Inclinations between planes of the same form.*

26. The form m-n in the trimetric system is represented in the octahedron, f. 13, (except that we here make b the longer lateral axis). Placing X, Y, Z for the angles at the edges so marked, and writing as above,

$$M \text{ for } \surd(a^2\ b^2+c^2a^2+b^2c^2).$$

$$\text{Cos}\,\tfrac{1}{2}X=\frac{ab}{M}. \qquad \text{Cos}\,\tfrac{1}{2}Y=\frac{ac}{M}. \qquad \text{Cos}\,\tfrac{1}{2}Z=\frac{bc}{M}.$$

$$\text{Tan}\,\tfrac{1}{2}X=\frac{c\surd(a^2+b^2)}{ab}. \ \text{Tan}\,\tfrac{1}{2}Y=\frac{b\surd(a^2+c^2)}{ac}. \ \text{Tan}\,\tfrac{1}{2}Z=\frac{a\surd(b^2+c^2)}{bc}.$$

$\tfrac{1}{2}X$=supplement of m-n on ∞-$\breve{\infty}$, and $\tfrac{1}{2}Y$=supplement of m-n on ∞-$\bar{\infty}$.

27. Simplifying for the particular cases following:

a.	In ∞,	$\text{Tan}\,\tfrac{1}{2}X'=\frac{c}{b}$	$\text{Tan}\,\tfrac{1}{2}Y'=\frac{b}{c}$
b.	∞-$\breve{n}$,	$\text{Tan}\,\tfrac{1}{2}X=\frac{nc}{b}$	$\text{Tan}\,\tfrac{1}{2}Y=\frac{b}{nc}$
c.	∞-$\bar{n}$,	$\text{Tan}\,\tfrac{1}{2}X=\frac{c}{nb}$	$\text{Tan}\,\tfrac{1}{2}Y=\frac{nb}{c}$
d.	m-$\breve{\infty}$,	$\text{Tan}\,\tfrac{1}{2}Y=\frac{b}{ma}$	$\text{Tan}\,\tfrac{1}{2}Z=\frac{ma}{b}$
e.	1-$\breve{\infty}$,	$\text{Tan}\,\tfrac{1}{2}Y'=\frac{b}{a}$	$\text{Tan}\,\tfrac{1}{2}Z'=\frac{a}{b}$
f.	m-$\bar{\infty}$	$\text{Tan}\,\tfrac{1}{2}X=\frac{c}{ma}$	$\text{Tan}\,\tfrac{1}{2}Z=\frac{ma}{c}$
g.	1-$\bar{\infty}$	$\text{Tan}\,\tfrac{1}{2}X'=\frac{c}{a}$	$\text{Tan}\,\tfrac{1}{2}Z'=\frac{a}{c}$

3. *Dimensions of forms.*

28. Let α = the inclination of the macrodiagonal terminal edge on the vertical axis;

Let β =the inclination of the brachydiagonal terminal edge on the vertical axis;

Let γ = the inclination of a basal edge on the macrodiagonal;

$$\text{Then for } m'\text{-}n',\ a' : b' : c' = \begin{cases} 1 : \tan\alpha : \tan\beta, \\ \cot\alpha : 1 : \tan\gamma, \\ \cot\beta : \cot\gamma : 1. \end{cases}$$

29. The angles α, β, γ are determined by the following equations:

$$\text{Cos}\,\alpha=\frac{\cos\tfrac{1}{2}Y}{\sin\tfrac{1}{2}X}. \qquad \text{Cos}\,\beta=\frac{\cos\tfrac{1}{2}X}{\sin\tfrac{1}{2}Y}.$$

$$\text{Sin } \alpha = \frac{\cos \frac{1}{2}Z}{\sin \frac{1}{2}X}. \qquad \text{Cos } \gamma = \frac{\cos \frac{1}{2}X}{\sin \frac{1}{2}Z}.$$

$$\text{Sin } \beta = \frac{\cos \frac{1}{2}Z}{\sin \frac{1}{2}Y}. \qquad \text{Sin } \gamma = \frac{\cos \frac{1}{2}Y}{\sin \frac{1}{2}Z}.$$

$$\text{Tan } \beta = \tan \tfrac{1}{2}X \sin \alpha\,; \quad \tan \alpha = \cot \tfrac{1}{2}Y \tan \beta.$$

$$\text{Cot } \alpha = \tan \tfrac{1}{2}Z \sin \gamma.$$

$$\text{Sin } \alpha = \cot \tfrac{1}{2}X \tan \beta\,; \quad \cos \alpha = \cot \tfrac{1}{2}X \tan \gamma.$$

$$\text{Sin } \beta = \cot \tfrac{1}{2}Y \tan \alpha\,; \quad \cos \beta = \cot \tfrac{1}{2}Y \cot \gamma.$$

$$\text{Sin } \gamma = \cot \tfrac{1}{2}Z \cot \alpha\,; \quad \cos \gamma = \cot \tfrac{1}{2}Y \cot \beta.$$

30. By comparing the angles α, β, γ, with the corresponding angles of the fundamental form, by means of the relations of a, b, c, to these angles, the relative values of m and n for that form may be determined.

Distinguishing α, β, γ and X, Y, Z, of the derivative forms, by accents:

(*a.*) In the form m, α being determined by one of the above equations, both for m and the fundamental form P, then $m = \cot \alpha' \tan \alpha$; so from β, $m = \cot \beta' \tan \beta$; or from Z, $m = \tan \frac{1}{2}Z' \cot \frac{1}{2}Z$.

(*b.*) In $1\text{-}\bar{n}$, $n = \tan \frac{1}{2}X' \cot \frac{1}{2}X = \tan \beta' \cot \beta = \tan \gamma' \cot \gamma$.

(*c.*) In $1\text{-}\breve{n}$, $n = \tan \alpha' \cot \alpha = \tan \frac{1}{2}Y' \cot \frac{1}{2}Y = \cot \gamma' \tan \gamma$.

(*d.*) In $m\text{-}\breve{m}$, $m = \cot \frac{1}{2}X' \tan \frac{1}{2}X = \cot \beta' \tan \beta = \cot \gamma' \tan \gamma$.

For determining m and n, we deduce from the equations,

(*e.*) For the forms ∞ and and $\infty\text{-}\breve{n}$ (§ 27 *a*, *b*), $n = \tan \frac{1}{2}X \div \tan \frac{1}{2}X'$; $n = \tan \frac{1}{2}Y' \div \tan \frac{1}{2}Y$.

(*f.*) For the forms ∞ and $\infty\text{-}\bar{n}$, $n = \tan \frac{1}{2}X' \div \tan \frac{1}{2}X$, $n = \tan \frac{1}{2}Y \div \tan \frac{1}{2}Y'$, in which the accented letters pertain to the form ∞. Also,

(*g.*) From the equations for $m\text{-}\breve{\infty}$ and $1\text{-}\breve{\infty}$,

$$m = \tan \tfrac{1}{2}Y' \div \tan \tfrac{1}{2}Y, \qquad m = \tan \tfrac{1}{2}Z \div \tan \tfrac{1}{2}Z'.$$

(*h.*) From the equations for $m\text{-}\bar{\infty}$ and $1\text{-}\bar{\infty}$,

$$m = \tan \tfrac{1}{2}X' \div \tan \tfrac{1}{2}X, \qquad m = \tan \tfrac{1}{2}Z \div \tan \tfrac{1}{2}Z'.$$

4. *Combinations in the Trimetric System.*

31. On this subject see the general laws on pages 53 to 56, which contain many of the specific cases below.

In this system, as in the preceding, forms with a horizontal intersection have $n = n$. In a rhombic octahedron, mP planes truncating or bevelling the terminal edges have $m' = m$; but as one edge is connected with the macrodiagonal, and the other with the brachydiagonal, the planes differ,—those of the macrodiagonal edge being $m\text{-}\bar{n}$ or $m\text{-}\bar{\infty}$, and those of the brachydiagonal $m\text{-}\breve{n}$ or $m\text{-}\breve{\infty}$.

In the following table, forms are said to be of the same kind, when connected with the same axis, and consequently having the same mark, ⌣ or —, placed above their signs.

1\. $m'\text{-}\bar{n}'$, bev. macrod. terminal edge of $m\text{-}\bar{n}$, when
2\. $m'\text{-}\breve{\bar{n}}'$, bev. brachyd. terminal edge of $m'\breve{\bar{n}}$, when $\Big\} \quad \frac{m'}{n'}=\frac{m}{n}.$

3\. $m'\text{-}\bar{n}'$, bev. brachyd. terminal edge of $m\text{-}\bar{n}$, when
4\. $m'\text{-}\breve{\bar{n}}'$, bev. macrod. terminal edge of $m\text{-}\breve{\bar{n}}$, when $\Big\} \quad m'=m.$

5\. $m''\text{-}\breve{\bar{\infty}}$, repl. A. of combination between forms m and m' by rbc. pl. $m''=\frac{2mm'}{m+m'}$
6\. " repl. A. of combination between forms m and ∞ by rbc. pl. $m'=2m$
7\. " repl. A. of combination between $\infty\text{-}\breve{\bar{n}}$ and $m\text{-}\breve{\bar{\infty}}$ by rbc. pl. $m''=mn$
8\. " repl. A. of comb. betw. m and $\infty\text{-}\breve{\bar{n}}$ by rbc. pl., when the form is $m(n'+1)\text{-}\breve{\bar{\infty}}$, or $m\frac{(n'+1)}{n'}\text{-}\breve{\bar{\infty}}$, the one replaces the upper, the other the lower I-E.

b. 1. $m'\text{-}\breve{\bar{n}}'$ repl. I-E. of form ∞ and $m\text{-}\breve{\bar{\infty}}$, when $n'=\frac{m'}{m'-m}$
2\. " trunc. I-E. of m and $\infty\text{-}\breve{\bar{\infty}}$ $m'=mn'$
3\. " bev. longer or shorter term E. of form m, $m'=m$
4\. " repl. I-E. of $m\text{-}\breve{\bar{n}}$ and $\infty\text{-}\breve{\bar{\infty}}$, $\frac{m'}{n'}=\frac{m}{n}$

V. HEXAGONAL SYSTEM.

32\. In the hexagonal system there are three lateral axes intersecting at 60°. The form $m\text{-}n$ completed is a double twelve-sided pyramid or berylloid, (f. 124); m and $m\text{-}2$ are double six-sided pyramids or quartzoids, (like f. 122 in form), the series $m\text{-}2$ intermediate to the series m, (see f. 121); ∞ and $\infty\text{-}2$ are hexagonal prisms, respectively corresponding to the pyramids. $\infty\text{-}n$, except when $n=2$ represents twelve-sided prisms. mR (equivalent to form $\frac{(m)}{2}$) stands for rhombohedrons, (R, fig. 126, and other rhombohedrons of the same series). The use of the signs + and − for rhombohedrons and scalenohedrons is explained on page 48. The scalenohedron has the general sign $\pm\frac{(m\text{-}n)}{2}$. Designated with reference to the axis of that rhombohedron from which they are derived, they come under the expression mR^n, in which m equals the semi-axis of mR, and n is a coefficient, which multiplied into m will give the semi-axis of the form mR^n. The expression $\frac{(m\text{-}n)}{2}$ is reduced to the form $m'R^{n'}$ by making

$$m'=\frac{m(2-n)}{n}, \text{ and } n'=\frac{n}{2-n},$$

and conversely the latter is reduced to the former by making

$$m=m'n', \text{ and } n=\frac{2n'}{n'+1}.$$

33\. For each mR there is a series of scalenohedrons mR^n, corresponding to a replacement of the lateral edges of the rhombohedron mR, in which n may have any value; when this value is infinite, the form is the prism $mR\infty$, and this is equivalent to ∞-2, since the prism is necessarily a prism diagonal to the fundamental prism. The latter sign is the one which is commonly used for the prism.

The pyramidal hemihedral forms, represented in f. 136, p. 48, have the symbol $\begin{smallmatrix} l \\ r \end{smallmatrix}\frac{(m\text{-}n)}{2}$ or $\begin{smallmatrix} r \\ l \end{smallmatrix}\frac{(m\text{-}n)}{2}$, $\begin{smallmatrix} l \\ r \end{smallmatrix}$ or $\begin{smallmatrix} r \\ l \end{smallmatrix}$ being used according as the planes are to the left or right above. The *gyroidal* hemihedral forms, analogous to f. 137, p. 48, have the symbol $r\,\frac{(m\text{-}n)}{2}$ or $l\,\frac{(m\text{-}n)}{2}$. The corresponding tetartohedral forms have the same symbols, except that 4 is written for 2; or else the equivalent $\frac{m'R^{n'}}{2}$, with r or l prefixed.

1. *Inclinations between planes of different forms.*

34. The formula for m-n on m'-n' is as follows—making $M=\sqrt{(4m^2a^2(n^2-n+1)+3n^2)}$ and $M'=\sqrt{(4m'^2a^2(n'^2-n'+1)+3n'^2)}$.

$$\text{Cos } Q=\frac{2mm'a^2(2nn'-n-n'+2)+3nn'}{M\,M'}$$

35. The following table contains the same for more simple cases.

	0	∞-n	m-2
m'-n	$\frac{n'\sqrt{3}}{M'}$	$\frac{m'a(2nn'-n-n'+2)}{M'\sqrt{(n^2-n+1)}}$	$\frac{n'(mm'a^2+1)\sqrt{3}}{M'\sqrt{(m^2a^2+1)}}$
m'-2	$\frac{1}{\sqrt{(m'^2a^2\times 1)}}$	$\frac{m'an\sqrt{3}}{\sqrt{(m'^2a^2+1)}\sqrt{(n^2-n+1)}}$	$\frac{mm'a^2+1}{\sqrt{(m'^2a^2+1)}\sqrt{(m^2a^2+1)}}$
∞-n'	0	$\frac{2nn'-n-n'+2}{2\sqrt{(n'^2-n'+1)}\sqrt{(n^2-n+1)}}$	

36. The formulas for the rhombohedral forms vary, as the forms are of like or unlike signs. In the following:—

$$N=\sqrt{(m^2a^2(3n^2+1)+3)} \text{ and } N'=\sqrt{(m'^2a^2(3n'^2+1)+3)}.$$

37. The cosine of the inclination of

$$\left.\begin{array}{l} +mR^n \text{ on } +m'R^{n'} \\ -mR^n \text{ on } -m'R^{n'} \end{array}\right\}=-\frac{mm'a^2(3nn'\pm 1)\pm 3}{N\,N'}$$

$$\left.\begin{array}{l} +mR^n \text{ on } -m'R^{n'} \\ -mR^n \text{ on } +m'R^{n'} \end{array}\right\}=-\frac{mm'a^2(3nn'\mp 1)\pm 3}{N\,N'}$$

the upper sign being used in each of these and the following equations, for the angles between planes inclined to the same pole of the vertical axis, and the lower for the angle between planes inclined towards different poles.

38. These simplified, become for

$$\left.\begin{array}{l} +mR^n \text{ on } +m'R \\ -mR^n \text{ on } -m'R \end{array}\right\} = -\frac{mm'a^2(3n\pm1)\pm3}{N\sqrt{(4m'^2a^2+3)}}.$$

$$\left.\begin{array}{l} +mR^n \text{ on } -m'R \\ -mR^n \text{ on } +m'R \end{array}\right\} = -\frac{mm'a^2(3n\mp1)\pm3}{N\sqrt{(4m'^2a^2+3)}}.$$

$$mR^n \text{ on } m'\text{-}2 = -\frac{(mnm'a^2\pm1)\sqrt{3}}{N\sqrt{(m'^2a^2+1)}}. \quad mR^n \text{ on } O = -\frac{\sqrt{3}}{N}.$$

39. Also when the forms $\frac{(m\text{-}n)}{2}, \frac{(m'\text{-}n')}{2}$, are of the same sign,

$$\text{Cos } P = -\frac{2mm'a^2(2nn'\mp n\mp n'\pm2)\pm3nn'}{M\,M'}.$$

40. When of different signs,

$$\text{Cos } P = -\frac{2mm'a^2(nn'\pm n\pm n'\mp2)\pm3nn'}{M\,M'}.$$

2. *Inclination between planes of the same form.*

41. For the form $m\text{-}n$ (f. 124) we have for the inclinations between the planes, M having the value on the preceding page—

$$\text{Cos } \tfrac{1}{2}X = \frac{ma(2-n)}{M}. \quad \text{Cos } \tfrac{1}{2}Y = \frac{ma\,(n-1)\sqrt{3}}{M}. \quad \text{Cos } \tfrac{1}{2}Z = \frac{n\sqrt{3}}{M}.$$

42. *a.* Representing the inclination of two planes over the axial basal angle (that to which the edge X extends) by T, and that over the adjacent basal angle, (to which Y extends), by U,

$$\text{Tan } \tfrac{1}{2}T = \frac{man\sqrt{3}}{\sqrt{(m^2a^2(2-n)^2+3n^2)}}. \qquad \text{Tan } \tfrac{1}{2}U = \frac{ma(n+1)}{\sqrt{3}\sqrt{(m^2a^2(n-1)^2+n^2)}}.$$

b. For $m\text{-}\frac{m}{m-1}$; writing S for $\sqrt{(4a^2(m^2-m+1)+3}$.

$$\text{Cos } \tfrac{1}{2}X = \frac{a(m-2)}{S}. \qquad \text{Cos } \tfrac{1}{2}Y = \frac{a\sqrt{3}}{S}. \qquad \text{Cos } \tfrac{1}{2}Z = \frac{\sqrt{3}}{S}.$$

$$\text{Tan } \tfrac{1}{2}T = \frac{ma\sqrt{3}}{\sqrt{(a^2(m-2)^2+3)}}. \qquad \text{Tan } \tfrac{1}{2}U = \frac{(2m-1)a}{\sqrt{3}\sqrt{(a^2+1)}}.$$

c. For m, in which $Z=U$,

$$\text{Tan } \tfrac{1}{2}X = \frac{\sqrt{(m^2a^2+1)}\sqrt{3}}{ma}. \quad \text{Tan } \tfrac{1}{2}Z = 2ma\sqrt{\tfrac{1}{3}}. \quad \text{Tan } \tfrac{1}{2}T = \frac{ma\sqrt{3}}{\sqrt{(m^2a^2+3)}}.$$

d. For $m\text{-}2$, in which $Z=T$,

$$\text{Tan } \tfrac{1}{2}Y = \frac{\sqrt{(3m^2a^2+4)}}{ma}. \quad \text{Tan } \tfrac{1}{2}Z = ma. \quad \text{Tan } \tfrac{1}{2}U = \frac{ma\sqrt{3}}{\sqrt{(m^2a^2+4)}}.$$

e. For $\infty\text{-}n$,

$$\text{Tan } \tfrac{1}{2}X = \frac{n\sqrt{3}}{2-n}. \qquad \text{Tan } \tfrac{1}{2}Y = \frac{n+1}{(n-1)\sqrt{3}}.$$

f. For $\frac{m\text{-}n}{2}$ (p. 46), in which X is the *shorter* terminal edge, Y the *longer*, Z a basal edge ($=T$ of $m\text{-}n$),

$$\text{Cos } \tfrac{1}{2}X = \frac{ma\sqrt{3}}{M}. \qquad \text{Sin } \tfrac{1}{2}Z = \frac{man\sqrt{3}}{M}.$$

$$\text{Sin } \tfrac{1}{2}Z = \text{Cos } \tfrac{1}{2}X + \text{Cos } \tfrac{1}{2}Y = 2 \text{ Cos } \tfrac{1}{4}(Y+X) \text{ Cos } \tfrac{1}{4}(Y-X).$$

For cos $\frac{1}{2}Y$, the same formula as in m-n.

g. For $\pm\frac{(m)}{2}$ or $\pm mR$, in which $Y=180°$,

$$\text{Cos } X = \frac{2m^2a^2-3}{4m^2a^2+3} = -\cos Z. \qquad \text{Tan } \tfrac{1}{2}X = \frac{\sqrt{(m^2a^2+3)}}{ma\sqrt{3}}.$$

In R, Tan $\frac{1}{2}X = \frac{\sqrt{(a^2+3)}}{a\sqrt{3}}$; and if $a^2 = \frac{3}{2}$, $X=90°$, and the rhombohedron is a cube.

Designating the inclination, in mR, of the inclined diagonal on the vertical axis, by α, and that of a terminal edge on the same by β,

$$\text{Cot } \alpha = 2ma\sqrt{\tfrac{1}{3}}. \qquad \text{Cot } \beta = ma\sqrt{\tfrac{1}{3}}.$$

The plane angle A (angle at vertex) in mR, and the volume V, may be found by the equations,

$$\text{Cos } A = \frac{2m^2a^2-3}{2(m^2a^2+3)}. \qquad V = 4ma\sqrt{\tfrac{1}{3}}.$$

h. For mR^n, in which X, Y, Z, are used as above,

$$\text{Tan } \tfrac{1}{2}X = \frac{\sqrt{(m^2a^2\,(3n-1)^2+12)}}{ma\,(n+1)\,\sqrt{3}}.$$

$$\text{Tan } \tfrac{1}{2}Y = \frac{\sqrt{(m^2a^2(3n+1)^2+12}}{ma(n-1)\sqrt{3}}. \qquad \text{Tan } \tfrac{1}{2}Z = \frac{man\sqrt{3}}{\sqrt{(m^2a^2+3)}}.$$

See also § *f*, above.

i. For ∞R^n,

$$\text{Cos } X = \frac{3n^2-6n-1}{2(3n^2+1)}. \quad \text{Cos } Y = \frac{3n^2+6n-1}{2(3n^2+1)}. \quad \text{Cos } Z = \frac{3n^2-1}{3n^2+1}.$$

3. *Determination of* m *and* n *by inspection.*

43. *a.* As in other systems, forms m-n and m'-n', or mR^n and $m'R^{n'}$, making horizontal intersections, have $n=n'$, (f. 121).

b. Two forms m-n and m'-n' making intersections parallel to a diagonal edge, have $m=m'$, (f. 128).

c. Two forms mR^n and $m'R^{n'}$, whose lateral (called also, basal) edges are parallel, have $m=m'$, (f. 128).

d. For each scalenohedron mR^n, (f. 127), there is (1) an inscribed rhombohedron $m'R$ of like sign, (+ or −), whose lateral edges coincide with those of the scalenohedron; having $m=m'$.

(2). A rhombohedron $m''R$ of like sign, whose terminal edges coincide with the shorter terminal edge (X) of the scalenohedron, having $m''=\frac{1}{2}m(3n-1)$, (4, f. 131; a rhombohedron having its terminal edges coincident with X, would have its faces parallel to planes 4 in this figure).

(3). A rhombohedron $m'''R$ of unlike sign, whose terminal edges coincide with the longer terminal edge (Y) of the scalenohedron, having $m'''=\frac{1}{2}m(3n+1)$, (5, f. 132).

e. The rhombohedron $m'R$ truncating edge Y of mR^n, has $m'=\frac{1}{4}m(3n+1)$, (f. 133).

The rhombohedron—$m''R$, truncating edge X of mR^n, has $m'=\frac{1}{4}m(3n-1)$, (f. 134).

m^n, in the table below, is equivalent to mR^n.

f. m-n	1. Edge Y trunc. by plane m',	$m'=\frac{m(n+1)}{2n}$
	2. Y-basal angle repl. by m', I-E. par. to other term. E.	$m'=m$
	3. Term. angle repl. by m', faces rhombs,	$m'=\frac{m}{n}$
	4. Edge X trunc. by m-2,	$m'=m$
	5. X-basal A. repl. by m'-2, I-E. par. to other term. E.	$m'=\frac{2m(n+1)}{3n}$
	6. Repl. of term. angle by m'-2, faces rhombs,	$m'=\frac{2m(2n-1)}{3n}$
g. m	1. Repl. of basal A. with 4 pl. m'-n', I-E. par. to vertical on face of m,	$\frac{m'(n'+1)}{n'}=2'm$
	2. Repl. of basal A. with 4 pl. m'-n', I-E. par. to term E. of m,	$\frac{m'}{n'}=m$
	3. Term. E. trunc. by m'-2, (f. 121), or bev. by m'-n',	$m'=m$
	4. Basal angle repl. by m'-2, I-E. par. to vert. of m ($\frac{4}{3}$2, f. 121),	$m'=\frac{4}{3}m$
	5. Basal angle repl. by m'-2, I-E. par. to term. E. of m, (22, f. 121),	$m'=2m$
	6. Term. angle repl. by m'-2, faces rhombs,	$m'=\frac{2}{3}m$
h. m-2	1. Term. edge bevelled by m'-n',	$\frac{m'(n'+1)}{n'}=\frac{3}{2}m$
	2. Basal A. repl. by 4 pl., I-E. par. to vert. on m-2,	$m'=m$
	3. " " " I-E. par. to term. E. of m-2,	$\frac{2m'(2n'-1)}{n'}=3m$
	4. Term. edge trunc. by m', ($\frac{4}{3}$2 and 1, f. 121),	$m'=\frac{3}{4}m$
	5. Basal A. repl. by 2 pl. I-E. par to vert. on m-2, (12 and 1, f. 124),	$m'=m$
	6. Basal A. repl. by two planes m', I-E. par. to term. E. of m-2,	$m'=\frac{3}{2}m$
	7. Term A. repl. by 6 rhombs. m',	$m'=\frac{1}{2}m$
i. mR^n	1. $m'^{n'}$ of like sign, bevel edge X (f. 134),	$m'(3n'-1)=m(3n-1)$
	2. " " " " Y (f. 133),	$m'(3n'+1)=m(3n+1)$
	3. $m'^{n'}$ repl. basal A. by 2 pl. incl. on X, I-E. par. to edge Y of m^n	$m'(3n'+1)=m(3n+1)$
	4. *Ibid.* incl. on Y, I-E. par to X,	$m'(3n'-1)=m(3n-1)$
	5. $m'^{n'}$ of unlike sign, bev. edge X, (f. 134),	$m'(3n'+1)=m(3n-1)$
	6. $m'^{n'}$ of unlike sign, repl. basal A, I-E. par to Y of m^n,	$m'(3n'-1)=m(3n+1)$
k. mR	1. $m'^{n'}$ of like sign, bev. term. E. of m, (f. 131),	$\frac{1}{2}m'(3n'-1)=m$
	2. $m'^{n'}$ of like sign, repl. lat. A, I-E. par. to incl. diag.	$\frac{1}{4}m'(3n'+1)=m$

	3. $m'^{n'}$ of like sign, replace lateral edges,	$m'=m$
	4. $m'^{n'}$ of unlike sign, bev. term. E. of m, (f. 132),	$\frac{1}{2}m'(3n'+1)=m$
	5. $m'^{n'}$ of unlike sign, repl. lat. A, I-E. par. to incl. diag.	$\frac{1}{4}m'(3n'-1)=m$
	6. m' of unlike sign, trunc. term. E, (f. 125),	$m'=\frac{1}{2}m$
	7. m' of unlike sign, repl. bas. A, I-E. par. to incl. diag. (sim. to f. 125),	$m'=2m$
	8. m'-2, bev. term. E. of m,	$m'=\frac{2}{3}m$
	9. m'-2, repl. bas. A, I-E. par to incl. diag.	$m'=\frac{4}{3}m$
l. m-2,	1. Bev. of altern. term. E. by $m'^{n'}$	$\frac{1}{2}m'(3n'+1)=m$
	2. Trunc. of altern. term. E. by m'R,	$m'=\frac{3}{4}m$

44. *a.* If a plane $m''R^{n''}$ forms parallel intersections with two planes mR^n and $m'R^{n'}$, then

$$m''n''(m-m')\pm m'n'(m''-m)-mn(m''-m')=0,$$

using the upper sign, when the planes incline to the same pole of the vertical axis, and the lower when to opposite poles.

b. If the planes are m''-2, mR^n, $m'R^{n'}$, then

$$m''(m-m')+mm'(n+n')=0.$$

c. If the planes are $m''R^{n''}$, $-m'R^{n'}$, mR^n,

$$m''n''(m+m')\mp m'n'(m''-m)-mn(m''+m')=0.$$

d. If the planes are m''-2, $-m'R^{n'}$, mR^n,

$$m''(m+m')-mm'(n\pm n')=0.$$

e. If the planes are $m''R^{n''}$, m'-2, mR^n,

$$m''(n''-n)m\pm m'(m-m'')=0.$$

4. *Determination of* m, n, *and axis* a, *by calculation.*

45. *a.* From the angles X, Y, Z, of m-n,

$$\frac{ma(2-n)}{n\surd 3}=\frac{\cos\frac{1}{2}X}{\cos\frac{1}{2}Z} \qquad \frac{ma(n-1)}{n}=\frac{\cos\frac{1}{2}Y}{\cos\frac{1}{2}Z}.$$

$$\frac{2-n}{n-1\surd 3}=\frac{\cos\frac{1}{2}X}{\cos\frac{1}{2}Y}$$

Cos $\nu=\cos\frac{1}{2}X\div\sin\frac{1}{2}Z$; and, $n\div(2-n)=\surd\frac{1}{3}\tan\nu$.
Cos $\nu'=\cos\frac{1}{2}Z\div\sin\frac{1}{2}X$; and, $ma=\tan\nu'$.
Cos $\delta=\cos\frac{1}{2}Y\div\sin\frac{1}{2}Z$; and, $(n+1)\div(n-1)=\surd 3\tan\delta$.
Cos $\delta'=\cos\frac{1}{2}Z\div\sin\frac{1}{2}Y$; and, $ma=\tan\delta' n\surd 3\div(n+1)$.

$$\frac{2-n}{n-1}=\frac{\surd 3\cos\frac{1}{2}X}{\cos\frac{1}{2}Y};\ ma=\cot\varepsilon;\ \cos\varepsilon=\frac{n\surd 3}{2-n}\cot\frac{1}{2}X.$$

Also, $ma=\tan\frac{1}{2}Z\,(\sin 150^\circ-\delta)=\tan Z\,\frac{1}{2}\sin\nu$.

b. From the angles X, Z, and U, of $m\frac{m}{m-1}$,
Sin $\xi'=\cos\frac{1}{2}Z'\cot\frac{1}{2}X\surd 3$; $ma=\tan(\frac{1}{2}Z'+\xi')$; Z' is Z of 2-2.
Cos $\delta=a\cot\frac{1}{2}Z$; $2m-1=\tan\delta\surd 3$.

$$2\,m-1=\tan\tfrac{1}{2}U\frac{\surd 3}{a}\surd(a^2+1);$$

or since we have for U' in the form 2-2,

Tan $\frac{1}{2}U'=a\surd 3\div\surd(a^2+1)$, therefore $2m-1=3\tan\frac{1}{2}U\times\cot\frac{1}{2}U'$, whence the value of m may be obtained. The inclination of 2-2 on a, (see f. 151 and 344 of Quartz), diminished by 90° is $\frac{1}{2}U'$; and that of any plane of the oblique series on a diminished by 90° is $\frac{1}{2}U$ for that plane.

Planes in the same series, between 2-2 and R, or 1, (f. 344), are of the form *m-m;* and taking the corresponding $\frac{1}{2}U$ of such a form, (that is, the angle *m-m* on *i* diminished by 90°), and working the above equation, the resulting value of m is the value in the form *m-m.*

c. From a pyramid m,

$$ma=\frac{\sqrt{3}}{2}\tan\tfrac{1}{2}Z. \qquad m=\frac{\tan\frac{1}{2}Z}{\tan\frac{1}{2}Z'}=\frac{\tan\frac{1}{2}U}{\tan\frac{1}{2}U'}.$$

$$ma=\cot\varepsilon;\quad \cos\varepsilon=\sqrt{3}\cot\tfrac{1}{2}X.$$

Z' and U' are the corresponding angles in the pyramid P.

d. From a pyramid *m*-2,

$$m=\frac{\tan\frac{1}{2}Z}{a}. \qquad m=\frac{\tan\frac{1}{2}Z}{\tan\frac{1}{2}Z''}. \quad a=\tan\tfrac{1}{2}Z''.$$

$$ma=\cot\varepsilon,\ \text{when}\ \cos\varepsilon=2\cos\tfrac{1}{2}Y.$$

Z'' is the corresponding angle in the form 1-2.

e. From ∞-n, $\frac{n}{2-n}=\sqrt{\tfrac{1}{3}}\tan\frac{1}{2}X$; $\frac{n+1}{n-1}=\sqrt{3}\tan\frac{1}{2}Y$.

f. From a scalenohedron $\frac{(m\text{-}n)}{2}$,

$$n-1=\frac{\cos\frac{1}{2}Y}{\cos\frac{1}{2}X}. \qquad n=\frac{\sin\frac{1}{2}Z}{\cos\frac{1}{2}X}. \qquad n=\frac{\sin\frac{1}{2}Z}{\sin\frac{1}{2}Z-\cos\frac{1}{2}Y}.$$

g. From a rhombohedron mR,

$$ma=\frac{\sqrt{3}\cot\alpha}{2}=\sqrt{3}\cot\beta. \qquad m=\frac{\cot\alpha}{\cot\alpha'}=\frac{\cot\beta}{\cot\beta'}.$$

$\therefore$ *log.* $ma=\log.\cot\alpha+9{\cdot}9375306=\log.\cot\beta+0{\cdot}2385606$.

α and β are used as in page 81; and α' and β' are corresponding angles in R.

Also, $a^2=\frac{3(1+\cos X)}{2-4\cos X}$ gives the length of the vertical axis. It should be noted that $\cos X$ is *minus* when X is an obtuse angle.

Also, $\cos\xi=\cot\frac{1}{2}X\sqrt{\tfrac{1}{3}}$; and $ma=\cot\xi\sqrt{3}$.

h. From a scalenohedron mR^n,

$$\frac{n-1}{n+1}=\frac{\cos\frac{1}{2}Y}{\cos\frac{1}{2}X}; \qquad \frac{n+1}{2n}=\frac{\cos\frac{1}{2}X}{\sin\frac{1}{2}Z}; \qquad \frac{n-1}{2n}=\frac{\cos\frac{1}{2}Y}{\sin\frac{1}{2}Z}.$$

From X, $\cos\beta=\frac{3n-1}{(n+1)\sqrt{3}}\cot\frac{1}{2}X$; and then $m=\frac{2\sqrt{3}\cot\beta}{a(3n-1)}$.

From Y, $\cos\alpha=\frac{3n+1}{(n-1)\sqrt{3}}\cot\frac{1}{2}Y$; and then $m=\frac{2\sqrt{3}\cot\alpha}{a(3n+1)}$.

From Z, $\cos\beta'=\frac{1}{n\sqrt{3}\cot\frac{1}{2}Z}$; and then $m=\frac{\cot\beta'\sqrt{3}}{a}$.

From X of mR^n, and X' of $\frac{1}{2}m(3n-1)R$,

$$(3n-1)\div(n+1)=\tan\tfrac{1}{2}X\cot\tfrac{1}{2}X'$$

From Y of mR^n and X'' of $\frac{1}{2}m(3n+1)R$,

$$(3n+1)\div(n-1)=\tan\tfrac{1}{2}Y\cot\tfrac{1}{2}X''$$

From Z' (the lateral edge-angle) of the inscribed rhombohedron, and X, Y, or Z,

$$n=\tan(\varphi-\tfrac{1}{2}Z')\cot\tfrac{1}{2}Z'; \text{ when, } \sin\varphi=2\cos\tfrac{1}{2}X\cos\tfrac{1}{2}Z'.$$

$$n=\tan(\varphi+\tfrac{1}{2}Z')\cot\tfrac{1}{2}Z'; \text{ when } \sin\varphi=2\cos\tfrac{1}{2}Y\cos\tfrac{1}{2}Z'.$$

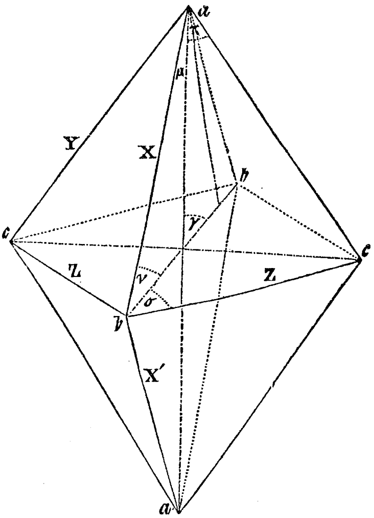
$$n=\tan\tfrac{1}{2}Z\cot\tfrac{1}{2}Z'.$$

In the series mR, mR^n, in which m is constant, n varies as the $\tan\frac{1}{2}Z$; an n in any mR^n of the series equals $\tan\frac{1}{2}Z$ of the mR^n divided by tangent half the corresponding angle of mR.

II. CLINOMETRIC SYSTEMS.

I. MONOCLINIC SYSTEM.

143.



46. The annexed figure represents the form ±1, in the monoclinic system; a, b, c, are the axes. The inclination of a on b is oblique, and the angle is marked γ, (called C beyond); b is the clinodiagonal, c the orthodiagonal. The upper faces in front are +1, the lower —1; and so with any forms m, and also m-n and m-∞ they are relatively + and —, above and below the clinodiagonal. $\pm m$-∞ is a form truncating the edge X above or X' below, and ∞-∞ is another in the same vertical series, on the front angle, parallel to the vertical axis. Planes pertaining to the clinodiagonal (planes on the side angles and edges of the octahedron) are designated m-$\grave{n}$, m-$\grave{\infty}$, ∞-$\grave{\infty}$; the planes m-$\grave{\infty}$ are the same above and below the orthodiagonal. The inner or rhombic prism in f. 25 is described by the expression 0, ∞; and the outer prism by 0, ∞-∞, ∞-$\grave{\infty}$; the inner in f. 112 by 0, ∞, $+m$-∞; in 113 by 0, ∞, $-m$-∞; in 114 by 0, ∞, m-$\grave{\infty}$.

47. An octahedral plane in the preceding figure is inclined to each of the three axial planes or sections. Let the inclination

of $+1$ on the clinodiagonal section be designated by X; on the orthodiagonal section by Y; on the basal section by Z; and the corresponding inclinations of -1 by X', Y', Z'. The angles X, X', are each half the interfacial angles of the octahedron at the edges X, X'. Let us represent also the inclination of

Edge X on a by μ, X on b by ν, Y on a by π.
X' on a by μ', X' on b by ν', Z on b by σ.

48. Then,

$$\text{Tan}\left\{\begin{matrix}X\\X'\end{matrix}\right.=\frac{c\sqrt{(a^2+b^2\mp 2ab\cos C}}{ab\sin C}\qquad \text{Tan}\left\{\begin{matrix}Y\\Y'\end{matrix}\right.=\frac{b\sin C\sqrt{(a^2+c^2)}}{c(a\mp b\cos C}.$$

$$\text{Tan}\left\{\begin{matrix}Z\\Z'\end{matrix}\right.=\frac{a\sin C\sqrt{(b^2+c^2)}}{c(b\mp a\cos C)}.$$

The lower sign is used in each case for the angles X', Y', Z'.

49. In terms of the angles μ, μ', π, σ, the tangents of the same angles are as follows:

$$\text{Tan } X=\frac{\tan\sigma}{\sin(C+\mu)}=\frac{\tan\pi}{\sin\mu}.\qquad \text{Tan } Y=\frac{\tan\mu}{\sin\pi}.\qquad \text{Tan } Z=\frac{\tan(C+\mu)}{\sin\sigma}.$$

$$\text{Tan } X'=\frac{\tan\sigma}{\sin(C-\mu')}=\frac{\tan\pi}{\sin\mu'}.\qquad \text{Tan } Y'=\frac{\tan\mu'}{\sin\pi}.\qquad \text{Tan } Z'=\frac{\tan(C-\mu')}{\sin\sigma}.$$

It will sometimes be convenient to observe, that $C+\mu=180^\circ-\nu$, and $C-\mu'=\nu'$; and consequently, $\sin(C+\mu)=\sin\nu$, and $\sin(C-\mu')=\sin\nu'$.

50. The values of the angles μ, μ', ν, ν', π, σ, may be obtained by either of the following formulas:

$$\text{Tan}\left\{\begin{matrix}\mu\\\mu'\end{matrix}\right.=\frac{b\sin C}{a\mp b\cos C}.\qquad \text{Tan}\,\pi=\frac{c}{a}.\qquad \text{Cos}\,\mu=\frac{\cos Y}{\sin X}.\qquad \text{Cos}\,\nu=\frac{\cos Z}{\sin X}.$$

$$\text{Tan}\left\{\begin{matrix}\nu\\\nu'\end{matrix}\right.=\frac{a\sin C}{b\mp a\cos C}.\qquad \text{Tan}\,\sigma=\frac{c}{b}.\qquad \text{Cos}\,\mu'=\frac{\cos Y'}{\sin X'}.\qquad \text{Cos}\,\nu'=\frac{\cos Z'}{\sin X'}.$$

$$\text{Cos}\,\pi=\frac{\cos X}{\sin Y}=\frac{\cos X'}{\sin Y'}.\qquad \text{Cos}\,\sigma=\frac{\cos X}{\sin Z}=\frac{\cos X'}{\sin Z'}.$$

51. *a.* In the form ∞,

$$\text{Tan } X=\frac{c}{b\sin C}=\tan X'=\cot Y;\quad \text{Tan}\left\{\begin{matrix}Z\\Z\end{matrix}\right.=\mp\frac{\tan C\sqrt{(b^2+c^2)}}{c}$$

b. In $\pm 1\text{-}\infty$,

$$\text{Tan }\frac{Y}{Y'}=\frac{b\sin C}{a\mp b\cos C}.\qquad \text{Tan}\left\{\begin{matrix}Z\\Z'\end{matrix}\right.=\frac{a\sin C}{b\mp a\cos C}.$$

c. In $1\text{-}\grave{\infty}$,

$$\text{Tan } X=\tan X'=\frac{c}{a\sin C}.\ \text{Tan } Z=\tan Z'=\frac{a\sin C}{c}=\cot X.$$

$$\text{Tan }\frac{Y}{Y'}=\mp\frac{\tan C\sqrt{(a^2+c^2)}}{c}$$

By writing ma for a these formulas apply to $\pm m\text{-}\infty$ and $m\text{-}\grave{\infty}$.

d. The equation for Z in the prism ∞, gives the inclination of the face of an oblique rhombic prism on its lateral faces, that is, of plane 0 on ∞, or any $\infty\text{-}n$. The same angle may be obtained by the equations—putting Π for the angle,

$$\operatorname{Cos} \Pi=\cos C \sin X ; \quad \operatorname{Sin} \Pi=\frac{\cos X}{\cos \sigma}.$$

The angle X here is the angle of that name in the prism $\infty\text{-}n$, whose inclination on 0 is desired.

In any form $m\text{-}n$, Y is the supplement of the inclination of a face of $m\text{-}n$ on $\infty\text{-}\infty$; the angle of X is the supplement of the inclination of $m\text{-}n$ on $\infty\text{-}\grave{\infty}$; the angle Z added to the angle between $0P$ and the corresponding $\infty\text{-}n$ (angle Π) equals the inclination of a face of $m\text{-}n$ on $\infty\text{-}n$.

Determination of the lengths of the axes.

52. From C, and X in ∞, $c=\tan X \sin C \times b$.
From C and X, in $1\text{-}\grave{\infty}$, $a=c \div \tan X \sin C$.

Also, for the relations of $a : b : c$,

$$1 : \frac{\sin \mu}{\sin (C+\mu)} : \tan \pi, \qquad 1 : \frac{\sin \mu'}{\sin' (C-\mu')} : \tan \pi.$$

$$\frac{\sin (C+\mu)}{\sin \mu} : 1 : \tan \sigma, \qquad \frac{\sin (C-\mu')}{\sin \mu'} : 1 : \tan \sigma.$$

$$a : b=\sin \mu : \sin \nu.$$

For the angle C,

$$\operatorname{Tan} C=\frac{2 \sin \mu \sin \mu'}{\sin (\mu-\mu')}=\frac{2 \sin \nu \sin \nu'}{\sin (\nu-\nu')}.$$

Rules for determining the signs of planes.

53. The rules deduced on pages 53 to 56 apply here, as well as to the other systems.

1. Two forms whose faces inclined to the same pole of the vertical axis form

a. I-E. parallel to the basal section, have $n'=n$.

b. I-E. par. to the orthodiagonal E., and both planes pertaining to the clinodiogonal, have $\frac{m'}{n'}=\frac{m}{n}$; both to the orthodiagonal, $m'=m$; the two to different diagonals; $\frac{m'}{n'}=m$, the accented letters referring to the form on the orthod. edge.

c. I-E. par. to the clinod. E. and both partaining to the clinod., $m'=m$; both to the orthod., $\frac{m'}{n'}=\frac{m}{n}$; the two to different diagonals, $m'=\frac{m}{n}$

2. Planes trunc. or bev. clinod. E. of $\pm m\text{-}\grave{n}$ belong to $\pm\frac{m}{n}\text{-}\infty$, or $\pm\frac{m}{n}\text{-}n'$.

3. Rbc. pl. repl. clinod. A. of intersection of $\pm m$ and ∞, is $\pm 2m\text{-}\infty$.

4. Plane trunc. E. between $+m$ or $-m$ and ∞ inclined to different poles, is $2m\text{-}\grave{\infty}$.

5. Plane trunc. E. between $+m$ or $-m$ and the pairs and faces $\infty\text{-}\infty$ or $\infty\text{-}\grave{\infty}$, is $\pm mn\text{-}n$ or $mn\text{-}\grave{n}$. Hence, planes whose I-E. with 1 are par. to clinod. or orthod. E. have the sign $m'\text{-}\grave{m}'$ or $m'\text{-}m'$.

II. TRICLINIC SYSTEM.

54. All the axial intersections in this system are oblique. As in the trimetric system, the longer lateral axis and the axial section corresponding is called the *macrodiagonal*, the shorter the *brachydiagonal*. The fundamental octahedron (f. 119) has only opposite faces similar; the upper are respectively 1 and 1′, and the lower -1 and -1′. The macrodiagonal and brachydiagonal planes may be distinguished by a long or short mark (- or ⌣), as in the trimetric system, and the lower planes from the upper by prefixing a minus (—) to the former (or the reverse). The planes between the macrodiagonal and brachydiagonal vertical zones to the right from those to the left, may be distinguished by adding the accents.

Thus the vertical series of planes or zones will be as follows:

1. Brach.	2	3	4	5. Macr.	6	7	8
$m\text{-}\breve{\infty}$	$m\text{-}\breve{n}$	m	$m\text{-}\bar{n}$	$m\text{-}\bar{\infty}$	$m\text{-}\bar{n}'$	m'	$m\text{-}\breve{n}'$
$\infty\text{-}\breve{\infty}$	$\infty\text{-}\breve{n}$	∞	$\infty\text{-}\bar{n}$	$\infty\text{-}\bar{\infty}$	$\infty\text{-}\bar{n}'$	∞'	$\infty\text{-}\breve{n}'$
$—m\text{-}\breve{\infty}$	$—m\text{-}\breve{n}$	$—m$	$—m\text{-}\bar{n}$	$—m\text{-}\bar{\infty}$	$—m\text{-}\bar{n}'$	$—m'$	$—m\text{-}\breve{n}'$.

Determination of the interfacial angles of Triclinic forms.

55. *a.* Let the mutual inclination of the sectional planes of the fundamental form at their intersections in the axes a, b, c, be represented respectively by A, B, C; and the inclination of the axes by α, β, γ: that is, the inclination of a on b, by γ, a on c, by β, b on c, by α. Let also the inclinations of a face of the fundamental octahedron, on the macrodiagonal, brachydiagonal, and basal sections be represented by X, Y, Z, respectively, and finally the inclinations of the edge

X on a by μ Y on a by π Z on b by σ
" b " ν " c " ρ " c " τ

$$\mu+\nu+\gamma=\pi+\rho+\beta=\sigma+\tau+\alpha=180^\circ.$$

b. The following are the values of the cosines of α, β, γ, in terms of the cosines and sines of the angles A, B, C:

$$\text{Cos}\ \alpha=\frac{\cos A+\cos B\cos C}{\sin B\sin C}.\qquad \text{Cos}\ \beta=\frac{\cos B+\cos A\cos C}{\sin A\sin C}.$$

$$\text{Cos}\ \gamma=\frac{\cos C+\cos A\cos B}{\sin A\sin B}.$$

c. The same angles may be determined by means of the values of μ, ν, and σ, &c. of any form, and the corresponding μ', ν', σ', of the coördinate form. The following equations may be employed for this purpose:

$$\text{Tan}\ \alpha=\frac{2\sin\sigma\sin\sigma'}{\sin(\sigma—\sigma')}=\frac{2\sin\tau\sin\tau'}{\sin(\tau—\tau')}.$$

$$\text{Tan}\ \beta=\frac{2\sin\pi\sin\pi'}{\sin(\pi—\pi')}=\frac{2\sin\rho\sin\rho'}{\sin(\rho—\rho')}.$$

$$\text{Tan } \gamma=\frac{2 \sin \mu \sin \mu'}{\sin (\mu-\mu')}=\frac{2 \sin \nu \sin \nu'}{\sin (\nu-\nu')}.$$

56. The three sections, the macrodiagonal, brachydiagonal, and basal, divide the fundamental octahedron into three-sided pyramids. If the plane in the basal section is considered the base, and the vertical solid angle of the octahedron the vertex, of one of these pyramids, its lateral interfacial angles are identical with the angles X, Y, A; and since the terminal edges are X, Y and the axis a, the plane angles at the summit are $X : Y$, $X : a$, and $Y : a$, of which, the last two angles equal respectively μ and π. If we make the vertex A a centre, and describe with any given radius an arc on each of the faces, a spherical triangle is formed, whose angles equal the inclinations of the faces of the pyramid, viz, X, Y, A, and whose sides are measured by the plane angles at the vertex, two of which are μ and π. In this spherical triangle, if the angles A, μ, and π are given, (that is, two sides, μ and π, and the included angle A), the angles X and Y are readily determined by Napier's theorem.

1. $\text{Tan } \frac{1}{2}(X+Y)=\cot \frac{1}{2}A \frac{\cos \frac{1}{2}(\pi-\mu)}{\cos \frac{1}{2}(\pi+\mu)}.$

$$\text{Tan } \frac{1}{2}(X-Y)=\cot \frac{1}{2}A \frac{\sin \frac{1}{2}(\pi-\mu)}{\sin \frac{1}{2}(\pi+\mu)}.$$

This gives the half sum and half difference of the angles X and Y, from which the angles themselves are easily obtained. In a similar way are deduced the following analogous formulas:

2. For X and Z, from B, ν, and σ:

$$\text{Tan } \frac{1}{2}(X+Z)=\cot \frac{1}{2}B \frac{\cos \frac{1}{2}(\sigma-\nu)}{\cos \frac{1}{2}(\sigma+\nu)}.$$

$$\text{Tan } \frac{1}{2}(X-Z)=\cot \frac{1}{2}B \frac{\sin \frac{1}{2}(\sigma-\nu)}{\sin \frac{1}{2}(\sigma+\nu)}.$$

3. For Y and Z, from C, ϱ, and τ,

$$\text{Tan } \frac{1}{2}(Y+Z)=\cot \frac{1}{2}C \frac{\cos \frac{1}{2}(\tau-\rho)}{\cos \frac{1}{2}(\tau+\rho)}.$$

$$\text{Tan } \frac{1}{2}(Y-Z)=\cot \frac{1}{2}C \frac{\sin \frac{1}{2}(\tau-\rho)}{\sin \frac{1}{2}(\tau+\rho)}.$$

57. When the angles X and Y in any particular form are desired, it will be necessary to obtain the values of μ and π for that form, and with these values and the angle A, the desired angle may be obtained by the above equations. In a similar manner, Y and Z, and X and Z, may be known from τ and ϱ, and σ and ν. If X and Y are determined, and ν and ϱ are known, Z may be obtained by the equation,

$$\text{Cos } Z=\frac{\cos B}{\sin \psi} \sin (X-\psi); \text{ or } \cos Z=\frac{\cos C}{\sin \psi} \sin (Y-\psi),$$

in which ψ is an angle to be determined by the equation,

$$\text{Cot } \psi=\cos \nu \tan \beta; \text{ or } \cos \psi=\cos \varrho \tan C.$$

By varying these formulas, X may be obtained when Y or Z is known, and Y, when X or Z is known.

58. The following trigonometrical formulas for the values of μ, ν, π, ϱ, σ, τ, may be employed to determine these angles. It must be observed, that when either of the angles α, β, γ, is obtuse, the cosine becomes minus:

$$\text{Tan } \mu=\frac{b\sin\gamma}{a-b\cos\gamma},\ \tan\nu=\frac{a\sin\gamma}{b-a\cos\gamma},$$

$$\text{Tan } \pi=\frac{c\sin\beta}{a-c\cos\beta},\ \tan\rho=\frac{a\sin\beta}{c-a\cos\beta},$$

$$\text{Tan } \sigma=\frac{c\sin\alpha}{b-c\cos\alpha},\ \tan\tau=\frac{b\sin\alpha}{c-b\cos\alpha}.$$

59. These angles, as functions of the angles X, Y, Z, may be found by the following formulas:

$$\text{Cos } \mu=\frac{\cos Y+\cos X\cos A}{\sin X\sin A},\ \cos\nu=\frac{\cos Z+\cos X\cos B}{\sin X\sin B},$$

$$\text{Cos } \pi=\frac{\cos X+\cos Y\cos A}{\sin Y\sin A},\ \cos\varrho=\frac{\cos Z+\cos Y\cos C}{\sin Y\sin C},$$

$$\text{Cos } \sigma=\frac{\cos X+\cos Z\cos B}{\sin Z\sin B},\ \cos\tau=\frac{\cos Y+\cos Z\cos C}{\sin Z\sin C}.$$

Formulas analogous to the following, may also be employed:

$$\text{Cos}^2\tfrac{1}{2}\mu=\frac{\cos(S-X)\cos(S-A)}{\sin X\sin A},$$

in which $S=\frac{1}{2}(Y+X+A)$. Their advantage consists in their admitting more conveniently of the use of logarithms.

60. The following relations subsist between the interfacial angles, and the angles of the sections:

$$\text{Sin } X : \sin Y :: \sin\pi : \sin\mu,$$
$$\text{Sin } Y : \sin Z :: \sin\tau : \sin\rho,$$
$$\text{Sin } Z : \sin X :: \sin\nu : \sin\sigma,$$

and consequently,

$$\text{Sin } \mu\sin\rho\sin\sigma=\sin\nu\sin\pi\sin\tau.$$

If μ is known, π may therefore be found by the equation,

$$\text{Sin } \pi=\sin\mu\sin X\div\sin Y.$$

Similar equations may be obtained for the angles ν, ρ, &c.

61. *a. Interfacial angles of a vertical hemiprism.*—The angles σ and τ are first to be found from the values of b, c, and α, in the hemiprism, and then according to the Napierian theorem,

from σ, γ, and B, we determine X and Z; or
from τ, β, and C, we determine Y and Z.

When X or Y has been found, the equation $A+X+Y=180°$, will give the unknown angle.

b. Inclined macrodiagonal hemiprism.—From a, c, β, the angles π and ρ may be obtained, and then by the Napierian theorem,

X and Y may be found, from π, γ, and A;
Z and Y, from ρ, α, and C.

Finally we have $B+X+Z=180°$.

c. Inclined brachydiagonal hemiprism.—From b, a, γ, the angles μ and ν may be found, and then by the Napierian theorem,

X and Y from μ, β, and A;

X and Z from ν, α, and B; and $C+Y+Z=180°$.

Determination of the dimensions of forms.

62. Several of the preceding formulas may assist in determining the lengths of the axes. The following proportions and equations are also important:

a. $\text{Sin}\,\mu : \sin\nu :: b : a$; $\sin\pi : \sin\rho :: c : a$; $\sin\sigma : \sin\tau :: c : b$.

b. When X and Y, in a vertical hemiprism, are known,

$$b : c :: \sin Y \sin\beta : \sin X \sin\gamma;\ X+Y+A=180°.$$

c When X and Z, in an inclined macrodiagonal hemiprism, are known,

$$a : c :: \sin Z \sin\alpha : \sin X \sin\gamma;\ X+Z+B=180°.$$

d. When Y and Z, in an inclined brachydiagonal hemiprism, are known,

$$a : b :: \sin Z \sin\alpha : \sin Y \sin\beta;\ Y+Z+C=180°.$$

63. When, in these several hemiprismatic forms, an edge is measured that is not parallel to the axis of the hemiprism, the plane angle of the prismatic faces must first be found, and then the Napierian theorem may be applied as follows:

a. If Z is the angle given in the vertical prism,

$$\text{Sin}\,\upsilon=\frac{\sin B\sin\gamma}{\sin Z},\ \text{or,}\ \sin\xi=\frac{\sin C\sin\beta}{\sin Z};$$

and then,

$$\text{Tan}\,\tfrac{1}{2}\,\sigma=\tan\tfrac{1}{2}\,(\upsilon—\gamma)\frac{\sin\frac{1}{2}\,(B+Z)}{\sin\frac{1}{2}\,(B—Z)},$$

$$\text{or,}\ \tan\tfrac{1}{2}\,\tau=\tfrac{1}{2}\,(\xi—\beta)\frac{\sin\frac{1}{2}\,(C+Z)}{\sin\frac{1}{2}\,(C—Z)}.$$

b. If Y is given in the inclined macrodiagonal prism,

$$\text{Sin}\,\zeta=\frac{\sin A\sin\gamma}{\sin Y},\ \text{or}\ \sin\xi=\frac{\sin C\sin\alpha}{\sin Y}.$$

$$\text{Tan}\,\tfrac{1}{2}\,\pi=\tan\tfrac{1}{2}\,(\zeta—\gamma)\frac{\sin\frac{1}{2}\,(A+Y)}{\sin\frac{1}{2}\,(A—Y)},$$

$$\text{or,}\ \tan\tfrac{1}{2}\,\rho=\tan\tfrac{1}{2}\,(\xi—\alpha)\frac{\sin\frac{1}{2}\,(C+Y)}{\sin\frac{1}{2}\,(C—Y)}.$$

c. If X is given in the inclined brachydiagonal hemiprism,

$$\text{Sin}\,\zeta=\frac{\sin A\sin\beta}{\sin X},\ \text{or}\ \sin\upsilon=\frac{\sin B\sin\alpha}{\sin X}.$$

$$\text{Tan}\,\tfrac{1}{2}\,\mu=\tan\tfrac{1}{2}\,(\zeta—\beta)\frac{\sin\frac{1}{2}\,(A+X)}{\sin\frac{1}{2}\,(A—X)},$$

$$\text{or,}\ \tan\tfrac{1}{2}\,\nu=\tan\tfrac{1}{2}\,(\upsilon—\alpha)\frac{\sin\frac{1}{2}\,(B+X)}{\sin\frac{1}{2}\,(B—X)}.$$

64. *Determination of the signs of forms.*—The rules on pages 53 to 56 should here be referred to. The formulas and rules deduced for the preceding systems, will be found of essential importance, also, in this system of crystallization.

EXAMPLES.

This subject may be further elucidated by some examples of the mode of calculation.*

1. *Monoclinic System.*

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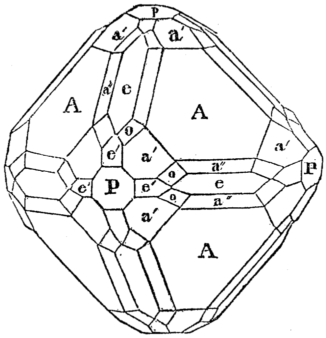

1. *Red Copper Ore.*—The annexed figure represents an octahedron with truncated and bevelled edges, and replaced angles.

A is a face of the octahedron =1.

e truncates the edges, and is therefore the face of a dodecahedron, =∞.

P truncates a solid angle, and is therefore a face of a cube =∞-∞.

a'' is an *m*   a' is an *m-m*.
e'   "   ∞-*n*   o   "   *m-n*.

a' truncates an edge between two planes e, (form ∞); its sign is therefore 2-2, (§ 13, e).

To determine a'' (m) we measure the inclination of e on a''=169° 32'. Subtracting 90°, 70° 32' remain, which equal half the interfacial angle a'': a''$=\frac{1}{2}\,2B$, (f. 49); using the formula, § 14, 3, $m=\tan.\ \frac{1}{2}B\sqrt{\tfrac{1}{2}}$, we find that $m=2$. The sign of a'' is therefore, 2.

The faces o (m-n) bevel the edges of form ∞, and therefore (§ 13, e, 1) $n=\dfrac{m}{m-1}$. To determine n, we measure the angle o : e and find its value 160° 54', the supplement of which, 19° 6', is the angle ε, (§ 14). But $\tan.\ \varepsilon=\dfrac{(n-1)\sqrt{3}}{n+1}$, and therefore by transposition $n=\dfrac{\sqrt{3}+\tan.\ \varepsilon}{\sqrt{3}-\tan.\ \varepsilon}$.

Making $\varepsilon=19°\ 6'$, and observing that $\tan.\ 19°\ 6'=\frac{1}{5}\sqrt{3}$ we obtain $n=\frac{3}{2}$. And since $n=\dfrac{m}{n-1}$, $\frac{3}{2}=\dfrac{m}{m-1}$, $\therefore\ m=3$, and the ascertained sign is 3-$\frac{3}{2}$.

This could have been determined without measurement, if the planes o were so extended as to form an edge with the plane A. Two opposite planes o would then have made parallel intersections with A, and consequently, (§ 13, a, 5), we should have had $n=\dfrac{2\,m}{m+1}$. Therefore since also $n=\dfrac{m}{m-1}$, $\dfrac{m}{m-1}=\dfrac{2\,m}{m+1}$, from which we find $m=3$, as before determined.

The signs of the planes collected together form the following description of the crystal: 1, 2, ∞, 2-2 ∞-2 3-$\frac{3}{2}$ ∞-∞.

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* These examples are taken from Naumann's Treatise, excepting those of Columbite and Monazite.

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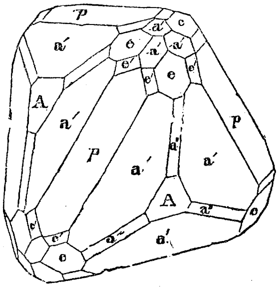

2. *Gray Copper Ore.*—This figure has a tetrahedral character. Its planes belong to the following forms:

A, face of a tetrahedron (f. 56, 1);
p, face of a cube, $=\infty\text{-}\infty$;

$a'=\frac{(m\text{-}m)}{2}$, (f. 59); $e=\infty$ (f. 14).

$e'=\infty\text{-}n'$, (f. 34, § 13, h, 2); $-a'=\frac{(m'\text{-}m')}{2}$

$a''=\frac{(m'')}{2}$, (f. 60, 64, § 13, h, 1).

The intersection of a′ with two planes e (∞) are parallel, and therefore, (§ 13, h, 3), $m=2$ and $\frac{(m\text{-}m)}{2}=\frac{(2\text{-}2)}{2}$. For the same reason, $-a'=-\frac{(2\text{-}2)}{2}$.

The planes a″ truncate the shorter edges of $\frac{(2\text{-}2)}{2}$, and, therefore, $a''=\frac{\left(\frac{3}{2}\right)}{2}$(§ 13, h, 1).

The edges e′ : a′ are parallel to the shorter edges of $\frac{(2\text{-}2)}{2}$, therefore, with respect to the plane e′, (§ 13, h, 2), $n'=m+1$, and hence $e'=\infty\text{-}3$.

The collected signs are, $\frac{(1)}{2}$, $\frac{\left(\frac{3}{2}\right)}{2}$, ∞, $\frac{(2\text{-}2)}{2}$, $-\frac{(2\text{-}2)}{2}$, $\infty\text{-}3$, $\infty\text{-}\infty$.

3. *Iron Pyrites.*—The several forms contained in this crystal are the following:

$P=\infty\text{-}\infty$, f. 1. $a=1$, f. 11. $a'=m''\text{-}m''$, f. 39.

$o''=\frac{[m\text{-}n]}{2}$. $o'=\frac{[m'\text{-}n']}{2}$. $e'=\frac{[\infty\text{-}n']}{2}$. $e''=\frac{[\infty\text{-}n'']}{2}$.

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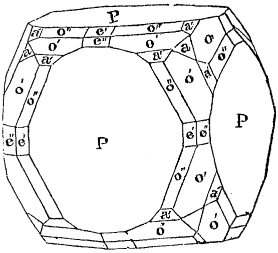

By measuring e′ on P and subtracting 90° from the angle, we obtain the angle e′ on e′ over P, which equals 2ν; and hence from § 14, 4, since $n=\tan\nu$, we find $e'=\infty\text{-}2$. e′ (∞-2) truncates the edge o″: o″, that is, the longest edge of the form o″; therefore, (§ 13 *i*, 5,) $n'=n=2$ and $m\text{-}n=m\text{-}2$. But o″ makes parallel intersections with e′ and a″ and consequently by means of the general equation, § 3, for the parameter of a plane forming parallel intersections with two others, we find $o''=4\text{-}2$

In the same manner also, it is found that $a'=2\text{-}2$, (§ 13, *i*, 3).

In consequence of the parallelism of the intersections of o′, a′ and o″, the planes o′ replace the edges *C* (fig. 49) of the hemi-hexoctahedron o″, and are inclined on the longest edge *B*, (f. 74); and therefore from § 3, $n'=\frac{m'(m^2-n)n}{(mn-1\ mn+m'(m-n^2)m}$. Substituting 4 for *m*, and 2 for *n*, and reducing the equation, we obtain $n'=\frac{1}{2}m'$.

If now the plane e′ were so extended as to form an edge with o′, this edge would be parallel to the intersections of o′ with a′, and from the parallelism of these two lines, observing that $a=1$, $e'=\infty\text{-}2$ it is determined that $n=\frac{2m}{m-1}$. By equating these two values of *m*, it is found that $m=2$ and $n=\frac{3}{2}$ and the whole sign of o′ is $3\text{-}\frac{3}{2}$. Also from § 13, *i*, 3, $e''=\infty\text{-}\frac{3}{2}$.

But as this intersection of e′ with o′ does not exist in the crystal, we must have recourse to a measurement. As above, we first ascertain by measurement that $e''=\infty\text{-}\frac{3}{2}$. Consequently, (§ 13, *i*, 3), $o''=3\text{-}\frac{3}{2}$.

The expression for the crystal is, therefore,

$$1,\quad 2\text{-}2,\quad \frac{[3\text{-}\frac{3}{2}]}{2},\quad \frac{[4\text{-}2]}{2},\quad \frac{[\infty\text{-}2]}{2},\quad \frac{[\infty\text{-}\frac{3}{2}]}{2},\quad \infty\text{-}\infty.$$

2. *Dimetric System.*

Idocrase.—In this figure a, a, are faces of the fundamental octahedron.

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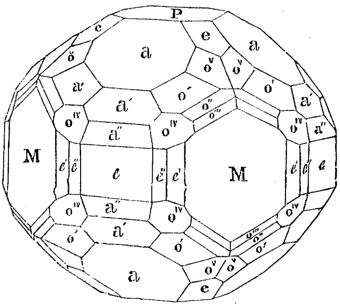

Axis $a=\sqrt{\frac{2}{7}}$. Consequently, cos. $Z=-\frac{3}{11}$, cos. $X=-\frac{7}{11}$. $X=129^\circ\ 31'$, and $Z=74^\circ\ 10\frac{1}{2}'$.

It is obvious that

P=0, $e=\infty$, M=∞-∞, e=1-∞, (§ 22, b, 3.)

Measurement gives the angle a′: $e=146^\circ\ 30'$, from which, if 90 be subtracted, we obtain $56^\circ\ 30'=\frac{1}{2}Z$, and since (§ 23, *d*)

$m=\dfrac{\tan\frac{1}{2}Z}{\tan\frac{1}{2}Z'}=\dfrac{\tan.56^\circ 30'}{\tan.\ 37^\circ\ 5'}=2$: therefore, a′=octahedron 2.

The planes e'', e' are of the general form ∞-n. By measurement we find, M: $e''=153^\circ\ 30'$, M: $e'=161^\circ\ 34'$. Subtracting 90°, there remains the value of $\frac{1}{2}X$ for each form; and since $n=\tan.\ \frac{1}{2}X$, (§ 23 *f*), $e''=\infty$-2, $e'=\infty$-3.

Because the planes o′, o^{iv}, and c'', have horizontal intersections, and $e''=\infty$-2, both o′ and o^{iv}, are of the form m-2. Because also o^{iv} forms parallel intersections with M and a′, (2), o^{iv}=4-2. o′, o″, o‴, form parallel edges between M and a, and the same are parallel with e, and they are, therefore, of the general form m-m. Consequently, from the above, o′=2-2. As the mutual intersections of a″, o^{iv}, o‴, are parallel to one another, and also to the normal section, $m'=m$, and since o^{iv}=4-2, o‴=4-4, and a″=4.

The planes o^{v} replace the basal angles of the pyramid 1, and their edges of intersection with the same a are parallel, or in other words, a truncates edge Y of the form o^{v} (m-n); therefore, (§ 22, *a*, 1), $m(n+1)=2m'n$; or since $m'=1$, $m(n+1)=2n$.

Again, since o^{v} replaces the edges between e (1-∞) and o′, (2-2), $m(n-1)=n$, (§ 3, *a*, 2). Therefore, $m(n+1)=2m(n-1)\ \therefore\ n=3$ and $o^{v}=\frac{3}{2}$-3.

Since the intersections of o^{v} and o″ are horizontal, $n'=n$, and consequently o″=3-3.

To determine o′ by measurement, we measure the angle o′: M, from which by subtracting 90°, we obtain $\frac{1}{2}T$. Then by formula, (§ 23, *b*), $m=\tan.\ \frac{1}{2}T\times\cot.\ \frac{1}{2}T'$, we determine m, as before, equal to 2.

The signs of the crystal thus developed are,

$$0,\ 1,\ 2,\ 4,\ \infty,\ 2\text{-}2,\ 4\text{-}2,\ \infty\text{-}2,\ \tfrac{3}{2}\text{-}3,\ 3\text{-}3,\ \infty\text{-}3,\ 4\text{-}4,\ 1\text{-}\infty,\ \infty\text{-}\infty.$$

3. *Trimetric System.*

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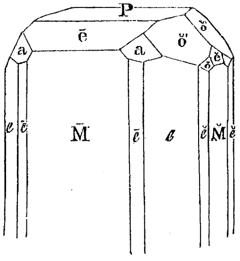

Columbite.—In this figure we take a, as a face of the fundamental form. The values of its axes are, $a=1{\cdot}0584=\sqrt{1{\cdot}12}$; $b=1{\cdot}206=\sqrt{1{\cdot}454}$; $c=1$. We have $P=0$; $\bar{M}=\infty\text{-}\bar{\infty}$; $\breve{M}=\infty\text{-}\breve{\infty}$; and since the edge a: e is horizontal, as seen in the crystal, $e=\infty$.

The angle $\breve{M}$: $\breve{e}=156^\circ\ 6'$, and therefore $\frac{1}{2}X$ in the prism $\breve{e}$ (∞-$\breve{n}$)=$68^\circ\ 6'$. Half the same angle in the prism e (∞)=$39^\circ\ 40'$: hence (§ 30, *e*) $n=3$ and $\breve{e}=\infty\text{-}\breve{3}$.

Since $\breve{o}'$, $\breve{o}'$, bevel the longer terminal edge of a (1), they have the general sign $\breve{P}n$, (§ 31, *b*, 3), and because also $\breve{o}'$ forms parallel intersections with $\breve{e}$ ($\infty\text{-}\breve{3}$) and P (0), $\breve{o}'$=1-3.

ē truncates terminal edge of the pyramid $\breve{o}'$, (1-3), and consequently $\breve{e}=\frac{1}{3}\text{-}\bar{\infty}$.

The planes $\breve{o}''$ $(m\text{-}\breve{n})$ replace the edge $\breve{o}'$: $\breve{M}$, and therefore, (§ 31, *b*, 4) since $\breve{o}'=1\text{-}\breve{3}$ $\frac{m}{n}=\frac{1}{3}$. By measurement of the interfacial angle $\breve{M}$: $\breve{e}$ we find it to equal 150° 20′; and hence since (§ 27, *d*) tan $\frac{1}{2}Z$ in the prism $\breve{e}$, $(m\text{-}\breve{\infty})=ma\div b$, we deduce, that $\breve{e}=2\text{-}\breve{\infty}$. Now $\breve{e}$ truncates a terminal edge of the pyramid $\breve{o}'$, and consequently, $\breve{o}''=2\text{-}\breve{n}$; and since $\frac{m}{n}=\frac{1}{3}$, $n=6$ and $\breve{o}''=2\text{-}\breve{6}$.

The inclination of $\bar{e}$ on $\bar{M}$ equals 157° 29′, and hence $\frac{1}{2}$ Y in the prism $\bar{e}=67°\ 29'$. Therefore, (§ 30, *e*) $\bar{e}=\infty\text{-}\bar{2}$.

The expression thus deduced for the crystal is as follows:

$$0,\ 1,\ \infty,\ 1\text{-}\breve{3},\ \infty\text{-}\breve{3},\ 2\text{-}\breve{6},\ 2\text{-}\breve{\infty},\ \infty\text{-}\breve{\infty},\ \infty\text{-}\bar{2},\ \tfrac{1}{8}\text{-}\bar{\infty},\ \infty\text{-}\bar{\infty}.$$

By substituting the values of the axes in the different forms for *a*, *b*, *c*, in the equations, § 26, the values of the angles of those forms may be obtained. In this manner we find for the fundamental pyramid, $X=102°\ 58'$, $Y=117°\ 51'$, $Z=107°\ 56'$. In the pyramid $1\text{-}\breve{3}$ ($\breve{o}'$) by writing *a*, *b*, 3*c*, for *a*, *b*, *c*, the same angles for this form may be found; and by substituting 2*a*, *b*, 6*c*, for *a*, *b*, *c*, the corresponding angles for the form $2\text{-}\breve{6}$ ($\breve{o}''$) may be obtained.

4. *Hexagonal System.*

1. *Apatite.*—The annexed figure represents a hexagonal prism, with truncated lateral edges and replaced basal edges and angles. The plane e may be selected as a face of the fundamental pyramid (1). Then

$$P=0,\ M=\infty,\ e=\infty\text{-}2,$$

a truncates a terminal edge of 1, and therefore $=1\text{-}2$, (§ 43, *g*, 3).

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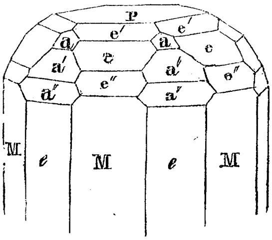

The edge a′ : e is parallel to a *terminal edge* of 1, since it is parallel to the edges of the plane a, which truncates this edge; consequently, $a'=2\text{-}2$, (§ 43, *g*, 5).

The edge a : e′ is parallel to a terminal edge of e′; therefore, since $a=1\text{-}2$, $e'=\frac{1}{2}$, (§ 43, *g*, 5).

a′ (2-2) truncates a lateral edge of the pyramid e″ (*m*), and therefore, $e''=2$.

The edge a″ : e″ is parallel to a terminal edge of e″ (2); consequently, $a''=4\text{-}2$.

Description of the crystal:

$$0,\ \tfrac{1}{2},\ 1,\ 2,\ 1\text{-}2,\ 2\text{-}2,\ 4\text{-}2,\ \infty\text{-}2.$$

2. *Calcite.*—The figure is secondary to a rhombohedron. Its larger faces *e′* belong to a scalenohedron. Its primary faces are marked *R*.

a is a face of the hexagonal prism ∞R.

The interfacial angle a' : a, subtracted from 180°, equals the inclination of a' on the axis, = the angle a; and since $m=\frac{\text{cot. } a}{\text{cot. } a'}$, (§ 45, *g*), a' being the corresponding angle in the primary $a'=-2R$.

The edges $R : e'$, $e' : e'$, $e' : R$, are parallel: consequently, $e' : e'$, are faces of a scalenohedron, R^n, (§ 43, *k*, 3). But also the planes a' $(-2R)$ truncate the acute terminal edges of the scalenohedron. It follows, therefore, that $e'=R^3$, (§ 43, *e*).

The terminal edges of the primary are truncated by $e=-\frac{1}{2}R$, (§ 43, *k*, 6).

The plane e′ forms a horizontal intersection with e' (R^3) and is, therefore, of the general form mR^3, (§ 43, *a*). Also, because it bevels the terminal edge of the primary R, $\frac{1}{2}m'\,(3n'-1)=m$, (§ 43, *k*, 1). Since $n'=3$, we have $4m'=m=1$ and $m'=\frac{1}{4}$, therefore, $e'=\frac{1}{4}R^3$.

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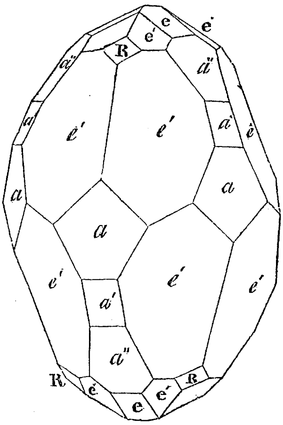

The two adjacent planes e′ ($\frac{1}{4}R^3$) form parallel intersection with two faces of the rhombohedron a'', and therefore bevel its terminal edges; consequently, since $\frac{1}{2}m'(3n'+1)=m$, (§ 43, *k*, 4), $a''=-\frac{5}{4}R$.

To obtain the value of the axis (a) from R on R, use equation, (§ 45, *g*), $a^2=\frac{3(1+\cos X)}{2-4\cos X}$.

If $x=105^\circ\ 5'$, then since $\cos 105^\circ\ 5'=-\cos 74^\circ\ 55=-0{\cdot}26022$; therefore

$$a^2=\frac{3(1-0{\cdot}26022)}{2+4\times0{\cdot}26022}=\frac{2{\cdot}21934}{3{\cdot}04088},$$

whence $0{\cdot}8543=a$ (the desired axis).

Description of the crystal: R^3. $\frac{1}{4}R^3$. ∞R. $-\frac{5}{4}R$. $-\frac{1}{2}R$. $-2R$. R.

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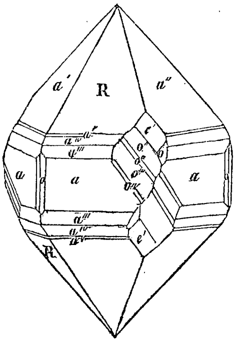

3. *Quartz.*—In the annexed figure R, a'', are the planes of the fundamental pyramid (1). a''', a^{iv}, a^{v}, are other paramids, and the obliquely situated planes are tetartohedral forms. $a=$ prism ∞.

The edge $R:e'$ being parallel to a terminal edge of the fundamental pyramid, $e'=2\text{-}2$, (§ 43, *g*, 5).

Because the intersections of the planes o', o'', o''', o^{iv}, are parallel to e' they have the general sign $m\text{-}\frac{m}{m-1}$.

The signs of the planes a''', a^{iv}, a^{v}, may be determined by measuring the inclination $a:a'''$, $a:a^{\text{iv}}$, $a:a^{\text{v}}$. They are thus found to be

$$a^{\text{v}}=\frac{5}{3},\ a^{\text{iv}}=3,\ a'''=4.$$

The tetartohedral forms o', o'', o''', o^{iv}, have the general formula $l\frac{(m\text{-}n)}{4}$, and o^{v} is $r\frac{(m\text{-}n)}{4}$. Moreover, as $n=\frac{m}{m-1}$, since the parallel intersections are parallel also to a terminal edge of 1. The inclinations of these planes on a, diminished by 90°, equal each the semi-angle U. Then from the equation for $2m-1$ (§ 45, *b*), we obtain for quartz, $2m-1=2{\cdot}34\tan\frac{1}{2}U$.

Hence to determine m for any plane, we have only to measure the angle between the plane and a, and subtract 90°; this gives $\frac{1}{2}U$, and then the equation $2m-1=2{\cdot}34\tan\frac{1}{2}U$, gives m. Thus we obtain

$$o^{\text{v}}=r\frac{(3\text{-}\frac{3}{2})}{4},\ o'=l\frac{(4\text{-}\frac{4}{3})}{4},\ o''=l\frac{(5\text{-}\frac{5}{4})}{4},\ o'''=l\frac{(6\text{-}\frac{6}{5})}{4},\ o^{\text{iv}}=l\frac{(8\text{-}\frac{8}{7})}{4}.$$

Description of the crystal:

$$1,\ \frac{5}{3},\ 3,\ 4,\ \infty,\ 2\text{-}2,\ r\frac{(3\text{-}\frac{3}{2})}{4},\ l\frac{(4\text{-}\frac{4}{3})}{4},\ l\frac{(5\text{-}\frac{5}{4})}{4},\ l\frac{(6\text{-}\frac{6}{5})}{4},\ l\frac{(8\text{-}\frac{8}{7})}{4}.$$

5. *Monoclinic System.*

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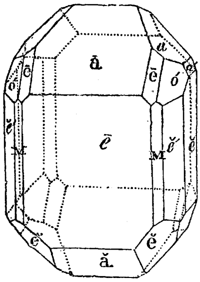

Monazite.—Assuming ē as a face of the fundamental form, $\bar{e}=\infty\text{-}\bar{\infty}$, $\breve{e}=\infty\text{-}\breve{\infty}$. The general descriptive expressions for the remaining planes are as follow:

$\bar{a}=m\text{-}\infty$ $a=m\text{-}\grave{\infty}$ $a'=m'\text{-}\grave{\infty}$ $\breve{e}'=\infty\text{-}\grave{n}$

$\breve{a}=-m\text{-}\infty$ $\breve{e}=-m$ $o'=m'\text{-}\grave{n}$ $M=\infty\text{-}n$

The plane $a(m\text{-}\grave{\infty})$ forms parallel intersections with ē and ĕ, which intersections, since they are parallel with the edge ē : ē (∞-∞) are also parallel with the orthodiagonal edge of ē (1). Hence, $\breve{e}=-1$ (§ 53, 1, *b*), and $a=1\text{-}\grave{\infty}$, (§ 53, 1, *b*); and also since M forms parallel intersections with ē and ĕ, $M=\infty$ (§53, 1, *a*).

ā truncates the edge between ē and ē, which is the clinodiagnal edge of 1, and therefore, $\bar{a}=1\text{-}\infty$ (§ 53, 1, c).

ă in the same manner truncates the clinodiagonal edge of —1. Consequently, ă $=1\text{-}\infty$, (§ 53).

The intersection of $o'(m\text{-}n)$ with ē (1) is parallel to the clinodiagonal edge of octahedron 1, consequently $n=m$ (§ 53 5), and $o'=m\text{-}m$. Again, o' forms parallel intersections with $a(1\text{-}\grave{\infty})$ and M, (∞), and therefore its sign is of the general form $m\frac{m}{m-1}$. But from the above, $n=m$, and consequently $m=\frac{m}{m-1}$; from which we find $m=2$, and $o=2\text{-}\grave{2}$.

The edge $o' : a'$ $(m'\text{-}\bar{\infty})$ is parallel to the orthodiagonal edge of o' $(2\text{-}\bar{2})$ consequently $m=2$, (§ 53, 1, b), and $a'=2\text{-}\bar{\infty}$.

The intersection of o' $(2\text{-}\bar{2})$ with ĕ′ $(\infty\text{-}\bar{n})$, is parallel to the basal section of $2\text{-}\bar{2}$, (apparent in the crystal, though not in the figure, a perspective representation of it); hence $n'=2$, (§ 53, 1, a), and ĕ′ $=\infty\text{-}\grave{2}$.

Thus all the expressions for the planes of this crystal have been determined without a measurement. If the intersection of o' with M were not apparent in the crystal, it would be necessary first to determine ĕ′ by measuring the interfacial angles M : ē and ĕ′ : ē ; these angles 136° 35′ and 117° 51′ diminished by 90° give the angles X in the two forms M (∞) and ĕ′, $(\infty\text{-}\grave{n}')$; and then, since $\tan 46° 35' = 2 \tan 27° 51'$, it follows that $n'=2$ and ĕ′ $=\infty\text{-}\grave{2}$. Thence since the intersection of o' with ĕ′ is parallel to the basal section of o', $(m\text{-}\bar{m})$, $o'=2\text{-}\grave{2}$, (§ 53, 1, a), as before found. The same might have been similarly determined by measuring the inclination of 1 on a and a'.

For the calculation of the dimensions and angles of the crystal we have as data, $\infty\text{-}\infty : 1\text{-}\infty = 140° 40'$, $\infty\text{-}\infty : -1\text{-}\infty = 126° 8'$, $\grave{\infty}\text{-}\infty : \infty = 136° 35'$.

$$180° - 140° 40' = 39° 20' = \mu',$$
$$180° - 126° 8' = 53° 52' = \mu,$$
$$136° 35' - 90° = 46° 35' = X \text{ in } \infty.$$

Since $1\text{-}\infty$ and $-1\text{-}\infty$ are coördinate forms, we may determine C by the equation $\tan C = \frac{2 \sin \mu \sin \mu'}{\sin(\mu - \mu')}$, whence we obtain $C = 70° 14'$.

To determine the axes there are given the angles C, μ, and X in the form ∞. If $b=1$, $\tan X \sin C = c$, (§ 51, a); consequently, $c=1{\cdot}0265$.

Again, $a=\frac{\sin(C+\mu)}{\sin \mu}=\frac{\sin 49° 54'}{\sin 35° 52'}$; therefore $a=0{\cdot}9471$.

Hence, $a : b : c = 0{\cdot}9471 : 1 : 1{\cdot}0265$.

After thus determining the axes, the angles X, Y, Z, in the various forms, are readily obtained by the equations, p. 86. For example, with regard to the form ±1, X and X' may be determined by the equations $\tan X = \frac{\tan \pi}{\sin \mu'}$, $\tan X' = \frac{\tan \pi}{\sin \mu}$, $\tan \pi$ having first been found by the equation, $\tan \pi = \frac{c}{a}$. This gives $X = 59° 41'$, which is half the interfacial angle ē : ē. By means of the equations $\tan Y = \frac{\tan \mu'}{\sin \pi}$, $\tan Y' = \frac{\tan \mu}{\sin \pi}$, we obtain Y and Y', which are respectively the supplemental angles of ē on ē and ē on ĕ. Again, by the equations, $\tan Z = \frac{\tan(C - \mu')}{\sin \sigma}$, $\tan Z' = \frac{\tan(C - \mu)}{\sin \sigma}$, ($\sigma$ being found by the equation $\sin \sigma = \frac{c}{b}$), we find the angles Z, Z', which are the supplements of P on ē and P on ĕ. $Y + Y'$ = the inclination of ĕ on ē over an orthodiagonal terminal edge, and $Z + Z'$ = the inclination of ē on ĕ over a basal edge of the form ±1.

In the form $2\text{-}\grave{2}$ whose axes have the ratio $2a$, $2b$, c, the angle μ is identical with the corresponding angle in 1. π is found by the equation $\tan\pi=\frac{c}{2a}$, and σ by the equation $\tan\ \sigma=\frac{c}{2b}=\frac{c}{2}$. After the determination of these angles, X, Y, Z in this form, may be found by the same equations as above. The inclination of P on M may be determined by the equation for $\tan Z$ in the form ∞, $\tan\left\{\begin{matrix}Z\\Z'\end{matrix}\right.=\mp\frac{\tan C\sqrt{(b^2+c^2)}}{c}$; (§ 51, a), which affords the supplement of the desired inclination; or by the equation, (§ 51, d), $\sin\Pi$ (the sought angle)$=\frac{\cos X}{\cos\sigma}$, or $\cos\Pi=\sin X\cos C$, in which X is the angle X in the form M (∞). The interfacial angle $a:\bar{e}$ is determined by the equation for $\tan Y$ in $1\text{-}\breve{\infty}$.

In a similar manner the angles of the other forms may be obtained.

ON THE DRAWING OF FIGURES OF CRYSTALS.

In the projection of crystals, the eye is supposed to be at an infinite distance, so that the rays of light fall from it on the crystal in parallel lines; and not diverging as in ordinary landscape perspective. If parallel lines were drawn from the vertices of the solid angles of a crystal, to a board placed behind it, and the points thus formed on the board were connected by straight lines, as in the crystal, a representation of the crystal would be formed, constructed according to the mode of projection employed in crystallography. The plane on which the crystal is projected, is termed the *plane of projection.* This plane may be at *right angles* with the vertical axis, may pass *through* the vertical axis, or may intersect it at an *oblique angle.* These different positions give rise, respectively, to the *horizontal, vertical,* and *oblique* projections. The rays of light may fall *perpendicularly* on the plane of projection, or may be *obliquely* inclined to it; in the former case the projection is termed *orthographic,* in the second *clinographic.* In the horizontal position of the plane of projection, the projection is always orthographic. In the other positions, it may be either orthographic or clinographic. It has been usual to give the plane of projection an oblique position, and to use the orthographic mode of projection. It is however preferable to employ the vertical position and clinographic projection, and this method is elucidated in the following pages.

The projection of the axes of a crystal, is the first step preliminary to the projection of the crystal itself. It will be more convenient to illustrate first the projection of the axes in the monometric system, which are equal and intersect at right angles. The projection of the axes in the other cases, may be obtained by varying the lengths of the projected monometric axes, and also, when oblique, their inclinations.

Monometric System.—When the eye is directly in front of a face of a cube, neither the sides nor top of the crystal are visible, nor the secondary planes that may be situated on the intermediate edges. On turning the crystal a few degrees from right to left, a side lateral plane is brought in view, and by elevating the eye slightly, the terminal plane becomes apparent. Half the planes on the crystal are now visible, and consequently this is a convenient position for projecting it. In the following demonstration, the angle of revolution is designated δ, and the angle of the elevation of the eye, ε. Fig. 151 represents the normal position of the horizontal axes, supposing the eye to be in the direction of the axis BB; BB is seen as a mere point, while CC appears of its actual length. On revolving the whole through a number of degrees equal to BMB′ (δ) the axes have the position exhibited in the dotted lines. The projection of the semiaxis MB is now lengthened to MN, and that of the semiaxis MC is shortened to MH.

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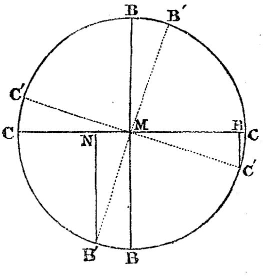

If the eye be elevated, (at any angle, ε), the lines B′N, BM and C′H will be projected respectively below N, M and H, and the lengths of these projections (which we may designate b′N, bM, and c′H) will be directly proportional to the lengths of the lines B′N, BM, and C′H.

It is usual to adopt such a revolution and such an elevation of the eye as may be expressed by a simple ratio between the projected axes. Let us designate the ratio between the two axes as projected after the revolution alluded to (MN : MH) by 1 : r; and the ratio of b′N to MN by 1 : s. Now the character of the view will vary with the values assumed for r and s. Suppose r to equal 3 and s to equal 2, then proceed as follows:

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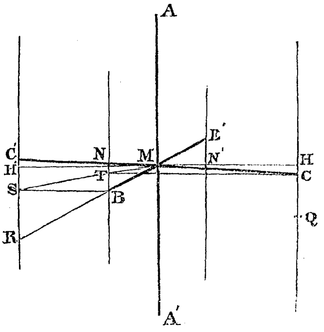

Draw two lines AA′, H′H (f. 154) intersecting one another at right angles. Make MH=MH′ $=b$. Divide HH′ into r parts, and through the points, N, N′, thus determined, draw perpendiculars to HH′. On the left hand vertical, set off, below H′, a part H′R, equal to $\frac{1}{s}b=\frac{1}{s}$ H′M; and from R draw RM, and extend the same to the vertical N′. B′B is the projection of the front horizontal axis.

Draw BS parallel with MH′ and connect S, M. From the point T in which SM intersects BN, draw TC parallel with MH. A line (CC′) drawn from C through M, and extended to the left vertical, is the projection of the side horizontal axis.

Lay off on the right vertical, a part HQ equal to $\frac{1}{r}$MH, and make MA=MA′=MQ; AA′ is the vertical axis.

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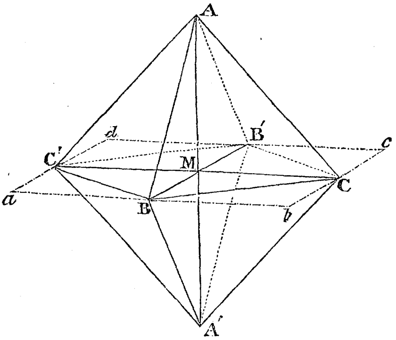

The values of r and s commonly taken, are $r=3$, $s=2$, in which case, $\delta=18°\ 26'$, and $\varepsilon=9°\ 28'$. It is not unusual to give s the value of 3, in which case $\varepsilon=6°\ 20'$. This affords a narrower terminal plane. The angle δ is obtained by the equation cot $\delta=r$, the angle ε by the equation cot $\varepsilon=r\ s$.

The regular octahedron may now be drawn, by connecting the extremities of the horizontal axes, and then uniting them by right lines with the points A, A′, as in f. 155. If lines be drawn through the points B and B′, parallel with C C′, and through C, C′, parallel with the axis BB′, a plane figure *abcd* is formed, which is a horizontal section of the cube. Through the points *a*, *b*, *c*, *d*, draw lines parallel with the vertical axis AA′, and extend them each side of these points, to a distance equal to the vertical semiaxis MA. By connecting the upper and also the lower extremities of these perpendiculars by lines parallel with the lines *ab*, *bc*, *cd*, *da*, the figure will represent a cube.

The cube may also be projected by drawing lines from M to the centre of each edge of the octahedron, and then extending these lines to double their length. Their extremities are the vertices of the angles of the cube.

It is convenient to have at hand an accurate figure of a cube drawn on a large scale, as it may readily be used by methods explained beyond for making figures of the type prisms of either of the other systems. Such a figure may be made as above explained. It may also be constructed with a graduated arc, or a scale of signs as follows. Draw two lines as AA′ and HH, f. 154, crossing at right angles; draw a line C′C, making an angle 3° 11′ with H′H, and BB′, making an angle 26° 34′, with H′H, each crossing AA′ in M. Then, M being the centre of each axis, make AA′ $4\frac{1}{4}$ inches in length, C′C $4\frac{1}{26}$ inches, BB $1\frac{1}{2}$ inches. From these axes the cube is readily constructed. The axes are more exactly, AA′ 4·245 in., CC′ 4·038 in., BB′ 1,500 in.

Dimetric System.—In the dimetric system the vertical axis may be made to correspond to the dimensions in a dimetric crystal, by laying off on MA and MA′, (taken as units), extended if necessary, a line equal to $a \div b$; or if b, the horizontal axis of the prism $=1$, the line should equal a (the vertical axis) simply. After determining thus the points A″, A‴, the dimetric octahedron may be formed in the same manner as the regular octahedron above described, except the points A″, A‴ should be substituted for A, A′. The method of describing the cube, already explained, may be employed also for the right square prism. Another right square prism may be represented by drawing lines parallel with the vertical axis, through the extremities of the horizontal axes, making them equal to the vertical axis, and uniting their extremities. Also another square octahedron may be constructed by connecting the points a, b, c, d, with the extremities of the vertical axis.

Trimetric System.—The monometric axes may be adapted to trimetric forms as follows: if the axis $b=1$, lay off MA″ and MA‴ equal to a, and MC″, MC‴ equal to c: if $c=1$, make MB″, MB‴, equal to b. By connecting the extremities of the axes, as already explained, the rhombic octahedron may be constructed. The rectangular prism may be projected in the same manner as the cube; the rhombic prism in the same manner as the second square prism just described; and the rectangular octahedron in the same manner as the second dimetric octahedron explained in the last section.

In changing a figure of a cube (in which the edges $=1$) to a square or rectangular prism $\infty\text{-}\infty$, it is only necessary to shorten or lengthen the edges to correspond with the axes of the new prism.

Monoclinic System.—The axes a and b in the monoclinic system are inclined to one another at an oblique angle$=\gamma$. To project this inclination, and thus adapt the monometric axes to a monoclinic form, lay off on the axis MA, Ma= MA cos γ, and on the axis BB′ (before or behind M, according as the inclination of b on a, in front, is acute or obtuse) Mb=MB×sin γ. From the points b and a, draw lines parallel respectively with the axes AA′ and BB′, and from their intersection D′, draw through M, D′D, making MD=MD′. The line DD′ is the clinodiagonal and the lines AA, C′C, DD′ represent the axes in a monoclinic solid in which $a=b=c=1$. The points a and b and the position of the axis DD′ will vary with the angle γ. The relative values of the axes may be given them as above explained; that is, if $b=1$, lay off in the direction of MA and MA′ a line equal to a, and in the direction of MC and MC′ a line equal to c, &c.

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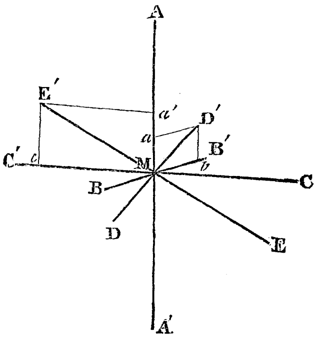

The right rhomboidal prism may be projected in the same manner as the cube or right rectangular prism, and the oblique rhombic prism, in the same manner as the right rhombic prism.

*Diclinic System.**—In the diclinic system, the vertical section through the horizontal axes intersect one another at right angles, as in the preceding system, but the inclination of a to b (γ) and a to c (β) are each oblique. This obliquity may be given the monometric axes as follows: Lay off on MA, (f. 156), Ma=MA×cos γ, and on the axis BB′, (brachydiagonal), Mb=MB′×sin γ. By completing the parallelogram Ma D′b, the point D′ is determined. Make MD=MD′; DD′ is the projected brachydiagonal. Again lay off on MA, Ma'=MA×cos β, and on MC′, to the left, Mc=MC′×sin β. Draw lines from a' and c parallel to MC′ and MA; E′, the intersection of these lines, is one extremity of the macrodiagonal; and the line E′E,

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* The diclinic system differs from the triclinic in having only two of the axial intersections oblique instead of the three. As no example of it has been observed among minerals, and the forms are as well described in the triclinic system, it was not treated of in the earlier part of the work.

in which ME=ME′, is the macrodiagonal. AA′, DD′, EE′ are the axes in a diclinic form, in which the axes are equal. From the observations on the preceding systems of crystallization, the method to be employed in giving the axes their relative values in a particular diclinic form, is sufficiently obvious. The construction of the oblique rectangular prism is analogous to that of the cube.

Triclinic System.—The vertical sections through the horizontal axes in the triclinic system are obliquely inclined; also the inclination of the axis a to each axis b and c, is oblique. In the adaptation of the monometric axes to the triclinic forms, it is therefore necessary, in the first place, to give the requisite obliquity to the mutual inclination of the vertical sections, and afterwards to adapt the horizontal axes, as in the diclinic system. The inclination of these sections we may designate A, and as heretofore, the angle between a and b, γ, and a and c, β. BB′ is the analogue of the brachydiagonal, and CC′ of the macrodiagonal. An oblique inclination may be given the vertical sections, by varying the position of either of these sections. Permitting the brachydiagonal section ABA′B′ to remain unaltered, we may vary the other section as follows:

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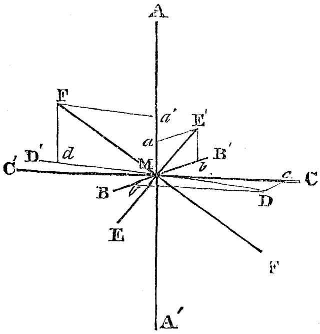

Lay off on MB, Mb'=MB×cos A, and on the axis C′C, (to the right or left of M, according as the acute angle A is to the right or left), Mc=MC× sin A; completing the parallelogram Mb' Dc, and drawing the diagonal MD, extending the same to D′ so as to make MD′=MD, we obtain the line DD′; the vertical section passing through this line is the correct macrodiagonal section. The inclination of a to the new macrodiagonal DD′ is still a right angle; as also the inclination of a to b, their oblique inclinations may be given them by means of the same formulas employed in the diclinic system, except that the axis D′D is to be substituted for C′C. The vertical axis AA′ and the horizontal axes EE′ (brachydiagonal) and FF′ (macrodiagonal) thus obtained, are the axes in a triclinic form, in which $a=b=c=1$. Different values may be given these axes, according to the method heretofore illustrated.

Hexagonal System.—In this system there are three equal horizontal axes, at right angles with the vertical. The normal position of the horizontal axes is represented in f. 158. The eye, placed in the line of the axis YY, observes two of the semiaxes, MZ and MU, projected in the same straight line, while the third, MY, appears a mere point. To give the axes a more eligible position for a representation of the various planes on a tetraxonal solid, we revolve them from right to left through a certain number of degrees δ, and elevate the eye at an angle ε. The dotted lines in the figure represent the axes in their new situation, resulting from a revolution through a number of degrees equal to δ=YMY′. In this position the axis MY′ is projected upon MP, MU′ upon MN, and MZ′ on MH. Designating the intermediate axis I, that to the right II, that to the left III, if the revolution is such as to give the projections of I and II, the ratio of 1 : 2, the relations of the three projections will be as follows: I : II : III=1 : 2 : 3.

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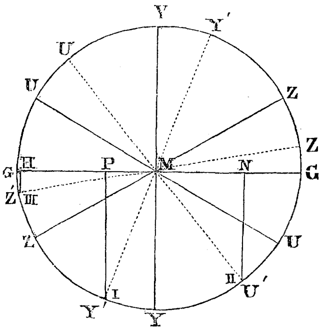

Let us take r (PM : HM) equal to 3, and s (b'P : PM) equal to 2, these being the most convenient ratios for representing the hexagonal crystalline forms. The following will be the mode of construction:

1. Draw the lines AA, HH (f. 159) at right angles with, and bisecting each other. Let HM=b, or HH=$2b$. Divide HH into six parts by vertical lines. These lines, including the left and right hand verticals, may be numbered from one to six, as in

the figure. In the first vertical, below H, lay off HS$=\frac{1}{s}\,b$, and from S draw a line through M to the fourth vertical. YY′ is the projection of the axis I.

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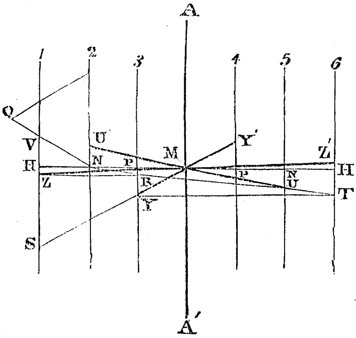

2. From Y draw a line to the sixth vertical and parallel with HH. From T, the extremity of this line, draw a line to N in the second vertical. Then from the point U in which TN intersects the fifth vertical, draw a line through M to the second vertical; UU′ is the projection of the axis II.

3. From R, where TN intersects the third vertical, draw RZ to the first vertical parallel with HH. Then from Z draw a line through M to the sixth vertical: this line ZZ′ is the projection of the axis III.

4. For the vertical axis, lay off from N on the second vertical (f. 159) a line of any length, and construct upon this line an equilateral triangle; one side (NQ) of this triangle will intersect the first vertical at a distance, HV, from H, corresponding to Z′H in f. 158; for in the triangle NHV, the angle HNV is an angle of 30°, and HN$=\frac{1}{2}$MH. MV is therefore the radius of the circle, (f. 158). Make therefore MA=MA′=MV; AA′ is the vertical axis, and YY′, UU′, ZZ′ are the projected horizontal axes.

The vertical axis has been constructed equal to the horizontal axes. Its actual length in different hexagonal or rhombohedral forms may be laid off according to the method sufficiently explained. If lines be drawn through the extremities of the horizontal axes, parallel with the vertical axis, and the parts above and below be made equal to the vertical semiaxis, their extremities will be the vertices of the angles of a *hexagonal prism*, and by connecting them we obtain the projection of this solid. A double hexagonal pyramid, the isosceles dodecahedron, may be projected by connecting the extremities of the horizontal axes with each other, and also uniting them with the extremities of the vertical axis. By drawing lines through the extremities of each horizontal axis, parallel to a line connecting the extremities of the other two axes, a plane hexagonal figure will be obtained, which is the section of a hexagonal prism diagonal with the one above referred to: and by connecting the angles of this hexagonal plane with extremities of the vertical axis, a *second* isosceles dodecahedron is projected.

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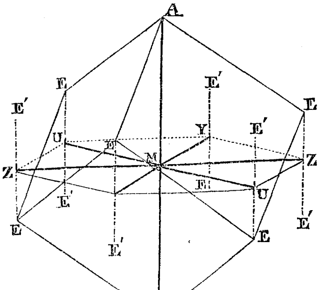

To construct a rhombohedron, lay off verticals through the extremities of the horizontal axes, and make the parts both above and below these extremities, equal to the third of the vertical semiaxis, (f. 160). The points E, E, E′, E′, &c., are thus determined; and if the extremities of the vertical axis be connected with the points E or E′, rhombohedrons in different positions, *m*R or —*m*R, will be constructed.

Delineation of Secondary Planes on the Primary Forms.—Previous to drawing the secondary planes on a primary, it becomes necessary to determine the direction of the intersections of these planes with the primary faces, and also in most cases, with other secondary planes. The principles of analytical geometry have afforded Naumann formulas for these intersections; but it would be giving this article too great an extension to enter into a full discussion of this method of determining intersections. It is in general sufficient to employ the method of construction.

In the employment of the plan of construction, the projection of the prism 0, ∞-∞, is the most convenient preliminary step; that is, the cube in the monometric system, right square prism in the dimetric system, the rectangular prism in the trimetric, the right rhomboidal in the monoclinic, and the prism 0, ∞-$\bar{\infty}$, ∞-$\breve{\infty}$, in the diclinic and triclinic systems. This is advisable because in these forms the lateral edges are equal and parallel to the vertical axis, and the basal edges, to the horizontal axes; and consequently in laying off the different planes, these edges may be substituted for the axes.

Suppose, for example, the right rectangular prism has been projected, (f. 161), and it is required to place on its angles the plane 2, whose parametric ratio is 2 : 1 : 1. Since 2 refers to the vertical axis, we lay off on the lateral edge (*e*) twice as many parts of this edge as of each of the terminal edges, (ē and ĕ). Consequently, by taking a point in the edge *e* distant from *a*, ¼ the length of *e*, and a point in each ē and ĕ, ⅛ their respective lengths, and then joining these points, the conditions will be complied with, and the plane 2P will be constructed. If the plane to be introduced were 4-2̄, the parametric ratio of which is 4 : 2 : 1, (in which 4 refers to the vertical axis and 2 to the longer horizontal) we should in the same manner mark off 4 parts of *e*, 2 of ē, and 1 of ĕ; if the plane were 4-2̆ (in which 2 refers to the shorter horizontal axis), 2 parts of ĕ should be laid off, and 1 of ē. By connecting the points thus determined, the plane 4-2̄ or 4-2̆ would be delineated. If the plane were 2-∞̄ (2 : ∞ : 1), which represents a plane on the longer terminal edge, 2 parts of *e* should be laid off, and 1 of ĕ; from the determined points in *e* and ĕ, lines should be drawn to the opposite edges parallel with the edge ē, and by connecting the extremities of the lines thus drawn, the desired representation of a plane 2-∞̄ would be completed. The same should be repeated on all the similar edges. This will suffice to illustrate the manner of substituting the edges for the axes, and also the method of delineating single planes.

The manner of determining the intersection of planes, we may illustrate by an example. Suppose it were required to place the planes 1, 2, 4-2̆, and 2-2̄, on a right rectangular prism. Two rectangular prisms should first be accurately projected by the method which has been explained. One, of a size which may be considered convenient for a representation of the crystal, drawn with light pencil marks; the other of larger dimensions, for the purpose of determining the direction of the intersections; these intersections, when determined, are to be transferred to the smaller figure. On f. 161 we may first lay down the plane 1, by drawing lines connecting the centres of the three edges about the angle. These lines are necessarily parallel to the diagonals of the three faces; the triangle *mno* is therefore the plane 1. By connecting the points *m*, *b*, *n*, the plane 2 is constructed; for the plane *mbn* cuts off 2 parts of *e* to 1 of each ē and ĕ, as the expression 2 requires. To lay off 4-2̆, (4 : 1 : 2), let the whole edge *ab* represent 4; then *an* (½ of ĕ) will represent 2 parts on the edge ĕ, and *ap* (¼ of ē) will equal 1 part on ē, agreeably to the expression 4-2̆; *npb* is therefore the plane 4-2̆. The perimeters of the planes *npb* (4-2̆) and *nmo* (1) intersect one another in the points *n* and *a*; consequently the line of intersection between these two planes must be situated between these points, and therefore the direction of the intersection of 1 and 4-2̆ is *n a*.

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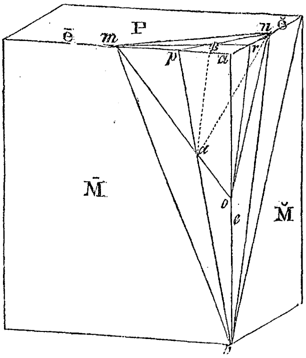

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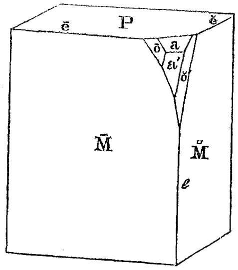

The planes *nmb* (2) and *npb* (4-2̆) intersect in the line *nb*, and therefore the intersection of 2 and 4-2̆ is in the direction of *nb*.

Again, the intersection of 1 and 2 has the direction of *mn*.

We may next lay off the plane 2-$\bar{2}$, (2 : 2 : 1), which may be constructed by marking off 2 parts on each *e* and ē, and 1 part on ĕ. Such a plane is *mro*, since $ao = \frac{2}{4}e$, $am = \frac{2}{4}\bar{e}$, and $ar = \frac{1}{4}\breve{e}$. Therefore the intersection of *mro* (2-$\bar{2}$) with *mno* (1) has the direction of the common line *mo*.

The perimeters of the planes *mro* (2-$\bar{2}$) and *npb* (4-$\breve{2}$) intersect in the points *α* and *β*. If therefore these planes formed an edge of intersection it would have the direction of the line *αβ* or *ro*.

The line *ro* of the plane *mro* (2-$\bar{2}$) is parallel to *nb* of the plane *mnb* (2); the intersections of 2-$\bar{2}$ and 2 would therefore be parallel with these lines. In this manner all the mutual intersections of these and other planes may be obtained.

Fig. 162 exhibits these planes in their respective positions, as above determined. The planes may be lettered as in the figure; *mno*=a, *mnb*=a′, *mro*=ō, *npb*=ŏ′. The edges a : P and a : a′ were made parallel with *mn*, (f. 161). The intersection of P with ō has the direction *mr*, that of P with ŏ′, the direction of *np*. The intersections of a, ō, M̄, are parallel with *mo*; those of a′ ŏ, M̆, have the direction *bn*, as determined above. The edge a : ō′ is drawn in the direction *na*, explained above as the intersection of *npb* and *nmo*. Finally, the edge M̄ : a′ is drawn parallel with *mb*, and the edge M̄ : ŏ parallel with *pb*, which in f. 161 is obviously the intersection of *pbn* with M̄. The planes ō and ŏ′ do not meet; were the plane a′ wanting, their intersection would have been drawn parallel with *αβ* or the edge a′ : ŏ′.

In this manner a sketch of a crystal may be made or rectified, or a figure may be drawn, whose prototype has not been observed. The crystallographic expressions, however, do not indicate the size of the planes. The edge M̆ : ŏ′ might have been so drawn as not to have formed an intersection with the plane P. Again, these secondary planes might have been so extended, that in connection with the corresponding planes on the other angles, they should obliterate mostly or entirely the primary faces. The intersections of the planes would not however be changed in direction. There would be new intersections of planes on opposite parts of the same primary face, to be determined in the above manner.

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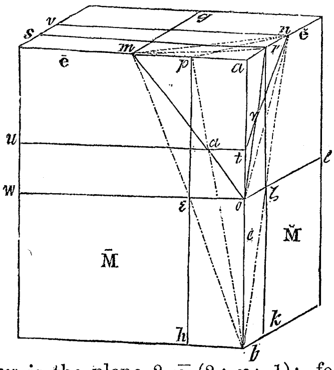

We may now add the planes $\frac{2}{3}$-$\bar{\infty}$, 2-$\bar{\infty}$, 1-$\breve{\infty}$, and ∞: the two former are replacements of the longer terminal edge ē, the third is situated on the shorter edge ĕ, and the last is a replacement of a lateral edge. We may also suppose that $\frac{2}{3}$-$\bar{\infty}$ meets the planes a and ō; 2-$\bar{\infty}$ the plane ō; 1-$\breve{\infty}$ the planes a′ and ŏ′; and ∞ the planes a′ and ŏ′. It is therefore necessary to determine the direction of these intersections. For this purpose f. 161 is redrawn, (f. 163), to avoid confusion from the multiplicity of similar lines, (this would not be required in practice), and the lines in the preceding figure, not including the new planes, are here dotted.

The plane *ntuv* is so drawn that *an* equals $\frac{1}{2}\breve{e}$ an $at = \frac{2}{3}$ of $\frac{1}{2}e$, which fulfills the conditions for the plane $\frac{2}{3}$-$\bar{\infty}$ ($\frac{2}{3}$: ∞ : 1). Again, *srow* is the plane 2-$\bar{\infty}$ (2 : ∞ : 1); for it cuts off $\frac{1}{2}$ of *e* and $\frac{1}{4}$ of ĕ, or 2 parts of *e* to 1 of ĕ.

The perimeters of the planes *vntu* ($\frac{2}{3}$-$\bar{\infty}$) and *mno* (1) intersect in the points *n* and *α*; the intersections of $\frac{2}{3}$-$\bar{\infty}$ with 1 has therefore the direction *an*, and is parallel with the edge a : ŏ′ in f. 162.

The perimeters of the planes *vntu* ($\frac{2}{3}$-$\bar{\infty}$) and *mro*, (2-$\bar{2}$), intersect in the points *α* and *γ*; and a line from *α* to *γ* marks the direction of the edge between the planes $\frac{2}{3}$-$\bar{\infty}$ and 2-$\bar{2}$.

The perimeters of the planes *srow* (2-$\bar{\infty}$) and *mro* (2-$\bar{2}$) coincide in the line *ro*. The intersection of 2-$\bar{\infty}$ and 2-$\bar{2}$ has therefore the direction *ro*, and is parallel with the edge ō : a′ in f. 163.

Again, the plane *gmol* represents 1-$\breve{\infty}$ (1 : 1 : ∞), for it cuts off equal parts of the edges *e* and ĕ. The perimeters of the planes *gmol* and *nmo* (1) coincide in the line *mo;* their intersection is therefore parallel to this line, or to the edges a : ō and ō : M̄, f. 162.

The perimeters *gmol* and *npb* $(4\text{-}\breve{2})$ intersect in the points *α* and *ζ*; a line from *α* to *ζ* therefore marks the direction of the edge between $1\text{-}\breve{\infty}$ and $4\text{-}\breve{2}$, (ō′).

Again, the plane *prkh* is the projection of ∞, (∞ : 1 : 1), for it cuts off equal portions of ē and ĕ, and is parallel with the lateral edge. The perimeters *prkh* (∞) and *mbn* (2) intersect in the points *ε* and *ζ*; a line between these points is parallel with *mn*. The intersection of these planes will therefore be parallel with *mn*, or the edge a : a′, (f. 162).

The perimeters *prkh* (∞) and *pnb* $(4\text{-}\breve{2})$ intersect in the points *p* and *ζ*. A line drawn from *p* to *ζ* determines therefore the intersection of ∞ and $4\text{-}\breve{2}$ (ŏ′).

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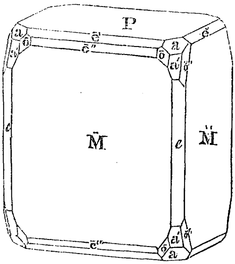

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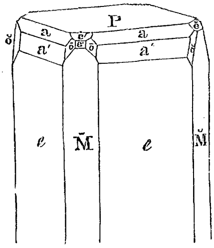

Figure 164 contains these additional planes laid down according to the above deductions. The edge a : ē′ $(\frac{2}{3}\text{-}\bar{\infty})$ is parallel with the edge a : ŏ′; the edge ē′ : ō has the direction *αγ*; the edge ē″ $(2\text{-}\bar{\infty})$: ō is parallel with the edge ō : a′; the edge a : ĕ $(1\text{-}\breve{\infty})$ is parallel with edge a : ō or M̄ : ō; the edge ō′ : ĕ has the direction of a line from *α* to *ζ*; the edge a′ : *e* (∞) is parallel with the edge P : a; and finally the edge *e* : ŏ′ has the direction of a line drawn from *p* to *ζ*.

In this manner the intersections of all possible planes may be determined and transferred. It should be observed that similar parts of a crystal are similarly modified. Fig. 146 is a completed representation of a crystal which presents the planes above designated, viz.:

$$\begin{array}{ccccccccccc} 0. & \infty\text{-}\bar{\infty}. & \infty\text{-}\breve{\infty}. & 1. & 2. & 2\text{-}\bar{2}. & 4\text{-}\breve{2}. & 1\text{-}\breve{\infty}. & \frac{2}{3}\text{-}\bar{\infty}. & 2\text{-}\bar{\infty}. & \infty. \\ \mathrm{P} & \bar{\mathrm{M}} & \breve{\mathrm{M}} & \mathrm{a} & \mathrm{a}' & \bar{\mathrm{o}} & \breve{\mathrm{o}}' & \breve{\mathrm{e}} & \bar{\mathrm{e}}' & \bar{\mathrm{e}}'' & e \end{array}$$

This same descriptive expression applies equally to f. 165, which contains the same planes as f. 164, but differently proportioned in size. The planes M have been diminished by the enlargement of *e*, thus producing a modified rhombic prism. The directions of the intersections are identical with those in f. 164. This figure illustrates a preceding remark, that the descriptive expression of planes indicate merely their situation, and not their size.

According to the same method, crystals may be projected in each of the crystallographic systems, after their axes have been accurately laid down. It was remarked that the figure employed for determining the intersections should be large: in a large figure slight variations from the true direction or position of lines produce errors of less magnitude. Also the lines should be carefully and delicately drawn. With the point of a needle on glazed cards, a great degree of accuracy may be attained.

Projection of Simple Secondary Forms in the Monometric System.—The projection of many of the simple secondary forms,—for example, the trisoctahedrons, the hexoctahedrons, &c.—by the method of construction which has been explained, would be a long and tedious process; at least when compared with the more simple method, depending on the relative lengths of the axes and the rhombic and trigonal interaxes in these forms. The right lines passing through the centre of the octahedron to the centres of its edges, are called *rhombic interaxes;* and those which pass to the centres of the faces, are the *trigonal interaxes.* In the several monometric forms, the extremities of one or more of these interaxes extended or diminished in their lengths, occupy the vertices of the solid angles. If therefore these points (the extremities of the interaxes) can be determined in the several crystalline forms, it will only remain to connect them, in order to form a projection of these solids. The principles of analytical geometry afford the means of determining how much the interaxes of the regular octahedron must be increased or diminished to equal the interaxes in these different forms. It is thus found that each half of a trigonal interaxis for any form mPn must be increased by that portion expressed in the fraction

$$\frac{2\,mn-(m+n)}{mn+(m+n)};$$

and for each half of a rhombic interaxis, we have the corresponding fraction $\frac{n-1}{n+1}$.

By giving m and n different values from 0 to ∞, the value of these interaxes for any monometric form may be obtained. The following values are thus deduced for several occurring forms:

	Trig. interax.	Rhombic interax.		Trig. interax.	Rhombic interax.
2 (f. 49)	$\frac{1}{5}$	0	∞-2 (f. 33)	1	$\frac{1}{3}$
∞ (f. 14)	$\frac{1}{2}$	0	∞-3 (f. 34)	$\frac{5}{4}$	$\frac{1}{2}$
$3\text{-}\frac{3}{2}$ (f. 51)	$\frac{1}{2}$	$\frac{1}{5}$	2-2 (f. 39)	$\frac{1}{2}$	$\frac{1}{3}$
4-2	$\frac{5}{7}$	$\frac{1}{3}$	3-3 (f. 40)	$\frac{4}{5}$	$\frac{1}{3}$

To construct the form 4-2, the octahedron is first to be projected, and its axes and interaxes drawn. Then add to each half of each trigonal interaxis, five-sevenths of its length; and to each half of each rhombic interaxis, one-third of its length. The extremities of the lines thus extended, are situated in the vertices of the solid angles of the hexoctahedron 4-2, and by connecting them, the projection of this form is completed.

In the *inclined hemihedral* monometric forms—that is, those hemihedral forms whose opposite faces are inclined to one another and not parallel, as the tetrahedron, &c.—the rhombic interaxes do not terminate in the vertices of the solid angles, and may therefore be thrown out of view in the projection of these solids. The two halves of each trigonal interaxis, terminate in the vertices of dissimilar angles and are of unequal lengths. One is identical with the corresponding in the holohedral forms, and is called the holohedral portion of the interaxis; the other is the hemihedral portion. The length of the latter may be determined by adding to the half of the octahedral interaxis that portion of the same indicated in the formula

$$\frac{2\,mn-(m-n)}{mn+(m-n)}.$$

If the different halves of the trigonal interaxes be assumed at one time, as the holohedral, and again as the hemihedral portion, the reverse forms $\frac{(m\text{-}n)}{2}$ and $-\frac{(m\text{-}n)}{2}$ may be projected. The following table contains the values of the above fraction for several of the inclined hemihedral forms, and also the corresponding values for the holohedral portion of the interaxis.

	Hol. interax.	Hem. interax.		Hol. interax.	Hem. interax.
$\frac{(1)}{2}$ (f. 55)	0	2	$\frac{(2)}{2}$ (f. 60)	$\frac{1}{5}$	1
$\frac{(2\text{-}2)}{2}$ (f. 59)	$\frac{1}{2}$	2	$\frac{(3\text{-}\frac{3}{2})}{2}$ (f. 65)	$\frac{1}{2}$	$\frac{5}{4}$
$\frac{(3\text{-}3)}{2}$	$\frac{4}{5}$	2	$\frac{(4\text{-}2)}{2}$	$\frac{5}{7}$	$\frac{7}{5}$
$\frac{(\frac{3}{2})}{2}$ (sim. f. 60)	$\frac{1}{8}$	$\frac{5}{4}$	$\frac{(5\text{-}\frac{5}{3})}{2}$	$\frac{2}{3}$	$\frac{8}{7}$

The *parallel hemihedrons* (for example, the pentagonal dodecahedron, or hemitetrahexahedron) contain a solid angle, situated in a line between the extremities of each pair of semiaxes, which is called an unsymmetrical solid angle. The vertices of these angles are at unequal distances from the two adjacent axes, and therefore are not in the line of the rhombic interaxes. The coordinates of this solid angle for any form, as $\frac{[m\text{-}n]}{2}$, may be found by the formulas $\frac{m(n-1)}{mn-1}$ and $\frac{n(m-1)}{mn-1}$. By means of these formulas, the situation of two points, *a* and *b*, (f. 166) in each of the axes may be determined: and if lines are drawn through *a* and *b* in each semiaxis parallel to the other axes, the intersections *c c'*, of these lines will be the vertices of the unsymmetrical solid angles, those marked *c* of the form $\frac{[m\text{-}n]}{2}$ and those marked *c'* of the form $-\frac{[m\text{-}n]}{2}$.

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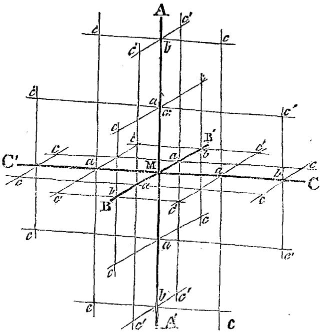

The trigonal interaxes are of the same length as in the holohedral forms. The values of these interaxes, and of the coördinates of the unsymmetrical solid angle for different parallel hemihedrons, are contained in the following table:

	Trigonal interaxis.	Coord. of the unsym. sol. A.			Trigonal interaxis.	Coord. of the unsym. sol. A.	
$\frac{[3\text{-}\frac{3}{2}]}{2}$ (f. 74)	$\frac{1}{2}$	$\frac{3}{7}$	$\frac{6}{7}$	$\frac{[\infty\text{-}\frac{3}{2}]}{2}$ (sim. f. 69)	$\frac{4}{5}$	$\frac{1}{3}$	1
$\frac{[4\text{-}2]}{2}$	$\frac{5}{7}$	$\frac{4}{7}$	$\frac{6}{7}$	$\frac{[\infty\text{-}2]}{2}$ (f. 69)	1	$\frac{1}{2}$	1
$\frac{[5\text{-}\frac{5}{3}]}{2}$	$\frac{2}{3}$	$\frac{5}{11}$	$\frac{10}{11}$	$\frac{[\infty\text{-}3]}{2}$	$\frac{5}{4}$	$\frac{2}{3}$	1

Dimetric System.—In an octagonal pyramid, *m-n*, (f. 89), the interaxes, or diagonals symmetrically intermediate between the horizontal axes, terminate in the interaxal basal angles. Their length exceeds the length of the interaxes of the octahedron, by a portion equal to $\frac{n-1}{n+1}$. If therefore the octahedron *m* and its interaxes be projected, and these interaxes be increased by a portion of their length expressed in the fraction, $\frac{n-1}{n+1}$, they will equal the interaxes of the octagonal pyramid *m-n*. This solid may then be projected by connecting the extremities of these interaxes with the extremities of the horizontal axes, and joining all the angles of the octagonal base thus formed, with the extremities of the vertical axis.

Hexagonal System.—The dihexagonal pyramid (f. 124) may be projected in the same manner as the octagonal pyramid just described; that is, by increasing the interaxes by a portion equal to $\frac{n-1}{n+1}$, uniting the points thus determined with the horizontal axes, and connecting the angular points of the base thus projected, with the extremities of the vertical axis.

The scalenohedron (f. 127 dotted lines) $m\mathrm{R}^n$ admits of a similar construction with the rhombohedron *m*R. The only variation required, is to multiply the vertical axis by the number of units in *n*, after the points E and E' in the rhombohedron *m*R have been determined; then connect the points E, or the points E', with one another and with the extremities of the vertical axis.

III. CLEAVAGE.

The mineral mica, as is well known, easily splits into thin transparent plates or laminæ. This is often effected with little more difficulty than separating the leaves of a book, and at once suggests the idea, that like a book, this mineral may be composed of a great number of closely applied leaves. This property of mica depends on its crystallization, and the process of separation is termed *cleavage*. Galena is another instance of a mineral capable of easy cleavage. It differs from mica, however, in having *three* cleavage directions at right angles with one another. This mineral, therefore, instead of splitting into thin plates, breaks into small *cubes*. Calcereous spar also admits of easy cleavage, but yields *rhombohedrons*. The directions in which a crystal may be cleaved, are termed *natural joints*, and the slices obtained, are called *laminæ*.

The facility with which cleavage may be obtained, is very unequal in different minerals. In some instances, as in the first above cited, the laminæ are separable by the fingers. In others, a slight blow of the hammer is sufficient; others require the application of a sharp-cutting instrument, and often some considerable skill in its use. When other means fail, it may sometimes be effected by heating the mineral and plunging it, when hot, into cold water. Attempts of this kind are occasionally effectual with quartz. In many instances, cleavage cannot be obtained by any means, owing to the strong cohesion of the laminæ. In these cases, however, the direction of cleavage is sometimes indicated by lines on the surface. It is often important to observe these lines when cleavage is possible, in order to determine its direction before applying the knife.

When cleavage is easily obtained, it is said to be *eminent*.

The general laws, with respect to cleavage, are as follows:

1. Cleavage in crystals of the same species yields the same form and angles.
2. Cleavage takes place parallel either to one or more of the faces of a fundamental form, or to its diagonals, or to some secondary planes.
3. Cleavage is obtained with equal ease or difficulty parallel to *similar* faces, and with unequal ease or difficulty parallel to *dissimilar* faces.
4. Cleavage parallel to similar planes, affords planes of similar lustre and appearance, and the *converse*.

According to the laws above stated, cleavage is obtained with equal ease or difficulty parallel to all the faces of a cube, octahedron, dodecahedron, or rhombohedron, which solids are contained under equal planes. The right square prism, right rhombic prism, and oblique rhombic prism, may be cleaved with equal ease or difficulty, parallel to their lateral planes, since these are similar. Often, however, no cleavage can be effected in these prisms, except parallel to the bases, and, in many instances, not even in this direction. Frequently the cleavage is diagonal; in the square prism it will be alike in both vertical axial planes, but in the rhombic prisms it will be unlike, since these planes are not equal.

The right rectangular, right rhomboidal, and oblique rhomboidal prisms, have the cleavage unequal parallel to their faces, if attainable at all in these directions; and according to the third law, the cleavage in the three directions will produce faces of unlike lustre and general appearance. This is exemplified in gypsum: in one direction, it is cleavable with great facility into thin laminæ of perfect transparency, and highly polished surfaces; in a second direction the crystalline laminæ first bend and then break, exhibiting a surface which is not smooth, nor possessed of much lustre; in a third direction, it is brittle, and breaks immediately on attempting to bend it, affording a surface smoother than the second, but not polished. In thick masses the second and third cleavages are scarcely attainable. Two of these cleavages incline at an oblique angle, but one is at right angles with the third.

Cleavage is said to be *basal* when in a form it is parallel to the base, (0); and *lateral*, when parallel to the lateral planes. *Prismatic*, when parallel to the lateral planes ∞. *Diagonal*, in a rhombic prism, when vertical and parallel to the planes ∞-∞. In the trimetric system, *macrodiagonal*, if parallel to the longer diagonal; *brachydiagonal*, if parallel to the shorter diagonal. In the monoclinic system, *clinodiagonal*, if parallel to the inclined lateral axis; *orthodiagonal*, if parallel to the other lateral axis.

When rhombohedrons have a cleavage parallel to a plane truncating the vertical angle, it is described as *basal*, it being parallel to the base of the related hexagonal prism. When the cleavage is parallel to the faces of a rhombohedron, it is styled *rhombohedral*. Other cleavages are described by mentioning the particular plane with which they correspond in direction.

M. A. Baudrimont has recently observed that the three primary rhombohedral cleavages of calc spar are not always absolutely equal, and, moreover, that there are other cleavages not before recognized. His observations seem to show, that while the fact that the vertical axis is normally an axis of symmetry, as demonstrated by the crystallization, and by optical, thermotic, and acoustic investigations, still extrinsic circumstances cause some variations from perfect symmetry in the cleavage, and also correspondingly in the lustre and transparency. The cleavages observed by him are as follows:—

1. Parallel to the faces of the primary rhombohedron.
2. Parallel to the longer diagonal of the primary faces.
3. Parallel to the shorter diagonal of the primary faces.
4. Parallel to different secondary planes.

I. Of the *first* kind the cleavage may be,
  a. Equal in three directions, (normal).—*Rare. Iceland spar.*
  b. Equal in two directions. *Less rare.*
  c. Unequal in three directions. *Common.*

II. Of the *second* kind, the cleavage may be,
  a. In a single direction. *Quite common.*
  b. In two directions unequal. *More rare.*
  c. In three directions. *Very rare.*

III. Of the *third* kind,
  a. In one direction. *Very rare.*

The cleavage parallel to the longer diagonal has long been noticed.

IV. IRREGULARITIES OF CRYSTALS.

The laws of crystallization, when unmodified by extrinsic causes, should produce forms of exact symmetry; the angles being not only equal, but also the homologous faces of crystals and the several dimensions. This symmetric harmony is, however, so uncommon, that it can hardly be considered other than an ideal perfection. Crystals are very generally distorted, and often the fundamental forms are so completely disguised, that an intimate familiarity with the possible irregularities is required, in order to unravel their complexities. Even the angles may vary rather widely in crystals that are seemingly pure.

The irregularities of crystals may be treated of under four heads:* 1. *Imperfections of surface;* 2. *Variations of form and dimensions;* 3. *Internal imperfections and impurities;* 4. *Variations of angles.*

I. IMPERFECTIONS IN THE SURFACES OF CRYSTALS.

1. *Striated Surfaces.*

The parallel furrows on the surfaces of crystals are called *striæ*, and such surfaces are said to be *striated.*

Each little ridge on a striated surface is enclosed by two narrow planes more or less regular. These planes often correspond in position to the secondary or primary planes of the crystal, and we may suppose these ridges to have been formed by a continued oscillation in the operation of the causes that give rise, when acting uninterruptedly, to enlarged planes. By this means, the surfaces of a crystal are marked in parallel lines, with a succession of narrow planes meeting at an angle and constituting the ridges referred to.

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* Many of the following facts, with the general arrangement of them, are extracted from Naumann's work on Crystallography.

This combination of different planes in the formation of a surface has been termed the *oscillatory combination*. The horizontal striæ on prismatic crystals of quartz, (f. 189 and 193), are examples of this combination, in which the oscillation has taken place between the prismatic and pyramidal planes. As the crystals lengthened, there was apparently a continual effort to assume the terminal pyramidal planes, which effort was interruptedly overcome by a strong tendency to an increase in the length of the prism. In this manner, crystals of quartz are often tapered to a point, without the usual pyramidal terminations.

Cubes of *pyrites* are generally striated in such a way that the striæ on adjacent faces are at right angles with one another, as in the accompanying figure. These lines are parallel to the intersections of the primary surfaces with the planes of a pentagonal dodecahedron, (f. 67, 68, and 69), the most common secondary of pyrites; and they have evidently resulted from an oscillation between the primary and this secondary.

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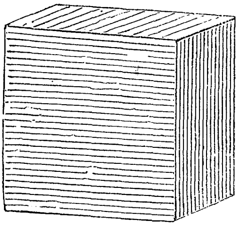

Iron Pyrites.

Diagonal striæ sometimes occur on the faces of a cube, showing an oscillatory combination between the cube and octahedron. The rhombic dodecahedron is often striated parallel either with the *longer* or the *shorter* diagonal of its faces; the *former* resulting from an oscillatory combination of the dodecahedron with the regular octahedron, and the *latter* with the cube or planes bevelling the edges of the cube, as in *Aplome*. The accompanying figure represents a distorted crystal of magnetic iron from Haddam, Ct., illustrating the oscillation between the octahedron and dodecahedron. The faces of trapezohedral garnets are often striated parallel with the symmetrical diagonal, showing an oscillation with the dodecahedron.

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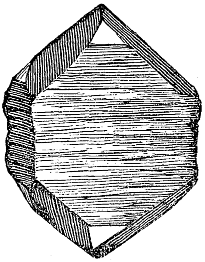

Mangnetic Iron.

Rhombohedrons of chabazite and red silver ore are often striated parallel to the terminal edges, indicating an oscillatory combination between the primary faces and a secondary plane replacing these edges.

Prisms of tourmaline are very commonly bounded by three convex surfaces, owing to an oscillatory combination of the planes I and *i*2. (See under *Tourmaline*).

It is obvious that the irregularities described must at times affect the angle of inclination between planes. The interfacial angles of a rhombic prism are thus made more obtuse, being sometimes increased 15 or 20 degrees, and occasionally, as just stated, the angles are lost in a curved surface. This seldom leads to important error, since the striations generally show that the faces are not simple planes. Tremolite, Tourmaline, &c., are examples.

The striations on the lateral surfaces of foliated minerals like mica and gypsum, are merely the edges of laminæ.

The interposition of foreign substances in parallel lines also produce striations. Brewster attributes to this source the parallel diagonal lines in some rhombohedral crystals of calc spar.

Besides striations, the surfaces of crystals are sometimes formed of minute crystals; such are the faces of octahedral crystals of fluor, consisting of minute cubes. Cubes of galena occur at Rossie having truncated angles and edges, in which the surfaces are covered with cubic prominences, the sides of which are parallel to the planes on the angles. These surfaces were probably eroded by some solvent or chemical agent.* Angular markings are also often observed, as on quartz crystals, beryls, &c., indicating the internal structure of the crystal.

2. *Cavernous Crystals.*

Crystals not unfrequently occur with a deep pyramidal depression occupying the place of each plane, as is often observed in common salt, alum and sulphur. The annexed figure represents a cavernous cube of salt. In the solution of crystals, the same form is sometimes obtained, owing to the fact that the centres of the faces yield sooner than the edges and angles. A remarkable cavernous crystal of pyrites, from Almerode, is described by Hausmann. It is an elongated cube with its upper edges replaced by faces of the dodecahedron; but instead of a corresponding replacement of the lateral edges, a deep rectangular channel occupies the place of each. It resembles a cruciform crystal of Harmotome; but the striations show that is not compound.

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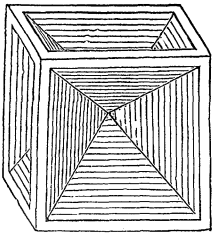

Common Salt.

Crystals of gold are often thus cavernous. Sometimes the octahedrons occur with a triangular cavity, in place of each face. The same is met with in other species. They may often be imitated in metallic species by pouring off the fused metal just after crystallization begins; the diagonal planes of the crystal joining opposite edges are entire, while the faces are wanting, showing that the cohesion in the latter is weaker.

Other crystals with cavernous faces are produced by an increase of a crystal on certain sides or planes, and not on others, as in f. 170, of calcite, in which, after the crystal had reached considerable size, it was enlarged on the planes R and not on a. In f. 171, also calcite, a six-sided prism tapering above nearly with a curve, was

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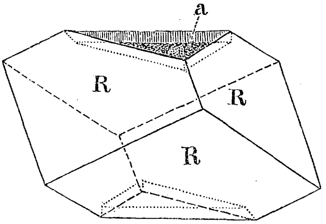
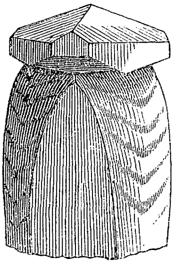
* For a paper of great interest by Brewster on the optical figures produced by the action of solvents on the surfaces of crystals, see Phil. Mag. (4), v. 16, Jan. 1851.

afterwards, by a subsequent process, capped with a flat rhombohedral crystal of the same species. It is from Bristol, Ct.

170



171

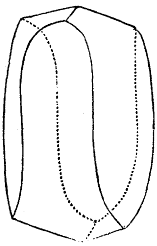


3. *Curved Surfaces.*

Curved surfaces resulting from what is termed oscillatory combination, have already been noticed. Other curvatures proceed from a curvature in the laminæ constituting the crystal. Crystals of diamond have convex faces, and they are sometimes almost spheres, (f.185, and f. 266 under Diamond). This mode of curvature, in which all the faces are equally convex, is less common than that in which a convex surface is opposite and parallel to a corresponding concave surface. Rhombohedrons of spathic iron and pearl spar are usually thus curved, as is shown under *spathic iron.* The saddle-shaped crystals of the same mineral, are remarkable instances of several curvatures in the same face.

A singular curvature is shown in the accompanying figure of white iron pyrites. The conical crystals of brown zinc blende and the lenticular and conical crystals of gypsum, are other examples. Crystals of quartz are sometimes curved and twisted. When this takes place in the left-handed and right-handed crystals, the twist is to the right or left, according as the crystal is right or left-handed.*

172



The surfaces of crystals are sometimes rounded, in consequence of having been partially fused, or dissolved. The globular quartz of St. Lawrence Co., N. Y., is supposed by Prof. Emmons to have been thus rounded.

Prismatic crystals of quartz are sometimes aggregated by their sides, and thus form plates, with the terminations of the crystals on the opposite surfaces. As the crystals continue enlarging at the extremities, these expand, while the confined sides can receive no additions; and the consequence sometimes is that crystals are formed with the prismatic sides concave, the prism being smallest

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* Fig. 151 of quartz, is a *left-handed* crystal, as is apparent from the relative situations of the planes.

at middle and largest at the base of the pyramid. It is not usual that such crystals are easily separated from one another, but this sometimes happens.

II. VARIATIONS IN THE FORMS AND DIMENSIONS OF CRYSTALS.

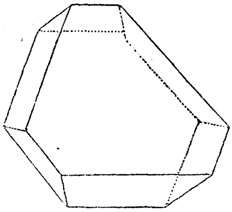
The simplest modification of form in crystals, consists in a simple variation in length or breadth, without a disparity in similar secondary planes. The distortion, however, extends very generally to the secondary planes, especially when the elongation of a crystal takes place in the direction of a diagonal, instead of the crystallographic axes. In many instances, one or more secondary planes are *obliterated* by the enlargement of others, proving a source of much perplexity to the young student. The interfacial angles remain constant, unaffected by these variations in form.

As most of the difficulties in the study of crystals arises from these distortions, this subject is one of great importance to the student.

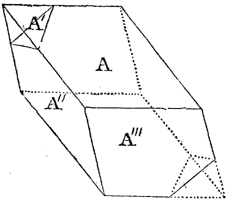
Monometric System.—A *cube*, (f. 1), lengthened or shortened along one axis, becomes a right square prism, (f. 2), and if varied in the direction of two axes is changed to a rectangular prism, (f. 3). Cubes of pyrites, galena, fluor spar, &c., are generally thus distorted. It is very unusual to find a cubic crystal that is a true symmetrical cube. In some species the cube or octahedron, (or other monometric form), is lengthened into a capillary crystal or needle, as happens in Red Copper and Pyrites. Crystals of acicular pyrites occur at the Middletown (Ct.) lead mine.

An octahedron *flattened* parallel to a face is reduced to a tabular crystal, (f. 173). If *lengthened* in the same direction, it takes the form in f. 174; or if still farther lengthened to the obliteration of A′, it becomes an acute rhombohedron, (same figure).

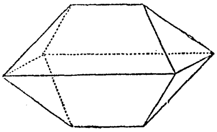
173



174

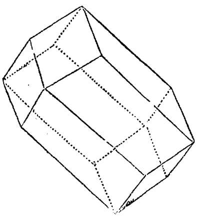


175

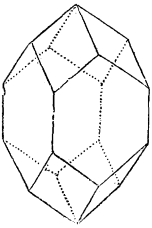


When an octahedron is extended in the direction of a line between two opposite edges, it has the general form of a rectangular octahedron; and still farther extended, as in f. 175, it is changed to a rhombic prism with dihedral summits. The figure represents this prism lying on its acute edge, (spinel, fluor, magnetite).

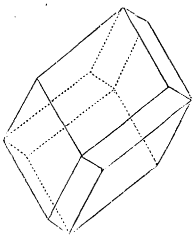
176



177

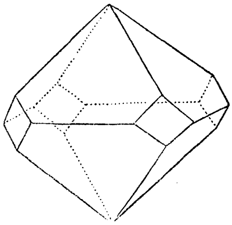


178



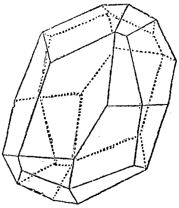
The *dodecahedron* lengthened along a diagonal between the obtuse solid angles, becomes a six-sided prism with three-sided summits, as in f. 176; and shortened in the same direction, is a *short* prism of the same kind, (f. 178). Both resemble secondaries to a rhombohedron, and are common in garnet and zinc blende. When lengthened in the direction of one of the crystallographic axes, it becomes a square prism with pyramidal summits, (f. 177), and shortened along the same axis it is reduced to a square octahedron, with truncated basal angles, (f. 179).

179

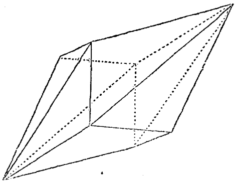


The trapezohedron is still more disguised by its distortions. When elongated in the line of an octahedral axis, it assumes the form in f. 180; and still farther lengthened, to the obliteration of some of the planes, becomes a scalene dodecahedron, (f. 181). This has been observed in fluor spar. If the elongation takes place along a crystallographic axis, it changes to a double eight-sided pyramid with four-sided summits, (f. 182); or if these summit planes are obliterated by a farther extension, it becomes a complete eight-sided double pyramid, (f. 183).

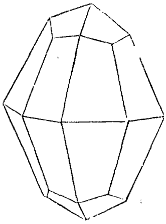
180



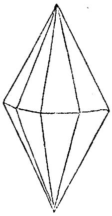
181



182

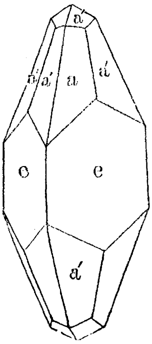


183

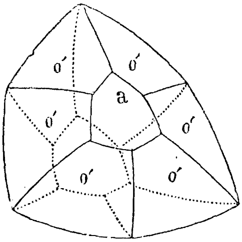


Still more complex forms are of occasional occurrence among monometric crystals, especially when modified by secondary planes. Fig. 184 represents a garnet from Monzoniberg; it is a combination of the dodecahedron and trapezohedron; but the crystal is so altered by distortion, that only *four* dodecahedral faces (e) remain, and *sixteen* of the trapezohedral, (a′); and the latter are of very unequal size. Fig. 185 is a distorted twin of diamond. It is shortened in the direction of a diagonal, so that only two octahedral planes (a) remain, and 12 out of 48 planes o′—the six around each a, (f. 51). Fig. 186 represents a crystal of Galena from Rossie. It is a shortened cube; the lateral faces are very irregularly curved, and consist of the primary faces of the cube and the planes truncating the lateral edges. Some of the terminal edges are also truncated. The crystal is surmounted by a low pyramid, consisting of four planes on each of the angles and edges, which, owing to the distortion, do not occur elsewhere on the crystal. The cleavages of the crystal easily explain the relations of the several planes to the primary.

184

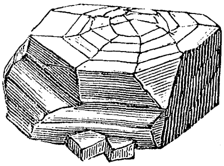


185



Diamond.

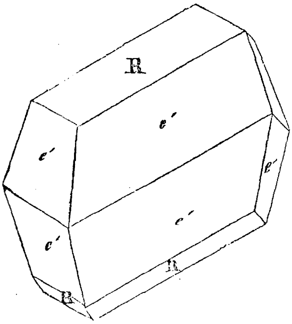
186



Galena.

The scalene dodecahedron of calcite is shown distorted in f. 187, which appears, however, to be an eight-sided prism, bounded laterally by the planes R, e', e', and R, and their opposites, and terminated by the remaining planes. The following figures of quartz, (f. 188, 189), represent distorted forms of this mineral, in which some of the pyramidal faces by enlargement displace the prismatic faces, and nearly obliterate some of the other pyramidal faces.

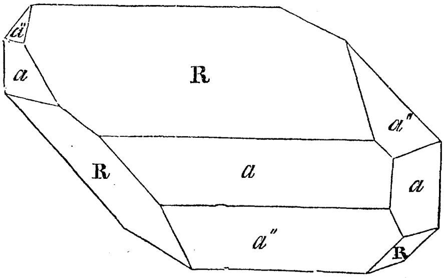
187



Calcite.

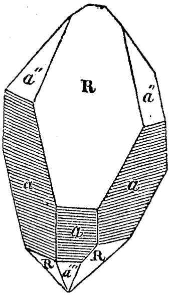
Figures 339, 340, under Quartz, are other crystals less distorted. The inclination of R on a or a'' is the same in all the various distorted forms; and by measuring the angles, and also by observing the similar surfaces of like planes, the homologous parts may be distinguished, however much disguised. The angle a on a around the prism is 120°; and consequently by a measurement these planes may be detected. It is also a help to note that like planes are alike in surface.

188



Quartz.

189

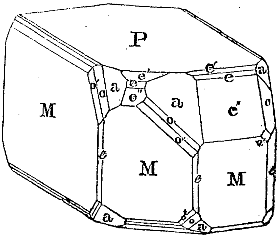


Quartz.

The prismatic planes of quartz may be usually distinguished from the other faces, by their horizontal striæ.

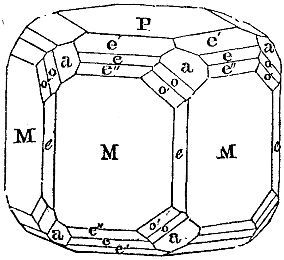
Fig. 190 of apatite is the same form that is represented in f. 191, but greatly distorted. The planes e′, e, e″, between P and the right M, are enlarged, while the corresponding planes below are in part obliterated. By observing that similar planes are lettered alike,

190



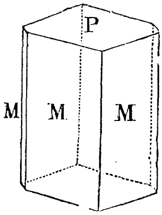
Apatite.

191



Apatite.

192



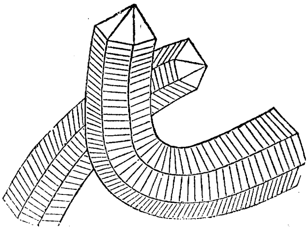
Beryl.

the two figures may be compared throughout. Fig. 192 represents a hexagonal prism of beryl distorted so as to resemble a rhombic prism with the acute lateral edges truncated, two opposite planes M being nearly obliterated by the extension of the other four.

Curved Crystals.—Curves in imbedded crystals are of frequent occurrence; and in implanted crystals they are not very uncommon. The annexed figure of quartz (f. 193) illustrates this kind of distortion; the same is described by Beck as occurring in the apatite of St. Lawrence Co., N. Y. Six-sided prisms of calcite are occasionally curved in the same manner.

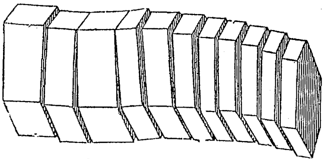
In many species, the crystals appear as if they had been broken transversely into many pieces, a slight displacement of which has given a curved form to the prism. This is common in tourmaline and beryl. The beryls of Monroe, Conn., often present these interrupted curvatures, as represented in f. 194.

193



Quartz.

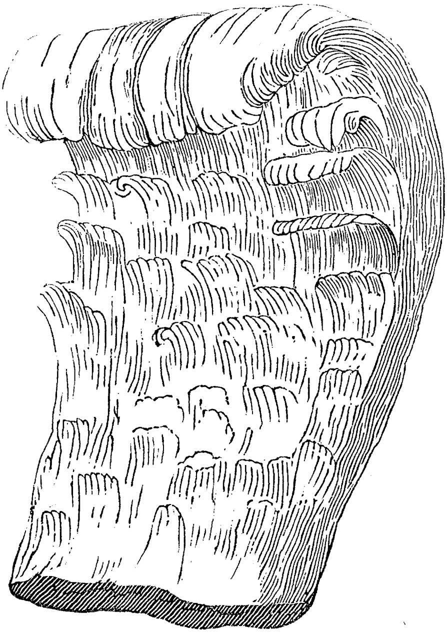
194



Beryl, Monroe, Ct.

Singular curvatures occur in crystalline plates of ice adhering to stems of plants. These plants are commonly implanted longitudinally either on one side or opposite sides of the stem, and many curve so far around as nearly to encircle it. They have a fibrous look, like some varieties of gypsum. They are often observed (as at New Haven, Ct.) in temperate latitudes in the cold season. An instance of the same on a stone wall recently built, has been observed by Professor Rigaud. The plates of ice were attached to the edges of the stones and curved away from the mortar.* Similar crystallizations of gypsum from the mammoth cave of Kentucky, have been described by Dr. Locke of Cincinnati. (Am. Jour. of Science, xlii.) "Alabaster rosettes" are common there a foot in diameter, consisting of a disk surrounded by circles of leaves rolled elegantly outward; and tortuous vines with tendrils, and curled leaves, are beautifully imitated.

195



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* See also a paper by Prof. J. Le Conte, on this subject, Proc. Amer. Assoc. iii, 1850, p. 20.

III. INTERNAL IMPERFECTIONS AND IMPURITIES.

The transparency of crystals is often destroyed by disturbed crystallization, or by impurities taken up from the solution during the process of crystallization. Oxyd of iron, chlorite, pyrites, silica, and alumina, are among the most common of these impurities. Any mineral, indeed, that may be dissolved or mechanically suspended in the menstruum with the crystallizing mineral, may be thus entangled and forced into the constitution of crystals.

The impurities often take a symmetrical arrangement. In general, foreign matters collect most abundantly about the centre and along the diagonals, and also in planes between the centre and edges of the crystal. The latter taking place in the cube, produces an arrangement similar in form to the cavernous cubes above described.

In chiastolite, the foreign matter is arranged about the central axis, and in planes running from this axis to the edges, and also about the lateral edges and exterior surface of the crystal, (see figures under Andalusite). Dr. Jackson has observed the same in staurotide. Tremolite has also been observed, according to Naumann, with an interior tesselated structure, like chiastolite. It had crystallized in contact with pulverulent carbonate of lime and magnesia. Fluor spar, common salt, and numerous other species, sometimes present similar appearances. The zircons of St. Lawrence County, New York, often have a tesselated structure. Some crystals are grayish-white with the exception of the angles, which are bright chestnut-brown, either of a uniform color, or in parallel stripes about the plane 33. In one crystal from this region, Professor Beck found a nucleus of carbonate of lime, and it is probable, as he suggests, that the white coloring matter thus symmetrically arranged, is carbonate of lime.

Crystals of quartz from Southington, Ct., have an asteriated structure within, arising from the meeting at centre of six whitish planes, corresponding to the six lateral edges of the crystals; the exterior of the prism is also whitish.

In many instances, the foreign matter lies in layers parallel with some of the exterior planes. This is often noticed in crystals of quartz, in which there are layers of different colors parallel with the faces of the terminal pyramids, owing usually to intermissions in the process of their formation. In this way transparent crystals sometimes have an exterior coating of an opaque white color, or contain a crystal within of different color, &c. Tabular crystals of heavy spar are often banded parallel with the lateral faces.

The mica from Jones's creek near Baltimore, contains opaque lines or bands in concentric hexagonal figures, which arise from the same cause. In one specimen the meeting of two hexagonal figures indicated a compound structure, or twin crystallization, a fact not apparent from any peculiarity on the surface of the mica. A mica from New Hampshire has similar markings, and in one transparent specimen in the cabinet of Dr. Jackson of Boston, there are broad bands of a deep black color meeting at angles of 120° and 60°, the angles of the crystal.

Among the most remarkable impurities are the drops of liquids that occur in many crystals. In some cases they appear to be simply water or a solution of the mineral itself, and when exposed by fracture, crystallization takes place on evaporation. In other instances, they are resinous fluids of different kinds, as first detected by Sir David Brewster in topaz, quartz, and other minerals.

The same author has discovered in topaz innumerable microscopic crystals arranged more or less in extensive layers, though sometimes in concentric arches or radiations, among which were many different forms, as the tetrahedron, the cube and its secondaries, rhombohedron, hexagonal plates, prisms with plane and pyramidal summits, flat octahedron more or less modified, rectangular plates. Some of the tesseral crystals melt easily and others not at all; and others are infusible: so that at least five different substances were indicated.* Two different fluids have been recognized by Brewster in some topazes. In one crystal a cavity 0·18 in. long was partly filled with a fluid of still different character, besides different crystals. Fluor spar, Calcite, and Heavy spar are other species that have been found to contain fluids.

A microscopic examination of iridescent feldspar has brought to light that in some cases it contains minute crystals of specular iron disseminated through it, to which the peculiar iridescence is owing. The same is true of some red Cancrinite.

IV. VARIATIONS IN THE ANGLES OF CRYSTALS.

The greater part of the distortions described occasion no change in the interfacial angles of crystals. But those imperfections that produce convex, curved, or striated faces, necessarily cause variations, as explained on pp. 111, 113. The surfaces of larger crystals often have a composite character, as a magnifying glass will show, if not visible to the naked eye; they appear as if there had been a tendency to the formation of smaller crystals, while the crystal was enlarging. The polygonal markings on quartz crystals are of this character. Octahedrons of fluor sometimes have the faces made up of little cubes. Such a cause produces more or less irregularity in the planes and their inclinations. Sometimes while

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* See further on this subject, Trans. Roy. Soc. of Edinburg, for 1823 and 1826; and Trans. Royal. Soc. London, 1847, xvi, 11; Phil. Mag. [4], v. 235, 1853; also Amer. Jour. Science, xii, 214, 1827, and [2] v, 420, 1848.

enlargement is in progress and far advanced, portions of a crystal become more or less independent in their crystallization, and thus quite large variations from symmetry result, exhibited either in the unnatural protuberance or breadth of certain parts, or a subdivision into distinct crystals.

Besides imperfections from these sources, there are others derived from the presence of impurities, entangled in the crystallizing mineral. Such impurities, although in many instances symmetrically arranged, still influence unfavorably the form of the crystal; the foreign particles are guided in an imperfect degree by the forces of the crystallizing molecules, and have not the powers of arrangement in themselves which can carry each to its place; and hence impure crystals, as macles, commonly differ much in their angles. When these foreign ingredients are not thus symmetrically arranged, their injurious effect on the form is even more striking; and there are few cases of crystals of large size, in which such impurities do not exist.

Even the presence of foreign ingredients in solution, when the crystallization is going on, seems often to affect the angles; and such ingredients may be included in the species without its being at all apparent except by analysis.

According to the measurements of calc spar by A. Baudrimont, the rhombs of this mineral seldom have the three angles at summit perfectly identical.

The variations of angles just alluded to, are of no constant character, and are therefore imperfections. They often amount to 30′ even in crystals that appear regular, and sometimes to two or three degrees. A cube under some circumstances may have the angles of a rhombic prism; but the identity of the similar faces, and the tesseral character in the modifications of the crystal, will still be apparent; the six bounding planes will be alike in lustre, cleavage, hardness, and striæ, however much the angles may vary, and this is never the case with any but equilateral solids. The distribution of modifying planes will prove in like manner the perfect similarity of the edges and angles. So in a form resembling a rhombohedron, if the angles at the lateral edges differed fundamentally from one another, the edges would be *unlike*, and the modifications would be monoclinic, (or those of an oblique rhombic prism), instead of rhombohedral. Thus by means of the modifications and physical characters, as already illustrated, we may distinguish without difficulty between accidental variations and those of a fundamental character. Without such modifications some cubical crystals, as of salt, might be taken for rhombohedrons of 92° or 93°.

The angles of crystals are varied also by temperature. But this kind of variation depends on the nature of matter or its relation to heat, and is not properly noticed in this place.

V. DETERMINATION AND MEASUREMENT OF CRYSTALS.

Owing to the irregular variations of form in crystals, it is evident that the shape alone is seldom sufficient to determine the system of crystallization. The indications giving important aid, may be briefly reviewed.

a. Cleavage.—Cleavage being *alike* parallel to like faces, and *unlike* parallel to unlike faces, if a cube affords three equal rectangular cleavages, (equal in ease and alike in lustre), the form must be monometric; if two equal rectangular cleavages, it is dimetric; if three unequal, it is trimetric. Again, if the angle between the cleavage planes is oblique, this gives further evidence as to the system, as the principles already explained sufficiently elucidate.

b. Lustre, Hardness, Color, Character of Surfaces.—*Like* planes are *alike* in lustre, hardness, striæ, whatever may be the variations in size. Hence, if a cube has like striæ on all its six sides, the form is plainly monometric; but if the surface of one of its opposite sides differs from that of the others, the form belongs to some other system. So hardness and color often differ, and lustre almost uniformly, for unlike planes. (See beyond, under Color).

c. Refraction, Polarization.—As explained on a following page, the system of crystallization has generally a direct relation to the polarizing properties of the crystal. When we have but fragments of a mineral, this mode is highly important.

d. Heat, Elasticity.—The properties of crystals as regards the conduction of heat, and their elasticity, have a direct dependence on their crystalline form; but the means of making observations on these points are not yet easily obtained, and require much skill in their application.

e. Character of the modifications of crystals.—The position of planes upon crystals is an unerring guide to the system of crystallization, when the crystal is much modified, (except in some of the grosser distortions), and may serve to correct deductions from measurements. If a cube is found to have slightly oblique angles on measurement, and still the edges are all modified alike, and the angles also alike, there is good evidence that the crystal is monometric, for only like parts of a crystal are alike in their modifications. If the crystal were rhombohedral, as the apparently oblique angle might be thought to imply, there would be two kinds of edges to the rhombohedron, and two kinds of solid angles, to be modified differently. If a cubical crystal has different planes in number or inclination on a set of lateral edges from what it has on the basal, the form must be dimetric. The same principle is easily applied to other cases. In such examinations, the characters mentioned in the following table should be noted:—

1. All edges modified alike. 2. Angles trunc. or repl. by 3 or 6 similar planes.				Monometric System.
1. All edges *not* modified alike. 2. *Two*[*] or *none* of the angles trunc. or repl. by 3 or 6 similar planes.	Number of similar planes at extremities of crystal 3 or some multiple of 3.			Hexagonal System.
	Number of similar planes at extremities of crystal, neither 3 nor a multiple of 3.	The *superior* basal modifications in front *not* similar to the corresponding *inferior* in front or *superior* behind.	Two *adjacent*, or two *approximate* sim. pl. impossible.	Triclinic System.
			Two *adjacent, or* two *approximate* sim. pl. possible.	Monoclinic System.
		N.B. The Right Rhomboidal Prism on its Rhomboidal base may be distinguished from the other right prism by the dissimilar modifications of its lateral and basal edges and angles.		
		The *superior* basal modifications in front similar to the corresponding *inferior* in front or superior behind.	1. Similar planes at each base either 4 or 8 in number. 2. All lat. edges (if modified) simil. trunc. or beveled.[†]	Dimetric System.
			1. Similar planes at each base either 2 or 4 in number. 2. All lat. edges (if modified) *not* simil. truncated or beveled.[†]	Trimetric System.

The following are important laws for determining dissimilarity of planes, and their application will often prove a similarity where, from the great dissimilarity in the size of the planes, it was not supposed to exist.

1. Planes equally inclined to the same plane, are similar.
2. Planes equally inclined to similar planes, are similar.

b. Measurement of Angles.—The importance of this means of ascertaining the system of crystallization is obvious. As has been implied, it may lead to erroneous deductions; but in most cases it enables us to correct conclusions drawn from other sources. It generally gives essential aid in carrying out the mode of discrimination last laid down.

The occurrence of the angle 120° should always suggest the possibility (not the certainty) that the form may be hexagonal or monometric; or of 109° 28′, or 70° 32′, that the form may be the regular octahedron; or of 135°, that one of the planes giving the angle truncates a rectangular edge.

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[*] The rhombohedron is the only solid included in this division, any of whose angles admit of a truncation or replacement by three or six planes.

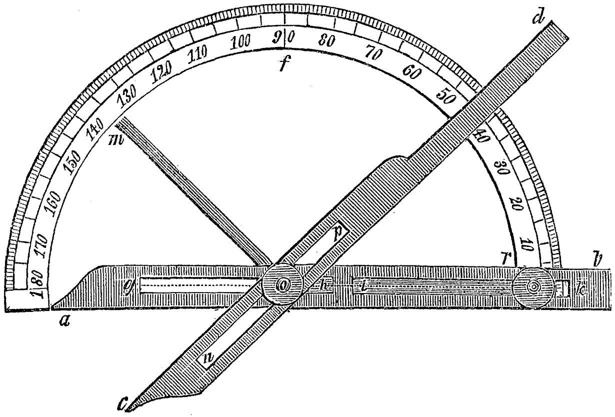
[†] The terminal edges of the octahedrons are here termed lateral, in order that these statements may be generally applicable both to prisms and octahedrons.

USE OF GONIOMETERS.

The angles of crystals are measured by means of instruments called *Goniometers.*

a. Common Goniometer, called also, Haüy's Goniometer.—The simplest of these instruments, called the Common Goniometer, is here represented. It consists, 1, of a semicircular arc graduated to half degrees, and, consequently, measuring 180°; 2, two arms, one of which, *ab*, is stationary, or admits only of a sliding motion backward and forward, by means of slits, *gh*, *ik*. The other arm turns on *o*, the centre of the arc, as an axis; there is also a slit, *np*, in this arm. By means of these slits, the parts of the arms below *o*, that is, *ao*, *co*, may be shortened, which is found necessary for the measurement of small crystals. The faces, whose inclination is to be measured, are applied between the arms *ao*, *co*, which are opened till they just admit the crystal, and are seen to be closely applied to the surface of the same. This should be determined by close examination, holding it at the same time up to the light and observing that no light passes between the arm and the plane of the crystal. The number of degrees on the arc, between *k* and the *left edge* of *d*, (this edge being in the line of the centre *o* of the arc), is the required angle.

196



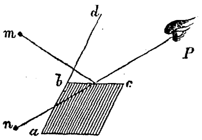
For measuring crystals partially imbedded, the arc is usually jointed at *f*, so that the part, *af*, may be folded back on the other quadrant. When the angle has been measured, the arms are secured in their place by the screw at *o*, and the arc restored to its former position, and there fastened by the bar, *mo*. The angle may now be read off. The arms sometimes admit of being separated from the arc, in order to obtain more conveniently the required angle. They may then be adjusted to the arc in a very simple manner, which will be understood by the observer without explanation, and the angle read off as above.

When a goniometer is not at hand, approximate results may be obtained by means of an extemporaneous pair of arms, made carefully of mica, or even of Bristol board. After taking the angles with them in the manner explained, place them on a sheet of paper, and with a pencil and ruler lay off the angle by drawing lines parallel with, or in the direction of, each arm of the forceps. This angle may then be measured by means of a graduated arc, or a scale of cords or tangents.

The results obtained with a common goniometer are seldom within a quarter of a degree of the truth. For polished crystals, we have a much superior instrument in the *Reflective Goniometer* of Wollaston.

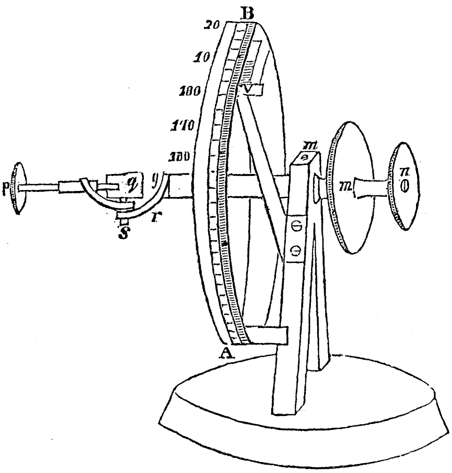
b. The Reflective Goniometer of Wollaston.—The reflective goniometer is represented in the annexed figure. The principle on which this instrument is constructed may be understood by reference to the following figure, which represents a crystal, whose angle, *abc*, is required.

197



The eye at *P*, looking at the face of the crystal, *bc*, observes a reflected image of *m*, in the direction of *Pn*. The crystal may now be so changed in its position, that the same image is seen reflected by the next face, and in the same direction, *Pn*. To effect this, the crystal must be turned around, until *abd* has the present direction of *bc*. The angle *dbc*, measures, therefore, the number of degrees through which the crystal must be turned. But *dbc*, subtracted from 180°, equals the required angle of the crystal, *abc*. The crystal is, therefore, passed in its revolution through a number of degrees, which subtracted from 180° give the required angle. This angle evidently might be measured by attaching the crystal to a graduated circle, which should turn with the crystal.

198



This object is conveniently accomplished by the ingenious and simple contrivance of Wollaston.

AB is the circle, graduated to half degrees. By means of the vernier, *v*, minutes are measured. The wheel *m* is attached to the main axis, and moves the graduated circle, together with the adjusted crystal. The wheel *n* is connected with an axis that passes through the main axis, (which is hollow for the purpose), and moves merely the parts to which the crystal is attached, in order to aid in its adjustment. The contrivances for the adjustment of the crystal are at *p*, *q*, *r*. To use the instrument, it must be placed on a small stand or table, and so elevated as to allow the observer to rest his elbows on the table. The whole, thus firmly arranged, is to be placed in front of a window, distant from the same from six to twelve feet, with the axis of the instrument parallel to it. Before operation, a dark line should be drawn below the window near the floor, parallel to the bars of the window; or, what is still better, on a slate or board, placed before the observer on the table.

The crystal is attached to the movable plate *q*, by a piece of wax, and so arranged, that the edge of intersection of the two planes, including the required angle, shall be in a line with the axis of the instrument. This is done by varying its situation on the plate *q*, or the situation of the plate itself, or by means of the adjacent joints and wheel, *r*, *s*, *p*.

When apparently adjusted, the eye should be brought close to the crystal, nearly in contact with it, and on looking into a face, part of the window will be seen reflected, one bar of which must be selected, or a cord stretched across the window, for the experiment. If the crystal is correctly adjusted, the bar or cord will appear horizontal, and on turning the wheel, *n*, till this bar, reflected, is observed to approach the dark line below, seen in a direct view, it will be found to be parallel to this dark line, and ultimately to coincide with it. If there is not a perfect coincidence, the adjustment must be altered until this coincidence is obtained. Continue then the revolution of the wheel, *n*, till the bar or cord is seen by reflection in the next face, and if here there is also a coincidence of the reflected bar or cord with the dark line seen direct, the adjustment is complete; if not, alterations must be made, and the first face again tried. A few successive trials of the two faces, will enable the observer to obtain a perfect adjustment.

After adjustment, 180° on the arc should be brought opposite 0 on the vernier. The coincidence of the bar and dark line is then to be obtained, by turning the wheel *n*. As soon as obtained, the wheel *m* should be turned until the same coincidence is observed, by means of the next face of the crystal. If a line on the graduated circle now corresponds with 0 on the vernier, the angle is immediately determined by the number of degrees marked by this line. If no line corresponds with 0, we must observe which line on the vernier coincides with a line on the circle. If it is the 18th on the vernier, and the line on the circle next below 0 on the vernier, marks 125°, the required angle is 125° 18′; if this line marks 125° 30′, the required angle is 125° 48′.

Some goniometers are furnished with a small polished reflector attached to the foot of the instrument, below the part *s q*, and placed at an oblique angle so as to reflect a bar of the window.

This is an important improvement, as the reflected bar answers the purpose of the line drawn below the window, and is more conveniently used. This reflector may be easily added to the common instruments, placing it at an angle of about 45°, or such as will reflect the bar to the eye when looking towards the crystal while observing.

Mitscherlich's Goniometer has a small lens mounted in a tube for sighting the crystal; but the lens diminishes so much the light reflected by the crystal to the eye, that it is not generally of much value. This instrument is furnished also with a micrometer screw for aid in turning the graduated circle, and certain valuable contrivances for adjusting the crystal.

Mohs's Goniometer differs from Wollaston's mainly in having the circle horizontal.

Babinet's Goniometer has a horizontal graduated circle. The crystal is placed at centre on the axis, with the edge vertical. There are two glasses mounted horizontally, with tubes and cross threads, for sighting the crystal: both are attached to the graduated arc, one moveable, the other fixed. The crystal is so placed that one face, (of the two including the required angle), on being viewed through the movable glass reflects the sight-threads of the other glass; it is then turned around till the other glass gives the same reflection. The arc through which the crystal is revolved, is then read off on the graduated circle.

Adelman's Goniometer is an ingenious contrivance, made at Paris, combining a common and a reflecting Goniometer. It is much less costly than Wollaston's.

In goniometrical measurements, a knowledge of the simple mathematical principles stated on page 61 are of great importance.

For accurate measurements of the angles of crystals, the temperature of the crystals should be noted; the angles often change somewhat with a change of temperature, as stated in the remarks on Heat.

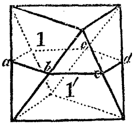
VI. COMPOUND CRYSTALLINE STRUCTURE.

The compound crystalline structure of minerals is exhibited either in distinct crystals having a composite character, or in aggregated crystallizations. The former are called *Compound* or *Twin Crystals;* they have regular facets and the same perfection of outline and angle as simple crystals.

Compound crystals may be compared to monsters in the animal kingdom. They may be composed of two united crystals, or of several.

Compound Crystals, composed of two individuals, or Twin Crystals.—Representations of some of these compound forms are given in the following figures, and in connection with the descriptions of many species through the succeeding pages of this work. Their structure may be imitated by cutting a model of a crystal in two halves, inverting one of the halves, (or revolving it 180°), and then applying it thus inverted to the other half. Fig. 199 is an octahedron, which is represented as cut in two in the plane *a b c d*. If we revolve one half 60° or 180°, and reapply it to the other, it produces the form in f. 200.

199



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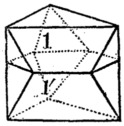


In compound crystals, composition may take place parallel to different secondary planes, but generally it occurs parallel to some face of the fundamental prism, or to the diagonal planes, that is, parallel to planes I, *ii*, 1*i*, or 1. Composition parallel to other faces is occasionally met with.

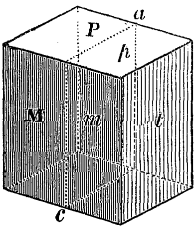
There are two modes in which composition may take place. They may be explained by reference to the method of imitating them, as follows. On dividing a crystal into halves, and holding the plane of division vertical,—

(1). One of the halves may be inverted, as if by revolution 180°, on a horizontal axis *at right angles* to the plane of section, and the two again united by the surfaces that were separated.

(2). One of the halves may be turned around, through 180°, as if by revolution on a horizontal axis *parallel* to the plane of section, and the face opposite and parallel to that of the plane of section may then be applied to the other half.

Fig. 201 represents an oblique prism, bisected vertically along the plane *a c*. The back planes may be considered as lettered like those in front with the addition of an accent. The *first* of these two modes of composition is illustrated in f. 202; *p m t* is inverted so that the back plane *m′* is in front, in place of *m*, and *p* is at top in place of *p′*. In the *second* mode, *t′* would be the outer plane instead of *t*, the latter being the plane of union with *P M T;* and *p′* would be at top as before, but *m* would remain in front. In the junction of the two parts, by this second mode, an obtuse plane angle of one of them comes against an acute of the other, so that the two parts do not fit into a symmetrical solid, unless the acute edges of the prism (the opposite edges *a* and *c*) be truncated, which is usually the fact in species in which this mode of composition occurs, viz. Feldspar and Albite.

201



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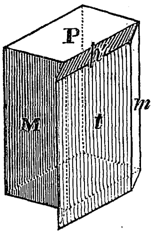


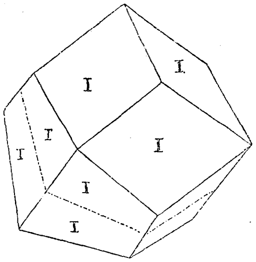
The first of these modes of composition may occur in each of the systems of crystallization, though not always apparent in all, in the external form. Examples of it are sometimes distinguished by internal arrangements of color, or by optical characters, when not otherwise recognizable. The second mode is of rare occurrence.

In the *monometric* system there may be composition in three directions, (1), parallel to an octahedral face or a plane truncating the angle of a cube; (2), parallel to a dodecahedral face, or a plane truncating the edge of a cube; (3), parallel to a face of the cube. The first kind produces forms with reëntering angles; and the second and third also when occurring in hemihedral forms. The third kind and the second, except in the case mentioned, are not distinguishable by the form, as the inversion of the halves of a cube parallel to a cubic face, or parallel to an edge, produces only a cube still, and no change of the apparent form. Such twins in holohedral forms cannot therefore be recognized by the external form when they occur.

Fig. 200 represents a twin of the first of these kinds; it occurs in Spinel, Magnetite, &c. When the form is shortened parallel to the plane of union, it becomes tabular, and is sometimes quite thin tabular.

Fig. 203 exhibits the same kind of composition in a dodecahedron. One half, as in the case of the octahedron, is revolved 60°, (or the result is equivalent to this). In a cube it produces a solid made up of two cubes united by their angles, parallel to an octahedral plane. In a form like f. 34, the result is similar in kind, but sometimes the six faces about one solid angle, and the six about the diagonally opposite, form together a twin having the form of a low double six-sided pyramid, resembling somewhat f. 89, as in Native Copper, the intermediate parts being absent. Fig. 185 is an example in the Diamond.

203



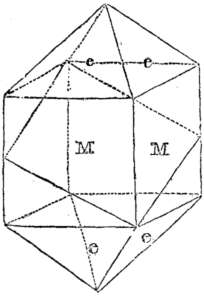
In f. 273 of Blende, a revolution of 60° produces the solid in f. 273 A.

In the *dimetric system* twins may occur parallel to (1) the basal plane (*O*) of a prism; (2) a lateral plane, *ii;* (3) a vertical diagonal plane I; (4) a plane replacing a basal edge of the prism *ii*, usually plane 1*i;* (5) a plane replacing an angle, usually plane 1. Only the last two kinds are marked by reëntering angles in holohedral forms, or are recognizable except it be by optical characters, while all may be distinguished in hemihedral forms.

The annexed fig. 204 represents a square prism terminating in a pyramid, divided by a diagonal section; and f. 205 shows the form resulting from revolving one of the halves thus formed 180°. It is common in tin ore, (Cassiterite).

The square octahedron 1*i* or 1 gives rise to twins by composition parallel to one of its faces, similar to f. 200, but of less symmetrical

204



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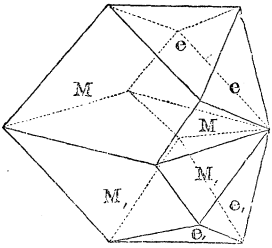


character, a process that may be instructively followed through by cutting out models. A form of this kind is represented in f. 295; composition is parallel to 1*i*. Tabular forms may result with this kind of composition; and thin tables thus formed are sometimes aggregated, or, as it were, piled up, together.

In the *trimetric system* composition may occur in the same directions as in the dimetric; and as the lateral axes are unequal, twins formed by composition parallel to these axes, (as to planes 1*ī* or 1*ĭ*), are different in kind. Composition parallel to the axial sections, as *iī* or *iĭ*, does not produce twins recognizable as such by external form; but when it takes place parallel to the plane I, (f. 4, 22, 24), as these planes form a rhombic prism, there are reëntering angles, as shown in Aragonite, (q. v.) An example of composition parallel to plane 1*ĭ* is given in f. 332, under Manganite.

In the *oblique systems*, twins parallel to the axial sections may have reëntering planes, or planes in abnormal positions, as a result of the composition, as well as those formed by composition in other directions. Fig. 357 (Augite) represents an example of composition parallel to *ii*, the simple form of which is shown in f. 350. Fig. 362 is another in Hornblende; f. 361 is the simple form. Fig. 415, 416 (Albite) are examples of composition parallel to *ii*; the former, by an inversion of the *first* kind, and the other of the *second* kind, described on page 128. Fig. 424, 425, are twins of Orthoclase, compounded parallel to *ii*, similar to the last mentioned of Albite. In f. 428 composition is parallel to 2*i*. Gypsum and several other species afford additional examples.

In the *hexagonal system*, twins of rhombohedral forms occur compounded (1) parallel to the terminal plane *O* (0*R*); (2) the prismatic planes I or *i*2: the rhombohedral faces (*R*); (4) planes truncating the terminal edges, or $-\frac{1}{2}R$; (5) rarely parallel to the face of the pyramid 1-2 and the rhombohedron $-2R$.

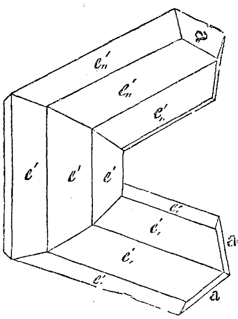
When composition is parallel to *O*, the twin appears as if made by a revolution through 60° of one half of the simple crystal, the axis of revolution being the vertical axis of the prism. Several figures under Calcite (q. v.) are forms of this kind. A similar mode of composition produces the form in f. 300 A, (Pyrargyrite); the hexagonal prism of the simple crystal has its alternate edges truncated; and in the compound form (produced through a revolution of one half 60°) this truncation appears on half of each edge alternately above and below. Composition parallel to I is represented in one of the forms of Calcite, (q. v.) Composition parallel to R occurs in Calcite, Chabazite, Quartz, &c. Composition parallel to $\frac{1}{2}R$ is met with in Calcite and Pyrargyrite; see f. 300. Composition parallel to $-2R$ is exemplified under Calcite, (q. v.) Composition parallel to the pyramid 1-2, or an edge of the common pyramid of Quartz, sometimes occurs, (f. 342).

In the compound forms which have been described, the crystal is generally as complete and well finished as the simple form, and it is obvious that the formation of the twin commenced with the nucleal molecule, which itself possessed the compound character, or consisted essentially of two molecules. Such twins are properly *paragenic;* and they are distinct from another kind, *metagenic*, in which the composition took place subsequently to the commencement of the crystal.

In *metagenic* twins, the two parts of the twin are not united along a diagonal section, but by parts more or less distant from the proper centre of either. Such are the forms represented in f. 345, 346, (Quartz).

A mode of metagenic composition is observed in doubly geniculated crystals, as those of Rutile, annexed figure. The geniculations take place at equal distances either side of the centre of the crystal, and are evidently the result of some cause acting after the crystal had begun to form. The geniculation is usually parallel to a plane of common occurrence, either, one of those of the fundamental form, or its simplest modifications. This geniculation often is frequently repeated in the same crystal, and thus the ends of a crystal are, by successive geniculations, bent around together or into one another, as happens in Rutile.

206

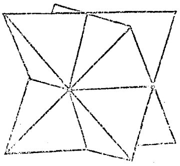


Rutile.

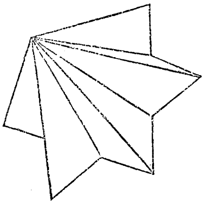
Compound Crystals composed of more than two Individuals.—In the *monometric* system, in which the axes are all equal, the composition occurring along one octahedral section may occur parallel to all such sections alike; and hence comes a compound form of pyrites, (f. 282 A), made up of pentagonal dodecahedrons. It corresponds to an interpenetration of two pentagonal dodecahedrons, a right and a left, (+ and —). In a similar manner there results the compound form represented in f. 306, which becomes very complex when the crystals are highly modified. Fig. 272 A, represents a crystal of Galena of this kind, distorted by being shortened in the direction of an octahedral axis.

In tetrahedral forms, composition parallel to the cubic faces produces the form in f. 207, which may be viewed as made of two interpenetrating tetrahedrons. By this method is formed the twin of Diamond represented in f. 267 A. With the composition parallel to an octahedral face, the form in f. 208 is produced, also made of two interpenetrating tetrahedrons. It illustrates the origin of the twin of Gray Copper in f. 303 A.

207

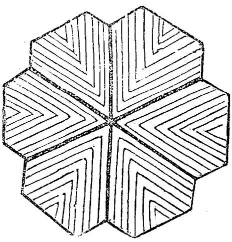


208



In the *dimetric* system, the eight octahedral sections are similar to one another, as in the monometric, and hence there may be composition simultaneously parallel to all. Very complicated forms are thus produced in Copper Pyrites and Tin Ore. Fig. 295 A, represents one of the occurring forms of Copper Pyrites.

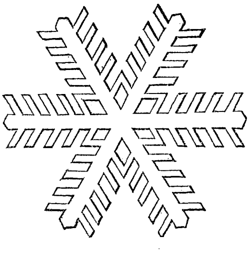
209



In the *trimetric* system, cruciform and stellate crystals are common. Fig. 209 represents a form in chrysoberyl. Other varieties are shown in f. 233, 234, 236, beyond; others under Staurotide, Aragonite, Cerusite, and Harmotome. In the stellate forms, the compound crystals consist of *three* or *six* rays, when the angle of the prism is near 120°, or one-third of 360°, and *five* rays when about one-fifth of 360°, as in Marcasite.

In *rhombohedral* species, as Pyrargyrite, Chabazite, Levyne, and Cinnabar, compound crystals occur, which in the simplest form resemble f. 306 of Fluor spar. They may be viewed as formed by the interpenetration of two rhombohedrons a + and a —, with the vertical axis as the axis of composition, or by a composition of six crystals united parallel to the prismatic planes I. In Ilmenite, analogous forms occur; by composition, upon the form in f. 314, compound crystals nearly similar in their faces to f. 313, are produced.

210



Stellate forms also occur in the rhombohedral system, as represented in the accompanying figure of a crystal of snow, (f. 210). Another form of compound crystal in this system is represented in f. 300, under Pyrargyrite. It consists of four crystals, united parallel to the faces $-\frac{1}{2}R$.

Crystals are often grouped in linear series, as in Native Copper and Silver, and thus constitute long threads or reticulations. In clustered crystals, it is generally a fact that adjoining crystals are parallel in position, and united by a plane parallel to one of the principal sections or planes of common occurrence. Senarmont mentions the union in Galena parallel to the octahedral faces as common; and he also describes an instance where the union was parallel to the plane $3\text{-}\frac{3}{2}$.

The positions of crystals on the supporting rock seem at first to be without any regularity. By closer inspection we detect even here the same law of harmony that governs the formation of the simple and compound crystal. The various positions assumed correspond generally with the more common kinds of composition in twin crystals. Brooke observes with respect to certain artificial crystallizations of nitrate of lead, that some of the octahedrons "had their axes perpendicular to the surfaces on which they rested"—"others rested on one of their planes, and others were attached by an edge to the bottom of the vessel;" thus exemplifying three kinds of composition. This regularity is not always manifest on account of the unevenness of the surface on which they rest. In general, however, on glancing the eye over a surface covered with crystals, a reflection from one face will be accompanied with reflections from the corresponding face in each of the other crystals, showing that the crystals are similar throughout in their positions.

This tendency to parallelism in the positions of associated cystals is even apparent in crystalline aggregates. In granite, for example, which is composed of feldspar, quartz, and mica, the feldspar crystallizations have usually a common position; that is, the corresponding extremities lie in the same direction, or nearly so. On this account granite is cleavable in one direction more easily than in others, and this direction is that of the perfect cleavage plane of the feldspar. The parallel positions of the mica in gneiss causes the fissile character of that rock.

In some cases also, crystals of different minerals associated together take a parallel or continuous position. Thus crystals of Albite and Feldspar, and of Staurotide and Kyanite, at times have this relation; and Breithaupt has observed the same between crystals of Rutile and Specular iron, the crystals of Rutile in this case having the vertical axis in the direction of a lateral axis of the Specular iron. Haidinger has observed Pyroxene and Hornblende crystals associated in parallel positions.

A prism of Calcite terminating in the planes $-\frac{1}{2}$, has been observed, in which each plane $-\frac{1}{2}$ was covered with small crystals of quartz all lying symmetrically, with their pyramids pointing towards the summit.

The subject of twin crystals will receive further illustration in the chapter on Crystallogeny.

VII. CRYSTALLINE AGGREGATES AND AMORPHOUS VARIETIES.

The greater part of the specimens or masses of minerals that occur on our globe, may be described as aggregations of imperfect crystals. Even those whose structure appears the most purely impalpable, and the most destitute internally of anything like crystallization, are probably composed of crystalline grains. We, consequently, include under the above head, all the remaining varieties of structure in the mineral kingdom. The only certain exceptions are liquids and gases, which require so few remarks, that a separate caption for them is unnecessary.

The individuals composing imperfectly crystallized individuals, may be,

1. *Columns, or fibres*, in which case the structure is *columnar.*
2. *Thin laminæ*, producing a *lamellar* structure.
3. *Grains*, constituting a *granular* structure.

1. *Columnar Structure.*

A mineral possesses a columnar structure, when it is made up of slender columns or fibres. There are the following varieties of the columnar structure:—

Fibrous: when the columns or fibres are parallel. Ex. gypsum, asbestus. Fibrous minerals have often a silky lustre.

Reticulated: when the fibres or columns cross in various directions, and produce an appearance having some resemblance to a net.

Stellated or *stellular:* when they radiate from a centre in all directions, and produce star-like forms. Ex. stilbite, wavellite.

Radiated, divergent: when the crystals radiate from a centre, without producing stellar forms. Ex. quartz, gray antimony.

2. *Lamellar Structure.*

The structure of a mineral is lamellar, when it consists of plates or leaves. The laminæ may be curved or straight, and thus give rise to the *curved* lamellar, and *straight* lamellar structure. Ex. tabular spar, some varieties of gypsum, talc, &c. When the laminæ are thin and easily separable, the structure is said to be foliaceous. Mica is a striking example, and the term micaceous is often used to describe this kind of structure.

3. *Granular Structure.*

The particles in a granular structure differ much in size. When coarse, the mineral is described as *coarsely granular:* when fine, *finely granular;* and if not distinguishable by the naked eye, the structure is termed *impalpable.* Examples of the first may be observed in granular carbonate of lime; of the second, in some varieties of specular iron; of the last, in chalcedony, opal, and other species.

The above terms are indefinite, but from necessity, as there is every degree of fineness of structure in the mineral species, from perfectly impalpable, through all possible shades, to the coarsest granular. The term *phanero-crystalline* has been used for varieties in which the grains are distinct, and *crypto-crystalline*, for those in which they are not discernible. Granular minerals, when easily crumbled in the fingers, are said to be *friable*.

4. *Imitative Shapes.*

Reniform: kidney shape. The structure may be radiating or concentric.

Botryoidal: consisting of a group of rounded prominences. The name is derived from the Greek βοτρυς, *a bunch of grapes*. Ex. limonite, chalcedony.

Mammillary: resembling the botryoidal, but composed of larger prominences.

Globular: spherical or nearly so; the globules may consist of radiating fibres or concentric coats. When attached, as they usually are, to the surface of a rock, they are described as *implanted globules*.

Nodular: in tuberose forms, or having irregular protuberances over the surface.

Amygdaloidal: almond-shaped, applied usually to a greenstone containing almond-shaped or sub-globular nodules.

Coralloidal: like coral, or consisting of interlaced flexuous branchings of a white color, as in some arragonite.

Dendritic: branching tree-like.

Mossy: like moss in form or appearance.

Filiform or *Capillary:* very slender and long like a thread or hair.

Acicular: slender and rigid like a needle.

Reticulated: net-like.

Drusy: closely covered with minute implanted crystals.

Stalactitic: when the mineral occurs in pendant columns, cylinders, or elongated cones.

Stalactites are produced by the percolation of water, holding mineral matter in solution, through the rocky roofs of caverns. The evaporation of the water produces a deposit of the mineral matter, and gradually forms a long pendant cylinder or cone. The internal structure may be imperfectly crystalline and granular, or may consist of fibres radiating from the central column, or may have a broad cross-cleavage.

Common stalactites consist of carbonate of lime. Chalcedony, gibbsite, brown iron ore, and many other species, also present stalactitic forms.

Amorphous: having no regular structure or form either crystalline or imitative. The word is from α, *privitive*, and μορφη, *shape*.

VIII. PSEUDOMORPHOUS CRYSTALS.

A pseudomorphous crystal possesses a form that is foreign to the species to which the substance belongs.

Crystals sometimes undergo a change of composition from aqueous agency or some other cause, without losing their form: for example, octahedrons of spinel change to steatite, still retaining the octahedral form; cubes of pyrites are altered to red or brown iron ore; anhydrite becomes gypsum by the addition of water: or crystals are sometimes removed entirely, and another mineral is substituted; as, for example, cubes of fluor spar may be transformed to quartz, without a change of form.

In these and other ways, many minerals appear under a form of crystallization which does not belong to the species. The discussion of the origin and chemical relations of pseudomorphs will be more properly considered in the chapter on Chemical Mineralogy.

Pseudomorphous crystals are distinguished, generally, by their rounded angles, dull surfaces, and often granular composition. They either have no cleavage, or the cleavage is wholly different in direction from that of the mineral imitated. Their surfaces are frequently drusy, or covered with minute crystals. Occasionally the resemblance to real crystals is so perfect, that they are distinguished with difficulty.

SECTION II.

CRYSTALLOGENY.

Crystallogeny, or the formation of crystals, may be discussed either from a practical point of view, by treating of the processes of crystallization and attendant circumstances; or theoretically, by considering the nature of molecular attraction in crystallization, and the laws under which it acts. Under the former head, only a few of the causes that determine the modifications of form in crystal are here mentioned, as a full discussion of the methods of crystallizing minerals by art belongs rather to chemical science.

I. PRACTICAL CRYSTALLOGENY.

Crystallization may take place—from a *solution* of a crystallizable material; from a state of *fusion* by heat; from a state of *vapor*, another condition dependent on temperature; from a *solid state without fusion*, under a continued elevation of temperature. The crystallization of sugar or alum is a common example of the *first* mode; the formation of ice, of the *second;* the production of snow from vapor, of the *third;* and the usual mode of hardening steel, (since it depends on varying the size or system of crystallization of the crystalline grains), is an example of the *fourth.* All solidification of inorganic matter is probably crystallization, and the solid condition is arrived at in one or the other of these methods. Frequently, however, the solid is formed immediately upon the combination of the elements that constitute it, or upon the liberation of the substance from some other state of combination.

The formation of distinct crystals usually requires a freedom from disturbing causes, a slow rate of progress in the process, and a large supply of material, or else a gradual supply from some constant source. In many instances a crystal that has been long out of a solution, may be restored and further enlarged.

Crystallization without a change from the solid state, is well illustrated by facts mentioned to the author by Mr. N. P. Ames. If a bar of tempered steel, bent in the form of a semicircle, be heated on the inner side, when the heat has reached a certain point, the bar may easily be bent around and made to curve in the opposite direction. He states that until the moment when the requisite temperature is acquired, the bar does not yield; but at this moment, a change takes place which is distinctly felt in the hands, and the bar at once bends. He carefully measured the inner and outer curves of the bar, after thus bending it, and found them of the same length as before. This shows that there had been no compression of the particles on the inner side, which would have shortened that side, and therefore, also, that there was actually a freedom of motion among the particles on either side. He observes, moreover, that the elasticity of the inner and outer sides was the same, which would not have been the case were the former compressed. By the old method of restoring a warped sword-blade it was rendered unequally elastic, and would spring more easily on one side than the other; but by the means here explained, the elasticity is perfectly equal on both sides. Here, then, there is a change in the position of the particles throughout the bar, produced by a temperature very far short of fusion. The same experiment was often repeated, and he found that, at every time he bent the steel, the temperature required was a little above that at which it bent the preceding time. The change resulting from friction or long repeated concussion, is probably owing to the combined action of the heat thus excited, and the vibration that takes place. Mr. Ames states instances in which a large bar of iron, used as an axle through a heavy wheel of cast iron, broke square off in the middle, after use for a few months; and in one case, there were two other fractures on either side of the centre. In these instances, the bar was rendered coarsely crystalline, and was wholly unlike the original iron.

Causes of secondary planes.—Beudant, in his treatise on Mineralogy, in which this subject has received some attention, states as the principal cause of secondary planes, *the nature of the solvent, and of the substances it holds in solution.*

He remarks, that when the solvent contains, *mechanically* suspended, minute particles of foreign matter, the crystals formed contain more or less of these foreign particles regularly arranged, either in concentric layers with the laminæ of the crystal, or in the direction of a diagonal, or occasionally intermingled without regular order; and that the crystals thus impure, are *more simple* and regular than those obtained from a clear liquid. Crystals of quartz are seldom perfectly regular bipyramidal prisms, except when they contain large portions of chlorite or oxyd of iron. But if the solvent contains other substances in *solution*, either solid, liquid, or gaseous, secondary forms are usually produced. "Common salt, crystallizing from pure water, presents, almost invariably, a cubic form. But in a solution of boracic acid, it always occurs with truncated angles," (f. 15). The Rev. E. Craig, in an interesting article on Microscopic Chemistry, in the Lond. and Ed. Phil. Mag. and Jour. of Science, July, 1836, p. 13, states the following remarkable transformations in crystals of carbonate of copper, produced by a change in the nature of the solvent: "If sulphuric acid be added to carbonate of copper, crystals speedily appear presenting the form of six-sided tabular prisms. Add a little ammonia, the form is changed entirely to a long rectangular prism, with the angles replaced. Add a little more ammonia, and the form changes to several varieties of the rhombic octahedron: a little nitric acid restores again the form of the rectangular prism. In all these successive changes, it is not that a few crystals of another form have been superadded, but each time the metamorphosis is seen to take place in the whole mass."

There are many evidences that the same cause has operated in nature to produce the peculiar secondary planes a crystal presents. Aragonite, in iron mines, crystallizes in very acute pyramidal crystals; but in the gypsum clays, accompanying the saliferous deposits, it always appears in prismatic crystals, grouped so as to form hexagonal prisms. Other similar instances might be added; but this will suffice to establish the fact, that secondary planes often arise from the peculiar nature of the solvent.

Another cause may be the electrical state of the rock supporting the crystal, and also its nature. M. Planiava has observed that, in some instances, in which the form of the *floating* crystal was the primary, it assumed secondary planes as soon as it attached itself to the sides of the vessel.*

In some instances, secondary planes proceed from some permanent peculiarity in the molecule; for, without this supposition, we cannot account for the invariableness in the occurrence of a particular secondary form of some minerals; for example, the prismatic form in quartz, whose primary is a rhombohedron.

The influence of magnetism or electricity on crystallization has received some attention, especially from Mr. Robert Hunt. By placing the poles of a horse-shoe magnet against a glass vessel or a plate of glass, in or on which crystallization was in progress, he has found the crystals to be guided in their positions by the poles of a magnet. The facts he has developed have a bearing upon the uniformity of position in crystallizations over large areas. But other causes have aided in directing the crystalline structure of rocks, and among them the pressure to which the material was subjected during crystallization may be the most important.†

M. Lavalle has shown, (L'Institut, 1853, 90), among his results, that when a crystal of alum lies on one of its sides, as it enlarges, the under surface and the opposite, if there is one similar, enlarge more than the rest; and if an angle be cut off and it be laid on this face thus made, a similar plane forms on the opposite angle, but not on the others; and if all the edges are removed by solution, the crystal will complete again every edge and angle.

Brewster has made some very remarkable investigations on the optical figures which reflected light exhibits upon the surfaces of crystals acted on by solvents, showing the points or directions of weakest cohesion. Phil. Mag. 1853, [4], v, 16.

II. THEORETICAL CRYSTALLOGENY.

THEORIES OF VARIOUS AUTHORS.

Speculations on the nature of molecules have displayed the ingenuity of men of science in various ages of the world. The Grecian philosophers, to account for the various phenomena in nature, imagined the ultimate particles of matter to be at different times "round, oval, lenticular, flat, gibbous, oblong, conical, smooth, rough, quadrilateral,"‡, and, to afford these atoms the means of uniting in the production of compounds, provided them with hooks.

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* Kastner's Archiv. X, 42; cited in Ferussac's Bulletin.

† See remarks on this subject by the author in Amer. Jour. Sci, [2], iii, 393, 394, where there are references to writers on this point.

‡ Epicurus.

The investigations of modern times have not, indeed, answered the inquiry, what is this plastic power in nature; but philosophers have been led to satisfy themselves with calling it by the general term, *attraction*, a term rather expressing the fact, that particles combine, than explaining the nature of this power.

This subject lay uninvestigated, from the times of the ancient philosophers till the 13th century.* From the 13th to the 17th century, appeared Albertus Magnus,† Agricola,‡ Cæsalpinus,§ Boetius de Boot,‖ Baptista von Helmont,¶ Christian Huygens,** Boyle,†† and many others, who advanced various hypotheses as to the *seeds* of crystals, their *generation*, &c. But, excepting Huygens, who in a very recondite treatise first developed the doubly refracting nature of Iceland spar, and inferred that its elementary particles were spheroids, to account for this peculiar refraction, none made any real improvements on the speculations of their predecessors.

With Nicolaus Steno, towards the latter part of the 17th century, commences a new era. This author examined minutely the different forms of several minerals, and first deduced the important principle afterwards rediscovered, that, *although the faces of crystals are subject to frequent variations of form, their inclinations remain constant.*‡‡ In the commencement of the 18th century, Gulielmini published on the crystallizations of the salts, and advanced another principle equally fundamental, that *cleavage in crystals of the same substance yields constantly the same forms.* Gulielmini was led, by his observations, to the same conclusions as

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* Many of the following facts have been cited from a valuable work on the History of Crystallography, by Dr. C. M. Marx, entitled *Geschichte der Crystallkunde;* 314 pp. 8vo. Carlsuhe und Baden, 1825.

† De Mineralibus et Rebus Metallicis, 12mo. Colon. 1619.

‡ De Ortu et Causis subterraneorum. Basiliæ. fol. 1657.

§ De Metallicis Libri Tres: Noribergæ, 1602. In Book II, 19, he says: "Relinquitur igitur ut sola hexagona fiat, sola enim perfecta est, quia fit ex triplici divisione superficiei ad angulos acutos, sex triangulis in unum veluti centrum coeuntibus, ut omnes anguli externi majores sint recto, ideo ad circuli naturam prope accedunt."

‖ Gemmarum et Lapidum Historia, quam olim edidit Anselmus Boetius de Boot, postea Andr. Tollius. Lugd. Bat., 1647.

¶ In a work published in German at Sulzbach, in 1683, he subscribes to the opinion, that the different crystals, like plants and animals, proceed each from its own peculiar seeds.

** *Christ. Huygeni* Op. Vol. I, Amst. 1728, 4to Tractatus de lumine.

†† *R. Boyle,* Specimen de Gemmarum Origine et Virtutibus. Colon. Allobr. 1680, 4to. P. 6, we find, "Reperiebam in solida lapidis massa cavitates, quarum latera undique circumdederant concretiones, quæ cum essent pellucidæ instar crystalli et elegantisime figuratæ, videbantur fuisse *succus lapidescens* purior, qui tandem percolatione quadam per substantiam crassioris lapidis penetraverat in illas cavitates, et postquam evaporassent superfluæ et aqueæ partes, aut imbibitæ fuissent a vicino lapide, poterant concurrere in pura illa crystalla."

‡‡ *Nic. Stenonis,* Dissertationis Prodromus de Solido intra Solidum naturaliter contento. Pistorii, 1763—(first published at Florence, 1669, also, in the Collect. Academ. de Dijon, Partie etrang. T. IV, p. 383).

the Abbé Haüy, namely, that the elementary corpuscles of bodies possess those simple forms which may be obtained from crystals by cleavage.* He neglected, however, to extend his investigations on this subject, and left to Romé de Lisle and Haüy the honor of founding the *science* of Crystallography.

Several writers on these subjects appeared during the half century following Gulielmini; but they made no essential additions to facts.—The theory of tetrahedral atoms was proposed by Ludwig Bourguet.†

J. Woodward makes quartz crystal the source of all crystallizations, concerning which he thus expresses himself in his treatise on his collection of "English Fossils,"‡ p. 146: "There is in all spar more or less crystal, which renders it more or less diaphanous," &c. Again, p. 220: "Crystal, pure and without mixture of other matter, concretes even into an hexagonal figure, pyramidal or columnar, terminating in an apex or point. Mineral or metallic matter concreting with it, frequently determines it to other figures peculiar to the disposition of each kind of that matter. *Iron* concreting with crystal, determines it to a rhomboidal figure; *tin*, to a quadrilateral pyramid; *lead*, to a cubic."

Somewhat similar was the opinion of Linnæus, who supposed that all crystals contained a salt, and to this owed their crystallization.§ This theory obtained considerable credit at that time. We find it clearly expressed in the Philosophical Transactions for 1749, p. 250, by W. Borlase: "'Tis by the force of *salts* that liquid bodies are thrown into all the geometrical planes, angles, and more compounded shapes, the variety of which is no less surprising, than the constancy and uniformity of each particular species." The discoveries in chemistry soon dissipated these views, and at last established philosophers on this settled ground, that the power of crystallization is naturally and independently inherent in all inorganic matter.

Immediately preceding the commencement of the Abbé Haüy's very successful scientific career, appeared Bergman, Werner, and Romé de Lisle. Bergman has the honor of discovering the fundamental forms of crystals, and Romé de Lisle that of first measuring

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* De Salibus Dissertatio epistolaris physico-medico-mechanica conscripta a *Dominico Gulielmini;* Lugd. Bat. 1707, 8vo. P. 2: "Determinatam figuram non ab universali aut particulari architectonico spiritu, non a propria innominata forma, sed a primarum particularum schemate unice derivandam." P. 10: "Corpuscula insectilia, terminata planis superficiebus ita ad invicem inclinatis, ut simplicem aliquam includent figuram." P. 19: "Figuris non omnibus, quæ possibiles sunt, utitur natura, sed certis quibusdam tantum, quarum determinatio non est a cerebro eximenda, aut a priori probanda, sed ab experimentis et observationibus desumenda."

† *L. Bourguet,* Lettres philosophiques sur la formation de sels et de cristaux; Amsterd. 1729, 8vo.

‡ An attempt towards a natural history of the fossils of England, in a Catalogue of the English Fossils in the collection of *J. Woodward;* 2 vols. London, 1728–9.

§ Systema Naturæ, ed. VI, p. 160: "Crystallus lapidea sal non est, sed continet sal, cujus figuram gerit, omnis enim crystallizatio ex sale," &c.

their angles, and thus rendering crystallography subservient to the purposes of the mineralogist.

Haüy seems to have entered on his studies with an entire ignorance of the results of Bergman and Gulielmini, and in all his observations was an original investigator. A mere accident, the dropping of a crystal from his hands and its fracture in consequence, exhibited to him the rhombohedral particles of carbonate of lime. He was thus led to commence his investigations, and with his philosophic mind soon arrived at general conclusions with regard to the primary forms.—An obvious theory as to their structure, *that* already proposed by Gulielmini, was the next result of his investigations. The primary cube he imagined to be constituted of cubic molecules, for cubes, and cubes only, can be obtained by mechanical division. Similarly, the rhombohedron was formed of rhombohedral molecules.

Investigations, with respect to the situation of secondary planes, and the laws which govern their formation, gave Haüy what appeared to be additional proof of the correctness of his theory. He discovered that the secondary planes on the edges of crystals might be exactly imitated by composing a primary of its molecules, and dropping one row (or, in his phraseology, by a decrement of one row) of particles in height and breadth, (f. 211), or, two rows in one direction, and one in the other, (f. 212), and so in some simple ratio for all planes. These splendid results proved that the science of Crystallography was founded on a mathematical basis, and they seemed to establish the truth of Haüy's views, on the same sure foundation.

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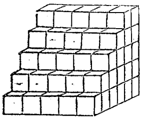

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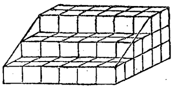

It appeared, however, to be a difficulty, that cleavage was obtained, in some instances parallel to two primaries at the same time. The rhombic prism, besides its rhombic cleavage, admitted of cleavage parallel to a diagonal, thus dividing it into two three-sided prisms. Again, octahedrons could not be composed of octahedral molecules, except by leaving large spaces, to fill which, tetrahedrons were necessary. Haüy surmounted the first difficulty, by supposing the molecules to be composed of still simpler solids, which he called *integrant* molecules. These are the tetrahedron, the three-sided prism, and the parallelopiped. The second difficulty, however, remained, and could only be avoided by the improbable hypothesis of two nucleal solids, an octahedron, and a tetrahedron.

The difficulties lay unremoved, when Dr. Wollaston brought forward his ingenious views on the *spherical* forms of the molecules of bodies, in the Philosophical Transactions for 1813. It is easily conceived, that many of the primary solids in crystallography may be formed by the regular aggregation of spheres. Two four-sided pyramids of shot, (similar to those frequently seen in arsenals), placed base to base, form the regular octahedron, (f. 213). If, to the octahedron, two three-sided pyramids are added, tetrahedrons, one to each of two opposite faces, a rhombohedron is formed, (f. 214). A rhombohedron of this kind is easily obtained in the cleaving of fluor spar; it is reduced to the octahedron by separating two tetrahedrons.

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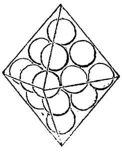

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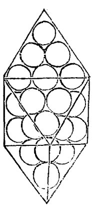

Rhombohedrons, however, occur of various angles. To obtain these, it is only necessary to suppose the particles of other rhombohedrons to be spheroids, instead of spheres; spheroids are also his molecules of the prisms. The formation of the cube is illustrated by Dr. Wollaston, as follows: "Let a mass of matter be supposed to consist of spherical particles, all of the same size, but of two different kinds in equal numbers, represented by black and white balls; and let it be required that, in their perfect intermixture, every black ball shall be equally distant from all surrounding white balls, and that all adjacent balls of the same denomination shall also be equidistant from each other. I say, then, that these conditions will be fulfilled, if the arrangement be cubical, and that the particles will be in equilibrio." He had previously stated, that "a cube may evidently be put together of spherical particles, arranged four and four above each other; but this is not the form which simple spheres are *naturally disposed* to assume, and, consequently, this hypothesis alone is not adequate to its explanation."

This theory is in some respects far more simple than that of Haüy. Yet it is manifest that it received but sparingly the attention of the philosophic mind of Dr. Wollaston. The cube and rhombohedron are similar solids, differing merely in that the latter is oblique. It is surely improbable, that their atomic arrangements should be as different as Wollaston's theory supposes; or with reference to the cube alone, that its formation, or even the explanation of it, should require two kinds of particles.

Other theories have been proposed, but only one seems to demand a notice in this place, before entering upon that which appears to afford the best explanation of the phenomena. I refer to the *Chemical* theory, as it may be called, since chemical facts are usually explained by a reference to its principles. According to this theory, the atoms of the elements are either spheres or spheroids, and the molecules of compounds result from a juxtaposition of the elementary atoms. These elementary atoms, moreover, are so arranged, that the compound molecule has the shape of the *primary form* of the compound.

It will be remembered that crystals are solids of definite dimensions, and constant angles, exhibiting a perfect symmetry in their several parts, and an exact regularity in the occurrence of secondary planes. In order, therefore, that the similar parts of a crystal should be similarly modified, there should be a corresponding similarity in the different parts of a molecule. The molecule of the cube, besides having the form of a cube, should present a uniformity of character on its six opposite parts, corresponding to the faces of the cube. Such molecules, it is evident, cannot be formed by the *juxtaposition* of the elementary atoms. An atom of sulphur, the fundamental form of which is a *rhombic octahedron*, united to an atom of lead, whose primary is the *regular octahedron*, could not in any way be made to receive the cubic form of galena. Nor were the molecules equal spheres, would it be a less difficult task; and if the form were possible, still the compound molecule would not contain similar atoms in its similar parts, and could not possess that symmetrical character necessary to account for the regularity in the ocurrence of secondary planes. Such examples might be multiplied indefinitely.

The chemical theory is equally unsatisfactory, in all attempts to account for crystallographic phenomena. Indeed, it may be considered as formed merely for illustrating combinations in a lecture room. In the explanations of optical phenomena, it has been rejected by the principal theorists, who, in accounting for the double refraction of crystals, suppose the molecules to have spherical and ellipsoidal forms, and a homogeneous structure.

Without further introduction, I proceed to explain what is conceived to be the most probable view of the nature of molecules and molecular action in the formation of crystals.

ON CRYSTALLINE MOLECULES.*

By *crystalline* molecule is understood, the molecule in the state peculiar to it, when about to enter into the constitution of a crystal, or when a constituent part of a crystal. Evidently, some important change takes place in molecules, at the time of crystallization. The moment before, when in the liquid state, they are in close connection, but move freely among themselves; in the act of crystallization, they unite, almost instantaneously, and are firmly compacted in the hard, unyielding crystal.

Forms of Molecules.—Adopting the idea of spherical and spheroidal molecules, we suppose the molecule of each primary to

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* The following views on crystallogeny were first published by the author in the American Journal of Science, 1836, xxx, 275, in an article on the formation of Compound or Twin Crystals.

be that spheroidal body or ellipsoid,* which, described within the prism, touches the centres of its faces. These molecules, by their aggregation, will build up the same forms that proceed from the aggregation of Haüy's polyhedral molecules; for they have the same proportional height, breadth, and thickness, and therefore, by combination, must produce a solid of the same dimensions.† Such molecules are potentially correct representatives of the forces of attraction indicated by the forms and structure of crystals, whether actualities or not.

Crystallogenic Attraction.—Crystallogenic attraction, and the attraction exerted in solidification, appear to be one and the same: and consequently the subject before us is that of solidification in general.

Attraction acting in every direction from the centre of a particle, will cause an addition of particles in no fixed direction, and

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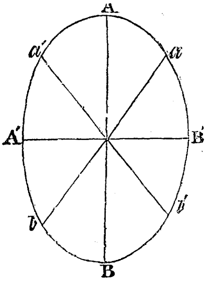
* The following remarks are made in explanation of the solids, termed ellipsoids or solid eclipses, and their conjugate axes and diameters.



AA′ BB′ is a plane ellipse. AB, A′B′, two lines crossing at right angles, are termed its *conjugate axes; a′b′, ab*, are *conjugate diameters.* The relative situation of the *conjugate diameters* is such, that if a line be drawn, touching the ellipse at *a*, the extremity of one diameter, *ab*, it will be parallel to the other *a′b′*. When *ab* and *a′b′* are equal, they are termed the *equal conjugate diameters;* when they intersect at right angles, they are *conjugate axes.*

The revolution of a plane semi-ellipse, AB′B, around one axis, describes the surface of a solid, which is denominated an ellipsoid of revolution.. The ellipsoid of revolution has its sections in one direction, *circles.* If these sections are ellipses, the solid is still an *ellipsoid,* but *not one of revolution,* as the simple revolution of a plane ellipse will not describe it.

The axes of ellipsoids are three, and intersect at right angles. The three conjugate diameters are any lines so drawn that a plane touching the ellipsoid at the extremity of one, is parallel to the plane in which the other diameters are situated. Each face of a prism, which touches the ellipsoid at the extremity of one crystallogenic axis, is necessarily parallel to the plane in which the other two axes are situated. Consequently, the crystallogenic axes (lines connecting the centres of opposite faces) are always the conjugate diameters of the ellipsoid, and, if they intersect at right angles, they are the conjugate axes.

† The above approaches the view of Brewster, deduced from the study of the refraction of crystallized and other substances, and published in 1830; but this philosopher considers the form of the molecule not that of the spheroid which may be inscribed within a primary, but another spheroid of such dimensions that the change of form superinduced upon it by the forces of aggregation determines the exact form of the combination. The form of the ultimate molecules of crystals existing separately, are regarded as determining only within certain limits the primitive form to which they belong; while the precise form of the crystal and its doubly refracting structure are produced by the action of the forces of aggregation.. The theory is suggested by the fact that compression will give a doubly refracting structure to glass and other substances not otherwise possessing it. The progress of science will probably soon clear up these doubtful points. See Brewster on Double Refraction, Transactions Royal Society for 1830, and American Journal of Science, xxi, 296; also an article by the author, American Journal of Science, [2], iv, 364.

must invariably produce a spherical solid. Proof of this fact is observed in every drop of water, or globule of mercury, whose sphericity results from this condition of attraction. To form solids, bounded by a definite number of surfaces, there must be a definite number of directions for the exertion of attraction. If attraction is exerted in but one direction, the particles will unite only in this direction, and by their union will form only a single line of spheres; exertion in two directions will, in a similar manner, produce a figure of two dimensions only, that is, a plane; in three directions, a figure of *three* dimensions, or a solid bounded by six faces, as the cube. For the construction of prisms, it is therefore necessary that the mutual attraction of the particles be strongest in three directions in each molecule.

These directions may be denominated axes, and their extremities, poles; the two, relatively, *positive* and *negative*, or *north* and *south*. This polar character is a fundamental law of molecular force. In each instance, the axes connect the centres of the faces or opposite edges of the prism; action in these directions will produce solids like the prisms.

The attraction within a molecule is not supposed to be confined to the extremities of the axes. On the contrary, every portion of the surface exerts attraction. But the attraction is strongest at the poles, and weakest at an intermediate point between them.

The crystallogenic axes of the *cube* are three equal lines intersecting each other at right angles, and hence the molecule is a sphere, with three equal conjugate axes, as axes of attraction, (f. 215). Influenced by these axes, the spheres will combine, as in f. 216, and a cube will be formed in the same manner as by the aggregation of an equal number of cubes. The *square prism* has its breadth and width equal, but a varying length; and the molecule, consequently, is an *ellipsoid of revolution*, (f. 217), with rectangular axes. The *rectangular prism* has three unequal dimensions, and therefore the ellipsoidal molecule is *not* an ellipsoid of revolution. Fig. 218 is a transverse section of the prism and ellipsoid. The axes are rectangular, as in the preceding forms. The right rhombic prism has a similar molecule to that of the rectangular prism, but its lateral crystallogenic axes, which connect the centres of opposite faces, are obliquely inclined to one another; and being *equal*, are the *equal* conjugate *diameters*, instead of *con-*

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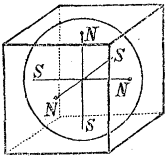

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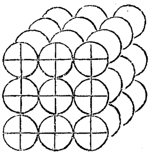

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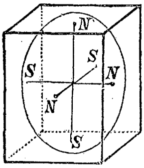

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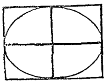

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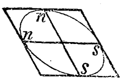
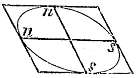


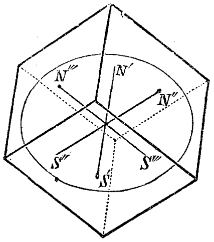
jugate axes, (f. 219). The vertical axis, as in the preceding prisms, is still one of the conjugate *axes*. The same is the fact with the *right rhomboidal prism ;* but its lateral axes are *unequal*, and may be any unequal conjugate diameters of the ellipsoid, at right angles with the vertical axis. In the preceding, we suppose that both the *rhombic* and *rectangular* prisms may be *crystallogenically* primary prisms.

220



In the oblique prisms, the vertical axis is inclined, and is not therefore one of the conjugate *axes*, but a conjugate diameter to each of the lateral axes, which are also conjugate diameters. The lateral conjugate diameters are equal in the rhombic, but unequal in the rhomboidal prism. In the rhombohedron, the lines connecting the centres of opposite faces are equal, and consequently the ellipsoid is one of revolution, and the three crystallogenic axes, its *equal conjugate diameters*, (f. 221 and 222).*

221



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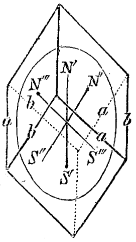

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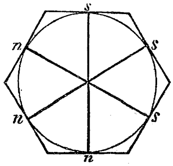

A comprehensive view of the molecules and their axes is given in the following table :

Prisms, all of whose cryst. axes intersect at *right* angles, and are therefore conjugate *axes* of the ellipsoidal molecule.	axes equal—*Cube.*
	two only equal—*Rt. Square Prism.*
	the three unequal—*Rt. Rectang. Prism.*
Prisms whose *lat.* axes are obliquely incl. and are therefore conj. diam. (not axes) of the molecule	lat. axes *equal* conj. diam.—*Rt. Rhombic Prism.*
	lat. axes *unequal* conj. diam.—*Rt. Rhomboidal Prism.*
Prisms, all of whose axes intersect at *oblique* angles, and are therefore conj. diam. (not axes) of the molecule.	the three axes, equal conj. diam.—*Rhombohedron.*
	two lat. axes, eq. conj. diam.—*Ob. Rhombic Prism.*
	the three axes, uneq. conj. diam.—*Ob. Rbdl. Prism.*

From this table it is apparent, that all possible positions of these diameters occur in the forms of crystals, from an equality and rectangularity in the cube, through different variations in length and situation, to a general inequality in length, and a like inequality in their mutual inclinations, as in the oblique rhomboidal prism.

Moreover, we perceive that all the prismatic primaries may pro-

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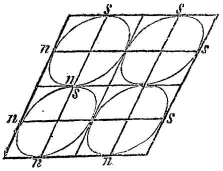
* The rhombohedron thus formed differs materially from that proposed by Wollaston, (f. 135). The molecule influenced by these axes will take an arrangement similar to that in the cube and other prisms.

ceed from one simple solid, an ellipsoid, (a sphere being an ellipsoid with equal rectangular axes), and all may result from a variation merely, in the length and direction of the conjugate diameters of this solid.

It has been stated that the axes of attraction have polarity. It may be inferred, with reference to the rhombohedron, that the three poles about each vertical solid angle are of the same name, those about one, *north*, and those about the other, *south;* in crystals of tourmaline there is then some correspondence between the crystallogenic poles and those induced by heat. The polarity in any case must vary with the condition or position of the crystal with reference to surrounding matter. Examples of a change from such a cause are found in some compound crystals, alluded to on a following page.

Laws governing the Crystalline Molecules in the formation of the Primary Solids.—The molecules of matter in the act of crystallization, must be subservient to the usual law of attraction, *the repulsion of like poles and the attraction of unlike;* that is, two norths or two souths repel, a north and a south mutually attract. There is this peculiarity, that *only the unlike poles of similar axes can unite.* An attraction exists between the north pole of the vertical axis of one molecule, and the south pole of the vertical of another; but none between the north of the vertical axis, and the south of a lateral, when the lateral and vertical are unlike axes. This is a natural inference from the general nature of attraction. It also proceeds from the nature of axial attraction, that similar axes by their union form a straight line; that is, will unite as in f. 224, and not as in f. 226.

224



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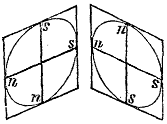

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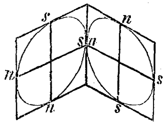
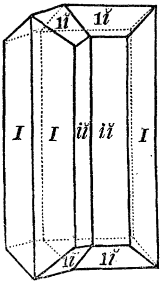


Paragenic Compound Crystals.—The mutual influence of the molecules causes them to assume the parallel position of f. 224, unless some peculiar circumstances operate to prevent it. During the formation of crystals, myriads of which are sometimes produced at a single process of crystallization, it must be no uncommon occurrence that two molecules, in close proximity, assuming simultaneously their axes, should have the position given in f. 225. A north and south pole are here adjacent, as in f. 224; but the north pole of the other axis in one molecule, has the direction of the south pole in the other molecule. The natural tendency to an inversion of one molecule, in order that the uniting axes may be in the same straight line, is inferior to the attraction exerted between the adjacent north and south poles; the molecules therefore unite as in f. 226, and constitute, by their union, a nucleus, each half of which acts independently of the other, though in connection with it, and thus produces a compound crystal. To this accident is owing the formation of *compound crystals*, in which composition is parallel to a face of a rhombic prism. Fig. 227 represents a crystal of Aragonite thus formed, and f. 228, a horizontal section of the same. The planes ĭĭ, ĭĭ, truncate the acute lateral edges, as may be observed by comparing with f. 225.

227



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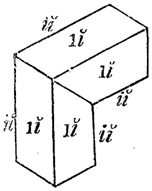

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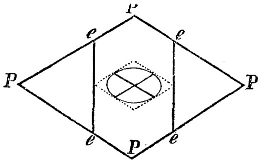

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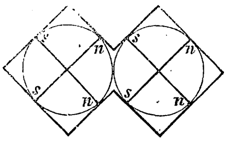


It is obvious that the axes of the molecules, which are at right angles with those represented in f. 226, (and therefore since they point towards the observer, cannot be represented), may either present their *similar* poles in the same direction, or by the inversion of one molecule, *opposite* poles may point in the same direction, as is the case with the parallel axes in the figure. There are therefore the above two methods of forming compound crystals like the above. In the *right* rhombic prism, however, both these methods produce the same result as regards external form. But in *oblique* prisms the difference of structure is apparent.

We here perceive that those accidents to which molecules governed by axial attractions are necessarily liable, actually take place in nature; and they afford strong presumptive evidence of the truth of the theory proposed to account for them.

In the formation of other compound crystals, two molecules unite in points of equilibrium of attraction between *two* poles, and thus give rise to twins of a *second kind;* or in similar points between three poles, producing twins of a *third kind.* In the first case, the situation of the molecules is that given in f. 230, where they are retained in combination by the action of two north poles of one molecule, on the two south poles of the other. It is obvious that this is an instance of composition parallel to an edge of a prism. In the second case, the combination is due to the action of three poles of one molecule on three opposite of the other, and consequently the composition is parallel to a plane on an angle.

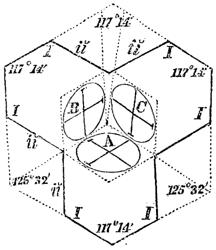
An example of the second kind of twins is given in f. 357, under Pyroxene, which represents a crystal compounded parallel to the edge *ii*. Figures of crystals of Feldspar represent other forms resulting by this method: the *similar* poles of the vertical axes lie in opposite directions.

The third kind of twins is exemplified in figures of Calcite, and in other species.

Compound crystals composed of more than two individuals, arise from the occurrence of the above species of composition parallel to two or more faces, edges, or angles, simultaneously. Examples of which are represented in figures beyond.

Fig. 231 represents a horizontal section of a crystal of Cerusite, four of whose lateral angles equal 117° 14′, the obtuse angle of the primary rhombic prism, and two equal 125° 32′, twice the acute angle of the same. In this instance, composition of the first kind has taken place parallel to two faces of the molecule A.

231



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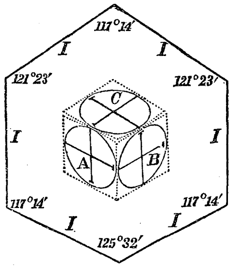

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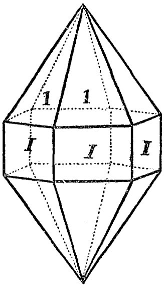
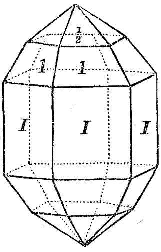


Fig. 232 is a horizontal section of f. 233, (another crystal of the same mineral). Composition has here taken place between A and B, and subsequently, though almost consentaneously, C was added by the attractions between the poles represented in contact. In the preceding prism, (f. 231), the union of B and C with A, was effected at the *same instant*, but here the addition of C was *subsequent* to the union of A and B, and from this has arisen the equal inclination of C to the other molecules.

In compound crystals thus formed, each face of the prism is a primary plane. The same form may result from the union of A and B merely, without the addition of C, provided the prism A and B have one of their acute lateral edges—the distant ones—truncated; for the two upper edges in f. 232 are parallel to the shorter diagonals of A and B, and therefore are also parallel to the truncating plane just referred to. The second figure under the species Aragonite is an instance of this mode of formation; two of the lateral planes of the prism are the planes *ii*, and four are primary planes, *I*, and the crystal is composed of two individuals, the planes with the letters accented *below*, belonging to one, and those without the accent, belonging to the other.

A horizontal section of f. 234, a crystal of Witherite, is exhibited in the outer lines of f. 235. This prism differs from the preceding in the disposition of its primary angles, which are lettered *a*, *b*, *c*, *d*. The angles *m* and *n*, each equal twice the acute angle.

234



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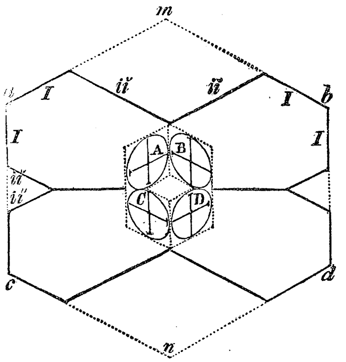

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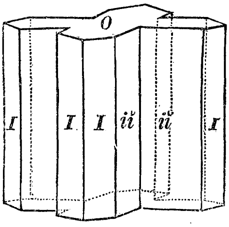
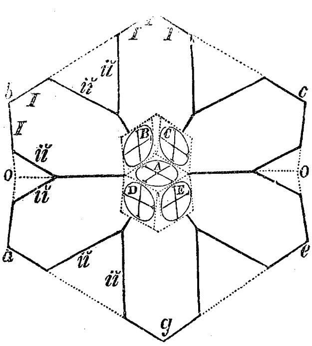


To form the nucleus, A, B, and C, D, were first united, and then the compound nuclei AB, CD, were joined by the action of the axes, which are here represented as nearly in contact. Fig. 236 is also based on this mode of structure.

In f. 237, a compound nucleus is represented, in which composition has been effected parrallel to all the lateral faces of the molecule A. The truncation of the lateral edges of the four crystals, B, C, D, E, would give rise only to a cruciform crystal. But the action of the central molecule A, in conjunction, will cause an addition of particles parallel to A, and thus produce the other two rays. This is a horizontal section of a stellate crystal of cerusite, (see under that species,) and possibly, also of the similar stellate forms of snow.

237



Stellate or hexagonal twins, like those of f. 234 *to* 237 *appear to be impossible in oblique crystals.* There are monoclinic species which are near 120° in the vertical prism—Orthoclase is an example; but although in trimetric species of the same angle such compound forms are very common, they are not known in Orthoclase and species of similar form. From the nature of the aggregation it is evident that the attraction above and below the middle plane must be perfectly symmetrical, or else such symmetrical aggregations of molecules about a centre could not take place. It is true that three oblique prisms of 120° might be placed with their backs together so as to make a triple crystal with a symmetrical pyramid at one extremity, and a corresponding concavity below. But in the molecules of such prisms, the lateral axes will have the front poles *n* (or *s*), and the back poles the reverse; so that in such an aggregation, all the molecules in the nucleus would be united by poles of the *same name*, which is an impossibility. If the prisms were joined by the acute angle, the summit would be a cluster of projections. We have sufficient reason, therefore, for concluding that in monoclinic forms such twins are not possible. Moreover, trimetric forms, when hemihedral, as in Datholite, do not become stellately compounded, since they are potentially monoclinic.

The second mode of composition, mentioned on page 128, does not come under the explanations thus far presented. This kind of twin cannot occur except under certain conditions. If two molecules are united by an axis, *n* to *s*, an inversion like that referred to would bring *n* against *n*, or *s* against *s*, and would be impossible. But if two molecules were united by a middle point between an *n* and an *s*, then an inversion might take place, and the right half of the compound form might have the plane of section *in* or *out*, and constitute a twin in one case of the first mode, and in the other of the second mode. Thus it appears to be, in Feldspar and Albite.

An important conclusion hence follows. The lateral *crystallogenic* axes in these species are not at right angles with one another, like the *crystallographic;* they intersect at an angle corresponding with the angle of the fundamental prism, or to lines connecting the centres of opposite lateral faces. The crystallographic axes are a mathematical convenience simply, and are not necessarily the crystallogenic; the latter may intersect at oblique angles as well as right angles, as has been assumed in the preceding pages. The same conclusion follows from the relations of the trimetric species near 90° in angle to monometric forms. For very many of them approach the regular octahedron, not in the rhombic octahedron that is formed on the *edges* of the rhombic prism, but in the rectangular octahedron formed on the *angles* of this prism, and consisting of planes $1\bar{\imath}$ and $1\breve{\imath}$. The axial lines connecting the lateral solid angles of such an octahedron are homologous with those of the regular octahedron; but they cross at an oblique angle, corresponding to the angle of the rhombic prism.

Metagenic Compound Crystals.—Metagenic crystals have been described as either—

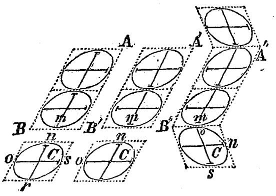
1. Doubly geniculated crystals, that is, those which have been apparently *bent* subsequently to their formation; or—

2. Those which are composed of two distinct crystals, united by their similar parts.

Compound crystals of the former kind result from a reversion of the original polarity in the molecules of the crystal, after the crystal has attained some size. The causes of this reversion are, probably, agents that are not unknown to us. Heat will have this effect on crystals of tourmaline and other minerals, their polarity varying with the temperature. Electricity is equally an efficient agent in producing similar results.

Let AB (f. 238) represent a line of molecules in a crystal in the act of formation, with its poles situated as there seen, the marked poles being north. The particle C is supposed to be on the point of obeying its axes of attraction, by uniting the pole n with m. At this moment there is a sudden reversion of the polarity of the crystal, as represented in $A'B'$. The molecule C now finds a repellant pole opposing it—since m and n are both north—and is immediately drawn around by the attraction between o, the nearest south, and m, and the union exhibited in $A''B''C$ takes place, producing a geniculation in the crystal. The process, going on simultaneously at the other extremity of the crystal, causes another geniculation of the same. Fig. 239 is a section of a crystal, in which there is seen both a paragenic and metagenic composition. The latter was effected as above described. Geniculation, parallel to a plane on an edge, (or plane $1i$), may be illustrated by means of f. 240; AB is again the crystal, C the next particle to be added. The molecules are those of a right square prism, which form is peculiarly subject to these accidents. In the figure, these molecules lie on one of their sides, and only one lateral axis is seen; the other directing its north pole, s, towards the observer. The union of m and n is again prevented by a reversion of the polarity; m therefore attracts the nearest north pole, which is s. A revolution of 90° must hence take place. But during this time, the unlike poles t and u, (the vertical of the prism), are acting on one another, and tending towards a union; consequently, the molecule will as-

238



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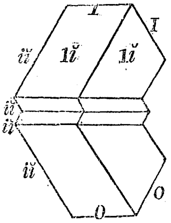

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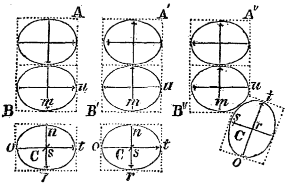

sume the intermediate position seen in A″B″C, in which, contact has taken place at the point of equilibrium between two poles. Fig. 206 represents a crystal of Rutile geniculated, either by this or the next method.

A similar composition could not occur in the right rectangular prism; for *s* could not be united to *m*, since they belong to unlike axes, and consequently, there must be a revolution of 180°, to bring *r* into union with *m*. We hence see why the right square prism is particularly subject to this kind of geniculation.

An explanation of metagenic geniculation, parallel to an octahedral plane 1, flows readily from the above. Fig. 316, under Cassiterite, may be an example of this kind of geniculation.

The remaining kind of compound crystal is represented in f. 346, of the species Quartz. It is perfectly analogous to the ordinary union of two molecules; for the crystals are united by their similar faces. They were, probably, brought originally into this parallel situation, by a process analogous to electrical induction, or the mutual action of their attracting influences.

FORMATION OF SECONDARY PLANES, AND ORIGIN OF CLEAVAGE.*

It has been abundantly explained that the same substance may crystallize under a variety of forms, all being modifications of one type. A species may occur under the form of a cube, or a cube with truncated edges, or with bevelled edges, or with variously modified angles. *If, then, a certain state of the attraction in a molecule will produce the primary cube, some variation from this state is necessary to produce another form, and a different variation for every different secondary form.*

In view of the fixed simple ratios of mathematical exactness, governing secondary planes, it is obvious that *the variations which the attraction undergoes, are in some fixed ratio.* And as similar parts of crystals are similarly modified, and similar parts are those similarly situated as regards like axes, *the homologous parts of molecules experience the variation similarly and simultaneously.*

The only exceptions to this last principle are the cases of hemihedrism, in which half the similar parts are modified alike; and hence it follows that *in some cases the parts of a molecule on two opposite sides of a pole may undergo a different amount of variation of attraction;* but this takes place symmetrically, with reference to all the poles.

In the formation of a cube with truncated edges, the cube is not finished out on the edges. *There is, therefore, when secondary planes are formed, a diminution of the force of attraction in the*

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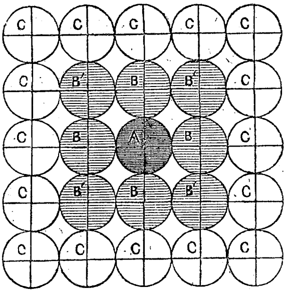
* See an article by the author in the American Journal of Science, [2], iv, 364.

line of the primary axes, since these axes fail of completing the primary solid; and this diminution, as above shown, is in some simple ratio.

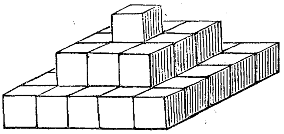
In an enlarging cube, the molecules are added in planes of increasing breadth, as in this way only would the form continue to be a cube. If we consider the case, we find that the central molecule attracts a molecule by each of its poles, and also simultaneously the added molecules act by their lateral axes to complete the plane. We observe in the sectional view (through the centre) in f. 241, when A by its axes unites with four B's, the B's, simultaneously, while in the act of union, unite with B′, B′, B′, B′; and thus the square form is retained. This is a simple statement of the process.

241



If now when the B's are uniting, their lateral axes do not act at the same time, then the forming cube will have the edges truncated as in f. 17. To understand this we must study the steps in the process. Fig. 242 presents the same secondary planes as in f. 17, without the primary faces. It is obvious that in the enlargement of such a secondary, when the summit molecule is annexed, its *lateral* axes do not act as they do when the cube is formed: but when another molecule is added beyond, then they act laterally. This may perhaps be more clearly seen in the transverse section in f. 243. When A attracts B, B does not act laterally as in f. 241; it does not so act until B attracts C, when a C is added either side of B. So C acts laterally when a D is added to C, and not before.

242



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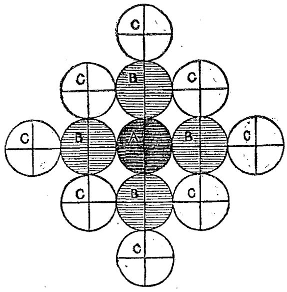
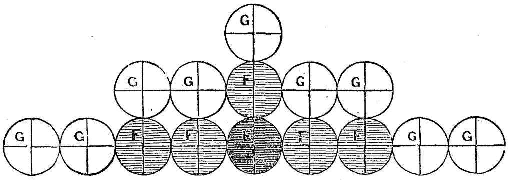


Again, in f. 244 we have a section of another figure, (the same secondary as in f. 32), showing the arrangement of molecules in a solid, presenting such a section. Examining it, we perceive that when G is added to the extremity of the central axis, two molecules, G, G, are added on either side of F, and none laterally to G.

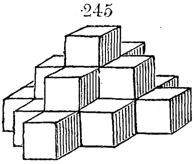
This figure represents the formation of the secondary plane, having the ratio 1 : 2, as is evident from inspection, and f. 242 or 243, another with the ratio 1 : 1.

244



If the period of time occupied by the union of a molecule be represented by *p*, then when the lateral axes act only after the period of time *p*, and then add a single row of molecules, the secondary plane is the truncating plane 1 : 1. For the plane having the ratio 1 : 2, in which two are added laterally to one terminally, or what is equivalent, one laterally for every half one terminally, the time would be $\frac{1}{2}p$; for the plane 1 : 3, the time would be $\frac{1}{3}p$.

245



To understand the origin of planes on an angle, we must again consider the actual circumstances. Fig. 245 (the same secondary as in f. 15) will aid the mind in conceiving of it. Here, when the summit particle unites itself, it adds nothing laterally, as was the case also in f. 243; when another unites beyond, then four particles are united, one by each lateral pole; but these four add nothing, until still another particle is added to the summit. In this case there is an interval of time *p*, between the action of the terminal and lateral axes, and another interval *p*, between the adding of the four molecules and the action by *their* lateral axes. And this is the difference between the plane truncating an angle, (f. 15), and another truncating an edge of a cube, (f. 17). This plane truncating an angle has the ratio 1 : 1 : 1. For a plane 1 : 2 : 2, the times will be each $\frac{1}{2}p$, and for any plane 1 : *m* : *n*, the times will be $\frac{1}{m}p$ and $\frac{1}{n}p$.

It appears that the lateral axes act less speedily therefore for the truncating plane of an angle, than for that of an edge: the centre of the former in a cube is 54° 44′ from the centre of the face of the cube, and the centre of the latter from the same is 45°.

We have before observed, that the production of secondary forms depends on the fact, that the force of attraction in the axes of the molecules, when secondaries are produced, is less than that which is exerted when the primary prism or cube is formed. But we cannot suppose the whole force of attraction in a molecule to be different in different circumstances. No facts nor reasoning would sustain this conclusion. We may admit that the attraction may be more concentrated in the primary axes, in some cases than in others. It is well known that the polar condition in bodies does not imply an addition of force, but simply an axial action or concentration of the force. This concentration or excited action may be induced by the condition of neighboring bodies or influences; and different bodies should differ widely in their susceptibility to it, as is evidently the fact. Now if the attraction is less concentrated in the primary axes, when a secondary plane forms, the *interval of time* above alluded to as characterizing the formation of different secondaries, will be longer or shorter according to the state of concentration in the primary axes. The more or less diffused state of the attraction is connected with the kind of secondary produced.

But when we observe in a complex crystal the evenness of the faces, the neat regularity of the edges, and the perfection throughout, even when many secondary planes are combined, it appears clear that such forms could not result from simply a generally diffused state of the attraction, any more than a primary could be so produced. In each case there must be as many distinct poles as there are planes. When therefore the principal axes lose their concentration, this loss consists in a distribution of the force into subordinate axes intermediate between the primary axes. For a truncation of the edges of a cube, the intermediate axes would have their poles just at the middle point between every two poles of the primary axes; for a truncation of the angles, the poles would be at the middle point between every three poles. We have remarked on the symmetrical arrangement of secondary planes in general, and this would follow from the necessary symmetrical arrangement of such axes. Moreover, the length of time p, will be greater the farther the secondary pole is situated from the primary poles. And this is true in fact. The pole for the octahedron is the most distant, being at the central point between three primary poles. The number of combined secondary forms may still seem mysterious. But a crystal, in its capacity as a unit, would necessarily have a corresponding character in its different parts to that of the molecules of which it consists, and consequently the attraction exerted by the molecules in these different parts would correspond, occasioning thus the secondary planes. The relative extent of the several different kinds of planes will depend primarily on the relative force of action in the different sets of axes.

These considerations lead us to conclude, that *the diminution of attracting force in the primary axes, on which the formation of a secondary depends, consists in the partial action of this force along intermediate axes, symmetrically situated with reference to the primary axes; and the greater or less amount of diminution, determines the kind of distribution.**

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* In the case of substances that very seldom crystallize or never, we have evidence that the polar forces are weak.

The relation of the planes in Humite (see page 59, and this species beyond) have an important bearing on this subject. The planes, or the numbers expressing their axial proportions, are parts of infinite series, which are different in the three crystals. Such mathematical series point out definitely a mutual dependence in the planes of each form; they suggest that the modifications of the attraction upon which they depend, are connected with the different conditions of the attraction that may be represented by curves to which such infinite series lead.

The same crystalline form may have different cleavage. For example, cubes of Galena have a cubical cleavage, while cubes of fluor spar have an octahedral cleavage, or yield octahedrons when cleaved. These different circumstances would result, provided that in one case (for Galena) the three primary axes of the molecule were dominant, and in the other, the eight intermediate or octahedral axes. The arrangement of the molecules in each case would depend on the dominant axes, and so also would the direction of the cleavage. Hence, *the direction of cleavaye may sometimes indicate in any species of matter which set of axes is dominant, the primary or a secondary set.*

In the preceding paragraphs, after explaining the general polar action of crystallogenic or cohesive attraction, we have pointed out the modifications of condition this attraction undergoes, the simple ratios presented by these modifications, and their dependence on the formation of intermediate axes. Cohesive attraction, instead of being a constant force, as might be inferred from the ordinary definitions, appears therefore to be complex in its actions, yet simple in the general laws by which this complexity is produced.

Owing to some intrinsic or extrinsic influence, (the presence and condition of matter near by or commingled with the crystallizing material), the primary axes may be sustained in an excited state. But if there is nothing to sustain or excite this concentration, and the action is quiet, or if bodies around induce it, owing to their own condition, the attraction becomes more diffused, and secondary axes multiply. All the crystals of a locality or region have usually the same form.

The constancy of certain forms in some species is evidence of the peculiar susceptibilities of the molecules of these substances. Thus the calc spar in the limestone of Lockport has the dog-tooth shape, the scalene dodecahedron; that of Boonville, N. Y., occurs in short six-sided prisms. That of the Rossie lead region in complex combinations of different secondary planes with the primary.

These facts indicate, that *the variations of attraction, producing secondary forms, depend often on surrounding bodies favoring the concentration or diffusion of the attracting force; and the causes often act in nature simultaneously over wide areas.*

Cleavage.—The peculiarities of cleavage give us information on another point, respecting cohesive or crystallogenic attraction. The facility of cleavage in prisms differs in the direction of unlike axes. Topaz cleaves easily parallel to the base of the prism, and hardly at all in other directions. This difference does not depend upon the relative strength of attraction in the unequal axes; for it is often the reverse of this. Again, while some of the hardest substances have perfect cleavage, other soft species have none.

If then this quality has no relation to the strength of the attraction which unites molecule to molecule, it must depend on some peculiarity in the manner in which this force acts. This force may act in two ways;—either *continuously* or *intermittedly;* and the latter mode only, could produce the result in view. The action of force in nature appears to be generally intermittent. Alternate action and comparative inaction, with corresponding results, are everywhere exemplified in organic growth; and it is therefore no anomaly that it should be exemplified in the inorganic kingdom.*

When, therefore, cleavage is produced in crystallization, the union of layers of molecules takes place by an intermitted action; that is, with regular successive variations or pulses in the intensity of the force of attraction. This intermitted action, when reduced to the adding simply of single layers in succession, becomes continuous. On these principles there might be every variety of this quality in nature, and there should be no necessary connection between cleavage and strength of attraction. We therefore infer that *the action of cohesive attraction is often intermittent, producing seriate results, (as exemplified in the cleavage of crystals), and the specific rate of intermittent action is different for unequal axes.*†

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* The successive layers in wood, the periodical reproduction of leaves or flowers, and of young in animals, and the seriate arrangement of parts in many plants and animals, all illustrate intermittent growth. In some zoophytes the buds form in successive series of two, four, or six, or some other fixed number; in other cases opposite sides alternate in budding, or when there are several rows, the rows bud in succession; and these are examples of intermittent action.

The spiral arrangement of leaves in vegetation, is another illustration of intermittent growth; for here the different sides of the growing plant bud successively, for the simple reason, of universal application, that reproduction produces temporary exhaustion, or, that force is exerted intermittedly.

The *pulsation* of molecular force is also an example of intermitted action, and must lie at the basis of the universal principle on this subject to which we have alluded. The reality of this pulsation we cannot doubt. The undulatory theory of light must be received as fully demonstrated; and if it is an ether that pulsates, it is molecular force which makes it pulsate, and this implies pulsating action in molecular force itself.

The attraction of cohesion is shown by cleavage to be intermittent in *intensity;* we do not learn from it that there is any actual intermission of time in the exertion of the force, or a variation in rate of pulsation.

† Many crystals, as remarked on page 110, have parallel striations, which consist of alternations of two or more sets of planes. Thus cubes of pyrites very generally have their faces marked with striæ which are oscillations between a plane replacing the edge, and either a face of the primary cube, or another plane of the same

In aggregated crystallizations, there is a mass of material entering the solid state together, and no opportunity exists for single crystals to perfect themselves. While a liquid mass is cooling, whenever the temperature of solidification is reached, at numberless points throughout the mass, crystallization will begin: and together, an aggregation of crowded crystals or grains is produced, with no external regularity of form; in other words, the *granular structure.* The same will happen in a crystallizing solution, if the process goes on rapidly.

When a solution is spread thinly over a large surface, minute crystalline points incrust the whole; and if the solution be gradually supplied as crystallization goes on, it is obvious that the minute points may elongate into crowded prisms or fibres, producing a *fibrous structure.* Such a structure is common in narrow seams in rocks, and the fibres are usually elongated across the seam.

The *concentric structure* is another result depending on the rate of solidification connected often with the rate of chemical combination. In the first place, the nucleus is always a cluster of molecules, instead of a single one, as in a simple crystal. The structure sometimes commences around some foreign body as a centre, though the aggregation is often without any proper nucleus except that of the cluster of molecules that first solidified. The second principle, on which the concentric structure depends, is the tendency of a body to communicate its own condition to other bodies within its influence. This law—the law of equilibrium, and contact or catalysis in chemistry—is one of the universal laws of existence. According to it, either a collection of molecules entering the solid state, or any foreign body already solid, will tend to bring adjacent bodies into the same or an intermediate condition. If susceptible to this influence, the particles adjoining become assimilated, and unite to the nucleus; these again act upon others adjoining, and thus a spherical form is produced, as a result of successive development.*

The influence of foreign substances associated with a crystallizing mineral is known to cause, not only secondary planes, but also considerable variations in the angles of crystals, even when they are chemically inert. This has been attributed to an intervention simply of the foreign particles among the others. But M. Nickles

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secondary. Some octahedrons of fluor spar have faces which consist of minute cubes. These facts, and they are common and well known, show a frequent intermittent mode of action in the different axes of molecules, (or a seeming strife between different sets); and such examples are well called an "oscillatory combination" of planes. Crystals of snow often well illustrate intermittent action.

* The concentric structure here explained is analogous in many respects to the circular and spherical forms in vegetation. The growing lichen extends itself circularly, owing to progressive assimilation or development. This proves no similarity of nature between the organic forces and cohesive attraction; it only shows that different forces act under a common law.

regards it as due to a change in the axial molecular attractions of the crystallizing material, and by way of illustration he alludes to the influence upon a planetary system from the sudden appearance in it of a new body: the attractions of the foreign particles modify more or less the molecules of the associated material. This chemist states that bimalate of ammonia was thus changed a degree or more in angle in his experiments.* It has long been known that a change in refraction or polarization is produced by this cause: but Senarmont has quite recently rendered certain salts (as nitrate of strontian) *pleochroic* by the same process—that is, by the introduction of foreign substances through crystallization, which were afterwards removed by recrystallizations in pure water.†

We have thus reviewed some of the various facts presented by matter, as it exists around us. Observation has proved more profitable than closet speculation in animal and vegetable Physiology; and thus it will be with regard to the organizing force of the so-called inorganic kingdom. The fact that the attraction of molecules is liable to modifications of condition, and especially the simple yet fixed relations between these modifications, nothing but a crystal could make known to us. Yet the principle is as wide as the universe in its application; for we live in a universe of molecules, and all the grandeur of physical nature is the result of molecular forces.

From the late rapid progress in science, we may be encouraged to hope that ere long this entrance to one of the innermost recesses of the works of nature will be thrown open, and that the qualities of atoms or molecules, their forms and peculiarities, will soon be fully understood. Its connection with the science of chemistry, and other physical sciences, renders it deserving of very minute experimental research. Beautifully and truly was it long since observed by Gulielmini, in his work *on Crystallization*—an author who, though afterwards forgotton, had a clearer insight into the nature of crystallization, than any of his contemporaries, and many of his successors—p. 144: "Crystallizatio geometrizantis naturæ opus quoddam est, et sane mirabilissimum; dignum ideo, ut totis ingenii viribus totâque mentis contentione exquiratur, non quod spectet tantam amœnitatem et voluptatem, quæ mirabilium scientiam consequitur, verum etiam ob maximam in re physicâ utilitatem; videtur quippe Natura hic se prodere, et omni exutâ velamine non qualis esse potest, sed qualis actu est sese præbere conspiciendam."

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* Compt. Rend. de l' Acad. Sci., 1848, xxvii, 270. Compt. Rend. de Laurent, etc., 1850; Ann. de Ch. et de Phys. 1853.

† Compt. Rend. de l' Acad. Sci. 1854.

PART II.

PHYSICAL PROPERTIES OF MINERALS.

I. CHARACTERS DEPENDING ON LIGHT.

LIGHT may be either *reflected*, *transmitted*, or *emitted*. The qualities of minerals thus produced are of six kinds :—

1. LUSTRE ; depending on the *power* and *manner* of *reflecting* light.
2. COLOR ; depending on the *kind* of light *reflected* or *transmitted*.
3. DIAPHANEITY ; depending on the *power* of *transmitting* light.
4. REFRACTION ; depending on the *manner* of *transmitting* light.
5. POLARIZATION ; depending on the *manner* of *transmitting* or *reflecting* light, and due to the polar nature of force.
6. PHOSPHORESCENCE ; depending on the *power* of *emitting* light.

I. LUSTRE.

The lustre of minerals varies with the nature of their surfaces. A variation in the *quantity* of light reflected, produces different degrees of *intensity of lustre ;* a variation in the *nature* of the reflecting surface, produces different *kinds of lustre.*

a. The *kinds of lustre* recognized are six.

1. *Metallic :* the lustre of metals. Imperfect metallic lustre is expressed by the term *sub-metallic.*

2. *Vitreous :* the lustre of broken glass. An imperfectly vitreous lustre is termed *sub-vitreous.* The vitreous and sub-vitreous lustres are the most common in the mineral kingdom. Quartz possesses the former in an eminent degree ; calcareous spar, often the latter. This lustre, in each case, approaches the lustre of broken glass of the color of the mineral.

3. *Resinous :* lustre of the yellow resins. Ex. Opal, and some yellow varieties of Blende.

4. *Pearly :* like pearl. Ex. Talc, Brucite, Stilbite, &c. When united with sub-metallic, as in Hypersthene, the term *metallic-pearly* is used.

5. *Silky :* like silk ; it is the result of a fibrous structure. Ex. fibrous Calcite, fibrous Gypsum.

6. *Adamantine:* the lustre of the diamond. When also submetallic, it is termed *metallic-adamantine.* Ex. Cerusite, Pyrargyrite.

b. The *degrees of intensity* are denominated as follows :—

1. *Splendent:* reflecting with brilliancy, and giving well defined images. Ex. Specular Iron, Cassiterite.

2. *Shining:* producing an image by reflection, but not one well defined. Ex. Celestine.

3. *Glistening:* affording a general reflection from the surface, but no image. Ex. Talc, Copper Pyrites.

4. *Glimmering:* affording imperfect reflection, and apparently from points over the surface. Ex. Flint, Chalcedony.

A mineral is said to be *dull* when there is a total absence of lustre. Ex. Chalk, the Ochres, Kaolin.

These different degrees and kinds of lustre are often exhibited differently by *unlike* faces of the same crystal, but always similarly by *like* faces. The lateral faces of a right square prism may thus differ from a terminal, and in the right rectangular prism the lateral faces also may differ from one another. The surface of a cleavage plane in foliated minerals, very commonly differs in lustre from the sides, and in some cases the latter are vitreous, while the former is pearly. As shown by Haidinger, only the vitreous, adamantime and metallic lustres belong to faces perfectly smooth and pure. In the first, the index of refraction of the mineral is 1·3—1·8 ; in the second, 1·9—2·5 ; in the third, about 2·5. The pearly lustre is a result of reflection from numberless lamellæ or lines within a translucent mineral, as long since observed by Breithaupt.

II. COLOR.

The external color of minerals often differs from the color of the powder, or that of a scratched surface. The latter, called the *Streak*, is the most constant character, since it seldom varies in the same species. The mineral species are liable to so many accidental mixtures of foreign substances, that, in general, little reliance can be placed on the external color. The metals and the metallic oxyds are among those species which are least subject to variation.

The following eight colors have been selected as fundamental, to facilitate the employment of this character in the description of minerals: *White*, *Gray*, *Black*, *Blue*, *Green*, *Yellow*, *Red*, and *Brown*.

a. Metallic Colors.

1. *Copper-red:* native copper.—2. *Bronze-yellow:* magnetic pyrites.—3. *Brass-yellow:* copper pyrites.—4. *Gold-yellow.*—5. *Silver-white:* native silver, less distinct in arsenical pyrites.—6.

Tin-white: Mercury, Cobaltine.—7. *Lead-gray:* Galena, Molybdenite.—8. *Steel-gray:* nearly the color of fine grained steel on a recent fracture; native platinum, and palladium.

b. Non-metallic Colors.

A. White. 1. *Snow-white:* carrara marble.—2. *Reddish-white:* some varieties of calcite and quartz.—3. *Yellowish-white:* some varieties of calcite and quartz.—4. *Grayish-white:* some varieties of calcite and quartz.—5. *Greenish-white:* Talc.—6. *Milk-white:* white, slightly bluish; some Chalcedony.

B. Gray. 1. *Bluish-gray:* gray, inclining to a dirty blue color.—2. *Pearl-gray:* gray, mixed with red and blue; Horn silver.—3. *Smoke-gray:* gray, with some brown; flint.—4. *Greenish-gray:* gray, with some green; Cat's eye, some varieties of Talc.—5. *Yellowish-gray:* some varieties of compact limestone.—6. *Ash-gray:* the purest gray color; Zoisite.

C. Black. 1. *Grayish-black:* black, mixed with gray, (without any green, brown, or blue tints); basalt, Lydian stone.—2. *Velvet-black:* pure black; Obsidian, black Tourmaline.—3. *Greenish-black:* Pyroxene.—4. *Brownish-black:* bituminous coal.—5. *Bluish-black:* Black Cobalt.

D. Blue. 1. *Blackish-blue:* dark varieties of blue Malachite.—2. *Azure-blue:* a clear shade of bright blue; pale varieties of blue Malachite, bright varieties of Lapis lazuli.—3. *Violet-blue:* blue, mixed with red; Amethyst, fluor spar.—4. *Lavender-blue:* blue with some red and much gray.—5. *Prussian-blue*, or Berlin blue: pure blue; Sapphire, Kyanite.—6. *Smalt-blue:* some varieties of gypsum.—7. *Indigo-blue:* blue with black and green; blue Tourmaline.—8. *Sky-blue:* pale blue with a little green; it is called mountain blue by painters.

E. Green. 1. *Verdigris-green:* green inclining to blue; some feldspar.—2. *Celandine-green:* green with blue and gray; some varieties of Talc and Beryl. It is the color of the leaves of the celandine, (Chelidonium majus).—3. *Mountain-green:* green with much blue; Beryl.—4. *Leek-green:* green with some brown; the color of leaves of garlic; distinctly seen in prase, a variety of quartz.—5. *Emerald-green:* pure deep green; Emerald.—6. *Apple-green:* light green with some yellow; Chrysoprase.—7. *Grass-green:* bright green with more yellow; green Diallage.—8. *Pistachio-green:* yellowish green with some brown; Epidote.—9. *Asparagus-green:* pale green with much yellow; Asparagus stone.—10. *Blackish-green:* Serpentine.—11. *Olive-green:* dark green with much brown and yellow; Olivine.—12. *Oil-green:* the color of olive oil; Beryl, Pitchstone.—13. *Siskin-green:* light green, much inclining to yellow; Uranite.

F. Yellow. 1. *Sulphur-yellow:* Sulphur.—2. *Straw-yellow:*

pale yellow; Topaz.—3. *Wax-yellow:* grayish yellow with some brown; Blende, Opal.—4. *Honey-yellow:* yellow with some red and brown; Calcite.—5. *Lemon-yellow:* Sulphur, Orpiment.—6. *Ochre-yellow:* yellow with brown; Yellow Ochre.—7. *Wine-yellow:* Topaz and Fluor.—8. *Cream-yellow:* some varieties of lithomarge.—9. *Orange-yellow:* Orpiment.

G. Red. 1. *Aurora-red:* red with much yellow; some Realgar. —2. *Hyacinth-red:* red with yellow and some brown; Hyacinth Garnet.—3. *Brick-red:* Polyhalite, some Jasper.—4. *Scarlet-red:* bright red with a tinge of yellow; Cinnabar.—5. *Blood-red:* dark red with some yellow; Pyrope.—6. *Flesh-red:* Feldspar.—7. *Carmine-red:* pure red; Ruby Sapphire.—8. *Rose-red:* Rose Quartz.—9. *Crimson-red:* Ruby.—10. *Peach-blossom-red:* red with white and gray; Lepidolite.—11. *Columbine-red:* deep red with some blue; Garnet.—12. *Cherry-red:* dark red with some blue and brown; Spinel, some Jasper.—13. *Brownish-red:* Jasper, Limonite.

H. Brown. 1. *Reddish-Brown:* Garnet, Zircon.—2. *Clove-brown:* brown with red and some blue; Axinite.—3. *Hair-brown:* wood Opal.—4. *Broccoli-brown:* brown, with blue, red, and gray; Zircon.—5. *Chestnut-brown:* pure brown.—6. *Yellowish-brown:* Jasper.—7. *Pinchbeck-brown:* yellowish-brown, with a metallic or metallic-pearly lustre; several varieties of Talc, Bronzite.—8. *Wood-brown:* color of old wood nearly rotten; some specimens of Asbestus.—9. *Liver-brown:* brown, with some gray and green; Jasper.—10. *Blackish-brown:* Bituminous coal, brown coal.

c. Peculiarities in the Arrangement of Colors.

Play of Colors.—An appearance of several prismatic colors in rapid succession on turning the mineral. This property belongs in perfection to the diamond; it is also observed in precious opal, and is most brilliant by candle light.

Change of Colors.—Each particular color appears to pervade a larger space than in the play of colors, and the succession produced by turning the mineral is less rapid; Ex. Labradorite.

Opalescence.—A milky or pearly reflection from the interior of a specimen. Observed in some Opal, and in Cat's eye.

Iridescence.—Presenting prismatic colors in the interior of a crystal.

Tarnish.—A metallic surface is tarnished, when its color differs from that obtained by fracture; Ex. Erubescite. A surface possesses the *steel tarnish*, when it presents the superficial blue color of tempered steel; Ex. Columbite. The tarnish is *irised*, when it exhibits fixed prismatic colors; Ex. specular iron of Elba.

The tarnish and iris colors of minerals are owing to a thin surface film, proceeding from different sources, either from a change in the surface of the mineral, or foreign incrustation. Hausmann states that hydrated oxyd of iron (usually formed from pyrites) is one of the most common sources of it, and produces the colors on *anthracite* and *specular iron*. *Arsenic* becomes irised through the action of hydrogen from the atmosphere: *arsenical cobalt*, *nickel*, and *iron*, by oxydation: *galena* probably, from the formation of sulphate of lead at the surface: *magnetic iron* and some ferruginous silicates from a change in the oxyd of iron to a hydrate: *pyrites*, and probably also copper pyrites and variegated pyrites, from the formation of a hydrate of iron: *antimony glance* and other antimony ores from the formation of antimony ochre; Gray Copper and other arsenical ores probably from the oxydation of the arsenic.

The irised colors may also proceed from a disengagement of carbonic acid or water, as in Spathic iron and Diallogite. Heat sometimes favors it, as in the case of steel.

Dichroism, *Pleochroism*.—Some crystals, viewed by transmitted light, present different colors in different directions. This property is termed *pleochroism*, (from the Greek πλεος, full, and χροα, color), or *dichroism*, (from δις, two-fold, and χροα), when the colors are different in two directions only. This property is exhibited by crystals which have at least two kinds of axes; the colors are the same in the direction of like axes, and different in the direction of unlike axes. Iolite owes its name (*dichroite*) to this property. Mica is nearly opaque in one direction, while it is transparent and of a different color in another. *Monometric* crystals are sometimes pleochroic, the color differing in the direction of unlike diagonals.

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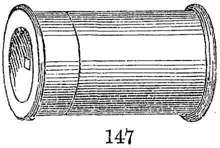

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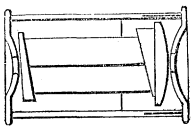

An instrument called a *dichroscope* has been contrived by Haidinger for examining this peculiarity of crystals. An oblong rhombohedron of Iceland spar has cemented to each extremity a glass prism of 18°. It is placed in a metallic cylindrical case, as in the figure, having a convex lens at one end, and a square hole at the other. On looking through it, the square hole appears double; and when a pleochroic crystal is examined with it, by transmitted light, on revolving it, the two angles, at intervals in the revolution, have different colors, the colors being those which the transmitted light affords. Andalusite, Tourmaline, Corundum, Topaz, Idocrase, Euclase, Mica, show well the property, and any colored crystals not monometric that are sufficiently transparent. Dichroism is thus detected by looking in but one direction, and the two colors are brought into direct contrast, and made thereby obvious when not otherwise perceived.

III. DIAPHANEITY.

The diaphaneity of a mineral is its capacity of transmitting light. The following terms are adopted to express the different degrees of this property.

Transparent: when the outline of an object seen through the mineral is perfectly distinct. Gypsum, Quartz.

Subtransparent, or *semi-transparent:* when objects are seen, but outlines are not distinct.

Translucent: when light is transmitted, but objects are not seen. Carrara marble.

Subtranslucent: when merely the edges transmit light, or are translucent.

When no light is transmitted, the mineral is said to be *opaque*.

This property occurs in the mineral kingdom, in every degree from a perfect opacity to a perfect transparency, and most minerals present, in their numerous varieties, nearly all the different shades. Few minerals, except the metals, are perfectly opaque. It is always *similar* in the direction of *like* axes of a crystal, and often *dissimilar* in the direction of *unlike* axes.

IV. REFRACTION, POLARIZATION.

A full account of the *refraction* and *polarization of light* belongs more especially to a treatise on optics, where the student will find the subject discussed at length. The remarks in this place are necessarily confined to a few simple explanations.

a. Simple Refraction.—If we look into a cup obliqely, at such an angle that an object at its bottom is just concealed from view by its sides, on filling the cup with water, this object will become visible. This is owing to a bending or *refracting* of the rays of light, by the water. This effect is termed *refraction*, and is produced by all transparent bodies, whether solid, liquid, or gaseous.

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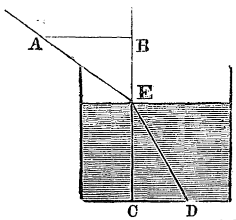


The part of the ray AED, within the water, is nearer the perpendicular BC, than if it had proceeded in its original direction AE; or, if we consider the ray as passing from the water into the air, the part AE, is farther from the same perpendicular than if it had proceeded in the original direction DE. We have therefore this important principle: *Light, in passing from a rarer to a denser medium, is refracted* TOWARDS *the perpendicular; if from a denser to a rarer, it is refracted* FROM *the perpendicular.*

It has been proved by experiment, that at whatever angle we look at the surface of the water, there will be a constant ratio between AB and CD, provided the eye and the object are at the same distance, A and D, from E. That is, if AB is twice the length of CD, viewing it at one angle, it will be twice at every other angle, until the eye is perpendicular over the object D, when there is no refraction. But AB is the *sine* of the angle AEB, which is the *angle of incidence*, and CD is the sine of the angle CED, which is the *angle of refraction*. This principle may therefore be thus stated:

The sine of the angle of incidence bears a constant ratio to the sine of the angle of refraction.

This ratio is termed the index of refraction. In water, the ratio is as 1·335 to 1. 1·335 is therefore the index of refraction of water.

The following are the indices of refraction for the substances enumerated:

Tabasheer,	1·211	Witherite,	1·700
Ice,	1·308	Boracite,	1·701
Water,	1·335	Chrysoberyl,	1·760
Cryolite,	1·349	Feldspar (Adularia),	1·764
Fluor Spar,	1·436	Corundum—white,	1·768
Alum,	1·457	“ red,	1·779
Borax,	1·475	“ blue,	1·794
Gypsum,	1·525	Garnet,	1·815
Chalcedony,	1·553	Zircon,	1·961
Rock Salt,	1·557	Cerusite,	2·084
Quartz,	1·548	Sulphur,	2·115
Euclase,	1·642	Blende,	2·260
Calcite	1·654	Diamond,	2·439—2·755
Aragonite,	1·693	Crocoisite,	2·500—2·974

There is some variation often in the same species, and it frequently corresponds to a change of color.

Double Refraction.—Many crystalline substances give two images instead of one, owing to *double refraction*. If a line be viewed through a transparent crystal of calc spar, it will appear double in every direction but one—that of the vertical axis of the rhombohedron. One image is seen by the ordinary refraction of light; the other, by an extraordinary refraction. If the same crystal is placed over a point, and turned around, one image will appear to revolve around the other. The direction in which there is no refraction is called the *axis of double refraction, or neutral line*, since in its direction the ordinary and extraordinary rays coincide. Double refraction increases in passing from this direction to one at right angles with it.

In some instances the extraordinary ray is situated between the ordinary ray and a perpendicular to the surface of the crystal; and in others it is exterior to this ray. The former possess a greater index of refraction for the extraordinary than for the ordinary ray, and the axis is called a *positive* axis of double refraction. In the latter, the reverse is the case, and the axis is a *negative* axis. Calcite has a negative axis, quartz, a positive. The following are the indices for a few substances:

	Ordinary ray.	Extraordinary ray.
Calcite (neg.)	1·654	1·483
Aragonite (neg.)	1·693	1·535
Quartz (pos.)	1·548	1·558
Euclase (pos.)	1·643	1·663
Topaz (pos.)	1·632	1·640

Zircon, tin ore, rutile, apophyllite, göthite, brucite, tungsten, and ice are examples of a *positive* axis; and idocrase, scapolite, meionite, tourmaline, corundum, emerald, apatite, nepheline, dioptase, alum, pyromorphite, arsenate and molybdate of lead, cinnabar, anatase, of a *negative* axis.

When there are two axes of double refraction, both rays, as shown by Fresnel, are due to *extraordinary* refraction. The two axes are in a vertical plane in right prisms, but not necessarily so in oblique prisms. The apparent angle between these axes has been determined for many minerals, and has served to distinguish species. The following are some examples:

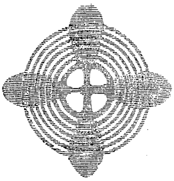
Cerusite,	5° 15′	Celestine,	50°
Strontianite,	6° 56′	Comptonite,	56° 6′
Mica—different kinds,	1° to 20° 50′,	Topaz (Scotland),	56°
	60° to 78°	Gypsum,	60°
Talc,	7° 24′	Iolite,	62° 50′
Aragonite,	18° 19′	Adularia,	63°
Chrysoberyl,	27° 51′	Topaz (Aberdeenshire),	65°
Anhydrite,	28° 7′	Axinite,	73°
Epsomite,	37° 24′	Kyanite,	81° 48′
Barytes,	37° 42′	Epidote,	84° 19′
Stilbite,	41° 42′	Andalusite,	87° 33′
Zinc Vitriol,	49° 42′	Chrysolite,	87° 56′
Topaz (Brazilian),	49—50°	Copperas,	90°

Monometric solids which have the three axes equal to one another have no double refraction. But all other forms exhibit this property; and if the horizontal diameters are equal, as in the dimetric and hexagonal systems, there is but *one axis*; if unequal, *two axes*, as in the trimetric and oblique systems.

Polarization.—The polarization of light is intimately connected with double refraction, this polarity being exhibited by the extraordinary ray, which is said to be a polarized ray. When such a ray is viewed by means of another doubly refracting crystal or crystalline plate, (called from this use of it, an analyzing plate), the ray of light becomes alternately visible and invisible, as the latter plate is revolved. If the polarized light be made to pass through a doubly refracting crystal, then on viewing it in the manner stated, rings of prismatic colors are developed, and on revolving the analyzing plate, the colored rings and intervening dark rings gradually change places. If crystalline plates having one axis of double refraction be viewed in the direction of the axis, the rings are circles, and they are crossed by a dark or light cross.

Fig. 249 shows the position of the colored rings and cross in calc spar, and f. 250 the same at intervals of 90° in the revolution of the plate. With a crystal having two axes of double refraction, there are two series of elliptical rings, as in f. 251 and 252, the latter alternating with the former in the revolution of the plate.

249



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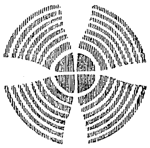
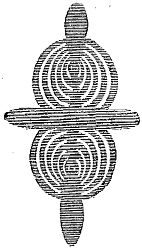


Calcite.

251



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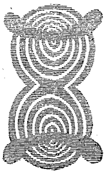

Nitre.

Light is polarized also by other means. If a ray of light be reflected from a plate of glass at a certain angle it is polarized; and so each reflecting substance has its own angle for polarizing light. In glass the angle between the ray and a perpendicular to the glass, is 56° 45′, or between the ray and the glass, 35° 15′, but varying somewhat for the kind of glass. In fluor spar the latter angle is 34° 51′, in quartz 33° 2′, calc spar 31° 9′, diamond 21° 59′. Again, if light be made to pass through a series of thin transparent plates of glass or mineral substance it is polarized, the angle of polarization differing as the number of plates is varied.

The angle of polarization or double refraction, varies widely in the same species, it varying with small differences of composition or the presence of impurities, and also the condition of crystals. Senarmont even refers all the micas to a single form, notwithstanding the wide difference in the angles. In common mica (species *muscovite*) the angle is acknowledged to vary between 45° and 78°. Phlogopite ranges in the angle between 3° and 20°.

Plates of transparent tourmaline, cut parallel to the vertical axis, are conveniently used both for the polarizer and analyzer; and it is necessary only to put the mineral between two such tourmaline plates and look through, revolving one of them, to see the rings and their changes. In mica they are well shown; but it is often necessary to look very obliquely to distinguish both of the poles in the biaxial micas, and the plate of mica must not be too thin. As the light from certain parts of the sky in a clear day is polarized, a single tourmaline is often sufficient to show the rings to the observer looking towards the sky.

The angle between the two poles is easily measured, when the crystals are not too minute, or the angle not too large. A convenient method, of sufficient accuracy for the mineralogist, is to take a graduated horizontal circle, having an arm moving over it, attached at the centre. The mica being put between the polarizer and analyzer, place it vertically (by means of some contrivance for the purpose) upon the movable arm, precisely at the centre of the circle. Look through until the middle of the system of rings is seen in the direction of a cord stretched vertically across a window; then move the arm until the centre of the other system of rings is seen in the same direction; the angle over which the arm has passed, will be read off on the graduated circle.

By a very simple arrangement, easily inferred from the above, a common Wollaston's goniometer may be employed. A contrivance for this purpose has been planned by Mr. W. P. Blake, and an instrument of the kind has been recently constructed which gives very accurate results, by Soleil of Paris. It is adapted with a small telescope for observing very small plates. Other instruments have been devised expressly for this purpose, but it is not necessary to speak of them in this place.

Polarization has the same relation to crystalline form as double refraction. Some monometric crystals give the rings of colors due to polarization; but the rings have a symmetrical arrangement like the faces of the crystals, and have been shown by Biot to be due not to the molecular character of the crystal, but to its cleavage or lamellar structure, the lamellæ polarizing as a series of thin plates, in the manner just mentioned. A peculiar polarizing structure in apophyllite, not according with the general law for dimetric crystals, is explained by him in this manner. Compression will give a doubly-refracting crystal to many monometric crystals.

Besides ordinary or plane polarization, there is also what is called circular polarization. Quartz crystals have been described as sometimes right-handed and sometimes left-handed in their modifications. The circles of colors, when plates of crystals cut transverse to the axis are examined, have a spiral character, and on revolving the analyzer, the spiral is found to turn to the right in right-handed crystals, and to the left in left-handed.

V. PHOSPHORESCENCE.

Phosphorescence, or the emission of light by minerals, may be produced in different ways: by *friction*, by *heat*, or by *exposure to light*.

By friction. Light is readily evolved from quartz or white sugar, by the friction of one piece against another, and merely the rapid motion of a feather will elicit it from some specimens of sulphuret of zinc. Friction, however, evolves light from a few only of the mineral species.

By heat. Fluor spar is highly phosphorescent at the temperature of 300° F. Different varieties give off light of different colors; the *chlorophane* variety, an emerald green light; others purple, blue, and reddish tints. This phosphorescence may be observed in a dark place, by subjecting the pulverized mineral to a heat below redness. Some varieties of white limestone or marble emit a yellow light.

By the application of heat, minerals lose their phosphorescent properties. But on passing electricity through the calcined mineral, a more or less vivid light is produced at the time of the discharge, and subsequently the specimen when heated will often emit light as before. The light is usually of the same color as previous to calcination, but occasionally is quite different.

The light induced by electricity is in general less intense than that of the unaltered mineral, but is much increased by a repetition of the electric discharges, and in some varieties of fluor it may be nearly or quite restored to its former brilliancy. It has also been found that some varieties of fluor, and some specimens of diamond, calc spar, and apatite, which are not naturally phosphorescent, may be rendered so by means of electricity. A dozen discharges through a non-phosphorescing statuary marble in powder, caused it to emit a yellow light when subsequently heated. Electricity will also increase the natural intensity of the phosphorescent light.

Acquired phosphorescence is not, however, equally permanent with the natural. On 21 days of exposure to the light, according to Mr. Pearsall, many specimens lost partially, and some entirely, this property; in others, the color of the light was changed; and generally to purple and orange tints. If laid away in a *dark* room, they retained this property for a much longer period of time.

Mr. Pearsall states that some colored fluors that had been rendered white by calcination, received a bluish or reddish tint, by means of repeated electrical discharges.*

Light of the sun. The only substance in which an exposure to the light of the sun produces very apparent phosphorescence, is the diamond, and some specimens seem to be destitute of this power. This property is most striking after exposure to the blue rays of the spectrum, while in the red rays it rapidly loses its phosphorescence.

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* Jour. Roy. Institution, i, 77, 267.

II. ELECTRICITY—MAGNETISM.

The electric and magnetic characters of crystals bear but slightly upon the Science of Mineralogy, although of high interest to the student of physics.

Frictional Electricity.—The development of electricity *by friction*, is a familiar fact. There is no line of distinction among minerals, dividing them into *positively* electric and *negatively* electric; for both kinds of electricity may be presented by different varieties of the same species, and by the same variety in different states. The gems are positively electric only when polished; the diamond alone among them exhibits positive electricity, whether polished or not. The time of retaining electric excitement is widely different in different species, and topaz is remarkable for continuing excited many hours.

Pyro-electricity.—On heating crystals of some minerals, they become electric with opposite polarity in opposite parts. This property is called *pyro-electricity.* Tourmaline, calamine, and boracite, are among the species thus affected. They are peculiar in having the opposite parts dissimilarly modified, and in these opposite parts are the opposite poles. The polarity continues as long as the temperature is increasing, and becomes reversed when it commences to decline; and when the heat is stationary it disappears. This subject has been investigated by the Abbé Haüy, Canton, Becquerel, Brewster, Erman, Köhler, Hankel, Riess, and Rose.

Rose and Riess* name one of the poles the *analogue electric pole*, and the other the *antilogue electric pole.* The former becomes positive while the crystal is heating and negative while cooling; and the latter the reverse, being negative while heating and positive while cooling. Becquerel says of the tourmaline: † "At 30° C., electrical polarity was sensible; it continued unchanged to 150°, as long as the temperature continued to rise; if stationary an instant, the polarity disappeared, but shortly manifested itself reversed, when the temperature commenced to decline. If but one end of the crystal was heated, the crystal was unpolarized, and when two sides were unequally heated, each acquired an electrical state independent of the other" In tourmaline, the extremities of the prism are dissimilarly modified, and that end which presents

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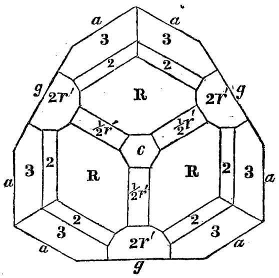
* Uber die Pyro-electricität der Mineralien, von P. Riess und G. Rose, Akad. Wissench. zu Berlin. 1843.—Also, Ueber den Zusammenhang zwischen der Form und der electrischen Polarität der Krystalle, von G. Rose; Ibid. for 1836.

† Ann. de Chem., xxxvii, 1, 1828.—Brewster's Edinb. Jour. x, 50, 1829.

the greatest number of planes is the antilogue pole; or if the number of planes is the same, the secondary rhombohedrons of the antilogue pole have (one or more of them) longer vertical axes than those of the analogue pole. In f. 456, under tourmaline, the upper extremity is the antilogue pole, (*positive* under increasing heat), and the other is the analogue pole. The pyramid of the analogue end is more flattened by its facets than that of the antilogue end.

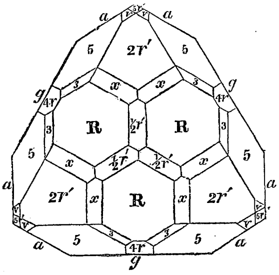
253

Analogue Pole.



254

Antilogue Pole.



The figures here given represent the extremities of a crystal from Gouverneur, N. Y., as drawn by Rose. On the antilogue end we find the rhombohedral faces, $4r$, $5r'$, while on the other the longest rhombohedron is $2r'$, thus conforming to the statement just made.

Pyro-electric polarity has been observed in the following substances; the names of those who first observed it, are annexed.

Tourmaline,	*Lemery.*	Prehnite,	*Haüy.*
Topaz,	*Canton.*	Electric Calamine,	*Haüy.*
Axinite,	*Brard.*	Sphene,	*Haüy.*
Boracite,	*Haüy.*	Rhodizite,	*Rose.*
Scolecite,	*Haüy.*	Heavy Spar,	*Brewster.*
Rock Crystal,	*Brewster.*		

Riess and Rose have confirmed the observations with regard to the above mineral species. Brewster has added *Calcite*, *yellow Beryl*, *Celestine*, *Cerusite*, *red and blue Fluor spar*, *Diamond*, *Orpiment*, *Analcime*, *Amethyst*, *Idocrase*, *Mellite?*, *Sulphur*, *Garnet*, *and Iolite.* But the more recent investigations of Riess and Rose have failed to detect this property in any but the species first enumerated.

Pyro-electricity is of two kinds:*—either *terminally polar*, or *centrally polar*. In the former, the extremities are opposite poles. In the latter, two sides of a prism are of the same name, and the opposite pole to each is intermediate between the two.

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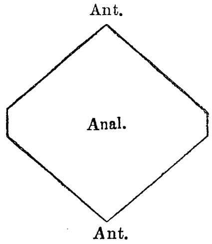
* Riess and Rose.

The examples of the first kind are Tourmaline, Calamine, and Scolecite, *uniaxial;* Axinite, *biaxial;* Boracite and Rhodizite, *with four axes.*

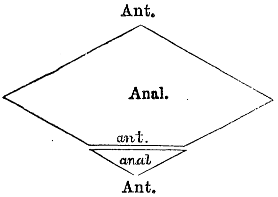
Calamine, like tourmaline, has the sharper extremity the *antilogue* end, and the more flattened the *analogue.* Compound crystals from Altenberg have both ends analogue, and the middle, between the twins, antilogue electric. As in tourmaline, the pyro-electric axis corresponds with the vertical axis of the prism.

Boracite, which crystallizes in cubes with the opposite solid angles differently modified, has four pyro-electric axes, corresponding to the four octahedral axes. In f. 53 of this species, the plane 1 is the antilogue pole, and the unmodified angle the analogue pole; and, generally, the antilogue pole is most largely modified by secondary planes, or has larger facets. *Rhodizite* resembles boracite in its pyro-electricity.

255



The species in which pyro-electricity of the second kind has been observed, are prehnite and topaz. If f. 255 represent a tabular crystal of prehnite, the poles will be situated as marked, the analogue being central, and the antilogue at either extremity of the shorter diagonal of the rhombic prism. Topaz has in a similar manner a central analogue pole and an antilogue at either extremity of the shorter diagonal. In some instances there is a separate set of similar poles near one or the other angle, as in the following figure; this has arisen probably from the compound nature of the crystal.



The particular character of the axes in Sphene, Barytes, and rock crystal has not been made out. Two specimens of Barytes were heated to 180° R, and positive electricity was observed, but not negative, and it was hence inferred that the pyro-electricity was centrally polar, as in topaz. Quartz was found to be pyro-electric in a single small crystal six lines long and two thick, after failing in six others, five of which were an inch in length and one half an inch thick. Great caution is required in the trial with this mineral, as the crystals are so readily rendered electric by friction.

Magnetism.—Substances have been divided into *magnetic* and *diamagnetic.* The magnetic take a longitudinal position between the poles of a strong magnet, the diamagnetic a transverse position. In the former division are *iron*, *nickel*, *cobalt*, *manganese*, *cerium*, *osmium;* among the latter, *bismuth*, *antimony*, *tin*, *mercury*, *gold*, *arsenic*, *zinc*, *lead.*

Magnetism is most strongly exhibited by iron and its compounds.

and specimens of magnetic iron often have polarity. Ilmenite and specular iron ore are also at times magnetipolar. The ordinary mode of testing whether a mineral is magnetic or not, is to bring it near a pole of a delicately suspended magnetic needle, and observe whether it causes it to vibrate; and another mode is to apply a strong magnet to the mineral in powder. These are sufficient for the mineralogist, without all the delicacy required for the purposes of physical science. Delessse has experimented extensively upon the magnetic force of minerals, and has determined the relative amount for numerous species. Calling this force for Styrian steel 100·000, the following are some of his results:—

Native platinum,	2·173—3·047
Magnetic iron ore,	15·00—65·00
Franklinite from the United States,	1·033
Chromic iron,	0·136—0·065
Spinel, (pleonaste), from Monzoni, Tyrol,	0·078
Titanic iron, (rhombohedral), often *magnetipolar*,	5·764
Specular iron—sometimes *magnetipolar*,	0·14 — 2·35
Graphite,	0·015—0·040
Spathic iron—(spherosiderite, the highest),	0·092—0·287
Iron pyrites,	0·039—0·057
Vivianite,	0·027—0·075
Columbite of Bodenmais and Haddam,	0·151
Pyrochlore,	0·010
Quartz.—It is diamagnetic, but many varieties are magnetic. For chrysoprase was found	0·004
Feldspar—not magnetic, or feebly so.	
Labradorite of an antique green pophyry,	0·077
Hornblende,	0·012—0·057

Crystallo-magnetic action.—The magnetic polarity thus far alluded to, belongs to the mass, and has no relation to crystalline form. There is also a kind of polarity directly related to the crystalline or optical axes of minerals, as has been recently developed by Faraday and Plücker. Plücker observes that a crystal of kyanite, suspended horizontally, points very well to the north, *by the magnetic power of the earth only*, and is a true compass needle, from which even the declination may be obtained; and the line of direction is the line of the optical axes. Other crystals, which are called *negative*, take a transverse or equatorial position. The latter are diamagnetic crystals, according to Knoblauch. A bare allusion to the subject is all that is proper in this place.

III. HEAT.

There are two sets of phenomena observed with crystals under the action of heat, in addition to phosphorescence and pyroelectric qualities.

(*a.*) Crystals expand unequally in the direction of unequal axes, and alike in the direction of like axes. The monometric solids change equally in all directions; but those of other systems have directions of least and greatest dilatation; and these correspond with axial lines in the crystals. Any dimetric or hexagonal crystal dilates alike in corresponding parts about the vertical axis; for the lateral axes of the crystal are equal. But the trimetric and clinometric forms have three unequal axes, and dilate unequally along these axes. Crystals are not only enlarged; their interfacial angles are also varied. This change in the angles takes place in all crystalline forms, excepting those of the monometric system. Mitscherlich found that in calc spar there was a diminution of 8′ 37″ in the angle of the rhombohedron, on passing from 32° to 212° F., the form thus approaching that of a cube, as the temperature increased. Dolomite, in the same range of temperature, diminishes 4′ 46″; and in aragonite, between 63° and 212° F., the angle of the prism diminishes 2′ 46″, and 1ĭ : 1ĭ increases 5′ 30″; Nitratine is increased about 27′; in gypsum *I* : *ii* is increased 5′ 24″, *I* : 1, 4′ 12″, and 1*i* : *ii* is diminished 7′ 24″. In some rhombohedrons, as of calc spar, the vertical axis is lengthened, (and the lateral shortened), while in others, like quartz, the reverse is true. The variation is such either way that the double refraction is diminished with the increase of heat; for calc spar possesses negative double refraction, and quartz, positive. According to Fresnel, the same is true of gypsum. The dilatation for calc spar, according to experiment, is 0·001961. In nitre, an increase of temperature of 180° changes the angle 1ĭ : 1ĭ, 44′, but scarcely at all the angle *I* : *I*.

Dr. Kopp has shown that in the carbonates of lime, magnesia, iron, manganese, and zinc, which are nearly the same in their crystals, the vertical axis (axis *a*) is shorter the greater the atomic volume. And since heat diminishes the density, and therefore necessarily increases the volume, the axis *a* should be lengthened by an increase of temperature, as is actually the case. He has determined by calculation, that the change of angle for 180° F. (from 32° to 212°) should be 7′ 37″, which is but 57″ less than Mitscherlich's observations—a near coincidence, when we consider the difficulties of measuring exactly the dilatation and change of angles.

(*b*.) Crystals conduct heat according to a similar law to that of their expansion. This subject has lately been investigated by Senarmont. This author states that, from a point in a tesseral or monometric crystal, heat is conducted equally in all directions, so that the isothermal surfaces are spherical surfaces, concentric about the point. In crystals of the dimetric and hexagonal systems, (whose molecules are *ellipsoids of revolution*), the isothermal surfaces are the surfaces of concentric ellipsoids of revolution. In the other systems, (in which the molecules are *ellipsoids not of revolution*), the isothermal surfaces are surfaces of concentric ellipsoids not of revolution.

The correspondence with the phenomena of light is striking.

Yet there are some points of difference. Quartz and calc spar differ, in the former being optically attractive, and the latter optically repulsive. Yet both have a prolate thermic ellipsoid. Oblate thermic ellipsoids have, however, been found in idocrase, specular iron, and corundum; and the most prolate occur in attractive crystals. The heat rays appear thence to correspond to light rays which lie beyond the extreme red. In calc spar, the proportion of the axes of the ellipsoid is 1·12; in quartz, 1·312; in beryl, 1·11; in idocrase, 1·13; in rutile, 1·27. In aragonite, the proportion of the horizontal axes is 1·22; in bournonite, for a perpendicular ellipse, parallel with the longer diagonal, 1·31, and parallel with the shorter diagonal, 1·29. In feldspar, augite, and gypsum, for the three principal elliptical sections,—1, vertical to the axis of symmetry, (a thermal axis), and 2 and 3, parallel to the axis of symmetry and one of the other two thermal axes:

	Feldspar.	Augite.	Gypsum.
1	1·23	1·24	
2	1·02	1.28	2·24
3	1·27	1·10	1·50

Senarmont's experiments were made by cutting thin slices of crystals in different directions, covering them with a thin coat of wax, and heating them at a point, by placing them on the fine point of a heated silver wire, (or some other means). The melting of the wax took place in circular or elliptical areas, according to the material, with great precision and uniformity for the same plate.

A correspondence to the phenomena of light and heat in the unequal elasticity of crystals along unequal axes, was first observed by Savart.*

M. Wiedemann,† moreover, has investigated the figures produced on different faces of crystals, by electricity acting on a light powder, or some kinds of oil; and he finds the same general correspondence between circular and elliptical areas and the axes, as was distinguished for heat by Senarmont.

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* Recherches sur l'élasticité du cristal de roche, etc., Ann. Ch. Phys. [1], xl, 113.

† Poggendorff's Annalen, lxxvi, 1849.

IV. SPECIFIC GRAVITY.

The specific gravity of a mineral is its weight compared with that of another substance of equal volume, whose gravity is taken at unity. If a cubic inch of any mineral weighs twice as much as a cubic inch of water, (water being the unit), its specific gravity is 2, if three times as much, its specific gravity is 3, &c. In the case of solids or liquids, this comparison is usually made with water; but for gases, atmospheric air is assumed as the unit.

It results from the nature of a fluid, that the weight lost by a solid immersed in water, is equal to the weight of an equal volume of water. The determination of specific gravity is, therefore, a very simple process. We ascertain the weight out of water, by weighing it in the usual manner; we then determine the weight in water; and the loss by immersion, or the difference of the two weights, is the weight of an equal volume of water: that is, if a mineral weighs 120 grains out of water, but 90 on emersion, it has lost 30 grains, which is the weight of a volume of water equal to that of the mineral. The mineral, consequently, weighs in this instance 4 times as much as the water; for 4×30 grains equals 120 grains, which is the weight of the mineral. The rule for the process is, therefore,—*Divide the weight out of water by the difference of weights obtained out and in water.*

The water employed for this purpose should be distilled, to free it from all foreign substances. Since the density of water varies with its temperature, a particular temperature has been selected for these experiments, in order to obtain uniform results: 60° F. is the most convenient, and has been generally adopted. But the temperature of the maximum density of water, 39·5° F., has been recommended as preferable.

If a pair of scales is used for obtaining the weight, they should be exceedingly delicate, when perfect accuracy is required. For original investigations they should turn with the 1000th of a grain. The weights must be selected with care, and should vary from the twentieth of a grain to 120 grains. To weigh the mineral immersed in water, it may be attached to the scales by a single fibre of raw silk or a fine hair, and thus let down into a jar of water, care being taken that the scales be kept perfectly dry. The attachment of the fibre of silk to the scales may be made by means of a small hook attached to the lower part of one scale. For the ordinary investigations of the mineralogist, in the determination of species, it will be found most convenient, if the scales are not provided with this hook, to make a small hole through the centre of one scale, and through it attach a horse hair permanently to the scale. By tying a slipping knot in the horse hair, the minerals under investigation may be attached and detached without difficulty, owing to the elasticity of the hair.

To insure accuracy, those specimens should be selected which are perfectly free from foreign substances, and contain *no vacuities*, even under a magnifying glass. If vacuities exist, they may usually be removed by *coarsely pulverizing* the mineral. An *impalpable* powder is apt to swim on the surface, although heavier than water.

A better and more simple process than the above, and one available for *porous* as well as compact minerals, is performed with a light glass bottle, capable of holding exactly a thousand grains (or any known weight) of distilled water. Pour out a few drops of water from the bottle after filling it and then weight it. Then add the powdered mineral till the water is again to the brim, and reweigh it. The difference in the two weights, divided by the loss of the water poured out, is the specific gravity sought. The weight of the glass bottle itself is here supposed to be balanced by an equivalent weight in the other scale.

Rose has recently observed that fine pulverization of a mineral, and even of a metal, gives uniformly a higher specific gravity than is obtained from the solid mass, and he considers the result therefore as involving a slight error.

The mineralogist is so seldom required to take the specific gravity of liquids or gases, that an explanation of the different methods employed is unnecessary.

V. CHARACTERS DEPENDING ON COHESION.

These characters are of three kinds:—1. Hardness; 2. Tenacity; 3. Fracture.

I. HARDNESS.

A harder body is distinguished from a softer, either by attempting to scratch the one with the other, or by trying each with a file. Each of these methods is used by the mineralogist in determining the hardness of the species, though the latter is in most cases to be preferred. Both methods should be employed when practicable. Certain varieties of some minerals give a low hardness *under the file*, owing either to impurities or imperfect aggregation of the particles, whilst they *scratch* a harder species,—showing that the particles are hard, although loosely aggregated. Chiastolite, spinel, and sapphire are common examples of this fact. When the mineral is too hard to be impressed by a file, the peculiarity of the grating sound will suffice to the practised ear.

To give a definite character to the results obtained with respect to the hardness of minerals, the distinguished German mineralogist Mohs introduced a *scale of hardness*. Mohs's scale consists of ten minerals, which gradually increase in hardness from 1 to 10. The intervals between 2 and 3, and 5 and 6, are larger than the others. Breithaupt has therefore introduced another degree of hardness between each of the above, and thus his scale consists of twelve minerals.

Mohs's scale is as follows:

1. *Talc;* common laminated light green variety.
2. *Gypsum;* a crystallized variety.
3. *Calcite;* transparent variety.
4. *Fluor Spar;* crystalline variety.
5. *Apatite;* transparent variety.

5·5. *Scapolite;* crystalline variety.

6. *Feldspar* (orthoclase); white cleavable variety.
7. *Quartz;* transparent.
8. *Topaz;* transparent.
9. *Sapphire;* cleavable varieties.
10. *Diamond.*

If the file abrades the mineral under trial with the same ease as No. 4, and produces an equal depth of abrasion with the same force, its hardness is said to be 4. If with more facility than 4, but less than 5, the hardness may be 4¼ or 4½, written in decimals 4·25, 4·5. Several successive trials should be made to obtain certain results.

The use of the file is acquired with very little experience; usually a single trial is sufficient. Care must be taken to apply the file to edges of equal obtuseness. That part, also, of the specimen should be selected which has not been altered by exposure, and has the highest degree of transparency and compactness of structure. The pressure for determination should be rather heavy, and the file should be passed three or four times over the specimen.

Rock salt is usually given in the scale of hardness for No. 2; but crystals are nearer 3.

Many specimens present different degrees of hardness on dissimilar faces; as an example of which, we mention kyanite and mica. This is confined to the inequilateral primary forms, and like the similar difference of color, lustre, &c., finds a ready explanation in the theory of their formation; *unlike faces are the result of the action of unlike axes.*

This difference in faces parallel to unlike axes may be perceived in nearly all cases, when the methods of trial are exceedingly delicate. Huygens long since observed that the cleavage face of a crystal of calc spar differed in hardness from the other faces; and even in a monometric crystal it has been found that the faces of the cube and octahedron are not exactly alike in this respect.*

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* This subject has been examined by Frankenheim, (De crystallorum cohæsione, 1829, and Baumgartner's Zeitschrift für Physik, ix, 94 and 194), Seebeck (Hartmann's Jahrbücher der Min. u. Geol. i. 123) and Franz, (Pogg. Ann. lxxx, 1850, 37).

II. TENACITY.

Solid minerals may be either brittle, sectile, malleable, flexible, or elastic. Fluids are either gaseous or liquid.

1. *Brittle;* when parts of a mineral separate in powder or grains on attempting to cut it; kerolite, calc spar.

2. *Sectile;* when pieces may be cut off with a knife without falling to powder, but still the mineral pulverizes under a hammer. This character is intermediate between brittle and malleable; gypsum.

3. *Malleable;* when slices may be cut off, and these slices flatten out under a hammer; native gold, native silver.

4. *Flexible;* when the mineral will bend, and remain bent after the bending force is removed; talc.

5. *Elastic;* when after being bent, it will spring back to its original position; mica.

A liquid is said to be *viscous*, when, on pouring it, the drops lengthen and appear ropy; petroleum.

The unequal elasticity of unlike faces of crystals has been shown by Savart in his Acoustic investigations, and he thus distinguishes the rhombohedral from the other faces in the pyramid of quartz crystal.

III. FRACTURE.

The natural fracture of crystalline minerals has already been noticed under *cleavage.* The fracture of amorphous minerals varies in the form and kind of surface produced.

1. *Conchoidal;* when a mineral breaks with curved concavities, more or less deep. It is so called from the resemblance of the concavity to the valve of a shell, from concha, *a shell;* flint.

2. *Even;* when the surface of fracture is rough, with numerous small elevations and depressions.

4. *Hackly;* when the elevations are sharp or jagged; broken iron.

VI. TASTE.

Taste belongs only to soluble minerals. The different kinds of taste adopted for reference are as follows:

1. *Astringent;* the taste of vitriol.
2. *Sweetish astringent;* taste of alum.
3. *Saline;* taste of common salt.
4. *Alkaline;* taste of soda.
5. *Cooling;* taste of saltpeter.
6. *Bitter;* taste of epsom salts.
7. *Sour;* taste of sulphuric acid.

VII. ODOR.

Excepting a few gaseous and soluble species, minerals in the dry unchanged state do not give off odor. By friction, moistening with the breath, and the elimination of some volatile ingredient by heat or acids, odors are sometimes obtained which are thus designated:

1. *Alliaceous;* the odor of garlic. Friction of arsenical iron elicits this odor; it may also be obtained from any of the arsenical ores or salts, by means of heat.
2. *Horse-radish odor;* the odor of decaying horseradish. This odor is strongly perceived when the ores of selenium are heated.
3. *Sulphureous;* friction will elicit this odor from pyrites and heat from many sulphurets.

Bituminous; the odor of bitumen.

5. *Fetid;* the odor of sulphuretted hydrogen or rotten eggs. It is elicited by friction from some varieties of quartz and limestone.
6. *Argillaceous;* the odor of moistened clay. It is obtained from serpentine and some allied minerals, after moistening them with the breath; others, as pyrargillite, afford it when heated.

PART III.

CHEMICAL MINERALOGY.

I. COMPOSITION OF MINERALS.

1. *General Remarks on the Constitution of Minerals.*

The mineral species are either the uncombined elements in a native state, or compounds of the elements with one another. The number of elements, as at present recognized, is sixty, forty-seven of which are metals.

The following table contains the names of the elements, with the abbreviations by which they are represented, and their atomic weights. In the catalogue here given, the more common compounds of the elements with oxygen and sulphur are also included, together with their atomic weights; and following these, the *percentage* proportion of oxygen and sulphur in each. The dots indicate atoms of oxygen; and the dashed letter, a double atom of the substance so expressed; thus $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ means 2 of Iron to 3 of Oxygen.

Aluminium, Al,	171·25	
Alumina, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$,	642·5	(O, 46·7)
2 $\dddot{\bar{\mathrm{A}}}\mathrm{l}$	1285·0	
3 $\dddot{\bar{\mathrm{A}}}\mathrm{l}$	1927·5	
4 $\dddot{\bar{\mathrm{A}}}\mathrm{l}$	2570·0	
5 $\dddot{\bar{\mathrm{A}}}\mathrm{l}$	3212·5	
6 $\dddot{\bar{\mathrm{A}}}\mathrm{l}$	3855·0	
Antimony (Stibium), Sb,	1612·5	
Sul. Antim., Sb S^3,	2212·5	(S, 27·12)
Argentum (Ag), see *Silver*.		
Arsenic, As,	937·5	
Arsenic Acid, $\overset{\cdot\cdot}{\dddot{\mathrm{A}}}\mathrm{s}$,	1437·5	(O, 34·8)
Sulphuret of A., As S^3,	1537·5	(S, 39·0)
Aurum (Au), see *Gold*.		
Baryum, Ba,	856·25	
Baryta, $\dot{\mathrm{B}}\mathrm{a}$,	956·25	(O, 10·45)
2 $\dot{\mathrm{B}}\mathrm{a}$	1912·5	
3 $\dot{\mathrm{B}}\mathrm{a}$	2868·75	
4 $\dot{\mathrm{B}}\mathrm{a}$	3825·0	
Beryllium (Be), see *Glucinum*.		
Bismuth, Bi,	2600	
Oxyd of Bismuth, $\dddot{\mathrm{B}}\mathrm{i}$,	2900	(O 10·35)
Boron, B,	136·2	
Boracic Acid, $\dddot{\mathrm{B}}$,	436·2	(O, 68·78)
Bromine, Br,	1000	
Cadmium, Cd,	696·8	
Calcium, Ca,	250	
Lime, $\dot{\mathrm{C}}\mathrm{a}$,	350·0	(O, 28·57)
2 $\dot{\mathrm{C}}\mathrm{a}$	700·0	
3 $\dot{\mathrm{C}}\mathrm{a}$	1050·0	
4 $\dot{\mathrm{C}}\mathrm{a}$	1400·0	
Carbon, C,	75	
Carbonic Acid, $\ddot{\mathrm{C}}$,	275	
Cerium, Ce,	587·5	
Protoxyd of C, $\dot{\mathrm{C}}\mathrm{e}$,	687·5	(O, 14·55)
Peroxyd of C, $\dddot{\bar{\mathrm{C}}}\mathrm{e}$,	1475	(O, 20·34)
Chlorine, Cl,	443·3	
Hydrochlor. Acid, HCl,	455·8	
Chromium, Cr,	333·75	
Oxyd of Chrome, $\dddot{\bar{\mathrm{C}}}\mathrm{r}$,	967·5	(O, 31·01)
Chromic Acid, $\dddot{\mathrm{C}}\mathrm{r}$,	633·75	(O, 47·34)
Cobalt, Co,	368·65	
Oxyd of Cobalt, $\dot{\mathrm{C}}\mathrm{o}$,	468.65	(O, 21·34)
Columbium (Tantalum) Ta,	2300·0	
Columbic Acid, $\ddot{\bar{\mathrm{T}}}\mathrm{a}$,	2600·0	(O, 11·54)

Copper (Cuprum), Cu,	396·25	
Oxyd of Copper, $\dot{\bar{\mathrm{C}}}\mathrm{u}$,	892·5	(O, 11·20)
Oxyd of Copper, $\dot{\mathrm{C}}\mathrm{u}$,	496·25	(O, 20·15)
Didymium, D,	600	
Erbium, Eb.		
Ferrum (Fe) see *Iron*.		
Fluorine, F,	237·5	
Hydrofluoric Ac., HF,	250·0	(F.95)
Glucinum (Beryllium), Be,	58·75	
Glucina, $\dot{\mathrm{B}}\mathrm{e}$,	158·75	(O, 63)
or Glucinum, Be,	88.125	
Glucina, $\dddot{\bar{\mathrm{B}}}\mathrm{e}$,	476·25	(O, 63)
Gold (Aurum), Au,	1231·25	
Hydrargyrum (Hg) see *Quicksilver*.		
Hydrogen, (H),	12·5	
Water, $\dot{\mathrm{H}}$,	112·5	(O, 88·89)
2 $\dot{\mathrm{H}}$	225·0	
3 $\dot{\mathrm{H}}$	337·5	
4 $\dot{\mathrm{H}}$	450·0	
5 $\dot{\mathrm{H}}$	562·5	
6 $\dot{\mathrm{H}}$	675·0	
7 $\dot{\mathrm{H}}$	787·5	
8 $\dot{\mathrm{H}}$	900·0	
9 $\dot{\mathrm{H}}$	1012·5	
Iodine, I,	1587·5	
Iridium, Ir,	1237·5	
Iron (Ferrum), Fe,	350	
Protoxyd of Iron, $\dot{\mathrm{F}}\mathrm{e}$,	450	(O, 22·22)
Peroxyd of Iron, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$,	1000	(O, 30)
Kalium (K), see *Potassium*.		
Lanthanum, La,	587·5	
Protoxyd of La., $\dot{\mathrm{L}}\mathrm{a}$,	687·5	(O, 14·55)
Peroxyd of La., $\dddot{\bar{\mathrm{L}}}\mathrm{a}$,	1475·0	(O, 20·34)
Lead (Plumbum), Pb,	1294·6	
Oxyd of Lead, $\dot{\mathrm{P}}\mathrm{b}$,	1394·6	(O, 7·17)
Lime, see *Calcium*.		
Lithium, Li,	81·66	
Lithia, $\dot{\mathrm{L}}\mathrm{i}$,	181·66	(O, 55·05)
Magnesium, Mg,	150	
Magnesia, $\dot{\mathrm{M}}\mathrm{g}$,	250	(O, 40·0)
2 $\dot{\mathrm{M}}\mathrm{g}$	500	
3 $\dot{\mathrm{M}}\mathrm{g}$	750	
4 $\dot{\mathrm{M}}\mathrm{g}$	1000	
5 $\dot{\mathrm{M}}\mathrm{g}$	1250	
6 $\dot{\mathrm{M}}\mathrm{g}$	1500	

	1	2	3	4	5	6	7	8	9
$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	0·467	0·934	1·401	1·868	2·335	2·802	3·269	3·736	4·203
$\overset{\cdot\cdot}{\dddot{\mathrm{A}}}\mathrm{s}$	0·348	0·696	1·044	1·392	1·740	2·088	2·436	2·784	3·132
$\dot{\mathrm{B}}\mathrm{a}$	0·1045	0·2090	0·3135	0·4180	0·5225	0·6270	0·7315	0·8360	0·9405
$\dddot{\bar{\mathrm{B}}}\mathrm{e}$	0·63	1·26	1·89	2·52	3·15	3·78	4·41	5·04	5·67
$\dot{\mathrm{C}}\mathrm{a}$	0·2857	0·5714	0·8571	1·1428	1·4285	1·7142	1·9999	2·2856	2·5713
$\ddot{\mathrm{C}}$	0·7273	1·4546	2·1819	2·9092	3·6365	4·3638	5·0911	5·8184	6·5457
$\dddot{\bar{\mathrm{C}}}\mathrm{r}$	0·31	0·62	0·93	1·24	1·55	1·86	2·17	2·48	2·79
$\dddot{\mathrm{C}}\mathrm{r}$	0·4734	0·9468	1·4202	1·8936	2·3670	2·8404	3·3138	3·7872	4·2606
$\dot{\mathrm{C}}\mathrm{o}$	0·2134	0·4268	0·6402	0·8536	1·0670	1·2804	1·4938	1·7072	1·9206
$\dot{\bar{\mathrm{C}}}\mathrm{u}$	0·112	0·224	0·336	0·448	0·560	0·672	0·784	0·896	1·008
$\dot{\mathrm{C}}\mathrm{u}$	0·2015	0·4030	0·6045	0·8060	1·0075	1·2090	1·4105	1·6120	1·8135
$\dot{\mathrm{F}}\mathrm{e}$	0·2222	0·4444	0·6666	0·8888	1·1110	1·3332	1·5554	1·7776	1·9998

Manganese, Mn,	344·7	
Protoxyd of M., $\dot{Mn}$,	444·7	(O, 22·47)
2 $\dot{Mn}$,	889·4	
3 $\dot{Mn}$,	1334·1	
4 $\dot{Mn}$,	1778·8	
5 $\dot{Mn}$	2223·5	
6 $\dot{Mn}$	2668·2	
Sesquoxyd of M., $\bar{\dddot{Mn}}$,	989·4	(O, 30·32)
2 $\bar{\dddot{Mn}}$	1978·8	
3 $\bar{\dddot{Mn}}$	2968·2	
4 $\bar{\dddot{Mn}}$	3957·6	
Mercury (Hg), see *Quicksilver.*		
Molybdenum, Mo,	575	
Molybdic Acid, $\dddot{Mo}$.	875	(O, 34·3)
Natrium (Na), see *Sodium.*		
Nickel, Ni,	369·33	
Protoxyd of Nickel, $\dot{Ni}$	469·33	(O, 21·3)
Niobium, (Columbium, Cb.)		
Nitrogen, N,	175	
Nitric Acid, $\ddddot{N}$,	675	(O, 74)
2 $\ddddot{N}$	1350	
3 $\ddddot{N}$	2025	
4 $\ddddot{N}$	2700	
Norium.		
Osmium, Os,	1243·6	
Oxygen, O,	100	
Palladium, Pd,	665·48	
Phosphorus, P,	387·5	
Phosphoric Acid, $\ddddot{P}$,	887·5	(O, 56·34)
2 $\ddddot{P}$	1775	
3 $\ddddot{P}$	2662·5	
4 $\ddddot{P}$	3550	
5 $\ddddot{P}$	4437·5	
Platinum, Pt,	1237·5	
Plumbum (Pb), see *Lead.*		
Potassium (Kalium), K,	488·86	
Potassa $\dot{K}$,	588·86	(O, 16·98)
2 $\dot{K}$	1177·72	
3 $\dot{K}$	1766·58	
4 $\dot{K}$	2355·44	
Quicksilver (Hydrargyrum), Hg,	1250	
Rhodium,	651·96	
Ruthenium, Ru,	652	
Selenium, Se,	493·75	
Silicium, Si,	266·25	
Silica, $\dddot{Si}$,	566·25	(O, 52·98)
2 $\dddot{Si}$	1132·50	
3 $\dddot{Si}$	1698·75	
4 $\dddot{Si}$	2265·00	
5 $\dddot{Si}$	2831·25	
6 $\dddot{Si}$	3397·50	
7 $\dddot{Si}$	3963·75	
8 $\dddot{Si}$	4530·00	
9 $\dddot{Si}$	5096·25	
Silver (Argentum), Ag,	1350	
Sodium (Natrium), Na,	287·5	
Soda, $\dot{Na}$,	387·5	(O, 25·80)
2 $\dot{Na}$	775·0	
3 $\dot{Na}$	1162·5	
Stannum (Sn), see *Tin.*		
Stibium (Sb), see *Antimony.*		
Strontium, Sr,	547·5	
Strontia, $\dot{Sr}$,	647·5	(O, 15·44)
Sulphur, S,	200	
Sulphuric acid, $\dddot{S}$,	500	(O, 60)
Tantalum, Ta,	2300	
Tantalic acid, $\ddot{Ta}$,	2600	(O, 11·54)
Tellurium, Te,	801·8	
Terbium, Tb,		
Thorium, Th,	743·86	
Thoria, $\dot{Th}$,	843·9	(O, 11·84)
Tin, (Stannum), Sn,	725	
Oxyd of Tin, $\ddot{Sn}$,	925	(O, 21·62)
Titanium, Ti,	312·5	
Oxyd of Titanium, $\bar{\dddot{Ti}}$,	925	(O, 32·42)
Titanic Acid, $\ddot{Ti}$,	512·5	(O, 39·02)
Tungsten (Wolfr'um), W	1150	
Tungstic Acid, $\dddot{W}$,	1450	(O, 20·69)
Uranium, U,	750	
Protoxyd of U., $\dot{U}$,	850	(O, 11·76)
Peroxyd of U., $\bar{\dddot{U}}$,	1800	(O, 16·66)
Vanadium, V,	856·9	
Wolframium (W), see *Tungsten.*		
Yttrium, Y,	402·5	
Yttria, $\dot{Y}$,	502·5	(O, 19·90)
Zinc, Zn,	406·6	
Oxyd of Zinc, $\dot{Zn}$,	506·6	(O, 19·74)
Zirconium, Zr,	419·73	
Zirconia, $\bar{\dddot{Zr}}$,	1139·5	(O, 26·3)

	1	2	3	4	5	6	7	8	9
$\dot{H}$	0·8889	1·7778	2·6667	3·5556	4·4445	5·3334	6·2223	7·1112	8·0001
$\dot{K}$	0·1698	0·3396	0·5094	0·6792	0·8490	1·0188	1·1886	1·3584	1·5282
$\dot{Li}$	0·5505	1·1010	1·6515	2·2020	2·7525	3·3030	3·8535	4·4040	4·9545
$\dot{Mg}$	0·40	0·80	1·20	1·60	2·00	2·40	2·80	3·20	3·60
$\dot{Mn}$	0·2247	0·4494	0·6741	0·8988	1·1235	1·3482	1·5729	1·7976	2·0223
$\bar{\dddot{Mn}}$	0·3032	0·6064	0·9096	1·2128	1·5160	1·8192	2·1224	2·4256	2·7288
$\ddddot{N}$	0·74	1·48	2·22	2·96	3·70	4·44	5·18	5·92	6·66
$\dot{Na}$	0·258	0·516	0·774	1·032	1·290	1·548	1·806	2·064	2·322
$\ddddot{P}$	0·5634	1·1268	1·6902	2·2536	2·8170	3·3804	3·9438	4·5072	5·0706
$\dot{Pb}$	0·717	0·1434	0·2151	0·2868	0·3585	0·4302	0·5019	0·5736	0·6453
$\dddot{Si}$	0·5298	1·0596	1·5894	2·1192	2·6490	3·1788	3·7086	4·2384	4·7682
$\dot{Sr}$	0·1544	0·3088	0·4632	0·6176	0·7720	0·9264	1·0808	1·2352	1·3896

As the use of the table in deducing formulas involves the frequent multiplication of the oxygen per-centage, the multiples by the digits 1 to 9 are given, for the compounds of most common occurrence, at the foot of the two preceding pages.*

The modes of combination and uses of chemical language are explained in chemical treatises, to which reference should be made by the student. A few brief illustrations are here added:

By *atomic weights* is understood the combining proportions of the elements. For example, when *iron* and *oxygen* combine, they unite in the proportion of 350 parts by weight of iron to 100 of oxygen, or in some simple multiple of this ratio. The protoxyd contains one part or atom of each, and has therefore the atomic weight 450; the peroxyd (more precisely *sesquoxyd*) contains 2 of iron $(2\times350=700)$ to 3 of oxygen, $(3\times100=300)$, and therefore has the atomic weight 1000, $(700+300=1000)$. To ascertain the per-centage of oxygen in this oxyd, we have 300 of oxygen in 1000 parts; hence the ratio, 1000 are to 300 as 100 to the number of parts in 100; therefore dividing 300×100 by 1000 gives the oxygen per-centage. Hence too if we multiply the per-centage of oxygen by the atomic weight of the oxyd, we obtain as a result, after dividing by 100, the oxygen amount in the compound. For alumina, $46{\cdot}7\times642{\cdot}5\div100=300$, the amount of oxygen; and in this way the correctness of the oxygen per-centage may be verified.

The mode of deducing chemical formulas may be illustrated by two or three examples.

1. We have an analysis of Red Silver Ore as follows:

Silver 59·02, antimony 23·49, and sulphur 17·49 per cent.

It is desired to ascertain the relative number of atoms of each element in the compound. This number must depend on the weights of the atoms, as compared with the quantity of each, for the less the weight, the greater the number of atoms. The rule consequently is,—*Divide the per-centage of each element by the atomic weight of the same;* as, 59·02 by 1350, the atomic weight of silver, and so on. (See preceding table). This process gives the relation,

$$0{\cdot}0437 : 0{\cdot}0146 : 0{\cdot}0875,$$

and *dividing each by the smallest*, to simplify it, it becomes

$$3 : 1 : 6,$$

which is therefore the number of atoms of each, silver, antimony, and sulphur. The formula $3Ag+1Sb+6S$, or $Ag^3\,Sb\,S^6$, expresses this relation.

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* Since the printing of the first half of the preceding table, (and a portion also of the second volume of this work), an article has appeared in the L. E. and D. Philosophical Magazine, noting the fact that Rose's Niobium is properly Hatchett's *Columbium*, and that consequently the name Columbium should be given it. The true Tantalum of Berzelius is another metal. Hence, after Columbium, p. 184, the Symbol Cb should be written; and for Columbic acid $\ddot{C}b$. The atomic weight of Columbium is yet undetermined, though near that of Tantalum.

As chemistry makes known a sulphuret of silver consisting of 1 of sulphur to 1 of silver, and also a sulphuret of antimony containing 3 of sulphur to 1 of antimony, the ingredients are regarded as thus combined in the compound. The 3Ag take 3S, making 3AgS, and leave 3S for the 1Sb to form 1(SbS³); so that Red Silver Ore is supposed to be represented by the formula

$$3AgS+SbS^3;\ \text{or}\ \overset{\prime}{A}g^3\overset{\prime\prime\prime}{S}b,$$

if the mark (ˡ) be used, as is common, for Sulphur.

2. An analysis of Feldspar gives in 100 parts,

Silica 64·78, Alumina 18·38, Potash 16·84.

Now if we ascertain the proportion of *oxygen* in these constituents we learn the ratio of the constituents, since we know that silica contains 3 of oxygen, alumina 3, and potash 1. From the above table we find that 100 of silica contain 52·98 of oxygen; consequently if 100 give 52·98, the amount in 64·78 parts will be found by multiplying 52·98 by 64·78, and dividing by 100; or what is equivalent, multiplying 0·5298 by 64·78. So in 100 parts of alumina the oxygen is 46·7; hence the oxygen in 18·38 parts of alumina will equal 18·38×46·7÷100. In this way we ascertain that

64·78 of silica	contain	34·32	oxygen,	or, dividing each by the smallest,	12
18·38 of alumina	"	8·58	"		3
16·84 of potash	"	2·86	"		1

Hence the amount of oxygen in the potash, alumina, and silica, is as 1 : 3 : 12. Now as each atom of silica contains 3 of oxygen, 12 atoms of oxygen correspond to 4 of silica: so also 3 of oxygen for the alumina correspond for a like reason to 1 of alumina; and 1 of oxygen for the potash to 1 atom of potash. The compound therefore contains 4 parts of silica to 1 of alumina and 1 of potash.

The next step in the usual method, is to determine how these constituents are combined; how much of the silica with the potash, and how much with the alumina. Reference is made to the possibility or probability of certain compounds, which Chemistry alone can teach; but aid is found in the principle, that the number of atoms of oxygen in each acid and base is usually some simple multiple, the one of the other. If in the above compound, 1 of silica be united with 1 of potash, the ratio alluded to is 1 to 3; and if the alumina be combined with the remaining 3 atoms of silica, the same ratio holds. This is the mode of combination commonly adopted; it is expressed in the following formula, the dots as explained, indicating the oxygen:

$$\dot{K}\,\dddot{Si}+\dddot{\bar{A}l}\,\dddot{Si}^3.$$

The index ³ expresses the number of atoms of silica: had the 3 been written as a prefix, thus, $3\dddot{\bar{A}l}\,\dddot{Si}$, it would have meant 3 atoms of a compound of silica and alumina.

The formula might also be written with equal precision, and without dividing the silica between the bases, as follows:

$$(\dot{\mathrm{K}}+\dddot{\bar{\mathrm{Al}}})\,\dddot{\mathrm{Si}}^4.$$

In a similar manner, an analysis of Garnet affords the ratio of ingredients as follows:

3 of lime ($3\dot{\mathrm{Ca}}$), 1 of alumina ($1\dddot{\bar{\mathrm{Al}}}$), 2 of silica ($2\dddot{\mathrm{Si}}$),

corresponding to the oxygen ratio 3 : 3 : 6 or 1 : 1 : 2. Apportioning the silica to the bases, we have the formula

$$\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}},$$

in which the oxygen ratio for each member is 1 : 1. Idocrase and Meionite afford other simple examples.

3. In Feldspar, above cited, the protoxyd portion is often not potash alone, but part soda or lime. Again, in Garnet, the protoxyds, instead of being alllime, may be part magnesia, protoxyd of iron, &c. In each case, however, all the protoxyds added together, make up the same specific number of atoms as if there were but one alone. So the peroxyd portion may not be all of it alumina, but part peroxyd of iron, the amount of this peroxyd of iron being just equivalent to the deficiency in the alumina; that is, an equivalent not in actual weight, but in atomic weight. In Garnet, as stated above, the oxygen ratio is 1 : 1 : 2; and whatever the peroxyds or protoxyds, the ratio still holds. Suppose an analysis of Garnet affords the per-centage, Silica 39·6, alumina 22·5, lime 32·6, protoxyd of iron 5·3: we ascertain the oxygen in each constituent in the manner explained, (in the *Silica*, by multiplying 0·5298 by 39·6,—in the alumina, by multiplying 0·467 by 22·5,—in the lime by multiplying 0·2857 by 32·6,—in the protoxyd of iron by multiplying 0·2222 by 5·3); then on *adding* the oxygen of the protoxyd of iron to that of the lime, the amount just equals that of the alumina, as the oxygen ratio requires. Moreover the oxygen of all the protoxyds and peroxyds together equals the oxygen of the silica.

As different protoxyds may thus replace one another, and as different peroxyds likewise admit of mutual replacement, it is common to write $\dot{\mathrm{R}}$ as a general symbol for the protoxyds of a compound, and $\dddot{\bar{\mathrm{R}}}$ for the peroxyds. It is also common to write the special symbols of the protoxyds which replace one another, in parentheses, with a comma between them. Thus in the Garnet referred to, in which lime and protoxyd of iron replace one another, the general formula may be either

$$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}};\ \text{or}\ (\dot{\mathrm{Ca}},\dot{\mathrm{Fe}})^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}.$$

The proportions of the lime and protoxyd of iron are not here stated, but may be; if 1 : 2, the formula becomes

$$(\tfrac{1}{3}\dot{\mathrm{Ca}}+\tfrac{2}{3}\dot{\mathrm{Fe}})^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}.$$

Again, the formula $(\dot{\mathrm{Ca}},\dot{\mathrm{Mg}})\ddot{\mathrm{C}}$, signifies that the compound is a carbonate of lime and magnesia, in definite or indefinite proportions; $(\frac{1}{2}\dot{C}a+\frac{1}{2}\dot{M}g)\ddot{C}$ that the proportion is 1 : 1; $(\frac{2}{5}\dot{C}a+\frac{3}{5}\dot{M}g)\ddot{C}$ that the proportion is 2 : 3, $\frac{2}{5}$ and $\frac{3}{5}$ having this ratio, and together equaling a unit. $\dot{R}\ddot{C}$ is a general expression for a carbonate of any protoxyd.

4. The formula for Garnet, $\dot{R}^3\dddot{S}i+\dddot{\bar{A}}l\dddot{S}i$, may also be written with equal precision as follows:

$$(\tfrac{1}{2}\dot{R}^3+\tfrac{1}{2}\dddot{\bar{A}}l)\dddot{S}i,$$

the ratio 1 : 1 : 2 being still retained, and the fact being also presented to the eye that the oxygen of all the oxyds is to that of the silica as 1 : 1. In Gehlenite, another silicate of alumina and lime, the oxygen ratio is 3 : 3 : 4, which gives 6 : 4 or 3 : 2 for the ratio of the oxyds and silica, (that is, the oxygen of the silica is *two thirds* that of all the oxyds), while that of the protoxyds and peroxyds is 1 : 1. The formula may hence be

$$\dot{R}^3\dddot{S}i^{\frac{2}{3}}+\dddot{\bar{R}}\dddot{S}i^{\frac{2}{3}};\ \text{or}\ (\tfrac{1}{2}\dot{R}^3+\tfrac{1}{2}\dddot{\bar{R}})\dddot{S}i^{\frac{2}{3}}.$$

In the first of these formulas each of the two members has the same oxygen ratio 3 : 2; in the second this ratio is also retained, and is more briefly expressed, without the hypothetical idea that the silica in the compound is divided off between the protoxyd and peroxyd bases.

5. To deduce the per-centage atomic relations from a formula, the process above described is reversed. For example: for feldspar we have 4 of silica, 1 of alumina, 1 of potash. In the preceding table the atomic weight of silica is 566·25, and four times this is 2265. Setting this down and the atomic weights of alumina and potash below it, and adding, we have

4 of Silica,	2265
1 of Alumina,	642·5
1 of Potash,	588·86
Total atomic weight of the feldspar,	3496·36

Now if this amount (3496·36) of feldspar contains 2265 of silica, what will 100 parts contain? Hence, to obtain the per-centage, we divide the atomic weight of each constituent in succession by the sum of the whole, and this gives the per-centage relation for each; viz. Silica 64·78, alumina 18·38, potash 16·84.

2. *Relations of Minerals, as exhibited in the Principles of Isomorphism or Homœomorphism, and Dimorphism.*

The principle has now been long established that analogous elements, bases, or acids, may replace one another in compounds, without an essential change in the crystalline form of the species. Mutual replacement of protoxyd of iron, protoxyd of manganese, lime, and magnesia, in garnet, has already been alluded to. Similarly arsenic and phosphoric acids may replace one another, and the crystallization remain unchanged, or with but a slight variation of angle. This capability of mutual replacement without change of form has been traced to a similarity of form in the replacing substances, and such substances are said to be *isomorphous*, (from ισος, *equal*, and μορφη, *form*), or *homœomorphous*, (from ὁμοιος, *similar*, and μορφη).

Absolute identity of form between related species occurs only when the crystallization is monometric. In this system very wide variations in composition take place, through isomorphous substitutions, without the slightest change of angle. There is a balance of forces in these equiaxial forms which is not overcome even when the substitutions are such as would make a difference of two or three degrees in a rhombohedral form. Thus in Garnet, magnesium and calcium take one another's places with no change in the angle of the form, while the same substitution in a rhombohedral carbonate makes a difference of nearly two and a half degrees.

The term *Isomorphism* is hence strictly applicable only to monometric species, while *Homœomorphism* is of general application.

The more important isomorphous groups of elements, bases, and acids, as regards the constitution of minerals, are the following:

1. Oxygen, Fluorine.
2. Chlorine, Bromine, Iodine.
3. Sulphur, Selenium; Sulphuric and Selenic Acids, with also in part Tantalic, Columbic, Molybdic, and Tungstic Acids.
4. Chromic and Vanadic Acids.
5. Arsenic, Phosphorus, Antimony, Bismuth; Arsenic and Phosphoric Acids.
6. Titanium, Tin; Deutoxyd of Tin, and of Titanium.
7. The metals of the Hydrogen Group, (see beyond); their protoxyds; their sesquoxyds. In the Sulphurets, Ꞓu or 2Cu replaces 1Pb, 1Fe, &c.

Homœomorphism, as Laurent has observed, is not confined to forms of the same system alone. Thus Orthoclase and Albite, one monoclinic and the other triclinic, are in fact homœomorphous; so also Natrolite and Scolecite; Epistilbite and Heulandite. The approximation of form between Idocrase and the monometric octahedron may be regarded as homœomorphism, as stated by Laurent; and still as the monometric species undergo the various isomorphous substitutions without a change of angle, it is a less satisfactory case than the others mentioned.

The same element may crystallize in different systems, so that the two forms are unrelated. Carbon is an example, the diamond being one form, (monoclinic), and graphite another, (hexagonal). In physical characters, the two are different; both as to hardness, specific gravity, color, optical characters, and also chemical reactions to some extent. This property of presenting two independent forms is called *dimorphism*, from δις, *twice*, and μορφη, *form*.

In some cases, the same substance has three independent forms. Thus carbonate of lime is sometimes *rhombohedral*, as in Calcite; sometimes *trimetric*, as in Aragonite; sometimes *monoclinic*, as in Barytocalcite. This is an example of *trimorphism*. *Rutile*, *Brookite*, and *Anatase*, are three forms of Titanic Acid. Garnet, Allanite, in part, and Biotite, are three forms of the same silicate. Carbon is regarded as actually trimorphous, the diamond and graphite, as just stated, being two forms or conditions, and charcoal the third condition.

Two substances may be both homœomorphous and correspondingly dimorphous; and they are then described as *isodimorphous*. Thus both Titanic Acid and Oxyd of Tin are dimorphous, and they are homœomorphous severally in each of the two forms. This is an example of *isodimorphism*.

There are also cases of *isotrimorphism*. Thus there are the following related groups; the angle of the rhombohedral forms here given is *R* : *R*; of the trimetric and monoclinic, *I* : *I*:

	Rhombohedral.	*Trimetric.*	*Monoclinic.*
$\dot{R}\ddot{C}$	Calcite, 105° 5′.	Aragonite, 116° 10′.	Barytocalcite, 95° 8′.
$\dot{R}\dddot{S}$	Dreelite, 93°–94°.	Anglesite, 103° 38′.	Glauberite, 83°–83° 20′.
$\dot{R}\dddot{S}+n\dot{R}\ddot{C}$	Susannite, 94°.	Leadhillite, 103°16′.	Lanarkite, 84°.

Calcite, Aragonite, and Barytocalcite, are an undoubted case of *trimorphism*, the same compound ($\dot{R}\ddot{C}$) occurring under these three forms. Dreelite, Anglesite, and Glauberite, constitute another like series, and moreover it is closely parallel in angle with the former. The difference between the angle *R* : *R* of Calcite and Dreelite is near that between *I* : *I* of Anglesite and Aragonite, and also that between *I* : *I* of Glauberite and Barytocalcite. In the third line we have the sulphato-carbonate Susannite near Dreelite in angle, Leadhillite (identical with Susannite in composition) near Anglesite, and Lanarkite, another Sulphato-carbonate, near Glauberite, forming thus a third parallel line. The sulphuric acid in these sulphato-carbonates dominates over the carbonic acid, and gives the form of the sulphates enumerated in the second line of the table.

The known cases of dimorphism among the elements are the following:

1. The two forms *monometric* and *hexagonal* ($R : R = 82°–88°$).—Arsenic, Antimony, Phosphorus, Bismuth, Palladium, Iridium, Iron (?), Copper, Carbon.
2. The two forms *monometric* and *dimetric*.—Tin.
3. The two forms *trimetric* and *monoclinic*.—Sulphur, Selenium.

The homœomorphous groups among minerals are numerous, and in many of them species very various in composition are included.

Before giving a list of them, the methods of comparison and evidence of true affinity or homology may be briefly reviewed.

Monometric System.—In this system, as the dimensions are unvarying, the species fall into a single group, unless cleavage and hemihedrism are important distinctions. *Cleavage* is often of little importance. The two species Gray Copper and Tennantite, analogous in composition, have one, an octahedral, the other, a dodecahedral cleavage. Sylvine (chlorid of potassium) has a cubic cleavage, while the related compound, chlorid of ammonium, has an octahedral. *Hemihedrism* is often of value in marking off species. It is a remarkable fact that while the protoxyd of zinc is rhombohedral, like the peroxyd of iron and aluminium, and unlike other protoxyds, the sulphuret of zinc is tetrahedral, unlike most related protosulphurets. Again, the borates, Boracite and Rhodizite, are hemihedral; and so also are all minerals containing boracic acid, that crystallize in other systems, excepting those that are oblique in crystallization. On the other hand, the related compounds, FeS^2 (pyrites), $Co(S,As)^2$, and $Co\,As^2$ differ, the first two being hemihedral, while the last is not so—indicating apparently that the sulphur here determines the hemihedral character.

Dimetric and Trimetric Systems.—In the dimetric system, there are two square prisms to each form, one diagonal to the other, and the axial dimensions of a species will vary according as we assume one or the other to be the fundamental prism. This uncertainty is one to be set aside by the best means we may have, and to be admitted where analogies still leave it unremoved. The length of the vertical axis also varies directly according as one octahedral plane or another in a series is referred to the unit octahedron. There is often a number of planes, between which we may choose, one of which will give a vertical axis two or three times as long as another. Here is a second source of doubt. The planes assumed as those of the unit octahedron by crystallographers, are ordinarily so assumed because they afford a simple view of the relations of the planes; and with no better evidence of correctness than this, they may lead to error, when we have in view a comparison of form between different species.

Cleavage affords the best criterion with regard to the vertical prism, the cleavage prism being usually the true fundamental prism. But in some cases there are no vertical cleavages, and only basal or octahedral. An octahedral cleavage affords important evidence as to the fundamental octahedron, whenever it occurs.

Frequency of occurrence of planes is another criterion, and one of some value in determining the true fundamental prism and the unit octahedron; yet it is often a false guide. A striking example of its want of value in another system, is seen in Calcite, the fundamental rhombohedron of which is of rare occurrence; also in Fluor, which is oftenest in cubes, although its cleavage is octahedral;—so also in Quartz, Tourmaline and other species, in which the fundamental form is far less common than some of the secondary forms, if ever observed.

Twin-composition parallel to an octahedron plane, is good evidence as to which is the true unit-octahedron, since twins are formed, with rare exceptions, parallel to planes of unit or primary value In the monometric system they occur only parallel to the three primary sections—that is, parallel to a cubic face, an octahedral and a dodecahedral; and they are almost always parallel to corresponding sections in the dimetric system. Still the doubt may remain whether the plane of composition, if a unit plane, belongs to the fundamental or diagonal series; and it is possible that it may be some other than a unit plane.

There is hence no criterion which is an unfailing reliance. All the several characteristics must be reviewed, and also the analogies with other species, in order to arrive at a satisfactory conclusion.

In very many cases, we may make out a relation in the angles of the *series* of octahedral planes occurring in dimetric species, when it is impossible to decide with certainty which plane in the series belongs to the unit-octahedron for the species. This *serial* relation is of the highest importance, and is independent of all the doubts above alluded to. It indicates a fundamental analogy between the species so related. Thus the table beyond shows that the octahedron regarded as 1 in zircon and rutile, is identical nearly in angle with that considered ½ in Nagyagite; and if these two planes have this relation, then the plane 2 of the former and 1 of the latter will be likewise related; so that there is a serial relation between the forms of the species. Again, 1 in zircon is nearly identical in angle with the intermediate octahedron 2*i* of Scapolite and Mellilite. There is no valid reason for making this octahedron of scapolite one of the diagonal series; and none also for assuming it as 2*i* rather than 1*i* or 4*i*, excepting the frequency of occurrence of the plane. This example and the further application of the same principle apparent in the table will suffice to illustrate what we mean by the *serial* relation of forms.

In *Trimetric* forms, doubts are still more varied. It is first necessary to decide which is the true *vertical* axis, as either of the three axes may be made the vertical. The best evidence on this point, is that afforded by *cleavage*, the prism of most perfect cleavage being almost always parallel to the true vertical axis.

The next point is to determine the *unit* vertical prism from which we may ascertain the relation of the lateral axes ($b : c$). This may be the *cleavage prism* just alluded to. Yet in some cases two species evidently closely related in form, have cleavage parallel to different prisms. In Augite, in the monoclinic system, cleavage is parallel to a prism of 87° 6′, and in hornblende, closely homœomorphous with augite, it is parallel to a prism of 124° 30′; the last has twice the breadth of the other,—a simple mathematical relation which proves an actual analogy of form in the two species; and this is sustained by finding that all the planes of one may be very simply deduced from the type of the other.

Another criterion is afforded by *twin composition*, on the principle already explained. Although as stated above, it is not always sure evidence, it is in very many cases of high authority.

Similarity in modes of composition always suggests, if it does not prove, that species are related in form, and that the planes of composition are homologous. Thus we have evidence in the twins parallel to a prism near 120° in angle, of the relation which exists between Aragonite, Cerusite, Chrysoberyl, Copper Glance, etc.; and at the same time, of the wide discrepancy between Aragonite and Bournonite, and between Chrysolite and Chrysoberyl. The prism of Bournonite (115° 58′), near the fundamental prism of Aragonite, is only a secondary prism ($i\overline{\tfrac{3}{2}}$); the *twins* of Bournonite are formed parallel to the true fundamental prism of the species, that of 93° 40′. Chrysolite also affords no stellate twins like those of Chrysoberyl; the angle of its vertical prism is 94° 3′, and it belongs to a different zone from that of Chrysoberyl. Chrysoberyl and Aragonite, on the contrary, are closely related; they have similar twins, and the former has a brachydome of 108° 26′, the latter of 109° 39′.

Additional assistance, but of less certain value, may be had by reference to the frequency of occurrence of planes, or superior lustre or smoothness, and also by noting the resemblance in habit to species that are already well determined.

After determining the true vertical axis and unit vertical prism, a unit dome or octahedron must next be ascertained, in order to fix the length of the vertical axis. Here *twin composition*, the *frequency of occurrence* of planes, and rarely *cleavage*, come in to afford help, yet only to afford presumptive, not demonstrative, evidence. Analogies with other species chemically related, afford very essential aid, and should never be overlooked.

Notwithstanding the doubts that may remain, we may, as in the dimetric system, discover a serial relation in the angles, and this is sure evidence of a true mathematical relation between forms. If we cannot decide whether the form which crystallographers have made the unit octahedron is in fact the true unit octahedron, we may discover that the angles of the forms $\frac{1}{2}$, 1, $\frac{3}{2}$ or 2, are similar to a series in another species, and prove thus a true fundamental resemblance.

Clinohedral Systems. In the *Monoclinic* System the same difficulties exist. Of the three axes the vertical must lie in the clinodiagonal section, but it may have any position in this section. A crystal in this system is hence like a wheel, any spoke of which may be made the vertical one. When there is distinct cleavage parallel to a prism, the axis parallel to the faces of this cleavage prism may be regarded as the true vertical axis. But the top plane of this prism is yet to be assumed or ascertained: either by taking a plane of *cleavage*, when there is one; or one of *twin-composition;* or one of *most frequent occurrence;* or one suggested by *analogies with other species.* The criterion appealed to by the crystallographer is usually, *simplicity in calculation*—one of some importance, but often misrepresenting the true relations of species.

Rhombohedral System. The remarks on the Dimetric System apply in principle here. In this system, there are two hexagonal prisms to each species, one diagonal to the other, (one lettered *I*, the other *i*2); also two series of pyramids, one corresponding to each prism, (one lettered 1, 2, 3, &c., the other 12, 22, 32, &c.) Either series may be the fundamental series: and in a series of pyramids, there may be a choice between two or three of them as to the unit pyramid. Hence the angle of pyramid 1 in one species, may be near that assumed by the crystallographer as 2 in another, and which might as correctly be made 1. In the table beyond, such relations are seen in numerous cases. The *serial* relations in angle exhibited are devoid of hypothesis on this point.

After the above explanations, the following tables are presented.

In the Dimetric and Rhombohedral Systems, the accepted values of the planes are given, without conforming them to one or more types. In the Trimetric System, the related species for the different groups are reduced to a common type, and the values of the planes as adopted by the best authors, when not the same as taken in the table, are mentioned in parentheses.

1. MONOMETRIC SYSTEM.

1. *Holohedral Forms.**

		Cleav.			Cleav.
Amalgam,	$\mathrm{AgHg^2}$	D.	Red Copper,	€uO	O.
Galena,	RS	H!	Melaconite,	CuO	
Cuproplumbite,	"	H!	Spinel,	$\mathrm{R\ddot{R}}$	H,O,*tr.*
Erubescite,	"	O.	Magnetite,	"	
Manganblende,	"	D.	Franklinite,	"	
Silver glance,	"	H, D, *tr.*	Chromic Iron,	"	
Naumannite,	RSe	H!	Arsenolite,	$\mathrm{AsO^3}$	O.
Clausthalite,	"	H.	Senarmontite,	$\mathrm{SbO^3}$	O.
Altaite,	RTe	H.	Fluor Spar,	CaF	O!
Linnæite,	$\mathrm{Co^3S^4}$	H.	Salt,	RCl	H.
Skutterudite,	$\mathrm{CoAs^3}$	H.	Sylvine,	"	H.
Smaltine,	$\mathrm{RAs^2}$	D, *tr.*	Sal Ammoniac,	"	O.
Chloanthite,	"	"	Horn Silver,	"	
Ullmannite,	$\mathrm{R(S, Sb, As)^2}$	H!	Bromic Silver,	RBr	
Dufrenoysite,	$\mathrm{RS+\frac{1}{2}As^2S^3}$.		Embolite,	$\mathrm{R(Cl, Br)}$	H.
Periclase,	RO	H.	Perofskite,	$\mathrm{\dot{C}a\ddot{T}i}$	H.

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* In this table H stands for Hexahedral or cubic; O for Octahedral; D for Dodecahedral.

		Cleav.			Cleav.
Pyrochlore,	$\dot{R}^3\dddot{T}a^2$?		Ittnerite,	$(\dot{R}+\ddot{\bar{R}})\dddot{Si}^{4}_{3}+2\dot{H}$.	
Alum,	$(\dot{R}+\ddot{\bar{R}})\dddot{S}^4+24\dot{H}$	O.	Sodalite,	" $+\frac{1}{3}NaCl$.	
Garnet,	$(\dot{R}^3,\ddot{\bar{R}})\dddot{Si}$	D.	Hauyne,	" $+\frac{2}{3}Ca\dddot{S}$.	
Leucite,	$(\dot{R}+\ddot{\bar{R}})\dddot{Si}^{8}_{3}$	D.	Nosean,	" $+\frac{1}{3}Na\dddot{S}$.	
Analcime,	" $+2\dot{H}$	H.			

2. *Tetrahedral.*

Blende,
Helvin,
Tritomite,
Boracite,
Rhodizite,

Gray Copper.
Tennantite.
Eulytine.
Pharmacosiderite.

3. *Pyritohedral.*

Pyrites,	FeS^2.	Cobaltine,	$Co(S, As)^2$.
Hauerite,	MnS^2.	Gersdorffite,	$Ni(S, As)^2$.

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2. DIMETRIC AND HEXAGONAL SYSTEMS.

In the Dimetric System, there are two grand groups, the first (Rutile Group) consisting of Sections I, II, III, and IV; and the second (Idocrase Group) of V and VI. The simple relation as to the vertical axis in the sections of each of these groups is obvious without further remark. In the first of these groups, the basal angle of the fundamental octahedron is near 90° (4° to 7° above it), and in the second near 109° 28′; or taking $1i$ of Idocrase as 1, the basal angle is also near 90°, but 1° to 6° less than 90°.

In the hexagonal system, there are also several Sections, if we take the values of the vertical axis as usually deduced. But the second section becomes united to the first if we take the plane $\frac{2}{3}$ as 1; and the IV, also, if we take $\frac{1}{4}$ as 1, the ratios of the axes for the sections being of this simple kind. In Section V, an intermediaet pyramid is very near in angle a pyramid in each of the other sections. The basal angle of pyramid 1 in this section is near 90°, *and hence* $R : R$ in Calcite, &c., is near 105°, and to this angle many species approximate. In Section IV, the angle $R : R$ is near 90°, but 1 to 6 degrees *less* than 90°. In Section III, the angle $R : R$ is also near 90°, but 2 to 5 degrees above it.

There are close correspondences in angle between Hexagonal and Dimetric species, as the two tables exhibit to the eye; and they indicate a kind of Homœomorphism; for a like inclination of the base on a pyramidal plane is truer evidence of analogy or identity than equality in the calculated axes; it is a correct measure of the relations in the ellipsoidal molecules of the two forms. With equal axes in a Dimetric and Hexagonal form, the inclination of O on $1i$ in the former will equal O on 12 of the latter; but O on 1 in the two will diverge widely, because in one the lateral axes cross at 90° and in the other at 60°; hence the unsatisfactory character of comparisons between the forms of the two systems made from the calculated axes.

Dimetric System.[*]

I.	$O : 1$	$O : 2$			$O : 3$
Tin,	151° 24′	132° 31′	......	......	121° 26′
II.	$O : \frac{2}{3}$			$O : 1$	$O : 2$
Zircon,	148° 52′	......	......	137° 50′	118° 54′
Rutile,	......	......	......	137° 40′	118° 46′
Cassiterite,	......	......	......	136° 26′	117° 43′
Œrstedite,	......	......	......	138° 2′	......
Edingtonite,	......	......	......	136° 20′	......
III.				$O : 2i$	$O : 4i$
Scapolite,	......	......	......	138° 38′	119° 36′
Sarcolite,	......	......	......	138° 25′	119° 24′
Meionite,	......	......	......	138° 43′	119° 40′
Mellilite,	......	......	......	137° 43′	118° 48′
IV.	$O : \frac{1}{3}$			$O : \frac{1}{2}$	$O : 1$
Apophyllite,	149° 30′	......	......	138° 32′	119° 30′
Nagyagite,	......	......	......	137° 30′	118° 37′
Uranite,	......	......	......	137° 27′	118° 35′
Anatase,	......	......	......	138° 23′	119° 22′
Matlockite,	......	......	......	138° 37′	119° 34′
Calomel,	......	......	......	138° 56′	119° 51′
Hausmannite,	......	......	......	140° 17′	121° 3′
Faujasite,	......	......	......	......	118° 16′
V.		$O : 1i$	$O : 1$		
Romeine,	......	134° 17′	124° 35′	......	......
Cerasine,	......	132° 40′	123° 06′	......	......
Chiolite,	......	......	123° 17′	......	......
Braunite,	......	......	125° 40′	......	......
Idocrase,	......	......	(2) 123° 27′	......	......
Copper Pyrites,	......	135° 25′	125° 40′	......	......
? Tin Pyrites,	......	......	......	......	......
Mellite,	......	(1) 133° 27′	123° 16′	......	......
Gismondine,	......	(1) 133° 45′	......	......	......
VI.		$O : \frac{1}{2}$	$O : 1i$		
Scheelite,	......	133° 38′	123° 59′	......	......
Scheeletine,	......	132° 5′	122° 33′	......	......
Wulfenite,	......	......	122° 26′	......	......
Fergusonite,	......	......	124° 20′	......	......

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[*] The angles given in the Dimetric System, are the inclinations of the basal plane O on the octahedral planes specified; and in the Hexagonal System, those of O on different pyramids specified, (or rhombohedrons). The isomorphous groups of species presented in this and the following tables, have to a large extent been made out by other authors. Von Kobell as early as 1831 showed the relations of a large part of the dimetric species in principle as above presented. The alumina group first indicated by Mitscherlich, was extended by Prof. G. Rose, who added the rhombohedral metals and Red Zinc Ore. Frankenheim and others have labored extensively in this department. The relations of the groups to one another in these several tables were first presented as here given by the author in the Jour. Lyceum Nat. Hist. N. Y. 1854, vi, 37, and Am. J. Sci. [2], xvii, 430, xviii, 35, and many additions to the groups were made by him at the same time, and to some extent in earlier papers.

Hexagonal System.

I.	$O:1$	$O:2$	$O:3$	$O:1\cdot2$	$O:2\text{-}2$	$O:4\text{-}2$
Coquimbite,.....	151° 00′	....	....	....	....	....
Beryl,..........	150° 3′	130° 57′	120° 3′	153° 29′	135° 4′	116° 37′
Pyrosmalite,.....	148° 30′	129° 13′	118° 33′	152° 3′	133° 18′	115° 13′
Eudialyte (R),...	148° 38′	129° 21′	118° 40′	152° 10′	133° 27′	115° 20′
Dioptase (R),....	148° 38′	129° 21′	118° 40′	152° 10′	133° 27′	115° 20′
II.	$O:\frac{2}{3}$	$O:\frac{4}{3}$	$O:2$		$O:\frac{4}{3}\text{-}2$	
Apatite, ...	150° 35½′	131° 35′	120° 36′	....	135° 41′	....
Levyne (R), ...	150° 43′	131° 43′	120° 44′	....	135° 50′	....
Mimetene,.......	150°	130° 53′	120°	....	135° 0′	....
Pyromorphite,...	150° 27′	131° 26′	120° 28′	....	135° 32′	....
III.	$O:\frac{1}{2}$	$O:1$	$O:\frac{3}{2}$	$O:\frac{1}{2}\text{-}2$	$O:1\text{-}2$	$O:2\text{-}2$
Quartz (R),......	147° 35′	128° 13′	117° 42′	151° 12′	132° 17′	114° 27′
Chabazite (R),...	148° 32′	129° 15′	118° 35′	152° 5′	133° 20′	115° 15′
Dreelite (R),.....	147°	....	....	....	....	....
Susannite (R), ...	147° 26′	128° 03′	....	151° 3′	132° 7′	114° 19′
Cinnabar (R), ...	146° 32′	127° 06′	....	150° 13′	131° 8′	113° 35½′
Zinc, ...	....	126° 57′	....	....	....	....
IV.	$O:\frac{1}{3}$	$O:\frac{2}{3}$	$O:1$	$O:\frac{1}{3}\text{-}2$	$O:\frac{2}{3}\text{-}2$	$O:\frac{4}{3}\text{-}2$
Corundum (R), ..	152° 19′	133° 37′	122° 26′	155° 34′	137° 44′	118° 49′
Specular Iron (R),	....	....	122° 30′	155° 37½′	137° 49′	118° 53′
Ilmenite (R), ...	....	....	122° 30′	155° 37½′	137° 49′	118° 53′
Willemite (R),...	....	....	122° 18′	155° 27′	137° 35′	118° 41½′
Phenacite (R),...	....	....	123° 16′	156° 15′	138° 39′	119° 36′
Bismuth, (R),....	....	....	123° 36′	156° 31′	139° 1′	119° 55′
Arsenic (R),.....	....	....	122° 9′	155° 20′	137° 26′	118° 34′
Antimony (R),...	....	....	123° 32′	156° 28′	138° 56′	119° 51′
Tellurium (R),...	....	....	122° 24′	155° 33′	137° 42′	118° 48′
Iridosmine (R), ..	....	....	121° 33′	....	....	....
Tetradymite (R),.	....	....	118° 38′	....	....	....
Red Zinc Ore, ...	....	....	123° 5′	156° 5′	138° 27′	119° 26′
Copper Mica (R),.	....	....	124° 9′	....	....	....
Alunite (R),.....	....	....	....	....	....	....
Brucite (R), ...	....	....	119°	....	....	....
V.	$O:\frac{2}{3}\text{-}2$	$O:\frac{4}{3}\text{-}2$	$O:2\text{-}2$	$O:\frac{1}{2}$	$O\,.\,1$	$O:2$
Pyrrhotine, ...	149° 53′	....	119° 53′	153° 20′	134° 52′	116° 28′
Greenockite, ...	....	....	....	154° 32′	136° 23′	117° 42′
Breithauptite, ...	....	....	....	153° 38′	135° 15′	116° 46′
Copper Nickel,...	....	....	....	154° 41′	136° 35′	117° 51′
Iodid of Silver, ..	....	....	....	154° 49′	136° 46′	118°
Nepheline,.......	....	....	....	154° 13½′	136°	117° 22½′
Cancrinite,.......	....	....	....	154° 7′	135° 52′	117° 16′
Parisite, ...	....	....	....	....	(⅛) 136° 53′	(¼) 117° 50′
Tourmaline (R),..	149° 10′	....	....	152° 40′	134° 3′	115° 49′
Calcite (R),......	150° 20′	....	....	153° 45′	135° 23′	116° 53′
Dolomite (R),....	....	....	....	154° 20′	136° 8′	117° 28′
Magnesite (R),...	....	....	....	154° 57′	136° 56′	118° 9′
Spathic Iron (R),.	....	....	....	154° 43′	136° 37′	117° 53′
Smithsonite (R), .	....	....	....	155° 2′	137° 3′	118° 24′
Diallogite(R), ...	....	....	....	154° 37′	136° 31½′	117° 48′
Pyrargyrite (R),..	....	....	....	155° 32′	137° 42′	118° 47′
Proustite (R),....	....	....	....	155° 7′	137° 9′	118° 19′
Levyne,.........	....	....	....	....	136° 1′	....
Millerite (R),....	....	....	....	....	142° 44′	....

3. Trimetric System.

The species of this system fall naturally into three or four great groups, differing in the angle of the unit vertical prism, (angle *I* : *I*), as follows:

1. Angle *I* : *I* from 90½° to 95°.
2. Angle *I* : *I* near 102°, or from 98° to 105°.
3. Angle *I* : *I* near 110°.
4. Angle *I* : *I* near 120°.

The species of the third group, by changing the position of the crystal, fall into the second group, and this may be their true place, although cleavage seems to indicate that the prism of 110° is the true vertical prism. The species are inserted in the second group, and also stand as Table III by themselves.

The angles mentioned in the Tables are the obtuse angle of the prism *I* : *I*, (column 1), and the angle at top of the unit macrodome and brachydome (1ī and 1ĭ).

Table I.

Angle of Vertical Prism I near 90°.

	Vert Prism. *I* : *I*	Macrodome. 1ī : 1ī	Brachydome. 1ĭ : 1ĭ	Axes. *a* : *b* : *c*
I.				
Thomsonite,	90° 40′	108° 18′	108° 56′	0·72253 : 1 : 1·0117
Mesotype,	91°	(2ī)108° 46′	(2ĭ)109° 42′	0·71644 : 1 : 1·0176
Harmotome,	91° 46′	108° 48′	110° 26′	0·71626 : 1 : 1·0312
Wöhlerite,	90° 54′	108° 2′	108° 56′	0·7261 : 1 : 1·01583
Polymignyte,	91° 44′	108° 6′	109° 46′	0·7252 : 1 : 1·0308
Æschynite,	90° 34′	111° 56′	112° 28′	0·675 : 1 : 1·01
Pyrolusite,	93° 40′	104° 22′	(½ĭ)107° 54′	0·776 : 1 : 1·0661
Andalusite,	90° 44′	109° 6′	109° 50′	0·71198 : 1 : 1·0129
Lievrite,	(⅔) 91° 32′	111° 14′	112° 40′	0·68429 : 1 : 1·0271
Staurotide,	(½) 93° 8′	(½ī)108° 12′	111° 10′	0·72388 : 1 : 1·05617
Wavellite,	(½) 90° 34′	(2ĭ)106° 14′	106° 46′	0·75047 : 1 : 1·0099
Olivenite,	92° 30′	108° 28′	110° 50′	0·72034 : 1 : 1·0446
Libethenite,	92° 20′	107° 40′	109° 52′	0·7311 : 1 : 1·0416
Caledonite,	95°	(½ī)105° 8′	(½ĭ)109° 54′	0·76568 : 1 : 1·0913
Chondrodite,	94° 26′	(½ī)106° 52′	(½ĭ)111° 4′	0·74176 : 1 : 1·0805
Antimony Glance,	90° 45′	(⅔ī)109° 26′	(⅔ĭ)110° 8′	0·6901 : 1 : 1·0132
Do. do:	90° 45′	(1ī) 88°	(1ĭ) 88° 47′	1·0352 ; 1 : 1·0132
Polycrase,	95°	(1ī) 88° 30′	(1ī) 93° 53′	1·02655 : 1 : 1·0913
II.				
Epsomite,	90° 34′	120° 4′	120° 33′	0·57647 : 1 : 1·01
Zinc Vitriol,	90° 42′	120° 20′	120° 3′	0·5735 : 1 : 1·0123
Diaspore,	93° 52′	115° 16′	118° 42′	0·63398 ; 1 : 1·0699
Göthite,	94° 52′	113° 6′	117° 30′	0·66063 : 1 : 1·0888
Polianite,	92° 52′	115° 26′	118°	0·6317 : 1 : 1·0513
Euchroite,	92° 8′	117° 20′	119° 13′	0·6088 : 1 : 1·038
Topaz,	(½) 93° 8′	(⅔ĭ)115° 22′	(⅓ī)118° 10′	0·63258 : 1 : 1·05617
Chrysolite,	94° 3′	(½ī)115° 36′	(½ĭ)119° 12′	0·6297 : 1 : 1·0733
Triphyline,	94°	(½ī)118° 27′	(½ĭ)121° 55′	0·59549 : 1 : 1·0724
Bournonite,	93° 40′	(⅔ī)115°	(⅔ĭ)118° 14′	0·63745 : 1 : 1·0662
Do.	“	(1ī) 92° 34′	(1ĭ) 96° 12′	0·95618 : 1 : 1·0662
? Warwickite,	93°–94°	......	......	....
? Lanthanite,	93° 45′	......	......	....

Table II.

Angle of Vertical Prism I near 102°.

	Prism *I*	Dome $1\bar{\imath}$.	Dome $1\breve{\imath}$.	Axes $a : b : c$.
I.				
Valentinite,	$(\frac{1}{2})$ 103° 30′	58° 17′	70° 32′	1·7934 : 1 : 1·2683
Barytes,	101° 40′	63° 40′	74° 36′	1·6107 : 1 : 1·2276
Anglesite,	103° 38′	62° 42′	75° 29′	1·6415 : 1 : 1·2715
Leadhillite,	103° 16′	60° 20′	72° 34′	1·7205 : 1 : 1·2632
Celestine,	104° 2′	62° 39′	75° 52′	1·6432 : 1 : 1·2807
Anhydrite,	102° 56′	61° 25′	72° 38′	1·6836 : 1 : 1·2557
Tantalite,	101° 32′	$(2\bar{\imath})$ 64° 7′	$(2\breve{\imath})$ 74° 58′	1·5967 : 1 : 1·2247
Glaserite,	104° 52′	59° 31′	73° 14′	1·749 : 1 : 1·3
Thenardite,	103° 26′	61° 12′	73° 42′	1·6905 : 1 : 1·267
Descloizite,	100° 28′	$(2\bar{\imath})$ 67° 36′	$(2\breve{\imath})$ 77° 47′	1·494 : 1 : 1·2052
Mascagnine,	107° 40′	65° 52′	83° 6′	1·5437 : 1 : 1·3680
Atacamite,	97° 2′	67° 40′	74° 20′	1·4919 : 1 ; 1·1310
Marcasite,	99° 40′	67° 12′	76° 24′	1·5049 : 1 : 1·1847
Sulphur,	101° 58′	$(\frac{2}{3}\bar{\imath})$ 65° 18′	$(\frac{2}{3}\breve{\imath})$ 76° 40′	1·5606 : 1 : 1·2342
"	"	$(1\bar{\imath})$ 46° 16′	$(1\breve{\imath})$ 55° 36′	2·3408 : 1 : 1·2342
II.				
Orpiment,	100° 40′	73°	83° 30′	1·3511 : 1 : 1·2059
Dimorphine (I),	98° 6′	75° 40′	83° 40′	1·2876 : 1 : 1·1526
" (II),	100° 32′	74° 2′	84° 24′	1·3262 : 1 : 1·203
Mispickel,	99° 52′	72° 58′	82° 40′	1·3520 : 1 · 1·1890
Aurotellurite,	101° 26′	71° 52′	83° 6′	1·3797 : 1 : 1·2235
Epistilbite,	$(\frac{1}{2})$ 100° 58′	$(\frac{1}{2}\bar{\imath})$ 70° 50′	$(\frac{1}{4}\breve{\imath})$ 81° 30′	1·4063 : 1 : 1·2121
Childrenite,	104° 14′	73°	87° 14′	1·3514 ; 1 : 1·2853
III.				
Prehnite,	99° 56′	$(2\breve{\imath})$ 89° 45′	99° 41′	1·0044 : 1 : 1·1904
Columbite,	100° 40′	86° 45′	97° 28′	1·0584 : 1 : 1·2059
Wolfram,	101° 5′	88° 6′	99° 13′	1·0337 : 1 : 1·2149
Mengite,	100° 28′	87° 24′	97° 54′	1·0463 : 1 : 1·2071
Brookité,	100°	83° 14′	93° 16′	1·1260 : 1 : 1·1918
Scorodite,	98° 2′	84° 40′	92° 43′	1·0977 : 1 : 1·1151
Hopeite,	101°	86° 38′	97° 40′	1·0607 : 1 : 1·2131
Struvite,*	101° 42′	85° 4′	96° 50′	1·0900 : 1 : 1·2283
"	"	$(\frac{3}{2}\bar{\imath})$ 62° 54′	$(\frac{3}{2}\breve{\imath})$ 73° 50′	1·6350 : 1 : 1·2283
IV.				
Manganite,	99° 40′	114° 19′	122° 50′	0·6455 : 1 : 1·1847
Calamine,	103° 54′	116° 39′	128° 26′	0·6170 : 1 : 1·2776
Haidingerite,	100°	118° 32′	126° 58′	0·5945 : 1 : 1·1918
Brochantite,	104° 10′	$(2\bar{\imath})$ 114° 29′	126° 41′	0·6434 : 1 : 1·2838
Cotunnite,	99° 46′	118° 28′	126° 44′	0·5953 : 1 : 1·1868
? Mendipite,	102° 36′			x : 1 : 1·2482
? Jamesonite,	101° 20′			x : 1 : 1·2203

* Taking $\frac{3}{2}\bar{\imath}$ as $1\bar{\imath}$, then the dimensions of Struvite are near those of Barytes.

TABLE III.

Angle of Vertical Prism, near 109° 28′.

	Prism *I.*	Dome 1ī.	Dome 1ĭ	Axes *a* : *b* : *c*.
I.				
Marcasite,	106° 5′	64° 52′	80° 20′	1·5737 : 1 : 1·3287
II.				
Mispickel,	111° 53′	59° 14′	80° 8′	1·7588 : 1 : 1·4793
Leucopyrite,	111° 30′			
Aurotellurite,	110° 48′	(2ī) 58° 52′	(2ĭ) 78° 34′	1·7723 : 1 : 1·4496

TABLE IV.

Angle of Vertical Prism, near 120° (115½°–120°).

	Prism *I.*	Dome 1ī	Dome 1ĭ.	Axes *a* : *b* : *c*.
I.				
Sternbergite,	119° 30′	69° 38′	100° 2′	1·4379 : 1 : 1·7147
II.				
Aragonite,	116° 10′	81° 40′	108° 26′	1·1571 : 1 : 1·6055
Cerusite,	117° 13′	80° 19′	108° 16′	1·1852 : 1 : 1·6388
Witherite,	118° 30′	77° 30′	106° 54′	1·2460 : 1 : 1·6808
Bromlite,	118° 50′	77° 18′	107° 5′	1·2504 : 1 : 1·6920
Stephanite,	115° 39′	85° 5′	111° 8′	1·0897 : 1 : 1·5844
Nitre,	118° 50′	80° 16′	109° 57′	1·1861 : 1 : 1·692
Chrysoberyl,	119° 46′	($\frac{3}{2}\bar{i}$) 78° 54′	($\frac{3}{2}\breve{i}$) 109° 38′	1·2152 : 1 : 1·4239
Discrasite,	119° 59′	81° 22′	112° 12′	1·1633 : 1 : 1·7315
Copper Glance, Stromeyerite,	119° 35′	($\frac{2}{3}\bar{i}$) 83° 56′	114° 10′	1·1117 : 1 : 1·7176
III.				
Herderite,	115° 53′	111° 42′	135° 58′	0·6783 : 1 : 1·5971
IV.				
Iolite,	119° 10′	94°	121° 38′	0·9325 : 1 : 1·7033
Mica,	119°–120°			

In Table I, of the Trimetric System, there are two sections; 1, *having the domes near* 109° 28′, *the angle of the regular octahedron;* 2, *having the domes near* 120°, *the angle of a dodecahedron.* In the first, the axes have approximately the ratio 1 : √2 : √2; in the second, the ratio 1 : √3 : √3. The former is almost exactly true of Andalusite, and the latter of Epsomite and Zinc Vitriol, (Goslarite).

For many of the species, the domes 2ī and 2ĭ might with as good reason be made the unit domes; and in that case, the summit angle would be near 70° 32′, (the supplement of 109° 28′)‘

which is the angle over the apex, in the regular octahedron. It is important to observe that the regular octahedron is represented by these united domes or the *rectangular* octahedron, and not by the rhombic octahedron of these trimetric species, and hence the axes of this rectangular octahedron (and not those of the rhombic, or the crystallographic axes) are homologous with those of the regular octahedron. Antimony Glance is an exception to this remark, and probably also Bournonite and Polycrase.

The relation of Topaz to Andalusite in form and formula, indicates the homœomorphism of oxygen and fluorine. At the same time the divergence in the angle of the domes shows the distinctive influence of fluorine; and the same is seen in the relations of Chondrodite and Chrysolite, or in the unlike angles of the three types of Chondrodite alone.

In Table II, section I has the macrodome near 60° and the brachydome near 70° 32′, both monometric angles, *and these angles necessarily require that the vertical prism should be near* 101° 34′ *in angle; and hence the frequency of angles near this.* In Valentinite the brachydome has exactly the angle 70° 32′, and the axes have nearly the typical value $1 : \sqrt{\frac{1}{3}} : \sqrt{\frac{1}{2}}$. Section II has the macrodome of 70° to 75° or near the brachydome of section I. Section III has the macrodome of 83° to 90°, or near the brachydome of section II, and 90° is nearly a mean between the macrodome and brachydome. In section IV, the macrodome is between 114° and 120° in angle, and 120° is nearly a mean between the two domes. The vertical axis in section III is *two-thirds* that of section I; and taking $\frac{3}{2}\bar{\imath}$ as $1\bar{\imath}$, the two groups would coalesce.

We hence perceive that in the change that takes place in a case of dimorphism from the monometric to these trimetric forms, the characteristics of the monometric system are still to a considerable extent retained.

In Table IV, Section I has the angle of the macrodome near 70° 32′; II, brachydome near 109° 28′; III, macrodome near 109° 28′; IV, brachydome near 120°.

By a change of position, making one or the other of the lateral axes the vertical axis, many of the species might be referred to Table IV. Although the cleavage is opposed to this change, it is of interest to view the species in this way, in order to apprehend more fully all the relations of the forms. Hausmann has thus compared the anhydrous sulphates and carbonates. The following Table (IV A) contains the species of the Tables I to III, which admit of this change; and in the first column, the particular dome is mentioned which is here made the vertical prism.

In the following and preceding tables, the only changes from the fundamental forms adopted by other authors,* are such as de-

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* The fundamental forms adopted through the Descriptive part of this work, are made to correspond with these tables, when there was no doubt as to the propriety of it; in other cases they stand as given by the best authors.

pend on the simple ratios 1 : 2 and 2 : 3. The general principle is everywhere illustrated, that species may be homœomorphous and still vary by the simple ratios 1 : 2 or 2 : 3 ; a fact which has been illustrated by reference to augite and hornblende, and is also exemplified in the case of Andalusite, Topaz and Staurotide, and in other species.*

Table IV. A.

		Prism *I*	Dome 1ī	Dome 1ĭ
From Table I.				
Chrysolite,	1ī	115° 36′	60° 48′	85° 57′
Do.	1ĭ	119° 12′	64° 24′	94° 3′
Triphyline,	1ī	118° 27′	58° 5′	86°
Do.	1ĭ	121° 55′	61° 33′	94°
Epsomite,	1ī	120° 4′	59° 27′	89° 26′
Do.	1ĭ	120° 33′	59° 56′	90° 34′
Diaspore,	1ī	115° 16′	61° 18′	86° 8′
Do.	1ĭ	118° 42′	64° 44′	93° 52′
Göthite,	1ī	113° 6′	62° 30′	85° 8′
Do.	1ĭ	117° 30′	66° 54′	94° 52′
Polianite,	1ī	115° 26′	62°	87° 8′
Do.	1ĭ	118°	64° 34′	92° 52′
Euchroite,	1ī	117° 20′	60° 47′	87° 52′
Do.	1ĭ	119° 13′	62° 40′	92° 8′
Topaz,	1ī	($\frac{2}{3}$) 115° 22′	61° 50′	86° 52′
Do.	1ĭ	($\frac{1}{3}$) 118° 10′	64° 38′	93° 8′
Bournonite,	1ī	($\frac{2}{3}$) 115°	61° 46′	86° 20′
Do.	1ĭ	($\frac{2}{3}$) 118° 14′	65°	93° 40′
From Table II.				
Valentinite,	1ī	120° 56′	77° 24′	109° 28′
Barytes,	1ī	116° 20′	78° 20′	105° 24′
Anglesite,	1ī	117° 18′	76° 22′	104° 31′
Leadhillite,	1ī	119° 40′	76° 44′	107° 26′
Celestine,	1ī	117° 21′	75° 58′	104° 8′
Anhydrite,	1ī	118° 35′	77° 4′	107° 22′
Tantalite,	1ī	115° 53′	78° 28′	105° 2′
Mascagnine,	1ī	114° 8′	72° 20′	96° 52′
Sulphur,	1ī	($\frac{2}{3}$) 114° 42′	78° 2′	103° 20′
Manganite,	1ī	114° 19′	57° 10′	80° 20′
Calamine,	1ī	116° 39′	51° 34′	66° 6′
Haidingerite,	1ī	118° 32′	53° 2′	80°
Brochantite,	1ī	114° 29′	53° 19′	75° 50′
Cotunnite,	1ī	118° 28′	53° 16′	80° 14′
From Table III.				
Marcasite,	1ī	115° 8′	73° 55′	99° 40′
Mispickel,	1ī	120° 45′	68° 7′	99° 2′
Ausotellurite.	1ī	121° 8′	69° 12′	101° 26′

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* The angle of Andalusite is 90° 44′; of Staurotide 129° 20′; while Topaz gives two prisms, one of 86° 52′ and 93° 8′, and one of 124° 19′. The relation of the forms of Andalusite and Staurotide is as 1 : 2, (for the axes *b*, *c*); while the two prisms in Topaz have the same relation, and either, with almost equal reason, might be made the fundamental prism. The prism $\breve{i2}$ of Staurotide is 93° 8′ in angle, as

4. Monoclinic System.—Triclinic System.

Among the minerals of the Monoclinic system, several prominent homœomorphous groups may be pointed out.

1. *Pyroxene Group.*—$I:I=85°$ to $88°$.

Borax,	$\dot{Na}\dddot{B}^2+10\dot{H}$.	Hornblende,	$\dot{R}^4\dddot{Si}^3=R^3\dddot{Si}^{\frac{9}{4}}$.
Glauber Salt,	$\dot{Na}\dddot{S}+10\dot{H}$.	Acmite,	$(\dot{R}+\dddot{\bar{R}})\dddot{Si}^3=(\dot{R}^3,\dddot{\bar{R}})\dddot{Si}^{\frac{9}{4}}$.
Hydromagnesite,	$\dot{Mg}^4\ddot{C}^3+4\dot{H}$.	Laumontite,	$(\dot{R}^3,\dddot{\bar{A}}l)\dddot{Si}^2+2\dot{H}$.
Pyroxene,	$\dot{R}^3\dddot{Si}^2$.	Leonhardite? see vol. ii, p. 308.	
Rhodonite,	$\dot{Mn}^3\dddot{Si}^2$.	Pectolite,	$(\dot{R}^3,\dddot{\bar{R}})\dddot{Si}^{\frac{9}{4}}+Aq$.
Wollastonite,	$\dot{Ca}^3\dddot{Si}^2$.	Caporcianite?	
Spodumene,	$(\dot{R}^3,\dddot{\bar{R}})\dddot{Si}^2$.	Okenite? see vol. ii, p. 306.	

2. *Monazite Group.*—$I:I=91—95\frac{1}{2}°$

Monazite,	$\dot{R}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$.	Lazulite.
Crocoisite,	$\dot{Pb}\dddot{Cr}$.	Wagnerite.

3. *Euclase Group.*—$I:I=$nearly $115°$.

Euclase,	$(\dddot{\bar{A}}l,\dddot{\bar{B}}e)\dddot{Si}^{\frac{3}{4}}$.	Datholite,	$(\dot{R}^3,\dddot{\bar{R}},\dot{H}^3)\dddot{Si}^{\frac{2}{3}}$.
Sphene,	$(\dot{Ca}+\ddot{Ti})\dddot{Si}^{\frac{2}{3}}=(\dddot{\bar{R}})\dddot{Si}^{\frac{2}{3}}$.	Barytocalcite,	$\dot{R}\ddot{C}$.
Zoisite.			

4. *Heulandite Group.*

Heulandite,	$(\dot{R}+\dddot{\bar{A}}l)\dddot{Si}^4+5\dot{H}$.	Stilbite,	$(\dot{R}+\dddot{\bar{A}}l)\dddot{Si}^4+6\dot{H}$
Brewsterite.	"	? Gypsum,	$\dot{Ca}\dddot{S}+2\dot{H}$.

Other groups are mentioned in the Descriptive part of this work.

In the Triclinic System, the feldspars (exclusive of orthoclase) make a natural group, having $I:I'$ nearly 120°, and characterized by a basal and clinodiagonal cleavage. Orthoclase is properly of the same homœomorphous group, although Monoclinic (or more probably Diclinic.)

In the discovery of the first facts in Isomorphism, the grand principle was announced by Mitscherlich, that analogous compounds of related elements were alike in crystallization, and the converse proposition was deduced, that similarity of form was evidence of similar or analogous composition. Dr. H. Kopp, in pursuing this subject, observed that such homœomorphous compounds were closely similar in atomic volume, and he obtained the following results for the carbonates:

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in Table I, and this although not an observed prism, may be made the fundamental prism, as the mere frequency of occurrence of a form (that having the angle 129° 20′ in Staurotide) is not necessarily proof of its being the fundamental form. But the plains of twin composition have complex expressions with either of these fundamental forms, and become simple (1, and $1\bar{i}$) only when the larger lateral axis is made two-thirds the usual length, in which case the prism is 109° 20′.

	Atomic volume.	Axis *a*.	Angle.
Carbonate of zinc,	175·33	0·807	107° 40′
Carbonate of magnesia,	181·25	0·812	107° 25′
Mesitine,	186·26	0.815	107° 14′
Carbonate of iron,	188·50	0·819	107°
Carbonate of manganese,	202·29	0·822	106° 51′
Dolomite,	202·36	0·833	106° 15′
Calcite,	231·20	0·854	105° 05′

This table, which contains also the length of the vertical axis, (axis *a*), and the angle of the rhombohedron of each of these minerals, illustrates the interesting principle which he next deduces, that the axis increases, in this series, or the angle diminishes, as the atomic volume increases.

Subsequent investigation showed that there may be resemblances of form among *unrelated* compounds. A simple multiple relation in the atomic volume was to some extent detected in such species, and this fact was regarded as the true explanation of the identity of forms. The author obtained simpler results by reducing the aggregate atomic volume of the compounds to a unit value by dividing by the number of atoms in the compound.* The following are examples of the atomic volumes thus obtained.

1. Borax 46·38, Pyroxene 46·1—48·8, Glauber Salt 49·6, Spodumene 43·44, Hornblende 48·2—48·6, Acmite 48·33.
2. Scapolite 51·6, Meionite 55·65, Dipyre 55·21.
3. Epidote 45·28, Orthite of the Ural 48·025, Orthite of Hitteroe 48·43.
4. Calcite 46·24, Dolomite 40·47, Spathic iron 37·70, Carbonate of zinc 35·07, Chrysoberyl, 37·15.
5. Quartz 54, Chabazite 51 5.
6. Andalusite 41·94, Topaz 42·6.
7. Feldspar family:—1. *Monoclinic:* Orthoclase 60·4; 2, *Triclinic:* [Albite 55·67, Andesite 55, Labradorite 53·0, Oligoclase 54·64, Anorthite 52·85; 3. *Monometric:* Leucite 63·08.

The serial relation of the rhombohedral and trimetric carbonates was pointed out in the same paper, as follows:

The upper range of figures pertain to the rhombohedral species, and the lower to the trimetric. Calcite is the only one certainly known to be dimorphous.

$\dot{\mathrm{Zn}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Mg}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Fe}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Mn}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Pb}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Sr}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Ba}}\ddot{\mathrm{C}}$
107° 40′	107° 25′	107° 0′	106° 51′	105° 15′			
35·07	36·25	37·70	40·46	46·24			
				43	50·6	50·54	57·3
				116° 10′	117° 13′	117° 19′	118° 30′

These, in each series, are acknowledged isomorphs, according to the old principle. Yet the range of numbers is wide.

From the tables on the preceding pages the subject of Isomorphism has a still wider extension. Some modification of earlier views are required, as was long since urged by von Kobell (1832.)

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* See Am. J. Sci. [2], ix. 1850, xii, 204.

It is still true that similarity or analogy of composition may be exhibited in similarity of crystallization; and when forms are similar and composition is analogous, homœomorphism is evidence of a homœomorphism in the constituents of the compound. Thus the similarity of form between Tantalite and Heavy spar is evidence that tantalic and sulphuric acids are homœomorphous.

But it is also evident that similarity of form may be independent of relations in composition, and result from a certain mathematical dependence of the prismatic forms on the monometric. The elements are mostly monometric in one state or another; and as the prismatic forms are derived from these elements, and often have a monometric form as one of their dimorphous states, the retained impress of the monometric forms, found in the angles of the domes, determines the prismatic angles, and leads often to identity of form when there is no analogy either in the nature of the elements or their proportions in the compound.

Among the striking cases of homœomorphism with unlike constitution, are the following: one group includes Sulphur, the Anhydrous sulphates $\dot{R}\dddot{S}$, Marcasite $Fe\,S^2$, Descloizite $\dot{Pb}^2\ddot{V}$. Another includes Childrenite a phosphate, Epistilbite a silicate, Orpiment $As^2\,S^3$, Mispickel $Fe\,(S, As)^2$, Aurotellurite $(Ag, Au)\,Te^2$. Another contains Tourmaline a silicate, Nitratine a nitrate, Pyrargyrite a sulphuret, the Anhydrous Carbonates, Iodic silver. Again, along with arsenic and some other metals, there are protoxyds, as protoxyd of zinc, many peroxyds, (as of iron, &c.) and Willemite, a silicate of zinc. The tables are made up of similar examples.

In many cases of homœomorphous compounds which are apparently dissimilar in composition, a resemblance may hereafter be detected when the true relations of the constituents are better understood.

Hermann has discussed the varying composition of Scapolite, Epidote, Tourmaline, and other species, and explains it by supposing the mineral to include two silicates which are mutually replaceable. Thus for the Scapolite group, these silicates or "heteromerous molecules" are

$$a,\ \dot{R}^3\dddot{Si}+2\dddot{\bar{R}}\dddot{Si},—b,\ \dot{R}\dddot{Si}+\dddot{\bar{R}}\dddot{Si},$$

Meionite$=a$; Edingtonite, which he refers to the group,$=a+12\,\dot{\bar{H}}$; Wernerite, one variety $a+b$; another variety $a+2b$; a third $a+6b$; a fourth, $a+12b$; a fifth,$=b$. This mode of explaining the facts is but partial in its bearing, and tends to give increased complexity to the subject, by multiplying points demanding explanation.

Scheerer endeavors to explain the relations of various magnesian species, hydrous and anhydrous, on the hypothesis that three parts or atoms of water may replace one of magnesia, and that three of alumina may replace two of silica. He thus reduces Talc, Steatite, and certain other magnesian silicates, to the hornblende type; and another set of related species to the augite type; and still a third group to the type $\dot{\mathrm{R}}\dddot{\mathrm{Si}}$. But the so-called species referred to are for the most part uncrystallized, and therefore not well adapted to settle questions in this department.

Others have met some of the difficulties by the view that protoxyds and peroxyds may replace one another, in the proportion of the oxygen they contain. It is found in Epidote and Idocrase, that while the protoxyds and peroxyds vary in their oxygen proportions, the ratio of the sum of the two to the silica is constant. Now a fact that is thus a constant one for a species is a fundamental fact of the profoundest signification; and there is hence the best reason to accept of the oxygen ratio between the oxygen of *all* the bases (protoxyds and peroxyds) and the silica as the essential characteristic of the species. The oxygen ratio of the protoxyds and peroxyds may still be in general a simple ratio, and this is probably true for the species mentioned, the two prevalent ratios being 1 : 2 and 3 : 2.*

This relation may be expressed in the formula in the manner already explained, (p. 189), making $3\dot{\mathrm{R}}$ replace $\dddot{\bar{\mathrm{R}}}$; thus the general formula (1), and two special formulas (2), (3), of idocrase, are,—

(1.) $(\dot{\mathrm{R}}^3, \dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$, (2.) $(\tfrac{1}{2}\dot{\mathrm{R}}^3+\tfrac{1}{2}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$, (3.) $(\tfrac{3}{5}\dot{\mathrm{R}}^3+\tfrac{2}{5}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$.

In Tourmaline, as Rammelsberg has shown, there are five varieties, differing widely in the oxygen ratios of the protoxyds, peroxyds, boracic acid, and silica, and varying nearly indefinitely for the boracic acid,—the ratios for the protoxyds, peroxyds and boracic acid lying between 1 : 3 : 1 and 1 : 14 : 3. Yet there is the constant ratio 4 : 3 between the oxygen of all the oxyds, including the boracic acid, and that of the silica. This ratio of 4 : 3 is consequently the characteristic of the species. Disregarding this fact, and making the boracic acid replace silica, we obtain no common type of formula for the species; Rammelsberg's formulas being

(1.) $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+3\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}$, (2.) $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+4\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}$, (3.) $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+6\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}$, (4.) $\dot{\mathrm{R}}\dddot{\mathrm{Si}}+3\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}$,
(5.) $\dot{\mathrm{R}}\dddot{\mathrm{Si}}+4\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}$.

But recognizing the true bearing of this ratio, we are compelled to place the boracic acid with the bases, and make it, on the principle stated, replace the other oxyds. The general formula is then

$$(\dot{\mathrm{R}}^3, \dddot{\bar{\mathrm{R}}}, \dddot{\mathrm{B}})\,\dddot{\mathrm{Si}}^{\frac{3}{4}},$$

in which $\dot{\mathrm{R}}^3, \dddot{\bar{\mathrm{R}}}, \dddot{\mathrm{B}}$ vary between 1 : 3 : 1 and 1 : 14 : 3.†

Thus the mode of making the oxyds replace one another in the proportion of the oxygen they contain appears to exhibit the true simplicity of nature.

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* The whole oxygen ratio for $\dot{\mathrm{R}}$, $\dddot{\bar{\mathrm{R}}}$, $\dddot{\mathrm{Si}}$ in Idocrase, is 1 : 1 : 2, for one variety, and 1 : $\tfrac{2}{3}$: $1\tfrac{2}{3}$ (or 3 : 2 : 5) for the other. Adding the first two terms, we have 1 : 1 for the ratio of the oxygen of the bases and silica in each.

† See further under Tourmaline, vol. ii, p. 271.

The correctness of this application of the principle alluded to, is proved by the remarkable isodimorphism of Tourmaline and Calcite. *R* : *R* in these species is respectively 103° and 105°. Now Calcite and Barytocalcite are dimorphous, and related carbonates. Moreover Barytocalcite and Euclase are quite nearly related in form.* Therefore Tourmaline and Euclase are dimorphous. Moreover, since the accepted formula of Euclase is $(\overset{\cdot\cdot\cdot}{\bar{\mathrm{R}}})\overset{\cdot\cdot\cdot}{\mathrm{Si}}^{\frac{3}{4}}$, Tourmaline and Euclase have on the ground taken, and no other, analogous formulas.

Another example illustrating the fact that $\dot{\mathrm{R}}^3$ and $\overset{\cdot\cdot\cdot}{\bar{\mathrm{R}}}$ replace one another, is afforded by Spodumene and Augite. The crystallization of these species is the same, and the resemblance is so close, that G. Rose, in his recent classification, places them together, although this does not correspond with the principles of his system. The augite oxygen ratio for the protoxyds and silica is 1 : 2. Spodumene contains peroxyds, with the oxygen ratio 1 : 4 : 10. Adding the 1 and 4, we have 1+4 : 10 or 1 : 2, the true augite ratio, and thus the species are reduced to the common type. The formulas of the two species are therefore

Augite, $\dot{\mathrm{R}}^3\overset{\cdot\cdot\cdot}{\mathrm{Si}}^2$; Spodumene, $(\dot{\mathrm{R}}^3,\overset{\cdot\cdot\cdot}{\bar{\mathrm{R}}})\overset{\cdot\cdot\cdot}{\mathrm{Si}}^2$, or exactly $(\frac{1}{5}\dot{\mathrm{R}}^3+\frac{4}{5}\overset{\cdot\cdot\cdot}{\bar{\mathrm{R}}})\overset{\cdot\cdot\cdot}{\mathrm{Si}}^2$,

the oxygen ratio of the oxyds in Spodumene being 1 : 4.

Again, this principle brings together the homœomorphous species Zircon and Meionite, in which the ratio is 1 : 1; so also Willemite and Phenacite, which, with the same ratio 1 : 1, are nearly alike in rhombohedral form and angle; so also Danburite and Axinite, both of which are triclinic.

The fact that the protoxyds and peroxyds are thus mutually replaceable is further shown by the crystallization of the oxyds themselves. The protoxyd of zinc is well known to be isomorphous, in many species with the protoxyd bases; yet it crystallizes in hexagonal forms, with the angles of alumina and other peroxyds. And hence it should also be capable of replacing peroxyds, and not only should this be true of protoxyd of zinc, but also of the other protoxyds by which zinc is replaceable. The protoxyds may exist apparently in two states, in one of which they replace protoxyds, in the other peroxyds. The peroxyd of iron is also supposed to crystallize in octahedrons in martite, and if this be sustained, the argument is double-headed; for we then not only have protoxyds with the hexagonal form of peroxyds, but peroxyds with the monometric form of protoxyds. The principle is sustained again by another well-known fact, that the peroxyds and protoxyds combine together and form *monometric* species, as in magnetite, spinel, etc.†

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* See paper by the author, Am. J. Sci. [2], xvii, p. 216.

† There are many examples showing that the rhombohedron of 84° to 88°, and a monometric form are related as the two forms of a dimorph, and that there is thus a mutual dependence. Arsenic, Antimony, Palladium, present both forms, proving

Many deductions bearing on the principles of Chemistry might be deduced from the facts that have been presented,* and large citations might be made from various authors. But the discussion has proceeded far enough to exhibit the bearing of the subject on the classification of minerals. The arrangement which is explained beyond, is a systematic view of the homœomorphous groups of species under the several grand divisions; and the parallel groups in the same division, which are analogous in composition, are examples of dimorphism—or, to use the more general term, of pleomorphism.

Cause of Dimorphism.—The occurrence of one of two forms of a dimorphous substance rather than the other, has been shown by Mitscherlich, Rose, and others, to result in many instances from the different temperatures attending crystallization. When a *right rhombic* prism of sulphate of zinc is heated to 126° F., certain points in its surface become opaque, and from these points bunches of crystals shoot forth, in the interior of the specimen; and in a short time the whole is converted into an aggregate of these crystals diverging from several centres on the surface of the original crystal. The small crystals, thus formed at 126° F., are *oblique* rhombic prisms; and the same form may be obtained by evaporating a solution, at this temperature, or above it. Sulphur crystallizes from fusion in oblique rhombic prisms, while the common form obtained by evaporation is a rhombic octahedron. Rose has obtained crystals of aragonite by evaporating a solution of carbonate of lime to dryness by means of a water bath, and crystals of calc spar by permitting the solution to evaporate in an open vessel at the ordinary temperature. The crystals of aragonite were minute six-sided prisms and double six-sided pyramids. They change to rhombohedrons of calc spar if left moist; but if washed and dried at once, they remain permanent. By exposing aragonite to a low temperature, the crystal falls to pieces, in consequence of the change to calc spar which takes place; or if the prisms hold together, they consist, after the change, of an aggregate of minute particles of calc spar.† Artificial aragonite has been observed in the interior of a copper boiler used to supply hot water for household purposes at Port Eliot, Cornwall. The crystals were minute six-sided prisms, and were at-

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this correlation. The oxyds come under this system, the peroxyds presenting usually this rhombohedron, but sometimes its correlate; the protoxyds usually the monometric form, but sometimes the rhombohedral.

* We call attention to one point, the close homœomorphous relations of *Sulphur*, *prismatic sulphuret of iron*, (Marcasite $Fe\ S^2$), and the *anhydrous sulphates*, table 2, p. 200; and of *Orpiment* $As^2\ S^3$, and *mispickel* $Fe, (S, As)^2$. In the former group, the sway of the Sulphur is seen; in the latter, that of the Arsenic. The same dominant sulphur influence is seen in the Sulphato-carbonates, Susannite having the form of Dreelite, (a *sulphate*), and Leadhillite the form nearly of Anglesite.

† Rose, Lond. and Ed. Phil. Mag. [3], xii, 465.

tached at base to the surface supporting them.* Breithaupt has described a carbonate of lime from a greenstone rock near Zwickau, which consists of alternations of layers of aragonite and calc spar; and he suggests that one may be a winter, the other a summer deposit.†

Temperature appears to be a prominent cause. Yet it is probable that the nature of the solvent, or the presence of some accidental ingredient in the solution, may have some effect in changing the molecules; but in general the only effect of these causes is to produce secondary planes. Rose did not succeed in obtaining aragonite crystals by mixing a strontian salt with the solution of lime, and shows that the strontia in arragonite does not alone produce the rhombic form.

The presence of one base in place of another isomorphous with it, often decides the form, as with the soda in albite and potash in orthoclase, the latter causing a monoclinic form, the former a triclinic in a compound otherwise identically the same.

II. CHEMICAL EXAMINATION OF MINERALS.

The chemical properties of minerals are ascertained (1) by the action of acids and other re-agents; 2, by heat, concentrated by means of the blowpipe, assisted by various chemical re-agents; 3, by chemical analysis. This subject, especially the last division of it, falls into the department of chemistry. Only the more ordinary chemical and blowpipe tests are here mentioned.

I. CHEMICAL TESTS.

The simplest use of acids consists in the detection of a volatile ingredient expelled by them. A carbonate is thus distinguished. The acids ordinarily employed are the sulphuric, muriatic, and nitric, and they are commonly diluted with one-half water. Carbonate of lime, when dropped into either of these acids diluted, gives off bubbles of gas, an effect called effervescence. Some carbonates require the addition of heat. Before making this trial it should be observed that the mineral is quite pure, as a carbonate in seams or fissures might give a fallacious result. Another gas of a pungent odor is obtained when common salt is subjected to the action of sulphuric acid; and another of acrid character when copper and some other metals are acted on by nitric acid.

In such examinations with acids it is important to observe the odor of the escaping gas—whether very suffocating and disagreea-

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* Lond. and Ed. Phil. Mag. [3], xii, 330, 1841.

† Pogg. li, 506, 1840.

ble, or merely pungent; also, its color, and the color of the solution. In many instances, solution is obtained without effervescence; and often a mineral is but partly soluble, and the insoluble part is thrown down in the state of a powder; frequently, it may be insoluble in cold, but soluble in hot acid. The fumes given off will sometimes redden paper tinged blue with litmus or cabbage liquor, owing to their acid character; others will blacken paper that is charged with acetate of lead, because of the sulphur they contain. Others, again, will discharge the color of brazilwood in paper, a property of hydrofluoric acid, which acid, when driven off from a mineral by strong sulphuric acid, will also corrode glass placed over it.

Another effect of the action of acids is the formation of a *jelly*. To accomplish this, the finely pulverized mineral is thrown into a *strong* acid, and a gentle heat applied. After a short time, as the solution cools, it gelatinizes; or in other cases, partial evaporation is necessary before the jelly appears. In a few instances, a jelly may be formed with cold acid. By heating the mineral, this property is often destroyed; but occasionally it takes place, with equal facility, before and after heating, and sometimes not at all until after heating. The minerals that gelatinize in this manner are silicates; it arises from the separation of the silica in a gelatinous state.

The following are some of the more common chemical re-actions:

a. Carbonates.—Effervesce with dilute muriatic acid, yielding a colorless inodorous gas, which gives a white precipitate when passed into lime water. The fumes slightly redden moist litmus paper and *heat restores* the blue color.

b. Sulphates.—No effervescence with acids. When in solution, they give with barytic water a white precipitate not soluble in water, or the muriatic, nitric, or sulphuric acids.

c. Nitrates.—With strong sulphuric acid give white corrosive vapors of nitric acid. With heated muriatic acid yield an acid that dissolves gold, becoming at the same time yellow.

d. Phosphates.—Well dried and heated in a glass tube with potassium, give a phosphuret, which in water produces phosphuretted hydrogen, a gas which inflames on coming into the atmosphere, and has a garlic odor. The phosphates generally dissolve unchanged in muriatic and nitric acids. In sulphuric acid they are for the most part decomposed—forming double salts. With nitrate of silver the soluble phosphates, or neutral nitric solutions of the insoluble, produce a characteristic yellow precipitate of phosphate of silver. When molybdate of ammonia is added to a solution of any phosphate, and then muriatic or nitric acid in excess, a yellow color soon appears, and after a while a yellow precipitate is thrown down.

e. Fluorids.—If a pulverized fluorid be subjected to the action ot strong sulphuric acid, in a platinum crucible, and heat be applied, fumes will be given off which will corrode a plate of glass placed over the crucible.

f. Chlorids.—In solution afford with nitrate or silver a white curdy precipitate, which darkens and becomes violet on exposure, is not soluble in water, hardly so in acids, and wholly in ammonia. Any chlorid heated in sulphuric acid yields muriatic acid, which acts as just stated with nitrate of silver; or heated with oxyd of manganese, affords chlorine.

g. Silicates.—Fuse in a silver crucible with three or four times their weight of caustic potassa or soda, yielding a silicate soluble in water, which gives with an acid a precipitate (silica) that dries to a white, insoluble powder, harsh to the touch. Many silicates gelatinize with acids, as already stated. They dissolve with effervescence in strong fluohydric acid.

h. Borates.—If a borate in powder is heated with sulphuric acid, and alcohol is then added, the flame will have a green color, especially on the edges.

i. Salts of Lime.—In solution, even if dilute, give with oxalic acid or oxalate of ammonia a white precipitate insoluble in water or acetic acid, but very soluble in either of the stronger acids.

k. Compounds of Iron.

	Protoxyd Salts.	Peroxyd Salts.
Precipitate with potash or soda,	greenish white, becoming green and then yellow on exposure.	brown, of hydrated peroxyd of iron.
Precipitate with ferrocyanid of potassium,	white, becoming blue on exposure.	Prussian blue.
Precipitate with nutgalls or tannic acid,	none; but becoming bluish black on exposure.	deep blue black.

l. Compounds of Manganese.—The oxyds heated with muriatic acid give chlorine. Heated with potash or its nitrate, the salts give manganate of potassa, which affords a green color with water, and a rose tint with dilute acids that is destroyed by sulphurous acid or organic matters.

m. Compounds of Copper.—Mostly soluble in nitric acid. Metallic iron in the solution becomes coated with metallic copper; potash or soda produces a blue precipitate, which becomes black on boiling; ammonia a green, which is soluble in an excess of ammonia and becomes fine blue.

n. Compounds of Zinc.—The sulphate gives a white precipitate with potash, soluble in an excess of this re-agent; no precipitate with sulphuretted hydrogen. Acetate of zinc affords an abundant white precipitate with sulphuretted hydrogen.

o. Compounds of Lead.—Dissolved in nitric acid, give with sulphuretted hydrogen a black precipitate, insoluble in excess; with iodid of potassium, or chromate of potash, a yellow precipitate. The acetate yields with metallic zinc, metallic lead in shining plates or scales. With a slip of zinc neutral solutions of lead precipitate metallic lead.

p. Compounds of Tin.—Dissolved in muriatic acid, form a chlorid, which with chlorid of gold give a purple color, or if strong, a brown precipitate.

q. Compounds of Mercury.—The protosalts in solution give with potash a black precipitate insoluble in excess; with sulphuretted hydrogen a black insoluble precipitate; with metallic copper, they yield metallic mercury, which is dissipated by heat. With muriatic acid afford a white precipitate or calomel.

r. Compounds of Silver.—Dissolved in nitric acid, a chlorid or muriatic acid throws down a dense, white, curdy chlorid of silver, which blackens on exposure, and is soluble in ammonia. With metallic copper it affords metallic silver.

s. Gold.—Dissolves in nitromuriatic acid, (aqua regia), but not in either of the acids unmixed. The solution gives, with protochlorid of tin, a purple precipitate, and with protosulphate of iron, metallic gold.

t. Platinum.—Dissolves in nitromuriatic acid, and not in either of the acids unmixed; the solution gives with muriate of ammonia a yellow precipitate, which heated in a platinum crucible gives metallic platinum in powder.

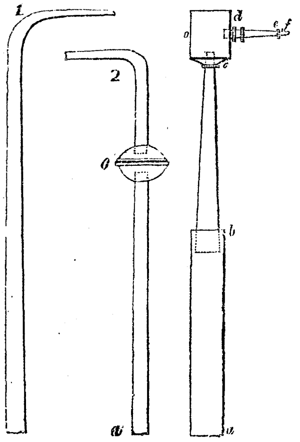
II. ACTION WITH THE BLOWPIPE.

The first of the following figures represents the simplest kind of blowpipe. It is merely a bent, tapering tube of brass, from seven to ten inches long, with a minute aperture at its smaller end. It is used to concentrate to a point the flame of a lamp or candle; and this is done by blowing through it while the smaller end is just within the flame.

After blowing awhile, the moisture of the breath often condenses in the tube; and to receive this moisture, and prevent its passing out at the beak, the chamber at *o* (see f. 258, 259) is usually added. The air-chamber in f. 259 is a cylinder, into which the tube *abc* is screwed at *c*, and the smaller piece, *def*, at *d*. The point *ef*, screws off, and is made of platinum in order that it may be cleaned when necessary, by immersion in an acid.

When the blowpipe is made of brass, it is usual to have an ivory mouthpiece, as it is more agreeable in the mouth. Silver is the best material; and the point, at all events, should be of platinum. Wollaston contrived a convenient pocket instrument on the plan of a common pencil case. The instrument represented in f. 259 has a screw

257 258 259



at *b*. On unscrewing it, the part *bc* may be inserted at *a* into the part *ab*, and the two screwed together again. In this way it is as portable as Wollaston's, and has the advantage of being more easily made tight with the screw, and is less liable to get out of order.

Operations with the blowpipe often require an unintermitted heat for a considerable length of time, and always longer than a single breath of the operator. It is therefore requisite that breathing and blowing should go on together. This may be difficult at first, but the necessary skill or tact is soon acquired. Let the learner attempt first to breathe through his nostrils with his cheeks inflated and mouth closed. This accomplished, if the blowpipe is now put to the mouth, he will find no difficulty in continuing his respirations while the muscles of the inflated cheeks are throwing their contained air through the blowpipe. When the air is nearly exhausted, the mouth may again be filled through the nose without intermitting the process of blowing. The chamber at *o* has been recently made of india rubber, with valves, which does away with all the difficulty.

The blowpipe flame consists of two cones: an inner of a blue color, and an outer, yellow. The heat is most intense just beyond the extremity of the blue flame. The inner flame is called the *reduction* flame, and the outer the *oxydation* flame. A mineral reduced to the metallic state by the *inner*, may often be oxydized, or combined with oxygen, in the *outer* flame, where it is in contact with the atmosphere. For oxydation, the beak of the blowpipe should have a large aperture, and the wick of the lamp should also be large: the heat may be that of incipient redness.

The best flame is that of a lamp with a large wick, fed by olive oil. A common candle with a large wick will answer for most of the purposes of the mineralogist, and is most conveniently carried about. When used, the wick should be bent in the direction of the flame.

To support the mineral in the flame, either charcoal or platinum forceps or wire may be used. The charcoal should be well burnt but firm; that from pine wood is the best, as it burns with least ashes. The reaction of the carbon of the coal aids in reducing or decomposing many mineral species.

A convenient kind of forceps is represented in the annexed figure.

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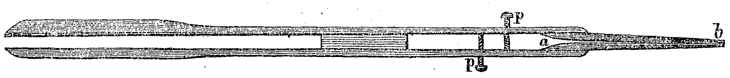

It is made of steel, with platinum points, *ab*, and pins at *p*, *p*, for opening the forceps. The mineral kyanite, and also mica, are sometimes used for a support when more convenient means are not at hand.

To test the presence of water or a volatile ingredient, the mineral may be supported near one end of a test tube, which may be three or four inches long, and the bore little larger than a quill. The flame is concentrated on the exterior of the tube beneath the assay, and the volatilized substance usually condenses in the upper part of the tube. By inserting into the upper end of the tube a strip of litmus or other test paper, it is ascertained whether the fumes are acid or not, the color of the paper, if so, changing to red.

The specimen to be subjected to the flame of the blowpipe should be a very small *thin* fragment, especially when the mineral is not very fusible; for fusion is often thus obtained, when impossible with a fragment without thin edges. A fragment as large as a pea might afford a score of pieces, large enough for a blowpipe trial.

Many minerals remain unaltered before the blowpipe, unless some substance be added to aid in the fusion or reduction. These substances are called *fluxes*. Those in common use are *borax*, *carbonate of soda*, and *salt of phosphorus* or *microcosmic salt.*[*] Care should be taken to obtain the fluxes pure, and for this purpose it is well to dissolve and recrystallize the borax; and the soda should be tested for sulphuric acid, as any adulteration with this acid will give the glass obtained with silica, a brown or reddish color. These fluxes should be powdered and added to the mineral, and the whole assay should not exceed the size of a small pea. One fourth this size is better than larger. The soda should be added in small successive doses; this flux is often absorbed by the charcoal, but generally reappears when the heat is sufficiently raised.

Besides the fluxes mentioned, other tests are sometimes used, of which the following are the most important.

a. Nitrate of cobalt in solution, for distinguishing alumina and magnesia. This solution should be pure, free from alkali and slightly concentrated. Berzelius recommends having a bit of platinum wire in the cork stopper, in order to take out a drop upon it when required for use.

b. Boracic acid and *iron wire*, used in testing for phosphoric acid.

c. Tin-foil, for using with certain peroxyds of metals to reduce them to protoxyds. The assay, previously heated in the reducing flame, should be touched with the end of the tin-foil; a very minute quantity of a metallic oxyd is often thus detected.

d. Gypsum and *fluor*, used as tests of one another. When two parts of the former rendered anhydrous by heating, and one of the

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[*] This salt, a phosphate of soda and ammonia, may be made by dissolving sixteen parts of sal-ammoniac in a small quantity of boiling water, and afterwards adding 100 parts of crystallized phosphate of soda, boiling gently the whole, and then setting it away to cool. The *salt of phosphorus* is deposited in small crystals. If the heat be too great during ebullition, decomposition takes place.

latter, are mingled and heated, they fuse to a clear glass, which is a milk-white enamel on cooling. The globule from fluor and heavy spar is transparent when cold; and that with sulphate of strontian is more or less frothy.

c. *Saltpetre* is employed in discovering manganese, bringing out the characteristic amethystine color when the quantity of this metal is too small to color glass without this reagent. The heated globule is touched with the point of a crystal, just at the moment of suspending the blast. The melted mass swells, foams, and either becomes immediately colored, or is so soon, upon cooling.

f. Anhydrous bisulphate of potash, used for detecting lithia. It is kept in a coarse powder in a phial well secured from moisture.

g. Oxalate of nickel, or *nitrate of nickel*, used to detect potash. The nickel must be quite free from cobalt; it may be tested by treating it with borax, with which it should give a brown, not a blue bead.

h. Nitroprussid of sodium,* for detecting sulphur.

The effects of the blowpipe are various. Some minerals are volatilized wholly or in part, others fuse at a low temperature; while others melt only on the edges, (then called *subfusible*), or are wholly infusible. Kobell has proposed the following scale for denoting in figures the degree of fusibility: 1. *Gray antimony.*—2. *Natrolite.*—3. *Cinnamon Stone*, (var. of garnet).—4. *Black Hornblende.*—5. *Feldspar.*—6. *Chondrodite.* The fusibility, when equal to that of natrolite, is designated by 2; or if like hornblende, by 4, and so on.

The fluxes are also often required in obtaining the pure metals from the metallic ores.

The following are some of the reactions with the fluxes:

1. *Silica, Silicates.*—Silica dissolves with effervescence in soda. The silicates are decomposed by salt of phosphorus, and the silica is set free, often remaining as a silica skeleton in the globule. *Columbic acid*, on the contrary, forms a clear glass with salt of phosphorus.

2. *Potassa, Soda, Lithia.*—Soda gives an intensely yellow color to the flame, even when in combination: yet this color may be otherwise produced. Potash salts often give a violet tinge, and a lithia salt a red color to the flame; but the presence of soda vi-

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* It is readily obtained by treating two parts of the powdered ferrocyanid of sodium with five parts of common nitric acid previously diluted with its own volume of water. The solution when the escape of gas has ceased, is heated in a water bath, until a salt of the protoxyd of iron gives a slate colored (and no longer a blue) precipitate. It is then cooled, when a precipitate forms; the liquid is next filtered and neutralized with carbonate of soda, when a green or brown precipitate goes down leaving it ruby colored; this liquid is poured off and evaporated, a crystallization takes place of nitrate of potash and soda, together with the new salt, the last in crystals of a splendid ruby-red color.

tiates the test by communicating its own color. A glass of borax containing potash becomes blue when a little oxalate of nickel is carefully added, and one of soda, brown; and this holds good for the potash salt, although soda be present. A lithia salt fused on platinum foil, if soda be present, produces a yellow stain; but this stain is produced also by other reagents. If a lithia mineral be mixed with one part of fluor finely pulverized, and one and a half parts of bisulphate of potash, the flame is red; if no lithia is present, it is faint violet.

3. *Lime.*—Lime and lime salts give a brilliant white light. They sometimes tinge the flame reddish, but more faint than carbonate of strontia.

4. *Magnesia.*—Magnesia and many magnesian silicates afford a clear rose-red color with cobalt solution, after a long heat. A fragment after heating, should be moistened with the solution, and then heated again; the color deepens on cooling. Magnesia is not acted on by soda.

5. *Alumina.*—If a fragment of alumina, or if an aluminous silicate, after heating to redness, be moistened by cobalt solution and again heated, but not to fusion, it assumes a fine blue color. The harder species should be finely pulverized. The test is sure except when oxyds of certain metals are present; and also when saltpeter is present, since it gives a blue color with silica and zirconia, and in some other cases.

6. *Arsenic and Arsenical Compounds.*—Give off usually arsenical fumes having an alliaceous odor when heated on charcoal or with soda. With many of the compounds heated in a tube, white arsenic or orpiment is condensed; and with charcoal metallic arsenic is obtained on the tube in crystals.

7. *Selenium and Seleniurets.*—Give a horse-radish odor in the outer flame on charcoal; yield in a tube a sublimate in the form of a dark red powder.

8. *Sulphurets.*—A glass made of soda and silica becomes red or orange yellow when sulphur is present. Heated on charcoal with soda and then adding a drop of water, the sulphurets yield sulphuretted hydrogen, which blackens silver foil or test paper containing acetate of lead. Heated in a glass tube closed below, with litmus paper above, they redden the paper and yield often a sulphureous odor.

A more delicate test for sulphur is the *nitroprussid of sodium*, as published by Prof. J. W. Bailey. Heat by blowpipe any sulphuret or sulphate (or anything containing sulphur) upon charcoal with carbonate of soda, put the fused mass into a watch glass with a drop of water, and add a particle not larger than a pin's head of the nitroprussid of soda; there will be a magnificent purple at once. If this test for sulphur is tried upon parings of nails, hair, albumen, &c., the carbonate of soda should be mixed with a little starch, which appears to prevent the loss of any of the sulphur by oxydation. On winding up a piece of hair four inches long by coiling it around one point of a platinum support, moistening it and dipping it into the mixture of carbonate of soda with starch, and then heating by the blowpipe, the fused mass will give with the nitroprussid an unmistakable action indicative of sulphur. By careful management perfectly satisfactory results may be obtained from a piece of hair less than an inch long.

9. *Tellurium and Tellurets.*—Give fumes but no odor. Heated on charcoal, the oxyd covers the charcoal with a brownish yellow coating, and the inner flame directed upon this coating is tinged bright green. In a tube the fumes rise and coat the glass, and when heated the coating melts into drops, which are but slowly driven off by the continued heat.

10. *Chromium.*—Oxyd of chromium with borax gives an emerald green color; but on platinum wire in the outer flame the color nearly disappears. Chromic iron gives the same color, and it is brightened on the addition of tin-foil.

11. *Antimony.*—The ores of antimony afford fumes usually white on charcoal, which are inodorous. The oxyds form with soda on the platinum wire, a clear colorless bead, which becomes white on cooling; on charcoal they are reduced. In an open tube, antimony gives white fumes, which coat the glass, and vaporize easily on a new application of the heat, without fusion to globules.

12. *Bismuth.*—Fuses and gives off inodorous fumes. On charcoal it becomes surrounded with a dark brown oxyd, which is pale yellow on cooling; the flame directed on the coating is not tinged; ultimately the metal is wholly vaporized.

13. *Titanium.*—Titanic acid with borax yields a colorless glass, which becomes milk-white on flaming, if not without. In the inner flame the glass with little of the assay is first yellow and afterwards amethystine and transparent. With more assay on charcoal in the inner flame becomes dark blue or nearly black on cooling; but it is pale blue afterwards on flaming. With salt of phosphorus, it forms in the outer flame a clear colorless glass; in the inner flame, a red or violet-blue glass, when cold, especially if tin be added. When iron is present the color after heating in the inner flame is deep red on cooling. Siliceous titanic minerals, as sphene, do not give the reaction with borax, except after long heating in the inner flame with salt of phosphorus, and it is apparent only on cooling.

14. *Tin.*—Oxyd of tin is slowly dissolved by borax to a transparent glass, which is transparent on cooling. With soda or cyanid of potassium on charcoal it is easily reduced; and if borax also be added, a very minute quantity of tin may be detected when present in other minerals.

15. *Cerium.*—Oxyd of cerium affords with borax and salt of phosphorus, a fine red or dark yellow glass in the outer flame, which becomes white on flaming. The protoxyd changes to

peroxyd, and the latter is not changed in the inner flame. In the compounds with silica, cerium is not distinguishable from iron by the blowpipe.

16. *Lead.*—Minium is black while hot, but at a low red heat changes to a yellow oxyd. The ores of lead on charcoal, with or without soda, are reduced; unlike tin, they often give a coating of oxyd on the charcoal, when heated in the outer flame.

17. *Zinc.*—Oxyd of zinc with borax gives a clear glass, which is milk-white on flaming; or with more assay, is enamel-white on cooling. In the inner flame on charcoal, fumes are given off, and a white coating surrounds the assay. With soda on charcoal, the ores, even when containing little zinc, afford the peculiar bluish flame of burning zinc, and the oxyd is deposited on the coal. With cobalt solution, a green color, while tin gives a bluish green.

18. *Cadmium.*—Oxyd of cadmium, even when in small proportions in other minerals, when heated on charcoal deposits a reddish brown powder; it forms from cadmiferous blende before the zinc begins to incrust the charcoal.

19. *Copper.*—Oxyd of copper gives a fine green glass with borax, which becomes cinnabar-red on cooling. The ores are reduced on charcoal with soda, and a malleable copper-colored globule obtained; when the copper is combined with oxyds that are reduced together with it, borax and tin should be used. If iron be present, the copper and iron are obtained separately.

20. *Manganese.*—Oxyd of manganese gives with borax in the outer flame an amethystine globule, (very deep, with much manganese), which becomes colorless in the inner flame. With soda on platinum the oxyd gives a green color which is bluish green on cooling. When other metals are present, soda should be added, and then the bluish green color is obtained, even with less than one per cent. of manganese.

21. *Iron.*—With borax in the outer flame, oxyd of iron gives a dark red glass, which becomes yellowish or colorless on cooling. In the inner flame it affords a bottle green color, or a bluish green in a more perfect reduction. With tin the green color is hastened. The peroxyd becomes magnetic when heated in the inner flame.

22. *Cobalt.*—Oxyd of cobalt gives a clear blue bead with borax, which does not become opaque on flaming. As in other metallic species, the sulphurets should be roasted before testing for the cobalt.

23. *Nickel.*—Oxyd of nickel forms a dark yellow or reddish glass with borax, which is nearly colorless on cooling; but with more of the oxyd, the glass is dark brown, while hot, and becomes red on cooling; and with saltpetre in the outer flame the color is changed to a blue or deep purple, distinguishing it from oxyd of iron.

Silver.—The ores on charcoal, with, if not without, a flux, are reduced to the metallic state. But when other metals are present, lead is to be mixed with the assay, with the borax, and thus an alloy of lead and silver formed, from which the silver may be obtained by cupellation.

25. *Chlorids.*—A dull green pearl, made by dissolving a little oxyd of copper in salt of phosphorus, becomes surrounded by a fine blue or purple flame if a chlorid be added, which continues till the chlorine is expelled.

26. *Fluorids.*—When fluorids are heated with salt of phosphorus previously melted in an open glass tube, the glass is coroded, and Brazil paper, placed within the tube, is turned yellow. The salt of phosphorus for this experiment should be free from all chlorids. If the fluorine is present only in small quantity the assay may be heated in the same way without the salt of phosphorus.

27. *Sulphates.*—Like the sulphurets, in their reaction with a glass of borax and silica.

28. *Nitrates.*—Deflagrate on burning coals, and also give off a red gas when heated in a matrass with a drop of sulphuric acid.

29. *Phosphates.*—If a phosphate be fused with boracic acid, and the extremity of a small iron wire be inserted into the melted globule, and the whole be heated in the reduction flame, the globule formed at the extremity of the wire will prove to be more or less brittle, when struck with a hammer on an anvil. As the bead cools, a flash of light is usually seen. Before this trial it should be ascertained that no sulphuric or arsenic acid is present, which also may form a globule with the iron; nor any metallic oxyd reducible by the iron.

30. *Borates.*—When a borate is melted with three parts of the flux called Turner's reagent, (a mixture of two parts of fluor spar and one of bisulphate of potash), the flame at the instant of fusion is brightly tinged with green. This trial should be made in a dark place.

For a more complete account of the blowpipe and of its use in chemical analysis, I would refer to the Treatise by Berzelius (Whitney's translation) and also that of Plattner.

In addition to the instruments already described, the following are important: 1. *A small hammer*, with a slightly rounded face and a transverse sharp edge at the other extremity. 2. *An anvil*, or piece of steel 3 inches long, 1 broad, and $\frac{3}{16}$ thick—to be used for pulverizing minerals, for which purpose the specimen should be first wrapped in a piece of paper. 3. *Platinum foil*, for enveloping minerals that decrepitate. 4. *Fine Platinum wire*, bent at one end into a circle one or two lines in diameter; it very conveniently holds the assay in fusion. 5. *Cutting pliers*, for separating small fragments of a mineral for assay.

Cupellation.—Cupellation is a process by which one metal in an alloy is oxydized and absorbed by a porous material, and the other left pure. It is used for separating silver and gold from lead. It is performed before the blowpipe by making a small rounded cavity in charcoal, about as deep as broad, (say ¼ inch), putting in fine bone ashes a little moistened, and made smooth by pressure, and upon this, after drying slowly, the assay; then heating in the outer flame. When the alloy of silver and lead is thus treated, the lead becomes an oxyd and is absorbed by the bone ashes, and the silver, though extremely minute in quantity, remains as a brilliant globule in the cavity.*

The ordinary process of cupellation is as follows: The assay is heated in a small cup (called a cupel) made of bone ashes, (or in a cavity containing bone ashes), *while the atmosphere has free access.* The heated metal is oxydated by the air passing over it, and the oxyd formed sinks into the porous cup, leaving the precious metal behind. In order to fuse the alloy and still have the atmosphere circulating over it, the cupel is placed in a small oven-shaped vessel, called a muffle, (f. 261); it is of infusible stoneware, and has a number of oblong holes through which to admit the flame from the fire, and give exit to the atmosphere which passes into it. The muffle is inserted in a hole fitting it in the side of a vertical furnace, with the open mouth outward and even nearly with the exterior surface of the furnace. The fire is made within the furnace, below, around, and above; and after heating up, the cupel is put in the muffle with the assay in its shallow cup-shaped cavity. It thus has the heat of the furnace to fuse the assay, and the air at the same time is drawn in over it through the large opening of the muffle. The oxygen of the atmosphere unites with the lead of the assay, and produces an oxyd, which oxyd sinks into the cupel, leaving the silver or gold behind. The completion of the process is at once known by the change of the assay suddenly to a bright shining globule.

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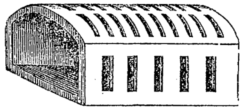

In the cupellation of gold containing copper, lead is melted with the assay. The lead on being fused in a draft of air oxydizes, and also promotes the oxydation of the copper, and both oxyds disappear in the pores of the cupel, leaving the gold behind, and the silver alloyed with it. In this process the gold is melted with three times its weight of silver, (a *quartation*, as it is termed, the gold being one part out of the four of the alloy), in order by diffusion to effect a more complete removal of the silver as well as the contained copper. The cupel is placed in the heated furnace, and the gold, silver, and lead on the cupel; the heat is sustained until the surface of the metal is quiet and bright, when the cupellation is finished; the metal then is slowly cooled and removed.

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* A table by Prof. W. W. Mather, is contained in the American Journal of Science, [2], iii, 414, which gives the ascertained weight of globules of silver, of given diameters. Similar tables are given in different Treatises on chemical analysis.

The button obtained, after annealing it by bringing it to a red heat, is rolled out into a thin plate and boiled in strong nitric acid. This process is repeated two or three times with a change of the acid each time, and the silver is thus finally removed. At the United States mint, half a gramme of gold is submitted to assay. The assay-gold and quartation-silver are wrapped in a sheet of lead weighing about ten times as much as the gold under assay. After cupellation, the plate of gold and silver, loosely rolled into a coil, is boiled for 20 minutes in 1¼ oz. of nitric acid, of 20 to 22° Beaumé; the acid is then poured off and another portion of stronger acid is added, about half the former quantity, and boiled ten minutes; then the same again. The gold thus purified is washed and exposed to a red heat, for the purpose of drying and annealing it, and then weighed.

III. PSEUDOMORPHS AND METAMORPHIC CHANGES IN MINERALS.

Pseudomorphs were formerly viewed as singular freaks of nature, of occasional or rare occurrence. As science advanced, their numbers were found to be large, collections of them began to be made, and chemistry was variously taxed for their individual explanation. At the present time they are looked upon as types and evidences of vast metamorphic changes and processes of decay or reformation in inorganic nature, which have modified extended rock strata, and altered the structure of the earth's surface.

The earliest systematic treatment of the subject was made by Haidinger in Brewster's Edinb. Jour., vols. ix, x. In 1843 appeared the extended work of Blum, which has been followed by two supplements. Since then, the wide range of metamorphic action as illustrated by pseudomorphs has been discussed with ability, and many new developments by Bischof, in his Chemical and Physical Geology. The work of Volger on the history of minerals, issued the year past, follows up the same subject in some of its departments with critical care, and some original views. Various memoirs by other authors have also appeared, illustrating this important topic. Mineralogy is thereby becoming a living science, and the active germ from which the science of Geology in some of its departments is to have its true development. Moreover, it is receiving a purification itself, by the thorough study of the liabilities of species to change, thus making known the causes of variations in analyses, and bringing to light the true types of the original species. A high importance is given moreover to these variations; for each marks out principles that have operated extensively in the earth's history. Even the smaller differences in the varieties of species are proving to have an influential bearing on the alterations of these or other species; and they have also become essential data towards discussing the origin and peculiarities of associated species and the genesis of the beds of rock in which they occur. Every analysis has therefore a high interest, a special as well as a general value, and they cannot be too much multiplied, nor too fully presented in a Mineralogical Treatise. The formulas commonly given have their value, if they are right, which is not always sure. But the details of the analyses have a higher and wider importance, geological as well as mineralogical.

Pseudomorphs have been classed under four grand heads:

1. *Pseudomorphs by alteration:* those formed by a gradual change of composition in a species; *e. g.*, change of Augite to Steatite.
2. *Pseudomorphs by substitution:* those formed by the replacement of a mineral which has been removed, or is gradually undergoing removal; *e. g.*, petrifaction of wood.
3. *Pseudomorphs by incrustation:* those formed through the incrustation of a crystal which may be subsequently dissolved away; often the cavity is afterwards filled by infiltration; *e. g.*, change of Fluor to Quartz.
4. *Pseudomorphs by paramorphism:* those formed when a mineral passes from one dimorphous state to another; *e. g.*, change of Aragonite to Calcite.

These different kinds of change are not always distinguishable without special study. In some cases a change may take place through *alteration* of the surface, and then, this process ceasing, the interior may be dissolved out, leaving a pseudomorph like one of *incrustation;* or a pseudomorph that appears to be a result of alteration, explicable on chemical grounds, may be wholly due to substitution simply.

Again, changes of some Scapolites to a feldspar, and of Augite to Uralite, (hornblende), have been considered by Scheerer examples of *paramorphism;* Scapolite being considered dimorphous with some feldspar, and Augite with Hornblende. But while such paramorphic changes undoubtedly take place with Aragonite, their occurrence in these silicates—which are common associates in the same rock, and must have been formed under like circumstances—is hardly probable.

The following table contains a list of the known varieties of pseudomorphs that have thus far been observed:

1. ELEMENTS.

Pseudomorph.	*Forms Imitated.*
Native Copper,	Red Copper, Aragonite.
Native Antimony,	Valentinite.
Graphite,	Pyrites.

2. Sulphurets, Arseniurets.

Pseudomorph.	*Forms Imitated.*
Pyrites,	Mispickel, Pyrrhotine, Stephanite, Red Silver Ore, Polybasite, Marcasite, Galena, Specular Iron, Barytes, Calcite, Quartz, Anhydrite.
Leucopyrite,	Stephanite.
Marcasite,	Stephanite, Calcite.
Erubescite,	Copper Glance.
Copper Glance,	Chalcopyrite.
Chalcopyrite,	Copper Glance, Gray Copper.
Gray Copper,	Galena.
Silver Glance,	Pyrargyrite, Native Silver.
Galena,	Pyromorphite, Calcite.
Blende,	Calcite.
Stephanite,	Polybasite.
Covelline,	Copper Pyrites.

3. Chlorids, Fluorids.

Horn Silver,	Silver, Red Silver Ore.
Common Salt,	Dolomite.
Fluor,	Calcite.

4. Oxyds.

Magnetite,	Spathic Iron, Specular Iron, Actinolite, Mica.
Hematite, (F̶e),	Pyrites, Magnetite, Limonite, Göthite, Spathic Iron, Pharmacosiderite, Dolomite, Calcite, Barytes, Fluor, Quartz, Garnet.
Göthite,	Pyrites, Dolomite, Smithsonite, Barytes, Calcite, Calamine, Vivianite.
Limonite,	Specular Iron, Pyrites, Leucopyrite, Marcasite, Beryl, Ankerite, Spathic Iron, Scorodite, Cube Ore, Spherosiderite, Blende, Galena, Pyromorphite, Cerusite, Barytes, Fluor, Calcite, Dolomite, Comptonite, Jeffersonite, Pyroxene, Red Copper, Beryl, Quartz.
Minium,	Cerusite, Pyromorphite, Galena, Calcite.
Pyrolusite,	Manganite, Polianite (?), Dolomite, Calcite.
Hausmannite,	Manganite, Calcite.
Braunite,	Manganite.
Wad, Psilomelane,	Pyrolusite, Barytes, Fluor, Pharmacosiderite.
Manganite,	Calcite.
Black Copper,	Copper Glance.
Tin Ore,	Feldspar.
Bismuth Ochre,	Needle Ore.
Antimony Ochre,	Gray Antimony.
Antimony Blende,	Gray Antimony.
Valentinite,	Gray Antimony.
Arsenolite,	Realgar.
Quartz,	Barytes, Fluor, Gypsum, Calcite, Smithsonite, Calamine, Diallogite, Barytocalcite, Dolomite, Scheelite, Cerusite, Augite, Corundum, Garnet, Stilbite, Heulandite, Natrolite, Datholite, Scapolite, Wolfram, Galena, Pyrites, Spathic Iron; as *Prase*, Calcite; as *Chalcedony*, Barytes, Fluor, Calcite, Dolomite, Datholite, Pyromorphite; as *Carnelian*, Calcite; as *Hornstone*, Fluor, Calcite, Mica, Spathic Iron; as *Jasper*, Hornblende; as *Semiopal*, Calcite.

5. Anhydrous Silicates.

Hornblende,	Augite.
Mica,	Pinite, Iolite, Feldspar, Andalusite, Wernerite, Tourmaline, Hornblende, Elæolite, Beryl, Idocrase, Augite, Epidote, Albite.

Pseudomorph.	*Forms Imitated.*
Orthoclase,	Calcite, Laumontite, Prehnite, Analcime, Leucite.
Ice Spar,	Leucite.
Albite,	Orthoclase, Wernerite.
Scapolite,	Epidote.
Kyanite,	Andalusite.
Sandstone, clay,	Common Salt.
	6. Magnesian Hydrous Silicates.
Talc,	Kyanite, Feldspar, Pyrope, Chiastolite, Couzeranite, Actinolite, Magnetite.
Steatite,	Dolomite, Spinel, Quartz, Chiastolite, Topaz, Feldspar, Mica, Scapolite, Tourmaline, Andalusite, Staurotide, Kyanite, Garnet, Idocrase, Hornblende, Pyroxene, Gehlenite.
Serpentine,	Pyroxene, Hornblende, Chrysolite, Spinel, Schiller Spar, Diallage, Mica, Garnet, Chondrodite.
Chlorite,	Garnet, Hornblende, Feldspar, Tourmaline, Magnetite (?) Limonite (?) Calcite, Fluor.
Rensselaerite,	Pyroxene.
Green Earth,	Pyroxene, Prehnite, Chabazite.
Meerschaum,	Calcite.
	7. Non-Magnesian Hydrous Silicates.
Kaolin,	Feldspar, Porcelain Spar, Scapolite, Leucite, Beryl, Sodalite,
Völknerite,	Spinel.
Lithomarge,	Topaz, Feldspar, Fluor.
Cimolite,	Pyroxene.
Pinite,	Labradorite, Hornblende.
Fahlunite, etc.,	Iolite, (see page 214, vol. ii).
Prehnite,	Analcime, Leonhardite, Laumontite, Natrolite.
Gieseckite,	Nepheline.
Natrolite,	Nepheline, (Elæolite).
Thomsonite,	Nepheline, "
Carpholite,	Wolfram.
Chrysocolla,	Copper Mica, Red Copper, Azurite, Chalcopyrite, Cerusite.
	8. Sulphates, Molybdates, Tungstates.
Celestine,	Strontianite.
Barytes,	Witherite, Barytocalcite, Calcite.
Anhydrite,	Common Salt.
Gypsum,	Anhydrite, Calcite, Common Salt.
Polyhalite,	Common Salt.
Copperas,	Pyrites.
Anglesite,	Galena.
Wulfenite,	Galena.
Scheelite,	Wolfram.
Wolfram,	Scheelite.
	9. Phosphates.
Pseudotriplite, etc.,	Triphyline.
Cobalt Bloom,	Smaltine.
Pyromorphite,	Galena, Cerusite.
	10. Carbonates.
Calcite,	Gay-Lussite, Gypsum, Anhydrite, Fluor, Feldspar, Pyrope, Garnet, Pyroxene, Barytes, Pyromorphite, Manganite.

Pseudomorph.	*Forms Imitated.*
Dolomite,	Calcite.
Brown Spar,	Cerusite.
Strontianite,	Gypsum.
Spathic Iron,	Calcite, Dolomite, Barytes.
Smithsonite,	Calcite, Fluor.
Cerusite,	Galena, Anglesite, Leadhillite, Linarite, Barytes, Fluor.
Diallogite,	Galena.
Malachite,	Red Copper, Chalcopyrite, Gray Copper, Azurite, Calcite, Cerusite.
Azurite,	Gray Copper, Red Copper.

These examples of pseudomorphism should be understood as cases not simply of alteration of crystals, but in many instances of changes in beds of rock. Thus all serpentine, whether in mountain masses or the simple crystal, has been formed through a process of pseudomorphism, or in more general language, of metamorphism. The same is true of other magnesian rocks, as stetatitic, talcose, and chloritic slates. The crystalline rocks often offer examples of a change similar in nature. The Graphite of these rocks may be but a pseudomorph (or metamorph) after some vegetable product, and as truly so as the petrified wood of more recent times. Thus the subject of metamorphism, as it bears on all crystalline rocks, and that of pseudomorphism, are but branches of one system of phenomena; the chemistry is the same for both.

The common change of pyrites, forming the main ingredient of the upper part of metallic lodes, to earthy red or brown iron ore, thus producing the *gossan* of miners, is an example of these processes now in progress. In a similar manner, lodes containing copper pyrites are sometimes changed above to red or black copper ore, or impure chrysocolla, or malachite, mixed with which are the results of alteration of other minerals, (as iron pyrites, arsenical pyrites, and other sulphurets and arseniurets), that were associated with the copper ores; and often the gossan contains disseminated silver or gold derived from the decomposed ores. These are cases of pseudomorphism, as truly as when a simple crystal of iron pyrites becomes limonite; the mode of change and its laws are the same. In like manner, the erubescite of the upper part of a copper lode is a comparatively modern product, arising from the alteration of vitreous copper; or copper pyrites and vitreous copper may have each proceeded from the yellow copper pyrites; for the erubescite and then the vitreous copper usually disappear as the lode is more deeply explored. So, when Spathic Iron is the veinstone of a lode, it is often extensively changed to earthy brown iron ore, more or less impure from mixed ingredients. Again, phosphates and arsenates of copper, lead, &c., as well as carbonates and sulphates, are among the surface species, or those that occupy the upper part of metallic lodes; they are the results of alteration within those depths to which atmospheric agencies penetrate.

Causes of Change.[*]

The causes of change are the simplest and most universal operations about us. (1), The solvent power of ordinary waters, cold or hot, or of steam; (2), the reactions, according to chemical principles, of the ingredients dissolved in these waters, or in mineral or sea waters, heated or at the ordinary temperature; (3), the process of gradual oxydation to which some substances are liable, and the reaction of substances thus formed on the ingredients at hand, aided or promoted by electrical currents or heat; (4), the action of exhaling gases from the earth, with or without volcanic action.

Ordinary waters hold in solution, as is well known, more or less of mineral matter. The Professors Rogers subjected a large number of minerals in powder on filters to the action of water containing carbonic acid; there were among them, different feldspars, tourmaline, mica, leucite, hornblende, pyroxene, epidote, axinite, garnet, prehnite, zeolites, steatite, serpentine, chlorite; and in all cases the water that passed the filter gave evidence of the presence of an alkali, or lime, or magnesia, and some even gave the tests with the first drops. *Pure* water gave with many of them a similar result, but more slowly. By digesting for forty-eight hours in carbonated water, hornblende, actinolite, epidote, chlorite, serpentine, feldspar, mesotype, &c., they procured a quantity of *lime*, *magnesia*, *oxyd of iron*, *alumina*, *silica*, and *alkali*, and the dissolved ingredients of these minerals severally amounted to from 0·4 to 1 per cent. of the whole mass. The lime, magnesia, and alkalies were in the condition of carbonates, and the iron passed from the state of carbonate to that of peroxyd during evaporation. Thus forty grains of hornblende digested for forty-eight hours in carbonated water at 60° F., with repeated agitation yielded *silica* 0·08, *oxyd of iron* 0·05, *lime* 0·13, *magnesia* 0·095, *manganese*, a trace. The silicates of magnesia, lime, and manganese, were especially ready in yielding to this action.

These facts illustrate two important points:

1. That ordinary waters upon and through the earth's surface, are constantly active in dissolving and decomposing minerals and rocks; and that even species reputed indestructible are thus acted upon.
2. That the waters are thus furnishing themselves with chemical agents for effecting other changes.

These waters penetrate all rocks, as well as percolate through soils, or run in streams over the earth's surface. Hence the action is a universal one, everywhere going on; and the results are universal. Bones, shells, corals, and animal remains generally are also sources of carbonate of lime, phosphates, and fluorids; and plants may contribute also potash and soda, and sometimes silica.

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[*] The following observations are derived mainly from Bischof's extensive work.

Carbonic acid is a constant ingredient of the atmosphere, and is dissolved by the rains as they descend; and hence this active decomposing agent is present in ordinary waters. It is also a result of different mineral changes. Sulphate of iron along with vegetable matters gives oxygen to the carbon of the vegetable matter, and thus produces carbonic acid and pyrites or sulphuret of iron, and the large quantities of pyrites in coal beds shows on how grand a scale this process has acted. Sulphate of zinc in a similar manner produces carbonic acid and blende or sulphuret of zinc. Bischof observes that the carbonic acid which has thus been eliminated, must have been sufficient in quantity to make if together an atmosphere of carbonic acid equal in height to our present atmosphere. Again, decomposition of sulphurets produces sulphuretted hydrogen; this by oxydation by means of the atmosphere forms sulphuric acid, and the sulphuric acid acting on limestone produces gypsum, it may be in extensive beds, and liberates carbonic acid. Sulphurous acid also forms about volcanoes, which becomes sulphuric acid, with the same result. Moreover silica in waters accompanied by heat will decompose limestone and liberate carbonic acid. Hence it is that this gas is exceedingly common in exhalations from mineral springs, and occurs more or less in all waters.

The dissolving and decomposing action of carbonated waters is therefore general. The sea and all other sources partake of this character, and unite in carrying on the changes to which the process leads.

The chemical agents with which ordinary waters are generally supplied, are the following:

Carbonic acid; carbonate of potash, of soda, bicarbonate of magnesia, of lime, of protoxyd of iron; chlorids of sodium, of magnesium, of calcium; sulphate of soda, of lime, of magnesia; silica or silicate of soda, of magnesia, of lime; phosphate of lime; with rarer ingredients, as *fluorine*, in some of its compounds, *nitrates*, salts of *lithia.*

Mineral waters contain the same ingredients only in larger quantities; also, *boracic acid* and *borates*, sometimes traces of *arsenic*, *copper*, and other metals, *bromids*, *iodids*, *sulphuretted hydrogen.*

The sea differs rather in the proportion of the salts than in their kinds. Chlorid of sodium or common salt is most abundant; next chlorid and sulphate of magnesium; then chlorid of potassium, of magnesium, sulphate and bicarbonate of lime, some silicate, (probably, according to Bischof, a silicate of magnesia), bromids, iodids, fluorids, boracic acid, and hydrosulphurets. The carbonic acid in sea water, most abundant about shores where animal life may contribute it by respiration, enables it to dissolve shells and corals, and form bicarbonate of lime.*

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* See on this subject, Bischof, Vol. I, p. 966, and elsewhere.

The following are the constituents of different natural waters in 10,000 parts:

I, Sea water from near coast of France, Vogel; II, ib. near Havre, Riegel; III, Mediterranean, Laurent; IV, Geysers, Dr. Sandberger; V, Rhine, Müller; VI, Thames, near Twickenham, Clarke; VII, Artesian well, near Vienna, Ragsky (containing also free carbonic acid, 4·44 cub. in. in 26 Prussian ounces); VIII, Salt Springs of Wiesbaden, Fresenius, (to the analysis add, chlorid of lithium 0·0018, chlor. ammonium 0·17, iodid of magnesium *trace*, bromid of magnesium 0·04, silicate of alumina 0·0051, arsenic acid 0·0015, *traces* of carbonate of baryta, strontia, oxyd of copper, and 32·2 cub. cent. nitrogen); IX, Marienbad, temp. 11·85° C. Kersten,—add Carb. lithia 0·06, carb. strontia 0·02, phosphate of alumina 0·07.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.
	Sea.	Sea.	Sea.	Geys.	Rhine.	Thames.	Art.well.	Wiesbaden.	Marienbad
Chlorid Sodium,	251·0	246·32	272·2	25·21	0·07	——	——	68·36	14·54
" Potassium,	——	3·07	0·1	——	——	——	——	1·46	——
" Calcium,	——	4·39	——	——	——	0·250	0·13	4·71	——
" Magnesium,	35·0	25·64	61·4	——	——	——	2·02	2·04	——
Carb. Lime,	2·0	1·76	0·1	——	0·85	1·823	3·65	4·18	6·04
" Magnesia,	——	0·78	1·9	——	0·43	0·147	0·90	0·10	4·64
Sulph. Lime,	1·5	10·97	1·5	——	0·33	0·064	2·58	——	——
" Magnesia,	57·8	21·46	70·2	0·04	0·26	——	——	——	——
Free Carb. Acid,	2·3	——	——	5·57	——	51·34[a]	4·44[a]	5229·0[a]	19·48[a]
Phosphate Lime,	——	——	——	——	——	——	——	0·004	0·02
Silica,	——	——	——	50·97	0·16	0·039	0·17	0·60	0·88
Sulphuret Sodium,	——	——	——	0·88	——	——	——	——	——
Carb. Soda,	——	——	——	19·39	——	——	——	——	11·54
" Ammonia,	——	——	——	0·83	——	——	——	——	——
Sulph. Soda,	——	——	——	10·70	——	0·286	——	——	47·22
" Potash,	——	——	——	4·75	——	0·095	——	——	0·65
Carb. Manganese,	——	——	——	——	0·04	——	——	0·006	0·05
" Iron,	——	——	——	——	0·08	——	0·01	0·06	0·45
Organic,	——	——	——	——	0·48	0·497	0·19	——	——
Nitrate Magnesia,	——	——	——	——	——	——[b]	1·50	——	——
" Soda,	——	——	——	——	——	——	1·27	——	——

a In cubic centimeters. b Add 0·195 alumina.

The amount of solid matter *in solution* in the Rhine, which passes Emmerich in a day, according to Muller, amounts to 44,240 cubic meters, of which 4,604 is sulphate of lime, 4,580 sulphate of magnesia, 11,523 carbonate of lime, 5,770 carbonate of magnesia, 940 carbonate of Iron and manganese, 930 chlorid of sodium, 1,930 silica, 2,730 alumina, 11,333 organic ingredients; and the amount for the year is 16,147,600 cubic meters of these ingredients.

For an analysis of the waters of the Dead Sea, see Vol. II, p. 91, and for others of sulphuric acid waters, p. 143. For American waters, Am. J. Sci. [2], ii, 218; iv, 385; ix, 123: xi, 174.

The following are the rates of solubility in water of some mineral substances, as given by Bischof:

Silica in its gelatinous condition,		1 part in	1,000		of water.
Silicate of Potash ($\dot{K}^3\ddot{Si}^8$, Wasserglas),		“	4 to 5	heated	“
Carbonate of Lime,		“	16,000—24,000		“
“ “	with carbonic acid,	“	1,000		“
Carbonate of Magnesia,	“ “	“	742		“
Carbonate of Baryta,	“ “	“	4,300		“
Sulphate of Lime,	32° F.,	“	462		“
“ “	212° F.,	“	462		“
Sulphate of Magnesia,	32° F.,	“	4		“
Sulphate of Baryta,		“	210,000		“
Silicate of Baryta,		“	20,000		“
Silicate of Strontia,		“	1,262		“
Silicate of Lime, (Wollastonite),		“	5,383—6,882		“
Silicate of Magnesia,		“	32,000—90,600		“
Silicate of Alumina, (formed by action of alkaline silicate on a hot solution of alum),			179,000—334,600		“

Very many of the ingredients in solution are, when pure, active agents in producing chemical changes: and their power is not altogether lost by diffusion in water. An alteration or decomposition may go on at slow pace, but it is all sure progress, and in process of time it will make itself apparent; with past geological ages to work in, the results may be measured only by the extent of the earth's surface itself. Heat may occasion greater activity in these changes; and the wide prevalence of thermal springs, and volcanic regions, extinct and active, and the foldings, elevations, and crystallization of rock strata, show that this aid has been extensively given.

The saline and other ingredients of waters are derived from various mineral species.

Lime.—From Calcite, and related species, Gypsum, Apatite, much Pyroxene (some giving 20 p. c.), Hornblende (12 p. c.), Wollastonite (46 p. c.), Scapolite (20 p. c.) and related species, Oligoclase (3 p. c.), Labradorite (11 p. c.), Anorthite (15 p. c.), Andesite (5 p. c.), Epidote (21 p. c.), Allanite (10 p. c.), Idocrase (33 p. c.), Garnet (some 30 p. c.), Axinite (20 p. c.), Margarite (10 p. c.); also from shells, Bones, etc.

Potash.—From Orthoclase (12 p. c.), less abundantly from the other feldspars; Muscovite (9 p. c.), Biotite (8 p. c.), Lepidolite (4—10 p. c.), Phlogopite (6—10 p. c.), Nepheline (5 p. c.), Leucite (21 p. c.), some Tourmaline, Scapolite. Hence Potash is abundant in granitic and most feldspathic rocks.

Soda.—From Albite (10 p. c.), Oligoclase (8 p. c.), other feldspars less abundantly. Nepheline or Elæolite (16 p. c.), some Scapolite (5 p. c.), Acmite (10 p. c.), some Tourmaline, some Mica, Analcime, and many Zeolites. Soda is therefore largely distributed in Granites, Syenites, and various igneous rocks, besides being so abundant in Seawater.

Magnesia.—From Talc or Steatite (33 p. c.), and Talcose rocks, Serpentines (40 p. c.), and related minerals, Chlorite (33 p. c.), and Chlorite rocks, Pyroxene (some 20 to 25 p. c.), Hornblende (some 20—30 p. c.), Chrysolite (50 p. c.), Chondrodite (55 p. c.), Iolite (10 p. c.), Biotite (18 p. c.), Phlogopite (26 p. c.), Spinel (20 p. c.) Sparingly in Garnet, Idocrase, Epidote, &c.

Lithia.—From Petalite (2·6 p. c.), Spodumene, (5 p. c.), Triphyline (5 p. c.) Lepidolite (sometimes 4 p. c.)

Silica.—From Quartz and all silicates. The Silicates contain Silica either in its soluble or its insoluble state, the former in those species which gelatinize with acids, and these are most readily decomposable and most soluble.

Fluorine.—From Fluor Spar (48 p. c.), Cryolite (54 p. c.), Apatite (1·25 p. c.), Chondrodite (8·5 p. c.), some Mica (sometimes 10 p. c.), Topaz (15 p. c.), Fluocerite, Yttrocerite; also traces in Hornblende, Pyrochlore, Leucophane, Fahlunite, Apophyllite, Carpholite and Pyromorphite, and several other phosphates; also in corals, shells, and animal remains.

Chlorine.—From Common Salt and other Chlorids; also Sodalite, Pyrosmalite; traces in Apatite and some other Phosphates, some Micas, Elæolite, Nosean, Hauyne, &c.

Boracic Acid.—From Boracite (69·5 p. c.), Danburite (27 p. c.), Tourmaline (4 to 12 p. c.), Axinite (5 p. c.), Datholite (21 p. c.), Warwickite (50 p. c.?)

Sulphur and Sulphuric Acid.—From Sulphate of Lime and other Sulphates, Iron Pyrites and other Sulphurets; also Nosean, Hauyne, Helvin, Lazulite, Skolopsite.

Phosphoric Acid.—From Apatite and other phosphates; also sparingly disseminated in Basaltic and other rocks; also from bones, shells, corals, and all animal remains, and soil which contains the results of their decomposition.

The following are some of the modes in which the ingredients in waters act, and the results of the operations. Governing the whole, is the general principle in chemistry, that *in decompositions the resulting compound is less soluble than the compound attacked.*

1 *Carbonic acid* ($\ddot{\mathrm{C}}$) *in solution.*

a. Dissolves calcite ($\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$), and thus aids in forming *pseudomorphs by substitution* after calcite, the new mineral present, as carbonate of iron or carbonate of manganese, taking its place. Hence Spathic Iron, Diallogite, etc., after Calcite.

b. Acts on *Scapolite;* combines with the lime and forms carbonate of lime ($\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$); and when the lime is removed $\ddot{\mathrm{C}}$ if it continues to act, removes alkalies, as alkaline carbonates.

c. Acts on *Labradorite* and the lime feldspars; combines with the lime, making carbonate of lime, (Calcite). Hence part of the *Calcite* in amygdaloids. If too little $\ddot{\mathrm{C}}$ to take up all the lime, the rest separates as silicate of lime. Hence may come *Wollastonite;* and with hydrous silicate of alumina, the *zeolites containing lime;* with alumina and silicate of soda from the soda of a feldspar, come the *zeolites containing soda,* and with infiltrating waters holding baryta in solution, those *containing baryta.* In the above process, part of the silica is set free as soluble silica; hence may come *silica in the form of rock crystal, agate, chalcedony, opal,* common in amygdaloids. Also with the feldspars, atmospheric waters, in which there is little $\ddot{\mathrm{C}}$, carry off part of the alkalies, and the rest separates as alkaline silicates, in solution, and leave *Kaolin,* ($\dddot{\mathrm{Al}}^3\ddot{\mathrm{Si}}^4\dot{\mathrm{H}}^6$), containing some disseminated silica, that is set free by the process.

d. Acts on *pyroxene, hornblende, trap or basalt,* (usually composed of labradorite and augite,) *and amygdaloid:* if solution is saturated with $\ddot{\mathrm{C}}$, lime is removed as carbonate of lime, also the magnesia as carbonate of magnesia; and thus by the removal of the bases may come *Cimolite.* With less $\ddot{\mathrm{C}}$, the magnesia is not acted upon until the lime is mostly removed, and if $\ddot{\mathrm{C}}$ is exhausted, the *magnesia* separates as silicate of magnesia; hence may come *Saponite;* and if iron is present, *chlorite,* both of which are common in amygdaloids.

e. Acting on olivine, removes the protoxyd of iron and some magnesia, as carbonate, hence *serpentine after olivine.* Carbonate of magnesia is a common associate of serpentine.

f. Dissolves gelatinous silica, and the silica crystallizes as quartz on heating slowly to 200 or 300 C. (Senarmont).

2. *Alkaline Carbonate in Solution,* ($\dot{\mathrm{K}}\ddot{\mathrm{C}}$ or $\dot{\mathrm{N}}\mathrm{a}\ddot{\mathrm{C}}$ with water).

a. Decomposes CaF (fluor spar), especially if heated, making carbonate of lime ($\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$); hence the pseudomorph *Calcite after Fluor.*

b. Acts on heavy spar, ($\mathrm{Ba}\dddot{\mathrm{S}}$), heated to 80° F., affords Witherite, and alkaline sulphates, ($\mathrm{Ba}\ddot{\mathrm{C}}$), hence *Witherite after Heavy Spar.* Temperature much below 80°, the sulphate is restored. Hence *Heavy Spar after Witherite.*

c. Acts on Celestine, ($\dot{Sr}\,\dddot{S}$) heated to 80° F., affords Strontianite ($\dot{Sr}\,\ddot{C}$), and alkaline sulphates; hence *Strontianite after Celestine.* Similarly on $\dot{Pb}\,\dddot{S}$?.

d. Acts on Silicate of lime, decomposing it, forming *Carbonate of Lime.*

e. Acts on pyroxene, the lime of pyroxene takes the $\ddot{C}$, and the alkalies take the place of the lime; hence *Green Earth after Augite.* The same on Scapolite; hence *Mica after Scapolite;* and also, *Algerite after Scapolite;* in a similar manner other altered alkaline forms.

f. Acts on an aluminous hornblende, the alkalies are left, and $\dot{Ca}$ removed; *hence Mica after Hornblende.* Or $\dot{Fe}$ and $\dot{Mg}$ removed and Chabazite is formed, (oxygen ratio of which for bases and silica is 1 : 2, as in hornblende).

g. Acts on phosphate of lime (apatite), producing carbonate of lime and alkaline phosphate; hence *Calcite after Apatite.*

h. Dissolves alumina, and may remove part of the alumina from aluminous minerals.

i. Acting on Sulphate of Copper, forms carbonate of copper or *Green Malachite,*(Rose).

k. Bicarbonate of Soda acts on Sulphate of lime and forms *Calcite* if the solution is very weak, (2° Beaumé); or *Aragonite,* if stronger, (5° or 6°); and hence aragonite in gypseous and saliferous deposits; the same acting on sulphate of magnesia heated forms Carbonate of Magnesia; on sulphate of iron forms Carbonate of Iron, etc.; on sulpho-arsenite of silver, forms *Light red silver,* Senarmont. Potash in solution acting on gypsum forms calcite, the carbonic acid in this case coming from the atmosphere.

3. *Alkaline Silicate in solution,* (derived largely from decomposition of feldspars.

a. Acts on sulphate or chlorid of lime, produces *Silicate of lime,* and sulphate of alkali; hence *Wollastonite.*

b. Acts on sulphate of magnesia, if heated, produces *Silicate of magnesia* and sulphate of alkali.

c. Acts on $\dot{Ba}\dddot{S}$ or $\dot{Sr}\dddot{S}$, no decomposition.

d. Acts on Mg Cl, produces *Silicate of magnesia* and chlorid of alkali.

e. Acts on bicarbonate of lime, heated, a partial decomposition, complete only after a long trial; forms alkaline carbonate, carbonate of lime, and free silica; hence *quartz,* &c., (in part) in amygdaloid; and *Quartz after Calcite.*

f. Acts on bicarbonate of iron, similar result.

g. Acts on *Magnesia Alba,* similar result.

h. Acts on carbonate of iron ($\dot{Fe}\ddot{C}$), and carbonate of magnesia, ($\dot{Mg}\ddot{C}$), together produces augite?.

i. Acts on aluminous hornblende, gives alkali removing lime, and forms mica; *hence Mica after Hornblende.*

k. Acts on ferruginous grains, and forms *Glauconite,* (green grains of cretaceous formation containing alkalies).

l. Decomposed when organic matter and an alkaline carbonate, which give rise to ammonia, are present, and silica separates, as *opal, quartz, chalcedony;* a common process.

m. With phosphate of lime ($\dot{Ca}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$) or phosphate of alumina no action, even when heated; and hence these compounds may coexist with alkaline silicates.

n. Potash silicate acted on by solution of common salt, more or less changed to soda silicate.

o. Decomposed by carbonic acid, if the silicate contains no more than 1$\dot{K}$ to 16$\dddot{Si}$; and hence alkaline silicates and carbonates of alkali coexist; so also silicate of soda and bicarbonate of lime, as in Cancrinite.

p. Silicate of baryta in solution is changed by sulphate of magnesia, lime or soda to sulphate of baryta.

Silica in solution is often distributed through other minerals, and may thus give them an unnatural hardness. The hydrous magnesian silicates and zeolites appear especially to be at times affected by this cause.

4. *Sulphate of Soda in Solution.*

a. Acts on chlorid of calcium, forms gypsum.

b. Acts on chlorid of magnesium, forms sulphate of magnesia.

c. Acts on $\dot{Ba}\ddot{C}$ forms sulphate of baryta, (Heavy Spar).

5. *Carbonate of Lime in Solution, as Bicarbonate.*

a. Acts on alkaline silicates, producing Silicate of Lime, Alkaline Carbonates, and free Silica; hence *Quartz,* &c., in rocks.

b. Acts on sulphate or chlorid of copper, and affords Sulphate of Lime and *Carbonate of Copper.*

c. Dissolves fluor spar; hence infiltrating waters in limestone dissolve out fluorids, (as *Fluor Spar*), and carry them to open spaces where they may crystallize. Perhaps the same with Apatite.

d. Acts on sulphuret of iron and forms Sulphate of Lime and *Carbonate of Iron,* or *Limonite* by oxydation of iron.

e. Acts on blende and forms *Carbonate of Zinc,* (Smithsonite).

f. Acts on Sulphate of Magnesia, if heated, and forms *Dolomite* (von Morlot) and Gypsum, which minerals are often associated.

6. *Sulphate of Lime* ($\dot{Ca}\dddot{S}$) *in Solution.*

a. Acts on Witherite ($\dot{Ba}\ddot{C}$) at ordinary temperature, producing Heavy Spar ($\dot{Ba}\dddot{S}$), hence *Heavy Spar after Witherite.*

b. Acts on Barytocalcite similarly; hence *Heavy Spar after Barytocalcite.*

c. Acts on Strontianite ($\dot{Sr}\ddot{C}$); hence *Celestine after Strontianite.*

d. Acts on Carbonate of Magnesia, producing *Sulphate of Magnesia* and *Calcite.*

e. Acts on Silicate of Strontia, yielding silicate of lime, and *Sulphate of Strontia,* (Celestine).

f. Acts on an alkaline silicate, affording *Silicate of Lime.*

g. Dissolves Apatite, ($\dot{Ca}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$).

h. Acted on by organic matter, yields carbonic acid by deoxydation of sulphuric acid and lime, and forms sulphuret of calcium and water.

i. Decomposed by steam, sulphuretted hydrogen produced.

7. *Carbonate of Magnesia in solution as bicarbonate.*

a. Acts on $\dot{Ca}\ddot{C}$ and produces a double carbonate of lime and magnesia, or Dolomite; hence *Dolomite after Calcite.*

b. Acts on sulphate of lime, and produces Dolomite; hence *Dolomite after Gypsum.*

c. Acts on silicate of lime, forming silicate of magnesia; hence *steatitic compounds.*

d. Acts on pyroxene, the carbonic acid taking off lime and leaving magnesia; hence *Hornblende after Augite, Pyrallolite after Augite, Bronzite and Hypersthene after Augite.* Further action, removing all the bases but magnesia, and adding magnesia in place of the lime, and water taken up; hence *Serpentine, Steatite, Talc, after Pyroxene.*

8. *Sulphate of Magnesia in solution.*

a. Acts on carbonate of baryta, ($\dot{Ba}\ddot{C}$), produces Heavy Spar, ($\dot{Ba}\dddot{S}$), and carbonate of magnesia, ($\dot{Mg}\ddot{C}$); and similarly with carbonate of strontia; hence *Heavy Spar after Witherite, Celestine after Strontianite.*

9. *Silicate of Magnesia in solution.*

a. With carbonate of magnesia, ($\dot{Mg}\ddot{C}$), produces the siliceous variety of magnesite.

b. Acts on $\dot{Mg}\ddot{C}$, produces Steatite; hence *Steatite after Magnesite.*

c. Acts on Spinel, produces Steatite; hence *Steatite after Spinel;* similarly for Chiastolite, Feldspar, Augite, and many other steatitic pseudomorphs.

10. *Sulphate of Iron in solution.*

a. Acts on phosphate of lime in solution, (from animal remains), and produces phosphate of iron; hence *Vivianite;* similarly from sulphate of copper in solution, *Phosphate of Copper* or *Pyromorphite.*

b. Acts on carbonate of lime, and produces carbonate of iron and sulphate of lime; hence *Spathic Iron after Calcite.* Similarly sulphate of zinc produces carbonate of zinc; and hence *Smithsonite,* ($\dot{Zn}\ddot{C}$), *after Calcite.*

11. *Carbonate of Iron,* ($\dot{Fe}\ddot{C}$), *in solution, as bicarbonate.*

a. Acts on phosphate of lime, and produces *Vivianite* or phosphate of iron, (probably the common process).

b. Acts on silicate of lime, and forms *silicate of protoxyd of iron,* Hisingerite, Pingerite, Chlorophæite, Silicates of Iron, resulting from decomposition of basalt, and minerals containing iron.

12. *Sulphuretted Hydrogen or Hydrosulphurets in solution,* (produced by oxydation of sulphurets, or by deoxydation of sulphates in water, through the intervention of organic matter with water).

a. Acted on by organic matter, a deposit of *Sulphur,* as in some sulphur water.

b. Acted on by sulphurous acid, a deposit of *Sulphur,* as about volcanoes, ($2HS+SO^2=2HO+3S$).

c. Changed by oxydation through oxygen of atmosphere, to sulphuric acid and water, and some sulphur deposited; and sulphuric acid, with chalk, or calcite, then forms gypsum, and gives rise to other sulphates; hence *Gypsum after Calcite and Gaylussite.* Hence gypsum beds and the sulphur they contain.

d. The sulphur acid acts on augite, feldspar, &c., in volcanic regions especially, and produces complete decomposition, separating silica as Hyalite, Quartz, siliceous incrustations, Sinter, forming also *Cimolite, Pholerite, Lenzinite, Scarbroite,* &c. *Lithomarge* after *Feldspar and Topaz.*

e. Acts on sulphate of zinc, and reduces it to sulphuret of zinc.

f. Acts on carbonate or phosphate of lead, and changes it to Sulphuret of Lead or Galena; on Native Silver, and changes it to Sulphuret.

g. Acts on chlorids of the metals, and forms sulphurets; thus Blende, Pyrites, Galena, Copper Glance, Silver Glance, Bismuth Glance, Antimony Glance, Tetrahedrite (Durocher).

14. *Oxydation.*

a. The protoxyd of iron is especially liable to peroxydation, when moisture is present; and compounds containing it, whether silicates or carbonates, often undergo alteration by this means. The protoxyd of iron usually passes to the state of a hydrous sesquoxyd ($\bar{\mathrm{F}}\mathrm{e}^2\dot{\mathrm{H}}^3$) and then to anhydrous sesquoxyd ($\ddot{\bar{\mathrm{F}}}\mathrm{e}$). Spathic iron ($\dot{\mathrm{F}}\mathrm{e}\ \ddot{\mathrm{C}}$) often goes through these changes, becoming brown, black, and when finally anhydrous, red, unless it passes to the crystalline state. Pyroxene, augite and augitic rocks, mica, garnet, often show commencing decomposition in the peroxydation of the iron; if carbonic acid exists in the moisture, the iron may pass into the state of carbonate; but then in many cases it passes soon to a hydrous oxyd.

b. The protoxyd of manganese is still more liable to oxydation, and it may pass to two states of oxydation, with or without water. This liability is so strong that some species, as the phosphates of protoxyd of manganese, are seldom found in an unaltered state. The silicates become black, and several species have been made from analyses of the altered varieties.

c. Sulphurets, arseniurets. Many sulphurets (RS^2 or RS) change readily to hydrous sulphates, by an oxydation of the sulphur and metal (air and moisture being present) often developing nitrogen if the oxygen is derived from the air; or sulphuretted hydrogen if partly from the water; and frequently some sulphur is set free. The sulphates may then promote other changes.

15. *Deoxydation.*

By means of organic matter, sesquoxyd of iron ($\ddot{\bar{\mathrm{F}}}\mathrm{e}$) may be reduced to protoxyd ($\dot{\mathrm{F}}\mathrm{e}$); and thus a carbonate of iron may be formed if carbonic acid is present or is formed in the process. Hence *spherosiderite.*

Sulphate of lime, of iron, of zinc, by the same means, may be reduced to sulphurets, sulphuretted hydrogen and carbonic acid often being given out at the time, the carbonic acid forming from the oxygen removed by the carbon of the organic matter; thus come *Pyrites, Blende,* etc., by the wet way; when a sulphate, oxyd of iron and organic matter are together, pyrites may be formed; thus sulphurets may have been produced in fossil plants, as in Fuci.

16. *Other reactions and results.*

a. Alkaline phosphates act on a magnesian salt and form *phosphate of magnesia:* also upon lime in Scapolite and form phosphate of lime.

b. Sulphate of baryta is rarely decomposed, like sulphate of lime, by organic matter. Sulphate of copper in solution, in contact with porous limestone forms *Brochantite.*

c. The decomposition of species containing iron, (as some augites, hornblende, &c.), gives rise in many cases to silicates of iron, as *Hisingerite, pinguite, chlorophæite,* etc.

d. Alkaline fluorids, acting on pargasite, may form *Chrondodite* (?); with wollastonite, they are decomposed into alkaline silicate and *fluor spar* (CaF).

e. Moisture, acting on anhydrite, water is absorbed and the species is changed to gypsum. Hence *Gypsum after Anhydrite.* Acting on other minerals it is more or less absorbed, and promotes their decomposition. Added to Labradorite, it may form *Mesolite.*

f. The degree of solubility of silicates of strontian and barytes accounts for their non-occurrence as species among minerals.

g. In pseudomorphs of oxyds of iron after calcite, it is probable, as Volger urges, that the calcite first passes to the condition of spathic iron; then to a hydrous sesquoxyd ($\ddot{\bar{\mathrm{F}}}\mathrm{e}^2\,\dot{\mathrm{H}}^3$, $\ddot{\bar{\mathrm{F}}}\mathrm{e}\,\dot{\mathrm{H}}^2$, or $\ddot{\bar{\mathrm{F}}}\mathrm{e}\,\dot{\mathrm{H}}$); then to an anhydrous sesquoxyd (at 160° to 180°, C. Senarmont); then it may be by deoxydation to Magnetite ($\dot{\mathrm{F}}\mathrm{e}\,\ddot{\bar{\mathrm{F}}}\mathrm{e}$), or to $\dot{\mathrm{F}}\mathrm{e}$; and then to $\dot{\mathrm{F}}\mathrm{e}\ddot{\mathrm{C}}$ or carbonate of iron again, if carbonic acid is present.

h. Carbonated waters dissolve silicate of zinc without decomposing it.

i. Organic matter with heat to 150° to 250° C., reduces salts of copper or lead.

k. *Steam*, acting for a period of time, will dissolve away or decompose many silicates; alter some sulphurets promoting their oxydation; at a high temperature acting on Galena, it will carry off the sulphur as sulphurous acid and sulphuretted hydrogen and leave metallic lead; acting on chlorid of iron, deposits Specular Iron, regarded by Gay Lussac and Mitscherlich the origin of specular iron of volcanoes; acting on chlorid or fluorid of tin, forms oxyd of tin or Cassiterite; on the same of titanium, forms brookite, anatase, or rutile; on the same of silicon, forms quartz: *Daubrée*, (Compt. Rend. 1849, 227, 229), who observes that these minerals just mentioned (rutile, quartz and specular iron) are associates in the Alps; acting on the furnace product $\mathrm{Ti\,Cy} + 3\mathrm{Ti}^3\mathrm{N}$, produces crystals of Anatase.

l. Carbonate of lime is decomposed by silica at the temperature of boiling water, and carbonic acid expelled; hence carbonic acid given out by many waters.

It is thus seen that in the decomposition of a silicate, there may not only be a removal of the alkalies and earths, but in other cases, a large addition of alkalies. It is also obvious, that no mineral can withstand the agencies to which it may be exposed, and even when apparently unaltered, changes may have already been begun. Bischof regards the feldspar called Andesine as Oligoclase from which some silica has been removed by the methods explained, and scapolites are considered as mostly altered, the Meionite oxygen ratio being taken as the true ratio of the unaltered species. Although these particular cases may be doubted, it is altogether probable that different feldspars and scapolite are liable to a loss of silica or other ingredients from this means.

In several of the processes of alteration, silica is set free. This silica takes on the form of opal or quartz, according as it is soluble or insoluble silica, these being two isomerous states of the same species.

Delesse has experimented on the loss of silica produced by the action of a potash solution, heated to boiling, on different igneous rocks in powder. He found no action on granite: but on porphyry a loss of 5·35 per cent., Basalt 7·60, Black lava 4·50, Obsidian 18·39, Retinite 9·50 to 12·23, Trachyte 17·06 to 36·00. There was also a removal of some alumina, the porphyry losing a *trace*, the Basalt 2·85 per cent., Black lava 2·60, Obsidian 3·78, Retinite 1·16 to 1·25, Trachyte *trace* to 2·39. The partially altered rocks were much the most easily acted upon, and those containing quartz the least. The Retinite, Perlite, Trachyte which contain the silica partly in the soluble condition or in easily attacked glassy silicates are most readily acted upon. The loss of alumina was greatest in the glassy rocks, and in those that contain augite.

The various recent papers on pseudomorphs by Haidinger should have attentive study in this connection.

Various applications of the principles that have been presented will be found throughout the Descriptive part of this work. On these principles and others of like nature which science may develop, the changes and origin of minerals and rocks are to be studied. Bischof, in all his discussions, has direct reference to Geology, and arrives at a Neptunian theory—making nearly all rocks by the "wet" way—in which few will follow him. The subject needs a much more extended investigation from the opposite point of view before the exact limits of the two agencies fire and water shall be appreciated. We have aimed in the preceding pages at a brief review of the elements of the subject, such as is appropriate to a treatise on Minerals; a fuller discussion pertains rather to Chemical Geology.

As an appendix to the above, some further results of Chemistry in the formation of minerals, and the artificial products of furnaces, may be mentioned, although several of the processes appear not to be the out-door processes of nature. The following are among the mineral species that have been made and crystallized artificially.

Grayish white Pyroxene, by mixing the constituents and exposing to a high temperature: Berthier, Ann. de Ch. xxiv, 376.

Idocrase, Garnet: Mitscherlich, Ann. de Ch. et de Phys. lvii, 219.

Spinel, colorless and of red, blue, and black colors, Chrysoberyl, Chromic Iron, Emerald, Chrysolite, Corundum: Ebelmen, Ann. Ch. Phys. [3], xxii, 211, 1848, by employing the dissolving action of boracic acid or borax; spinel was formed by mixing alumina and magnesia, with boracic acid, and exposing to a high heat, adding a little oxyd of chrome to form red spinel, oxyd of iron for the black, oxyd of cobalt for blue; the Chrysoberyl was formed in a similar way from 6 of alumina, 1·62 of Glucina, and 5·0 of boracic acid; crystallized corundum from four parts of borax and one of alumina.

Periclase, Perofskite, Tantalate of lime, (resembling Pyrochlore), Tantalate of iron: Ebelmen, Ann. Ch. Phys. [3], xxxiii, 34, 1851; by making lime to act on borate of magnesia at a high temperature, the magnesia (Periclase) separates in cubo-octahedra; similarly lime acting on a silicate of titanium, perofskite (titanate of lime) is produced, &c.

Oxyd of Copper, Sulphuret of Silver, of Copper, of Tin, of Lead, of Mercury, of Iron, Kermes, Iodids, &c.: Becquerel, Ann. Ch. Phys. xli, and xlii, 225, using weak electrical currents; the sulphuret of silver from solutions of nitrate of silver and hydrosulphate of potash, &c.

Native Copper, and other native metals, by electric decomposition through weak currents: BIRD, Phil. Mag. x, 376.

Sulphurets, Arseniurets, &c.; DUROCHER, Compt. Rend. xxxii, 823—see p. 334.

Crocoisite and Melanochroite: DREVERMANN, Ann. Ch. u. Pharm. lxxxvii, 120.

Diamond: DESPRETZ, Compt. Rend., 1853, by the action of galvanic heat on charcoal in a glass globe, the vapor of carbon thus formed condensing in minute octahedrons on the glass.

Carbonate of Magnesia (Magnesite), of Iron (Spathic Iron) of manganese (Diallogite), of zinc (Smithsonite), &c.; also Sulphurets of Iron, Manganese, Cobalt, Nickel, Zinc, etc: SENARMONT, Ann. Ch. Phys., [3], xxx, 129. This important paper contains many new processes, for carbonates, sulphurets, and other species.

Cassiterite, (Tin Ore), Brookite, Quartz, Apatite, Wagnerite, Topaz: DAUBRÉE, Compt. Rend. xxvii, 1849, 227, xxxii, 625, 1851, —see p. 335; Topaz by the action of fluorid of silicon on alumina at a high temperature; apatite by means of chlorid or fluorid of phosphorus acting on lime.

Dolomite: DUROCHER, by action of vapors of anhydrous chlorid of magnesium in a gun barrel on porous carbonate of lime: for VON MORLOT'S process, see p. 333: BROMEIS, by reaction of chlorid of magnesium in solution on carbonate of lime, Ann. Ch. Pharm. lxxxi, 129.

Heavy Spar, Celestine, Anhydrite, Pyromorphite, Wolfram, Tungsten, Scheeletine, Wulfenite, Crocoisite, Anglesite: N. S. MANROSS, Inaug. Dissert. Götting., and Am. J. Sci., [2], xii, 186.

The following are observed *Crystallized furnace products.*

1. *Elements.—Graphite*, in six-sided tables at Dillenberg; *Silver; Lead; Copper; Iron; Bismuth.*

2. *Silicates.—Chrysolite*, (Silicate of iron), having the form of crystals and angles of native chrysolite, from Iron and Copper Furnaces, at Fahlun, Oldbury in England, etc. *Pyroxene* at Garpenberg; also in an iron furnace near Hacheburg, and a copper furnace near Dillenberg; *Iron Augite* at Fahlun and Oldbury;—Hornblende in crystals, giving for the angle *I*: *I*, 123° 55′, yet with the composition of pyroxene;—a *fibrous amianthus-like* substance, at Westphalia;—*Mica*, at Garpenberg, having nearly the composition of a magnesia mica;—*Idocrase*, in square prisms, from hot-blast furnaces of Dudley, England, and Marchienne, Belgium;—*Gehlenite* (or near) in thin square prisms, white, and transparent when very thin, from a hot-blast furnace at Oldbury, England;—Humboldtilite (?) in long yellow square prisms, with perpendicular cleavage;—*Feldspar* in crystals at Sangerhausen;—Hexagonal crystals, resembling Nepheline, from Rauthenthal in the Hartz.

Also the following compounds unknown in nature;—*Chytophyllite*, Hausmann, a gray subfoliated species, resembling kyanite a little, H.=55, G.=2·940, and having the formula $(\dot{F}e, \dot{C}a)(\dddot{S}i, \dddot{\bar{A}}l)$; analysis, Silica 54·897, alumina 5·078, protoxyd of iron 20·794, lime 20·346.—Tabular Crystals, yellow or leek green, G.=2·89, H.=6·5; composition, Silica 48·20, alumina 8·41, lime 37·67, protoxyd of iron 0·97, of manganese 2·23, magnesia 0·74, with 1·78 of sulphuret of calcium, alkalies, water and loss (Schnabel); see further for analyses of doubtful compounds, Percy and Miller's paper, referred to below.

3. *Oxyds.*—*Magnetite* in octahedrons at different places; *Specular Iron*, usually in tabular crystals; *Oxyd of Zinc*, in many furnaces; *Red Copper*, in crystals; *Peroxyd of Chromium*, in brilliant black tabular crystals, like those of Specular iron.

4. *Sulphurets, &c.*—*Galena*, in cleavable tubes at Holzappel, Ems, &c.; *Blende*, in modified octahedrons and other forms in the Hartz, &c.; *Copper Pyrites*, in square octahedrons; *Magnetic Pyrites; Antimonial Nickel*, in long hexagonal needles, at Ems. The cyanid, $TiCy+3Ti^3N$ in cubes, at Bodenstein, Lahnstein, and Cornwall, (formerly called native titanium.)

5. *Sulphates, Arsenates, &c.*—*Anglesite; Arsenate of Copper; Arsenate of Nickel;* an antimonite of copper $3Cu^2O+SbO^3$, (not observed in nature), in copper-red or yellow hexagonal tables at Dillenburg.*

The subject also of the *association of minerals* in rocks has an intimate bearing on the question of their origin. Associated minerals may obviously have been either cotemporaneously or successively formed. If the former, the species were alike in the general phenomena attending their origin; if the latter, there may still have been many circumstances in common, arising from their condition in the same rocks, or their dependence on the same system of causes, or from the earlier contributing more or less to the material in the latter; or again, they may have no relation except that of relative position. The chemistry of the formation of species is therefore to be learned from a thorough study of all these conditions, as well as from the principles of chemical science itself. This subject properly pertains to geological science: and we only pass in rapid review in this place some of the more frequent associations of mineral species.

A full investigation of the subject, with reference to its geological bearings, would require that each species of mineral should

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* The more important papers on furnace products are the following:—Mitscherlich, Ann. de Ch. xxiv, 355, Pogg. 1826, 630; Kersten, Pogg. xxxiii, and Ann. de Ch. lvii, 219; Percy and Miller, Rep. Brit. Assoc. for 1846, 351, (Am. J. Sci. [2], v, 127,) giving several analyses; Hausmann, Beit. z. Met. Krystallkunde, Göttingen, 1850 and 1852, valuable papers from the Transactions of the Royal Academy of Science at Göttingen; Sandberger, Pogg. lxxxiii, 596, and Jahrb. d. Nassauisch. Ver. f. Nat., 1851, 131; Schnabel, Pogg. lxxxiv, 158, lxxxv, 462.

be taken up by itself, its associates in its various localities noted, and also the relative connection or relative position of a species and its associates, whether one is imbedded in the other, implanted upon it, or the two are only in juxtaposition, besides other peculiarities of condition. Breithaupt in his work on the "Paragenesis of Minerals," Bischof in his Chemical and Physical Geology, and Delesse, Durocher, and others, in various memoirs, have treated of these subjects. Very much remains yet to be done.

The following are some of the most prominent groups of associated species:

1. Beryl, apatite, columbite, tantalite, æschynite, uranium ores, orthoclase, albite or oligoclase; often together in coarse-grained granite; with sometimes chrysoberyl, garnet, automolite, zircon. At the columbite locality, near Middletown, the columbite occurs *imbedded* in each mica, feldspar, apatite, and beryl.

2. Topaz, tourmaline, mica, beryl, euclase, phenacite, apatite, fluor, tin, often lithomarge with topaz; with quartz and tourmaline makes topaz rock.

3. Spodumene, lepidolite, triphyline, blue and red tourmaline, petalite, (all containing lithia), in granite; also with garnet, staurotide, magnetite, scapolite, sphene, pyroxene.

4. Scapolite, hornblende, (often gray, white, or brown), pyroxene, asbestus, sphene, zircon, feldspar, graphite, yellow or other varieties of garnet, brown tourmaline, idocrase, apatite, chondrodite, mica, sphene, allanite, warwickite, perofskite, fluor, phlogopite, biotite, serpentine, corundum, spinel, rutile, clintonite, graphite, specular iron, in granular limestone; corundum is associated often with margarite, euphyllite, chloritoid, diaspore, tourmaline, chlorite, specular iron, &c.

5. Talc, actinolite, nephrite, dolomite, brown spar, magnesite, tourmaline.

6. Tabular spar, green pyroxene, coccolite, colophonite, sphene, in granular limestone.

7. Nepheline (elæolite), apatite, brookite, leucophane, schorlomite, zircon, mica, pyrochlore, cancrinite; in granite, syenite.

8. Nepheline, glassy feldspar, ilmenite, hornblende; in phonolite.

9. Garnet, hornblende, kyanite, corundum, staurotide; in mica slate or gneiss; with often anthophyllite, tourmaline, graphite.

10. Labradorite, ilmenite, magnetite, hypersthene; constituting a labradorite granite-like rock.

11. Oligoclase, albite, danburite, sphene; oligoclase, tantalite, and other tantalates, allanite.

12. Serpentine, diallage, hornblende, pyroxene, (*var.* sahlite and diopside common), pyrosclerite, chromic iron, brucite, hydromagnesite, aragonite, dolomite, emerald nickel, pyrope.

13. Quartz, and the various zeolites, with pectolite, wollastonite, prehnite, datholite, chlorite, chlorophæite, and sometimes spathic iron; in amygdaloid; the prehnite or datholite lowest when occurring with the zeolites; and next analcime; quartz either below or above.*

14. Olivine, augite; magnetite or ilmenite, labradorite, with sometimes leucite and sodalite; in basalt, or augitic lava.

15. Andalusite; in clay slate.

16. Manganesian epidote, greenovite, heteroclin.

17. Chlorite, sphene, hornblende, chlorospinel, garnet, epidote, rutile, magnetite, specular iron, quartz.

18. Tin ore, the tungsten ores wolfram and scheelite, molybdenite, magnetic pyrites, tourmaline, fluor, beryl, topaz, apatite, pyrochlore, lepidolite, native bismuth; in granite or gneiss; lodes less common in mica slate, hornblende slate, or clay slate.

19. Native gold, tetradymite, pyrites, bismuth needle ore, copper pyrites, galena, blende, rutile, magnetite, ilmenite, specular iron, in quartz veins intersecting talcose

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* See on this subject, a paper by the author, in the Am. J. Sci., xlix, 49, 1845.

and chloritic rocks or slates, or in these rocks near the veins; kyanite, brookite, monazite, garnet, platinum, iridium ores, and diamond, often in the same regions.

20. Specular iron, spathic iron, sulphuret of nickel, (millerite).

21. Specular iron, or magnetite, hornblende, epidote, black or dark red garnets, apatite, sphene, in gneiss or granite, &c.

22. Franklinite, red zinc ore, willemite, magnetite, hornblende, brown garnet, calcite, &c.

23. Cobaltine and other cobalt and nickel ores, mispickel, magnetic pyrites, axinite, glaucodot; also with copper pyrites, linnæite.

24. Magnetite, bitter spar, dolomite; disseminated in crystals through talcose and chlorite slates.

25. Galena, blende, salts of lead, often copper pyrites, as a large constituent of the vein of galena; calcite, sometimes heavy spar, spathic iron, quartz or fluor as gangue; with pyrites, &c., the blende having a black color when associated with pyrites, (Breit.); also tetrahedrite, &c.

26. Tetrahedrite, antimonial lead ores, galena, spathic iron, copper pyrites.

27. Red silver ore, silver glance, native silver, freislebenite, stephanite, spathic iron, argentiferous galena, antimonial lead ores, native arsenic, bournonite, calcite; in veins in gneiss, metamorphic slates, &c., the chlorid and bromid of silver usually in upper part of bed or vein, and in Chili near junction of stratified and igneous rocks; also often ores of nickel, cobalt, uranium, bismuth.

28. Limonite, wad, pyrolusite, red copper, phosphates of iron, kaolin; sometimes malachite, azurite, copper pyrites, gibbsite.

29. Copper glance, erubescite, native copper, malachite and other salts of copper, red copper, pyritous copper, (below in the lode), pyrites, often galena, &c.; the red copper, malachites, and native copper in upper part of lode.

30. Calamine, smithsonite, usually with galena and blende, and most commonly in stratified limestone.

31. Gypsum, sulphur, anhydrite, boracite, selenite, calcite, sometimes with fluor.

PART IV.

TAXONOMY.

I. MINERALOGICAL SPECIES.

It has already been remarked, that the power of crystallization in the inorganic kingdom is, in a certain sense, analogous to that of vitality in the other kingdoms of nature. As in these kingdoms, therefore, the existence of species and their peculiarities depend on the action of this vitality, so in the organic kingdom the existence and individuality of species are determined by the power of crystallization. It must be understood that the term crystallization, as here used, includes not merely the action of the attraction that aggregates the molecules in the formation of a crystal, but also the power that fixes the form and condition of the molecule.

Regularly crystallized minerals alone, therefore, are properly *perfect* individuals in the mineral department; imperfect crystallizations, like the monsters among organic bodies, have arisen from a suspension of the regular plan of nature by some extraneous influence. It would, hence, be theoretically correct, and in accordance with the practice in the sciences of Botany and Zoology, to confine the term species to perfectly crystallized individuals, and in the descriptions, to give their characters alone, reserving for subsequent remark, the imperfect crystallizations or mineral monsters. But inorganic nature differs from organic, in this essential particular, that while in the latter, exceptions to this regular organizing action are but seldom observed, in the former, they are far the most numerous, perfect individuals being of comparatively rare occurrence.

A *mineral species*, therefore, is any natural inorganic substance, composed of particles capable in favorable circumstances of combining by means of their mutual attractions so as to constitute a crystalline solid.

We thus include among mineral species the liquids found in nature, for they require only a proper temperature, or favorable circumstances of pressure, and a freedom from disturbing causes, to enable them to assume a regular crystalline form. The conditions of liquidity, gaseity, and solidity, are only different physical states of substances, and are never admitted as specific distinctions; much less can they separate one division of inorganic species from another, and thus be made a criterion for limiting the mineral department. We also include all natural inorganic products, in which a tendency to crystallization can be detected, although they have never been observed in regular crystals. We exclude all mechanical aggregates, which, as they are composed of heterogeneous particles, can never assume, from any innate powers, the forms of a crystalline solid.

This definition implies that the substance in the case of each species is a definite chemical compound, as such only are of homogeneous composition. But chemical analysis is not therefore always an available test of the homogeneity of a crystal; crystallization is quite as generally important as a test of chemical combination, and is often referred to for this purpose.

The question still arises, *what is distinctively a mineral species?* By some authors, every separate chemical compound among minerals has been arranged as a separate species, however like others in crystallization or physical characters. But since it has been found that, in accordance with the principles of isomorphism, there are elements which may replace one another indefinitely and still the form of the crystals remain the same, crystallization has been assumed as the only authoritative test of identity or distinction of species: and this idea has been the means of greatly simplifying the science. The species garnet would make, according to the old chemical view, a dozen or more species. The species hornblende includes a still greater variety of different chemical compounds. Indeed, as magnesia, lime, protoxyd of iron, and protoxyd of manganese, are substitutes for one another in all proportions, the species based on composition alone would be without number. Isomorphism has thus come to the aid of the science, and removed much perplexity. In some instances, however, this principle has seemed inadequate, and while those regarding the crystallographic criterion as paramount have retained together the varieties of like crystallization, others insisting upon a seeming incompatibility of chemical formula have widely distributed them. The species Epidote and Tourmaline are examples. But research may yet discover a principle (if not already accomplished) which will embrace these seemingly anomalous cases, and establish the canon that *individuals of analogous constitution which are one in crystallization, constitute a single species;* they are at least so far identical as to pertain naturally to a common group, whether we call it a genus, family, or species, or by any other name. The canon must be allowed some flexibility in the present state of science.

Minerals are so seldom in distinct crystals, that it becomes necessary to weigh well what importance should be attached to other characters.

After crystallographic characters, chemical composition takes the highest place, or rather both are on the same level. The physical characters differ much in value.

1. *Lustre.*—The distinction of *metallic* lustre from *non-metallic*, is of the first importance; but all the different kinds of non-metallic lustre are sometimes presented by the same species.

2. *Streak.*—A highly important character, seldom varying with the color of the mineral.

3. *Hardness.*—The liability of some minerals to decomposition, their accidental impurities, and the mechanical states they may present, render this in certain instances a character of some uncertainty. An allowance of 0·5 at least, should usually be made for variation.

4. *Specific Gravity.*—Subject to variation, like hardness, especially through variations in composition arising from impurities and substitution of isomorphous substances in the composition of species.

5. *Color.*—Subject to but little variation in those species that have a metallic lustre, and not without some value in the discrimination of non-metallic minerals.

6. *Diaphaneity.*—Subject to wide variations in the same species.

7. *State of Aggregation.*—More especially useful among the metallic minerals, and occasionally among the non-metallic species.

8. *Taste.*—Useful only among the soluble minerals.

9. *Fracture.*—Seldom of much value except in distinguishing varieties.

10. *Refraction*, *Polarization.*—Of great value in determining the character of crystallized substances, whose form is not distinct. By these means, species have been distinguished when the mineral was invisible unless magnified. The properties of elasticity and conductility of heat afford analogous results.

11. *Phosphorescence*, *Electricity*, *Magnetism*, and *Odor*, are each of limited importance.

In the determination of minerals, and especially the institution of new species, the value of the above characters should be well weighed. With distinct crystals, identity or non-identity may be fully ascertained. And with *two or more* concordant chemical analyses, when the species is crystalline and homogeneous, the determination may be as satisfactory. But when not obviously crystalline, and especially if earthy and opaque, analysis is often unsatisfactory, as there may be reasonable doubts of the homogeneity of the substance. Physical characters, without chemistry or crystallography, seldom afford a proper basis for the institution of a species.

Haste in making species is the bane of the Science; and every bad species, introduced through carelessness or a worse reason, cannot fail to prove a millstone to the reputation of its author.

II. CLASSIFICATION OF MINERALS.

In the classification of minerals it must be fully understood that we are dealing with but a small part of the third department of nature—the Inorganic Kingdom. The term Mineral Kingdom, so often used, is fundamentally erroneous, although all natural products not organic may be embraced under it. The distinction between *natural* and *artificial* inorganic products is convenient for the student, but is contrary to strict science; for nothing authorizes the wide separation usually admitted but the necessities of the school-room, or the fact that mineral information is the A B C of another science, and the basis of certain arts. Any classification therefore that can claim to be perfect, must take into consideration the whole range of inorganic compounds; and each species should have its place fixed on the broadest principles of the science of inorganic nature. The fullest development of the science of Chemistry is required to give the classification its highest perfection.

While considering the relations of Species, it should also be observed that some minerals are only the result of the decay or alteration of others. Every species has its perfect state, and also its changes from the influence of various disorganizing causes, which, like disease in organic beings, result in modifications of the type, and it may be in the total destruction of the original mineral. We cannot therefore give the history of a species without embracing these results of alteration, and we shall naturally cluster about the original species, others that originate in their decay, especially such of these results of alteration as are uncrystallized. As usually presented in full title among the other species, they are a burden to the Science. The Science will thus take on a consistent aspect and prove a more efficient handmaid to Geology.

With this restriction, the classification of Minerals must flow directly from the principles of Chemistry.

The true basis for the classification of compounds is found in the relations of the elements. These relations are indicated in a general way in the following classification of them. The elements exhibit their resemblances in their crystallization or isomorphous relations; and in their entering into like compounds with the same or analogous elements. Thus Iron, Chromium, Manganese, form both protoxyds and sesquoxyds, RO and R^2O^3; Sulphur and Selenium form acids RO^3; Arsenic and Phosphorus, Acids R^2O^5; Tin and Titanium compounds RO^2. The affiliations are seen to be most intimate when the *stable* compounds, or those of *most common occurrence*, are alike. Iron may exist in the compound RO^2 like Tin, but still the metals are rather remotely related, as RO^2 is the stable and common compound of the latter, while it is not at all so of the former. The principles of isomorphism, as well as other considerations, remove Carbonic Acid far from Titanic Acid, although each contains 2 of oxygen.

The arrangement of the elements is as follows:—

1. HYDROGEN GROUP. Either RO, R^2O^3, or RO^2, the most stable and common states of oxydation.

1. Hydrogen Section.—Hydrogen.
2. Iron Section.—RO or R^2O^3, the most common or stable state of oxydation. Crystallization mostly monometric, sometimes dimorphous, and then both monometric and hexagonal.—Gold; Platinum, Palladium, Rhodium, Ruthenium, Iridium; Mercury, Silver, Copper, Uranium, Lead; Zinc, Nickel, Cobalt, Manganese, Chromium, Iron, Aluminium, Beryllium, Thorium, Cerium, Lanthanum, Didymium, Yttrium, Erbium, Terbium, Magnesium, Calcium, Strontium, Baryum; Sodium, Lithium, Potassium.
3. Tin Section. RO^2 the most common and stable state of oxydation; crystallization dimetric.—Tin, Titanium.

2. ARSENIC GROUP. Oxyds include the compounds RO^3 or R^2O^5, these the most stable or common states of oxydation, and acting as acids.

1. Arsenic Section. R^2O^5* a common state of oxydation; crystallization usually hexagonal, sometimes monometric; or dimorphous, and both hexagonal and monometric.—Nitrogen; Phosphorus, Arsenic, Antimony, Bismuth, Osmium, Tellurium (?).
2. Sulphur Section. RO^3, the most stable state of oxydation; crystallization, (in part), trimetric or monoclinic.—Sulphur, Selenium; Tantalum, Columbium, Tungsten, Molybdenum, Vanadium.

3. CARBON GROUP.

1. Boron Section. The common oxyd RO^3, either a base or acid.—Boron.
2. Carbon Section. The common oxyd RO^2, always an acid.—Carbon.
3. Silicon Section. The common oxyd RO^3, always an acid.—Silicon.

4. CHLORINE GROUP. Chlorine, Bromine, Iodine.

5. OXYGEN GROUP. Oxygen, Fluorine (?).

The Hydrogen Group passes into the Sulphur Section of the Arsenic Group through Chromium, which forms an acid RO^3 analogous to the Vanadic; also through Iridium and Palladium, which are in part rhombohedral in crystallization. The Arsenic and Sulphur Sections are united through Tellurium, which is most analogous in its characters to the Arsenic Section, but is not known to afford the oxyd R^2O^5. The Carbon Group is most nearly related to the Hydrogen Group through Boron, whose oxyd BO^3 may replace the peroxyd bases of Aluminium, Iron, &c.†

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* Equivalent to RO^5 if the double atom of the element be taken as adopted in the table of atomic weights, pp. 184, 185.

† The relations of the elements may be viewed as follows, adopting Laurent's theory with regard to the oxyds. The oxyds RO, R^2O^3, RO^2, RO^3, are equivalent to RO, $R^{\frac{2}{3}}O$, $R^{\frac{1}{2}}O$, $R^{\frac{1}{3}}O$; in which 1 of oxygen is combined with a metal in different

The classification of the elements establishes the fundamental points in the classification of compounds or minerals.

The elements of the Hydrogen Group enter as electro-positives,

(1) Into compounds with elements of the Arsenic Group;
(2) Into compounds with elements of the Chlorine Group;
(3) Into compounds with elements of the Oxygen Group.

The elements of the Arsenic and following Groups also enter into combination with Oxygen.

There are hence the classes—

(1) *Sulphurets*, *Arseniurets*, *etc.;*
(2) *Chlorids*, *Bromids*, *etc.;*
(3) *Oxyds.*

In each of these divisions there may be *Binary Compounds* and *Double Binary Compounds*, the latter consisting of an acid in combination with bases, as the salts; the former being bases alone, either singly or united together, as the ordinary sulphurets, oxyds, &c.

The Binary Oxygen Compounds are either (1) *Oxyds of Elements of the Hydrogen Group;* (2) *Oxyds of Elements of the Arsenic Group;* or (3) *Oxyds of Elements of the Carbon Group.*

The Double Binary Oxygen Compounds or Salts, may be Salts (1) of Acids RO^3; (2) of Acids R^2O^5; (3) of Acids RO^2; (4) of Acids R^2O^3.

Such are the main points in the classification followed in this work. In general principle it is like that of Berzelius, and therefore closely related to the systems adopted by various authors in mineralogy. The details of the system will be gathered from the synopsis given beyond.

Analogous composition requires that species should be grouped together in the same division; and species that are related in form constitute a natural group in such a division.

From the facts already stated, it appears that boracic acid should be regarded as a base in all silicates. Datholite is related to Euclase as well as Sphene in both form and formula, if the boracic acid is thus regarded; and Axinite has also the simple oxygen ratio 1 : 1.

Again, titanic acid in the so-called silico-titanates, acts as a base, this acid RO^2 united with RO being equivalent to R^2O^3, and replacing thus an ordinary peroxyd. See under Sphene, ii, 269.*

The true relations of the anhydrous Silicates are made out by

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states, virtually equivalents, as they saturate equal quantities of oxygen. These states are R, $R^{\frac{2}{3}}$, $R^{\frac{1}{2}}$, $R^{\frac{1}{3}}$. The metals of the Hydrogen Section in the state expressed by R appear to be monometric and mutually replaceable; in the state of $R^{\frac{2}{3}}$ rhombohedral; in the state of $R^{\frac{1}{2}}$ dimetric, as in Tin, Titanium. Chromium in the states R and $R^{\frac{2}{3}}$ is related to Iron; in the state $R^{\frac{1}{3}}$ it should be classed with Vanadium, as exemplified in the relations of the Chromates and Vanadates. Iron in the state of $R^{\frac{1}{2}}$ (as in the deutoxyd) is related to Tin and Titanium. The dimorphous forms of a metal may depend on these different states or conditions.

* Also a paper by the Author, in the Am. J. Sci. [2], xvii, p. 218.

taking, as the basis, the oxygen ratio between all the oxyds and the silica, as explained on p. 207. They may for the most part be grouped into four grand sections.

1. Oxygen ratio for the bases and silica 1 : 3.
2. Oxygen ratio for the bases and silica 1 : 2.
3. Oxygen ratio for the bases and silica 1 : 1.
4. Oxygen ratio for the bases and silica 1 to less than 1.

The *first* group includes one or two doubtful species, Edelforsite a silicate of lime, Mancinite a silicate of zinc. The *second* includes Augite, Spodumene, Rhodonite, Beryl, &c., and is the *Augite* Section. The *third* includes Garnet, Chrysolite, Zircon, Meionite, Idocrase, Epidote, &c., and is the *Garnet* Section. The *fourth* includes Andalusite, Topaz, Staurotide, Kyanite, Sillimanite, Sphene, Euclase, Tourmaline, &c., constituting the *Andalusite* Section.

Besides these, there may be another group, characterized by the ratio 1 : 1½, represented in Eulytine, (Bismuth Blende), and Leucophane. The composition of Eulytine is however still in doubt.

There are in some cases accessory ingredients, or an excess of base or silica, which cause divergences from these ratios, and indicate another principle which should be recognized alongside of the prominent central one.

Thus Hornblende and Augite are related in form and so closely in composition that they graduate into one another, and a mineral with the form of one may have the composition of the other. Yet the oxygen ratio of Augite is 1 : 2, and of Hornblende 1 : 2¼. In Hornblende there is an addition therefore of *one eighth* to the silica, without removing the species from the Augite type.

Meionite has the oxygen ratio for the bases and silica of the Garnet Section 1 : 1, and Bischof and Rose regard this as the true ratio of all Scapolite. The analyses of Scapolite give mostly the ratio 1 : 1⅓, and taking this (as is probably correct) as the Scapolite ratio, there is here an addition of *one third* to the silica, which does not interfere with close homœomorphism with Meionite.

Again, Sodalite, Haüyne, and Nosean have a like trapezohedral form and also a common composition, *except* that one contains a portion of chlorid of sodium, another of sulphate of lime, another of sulphate of soda; and the accessory ingredients do not interfere with the fundamental resemblance of the species. In Ittnerite there is the same form and composition, with water as the accessory ingredient. Nepheline and Cancrinite are closely allied to one another both in form and composition, except that the latter includes a portion of carbonate of lime and soda; this addition in Cancrinite causes scarcely any divergence from the angles of Nepheline.

In Staurotide, the oxygen ratio for the peroxyds and silica is mostly 1 : ½; yet some good analyses afford the ratio 1 : ⅔; and moreover there is a difference in specific gravity, corresponding with the difference of composition, the ratio $1 : \frac{1}{2}$ being connected with the highest. In Andalusite the ratio is $1 : \frac{2}{3}$; yet a chemist analyzing Andalusite and associated Kyanite finds this ratio for the latter, and $1 : \frac{3}{4}$ for the former, in which last several analysts agree with him. The analyses of Sillimanite afford the oxygen ratios $1 : \frac{2}{3}$, $1 : \frac{3}{4}$, $1 : \frac{4}{5}$, and perhaps also 1 : 1. The facts therefore go to show that there may be an addition to the amount of silica without altering the type of the species.

In the Feldspars, Anorthite, a well characterized species, has the oxygen ratio for the bases and silica 1 : 1, as in Meionite. Oligoclase, Andesine, Labradorite, and Albite, are all Triclinic and closely homœomorphous with Anorthite. Yet these species differ from Anorthite in having an increased proportion of silica, and this silica is therefore added without changing the type. 1 : 1 is therefore the type ratio of the Feldspars, while 1 : 1, $1 : \frac{4}{3}$, 1 : 2, $1 : \frac{8}{3}$, 1 : 3, are the occurring ratios.

The Micas illustrate the same principle; the type ratio is 1 : 1, as with the feldspars. The Hydrous Silicates are also in many cases examples of the same, the water often not affecting the type, and the species, if the water is excluded, having an analogy in form and composition to anhydrous species.

In characterizing the sections of silicates laid down, it is therefore necessary to recognize not only the type ratios for the group, but also the variations on this type that occur. It appears also preferable to make distinct sections of the Micas and Feldspars, as these species form natural groups by themselves. The Feldspar section is characterized by a ratio of 1 : 3 for the oxygen of the protoxyds and peroxyds, which ratio does not occur in the other sections of anhydrous Silicates.

With respect to the Sulphurets and Arseniurets, an important fact is established by the homœomorphism of the species, as recognized by Frankenheim, viz: that Arseniurets and Sulphurets are related in form, and also in formula, if the halved atomic weight of arsenic be adopted. Thus $Fe\,S^2$, $Fe\,(As, S)^2$, $Fe\,As^2$, are related compounds.

In the following synopsis, it will be observed, that the species of each division are associated on the ground of their analogy in composition and divided into groups, according to their crystalline forms. These groups are therefore in many cases mutually dimorphous, or rather pleomorphous. The many cases of pleomorphism among minerals and their exact relations, are therefore exhibited in the arrangement.*

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* The classification which is here adopted, both in its Berzelian features, and its grouping species of like crystallization together, is similar to that published in the last edition of this work. There are however many modifications introduced, especially in the arrangement of the Silicates; and greater precision has been given to all of its divisions.

The recent arrangement published by Professor Gustaf Rose in his Krystallo-

General Review of the Classification of Minerals.

I. NATIVE ELEMENTS.

I. Hydrogen Group.

1. Iron Section.
2. Tin Section.

II. Arsenic Group.

1. Arsenic Section.
2. Sulphur Section.

III. Carbon Group.

II. SULPHURETS, ARSENIURETS, Etc.

I. BINARY COMPOUNDS.

1. Compounds of Elements of the Arsenic Group with one another, (p. 30).

1. *Realgar Group.* Composition R S. Monoclinic.—Realgar.
2. *Orpiment Gr.* Composition $R^2 S^3$. Trimetric.—Orpiment, Bismuthine, Stibnite.

2. Compounds of Elements of the Arsenic Group with those of the Hydrogen Group.

1. Discrasite Division. Composition R^2 A,* (p. 35).

1. *Discrasite Gr.* Trimetric.—Discrasite.

2. Galena Division. Composition R A, (p. 37).

1. *Galena Gr.* Monometric.—Silver Glance, Erubescite, Galena, Cuproplumbite, Manganblende, Syepoorite, Scheererite, Clausthalite, Tilkerodite, Naumannite, Altaite.
2. *Blende Gr.* Monometric, Tetrahedral.—Blende.
3. *Stromeyerite Gr.* Trimetric.—Copper Glance, Stromeyerite.
4. *Pyrrhotine Gr.* Hexagonal.—Cinnabar, Millerite, Pyrrhotine, Greenockite, Copper Nickel, Breithauptite.

3. Pyrites Division. Composition R A^2, (p. 54).

1. *Pyrites Gr.* Monometric.—Pyrites, Hauerite, Smaltine, Chloanthite, Cobaltine, Gersdorffite. Ullmannite.
2. *Marcasite Gr.* Trimetric.—Marcasite, Rammelsbergite, Leucopyrite, Mispickel, Glaucodot, Sylvanite.
3. *Nagyagite Gr.* Dimetric.—Nagyagite.
4. *Covelline Group.* Hexagonal.—Covelline.

4. Skutterudite Division. Composition R A^3. Monometric, (p. 67.)

Skutterudite.

Chemische Mineral-System (1853) has many points in common with the above. Yet in the adaptation of Crystallography to the Berzelian System, the author's method is his own and of earlier date; moreover the peculiarities are many and of a fundamental character. The author however takes pleasure in acknowledging his indebtedness to Prof. Rose's able work, for many invaluable facts and opinions therein contained.

* A stands for Arsenic, Sulphur, or any element of the Arsenic Group. The halved Atomic Weight of Arsenic is adopted in these formulas.

II. DOUBLE BINARY COMPOUNDS.

1. The Persulphuret a Sulphuret of Iron, Cobalt, or Nickel, (metals of the Hydrogen Group), (p. 67).

1. *Linnæite Gr.* Monometric.—Linnæite.
2. *Chalcopyrite Gr.* Dimetric.—Chalcopyrite, Tin Pyrites.
3. *Sternbergite Gr.* Trimetric.—Sternbergite.

2. The Persulphuret a Sulphuret of an element of the Arsenic Section, (p. 72).

1. *Persulphuret of the form* $R^2 S^3$.—Wolfsbergite, Berthierite, Zinkenite, Miargyrite, Plagionite, Jamesonite, Heteromorphite, Brongniardite, Chiviatite, Dufrenoysite, Freislebenite, Pyrargyrite, Proustite, Bournonite, Boulangerite, Aikinite, Wolchite, Kobellite, Tetrahedrite, Tennantite, Geocronite, Stephanite, Polybasite.
2. *Persulphuret of the form* $R^2 S^5$.—Enargite, Xanthocone, Fireblende.

III. FLUORIDS, CHLORIDS, BROMIDS, IODIDS.

I. BINARY COMPOUNDS.

1. Calomel Division. Composition $R^2(Cl, I, Br)$, (p. 89).

1. *Calomel Gr.* Dimetric.—Calomel.

2. Rock Salt Division. Composition $R\ (Cl, I, Br)$ or RF.

1. *Rock Salt Gr.* Monometric.—Sylvine, Rock Salt, Sal Ammoniac, Kerargyrite, Embolite, Bromyrite; Fluor Spar, Yttrocerite.
2. *Iodyrite Gr.* Hexagonal.—Iodyrite, Fluocerite.
3. *Cotunnite Gr.* Trimetric.—Cotunnite.

II. DOUBLE BINARY COMPOUNDS.

Cryolite, Chiolite.

IV. OXYGEN COMPOUNDS.

I. BINARY COMPOUNDS.

I. OXYDS OF ELEMENTS OF THE HYDROGEN GROUP.

a. *Anhydrous.*

1. Monometric Oxyds, (p. 101).

1. *Periclase Gr.* Composition $R\ O$.—Periclase, Red Copper.
2. *Martite Gr.* Composition $R^2\ O^3$.—Martite.
3. *Spinel Gr.* Composition $R\ O + R^2\ O^3$.—Iserine, Irite, Spinel, Automolite, Magnetite, Franklinite, Chromic Iron, Pitchblende.
4. *Melaconite Gr.* Composition $R\ O^2$.—Melaconite (?).

2. Hexagonal Oxyds, (p. 110).

1. *Zincite Gr.* Composition $R\ O$.—Zincite, Water (?).
2. *Corundum Gr.* Composition $R^2\ O^3$.—Corundum, Specular Iron, Ilmenite.
3. *Tenorite Gr.* Composition $R\ O^2$.—Tenorite.

3. Dimetric Oxyds, (p. 117).

1. *Rutile Gr.* Composition $R\ O^2$.—Cassiterite, Rutile, Anatase; Braunite, Hausmannite (?).

4. Trimetric Oxyds, (p. 122).

1. *Chalcotrichite Gr.* Composition $R\ O$.—Chalcotrichite.

2. *Chrysoberyl Gr.* Composition $R^2 O^3$.—Chrysoberyl.
3. *Brookite Gr.* Composition $R O^2$.—Brookite, Pyrolusite (?).

5. COMBINATION OF OXYDS AND CHLORIDS OR SULPHURETS, (p. 127).

Matlockite, Mendipite, Voltzite.

b. *Hydrous Oxyds.* (p. 128).

1. *Diaspore Gr.* Ratio of oxygen of oxyd and water 3 : 1. Trimetric.—Diaspore, Göthite, Manganite, (?) Polianite (?).
2. *Limonite Gr.* Ratio of oxygen of oxyd and water 2 : 1.—Limonite.
3. *Brucite Gr.* Ratio of oxygen of oxyd and water 1 : 1. Hexagonal.—Brucite, Gibbsite.
   Appendix. Völknerite, Psilomelane, Wad.
4. *Combination of oxyds and chlorids.*—Atacamite.

II. OXYDS OF ELEMENTS OF THE ARSENIC GROUP.

1. ARSENIC DIVISION, (p. 139).

1. *Arsenolite Gr.* Composition $R O^3$. Monometric.—Arsenolite, Senarmontite.
2. *Valentinite Gr.* Composition $R O^3$. Trimetric.—Valentinite, Bismuth Ochre(?).
3. *Kermesite Gr.* Composition $R (O, S)^3$. Monoclinic.—Kermesite.
4. *Cervantite Gr.* Composition, $R O^4$.—Cervantite.

2. SULPHUR DIVISION, (p. 143.)

1. *Sulphurous Acid Gr.* Composition $R O^2$.—Sulphurous Acid.
2. *Sulphuric Acid Gr.* Composition $R O^3$.—Sulphuric Acid.
3. *Wolframine Gr.* Composition $R O^3$.—Wolframine, Molybdine.

III. OXYDS OF CARBON, BORON, SILICON.

Carbonic Acid, (p. 144).
Sassolin, (p. 144).
Quartz, Opal, (p. 145).

II. DOUBLE BINARY COMPOUNDS, OR SALTS.

1. *Acid of the Form* $R O^3$.

I. SILICATES.

a. *Anhydrous Silicates.*

1. EDELFORSITE SECTION. Oxygen ratio of bases and silica, 1 : 3, (p. 155).

Edelforsite, Mancinite.

2. AUGITE SECTION. Oxygen ratio 1 : 2—varying to 1 : $2\frac{1}{4}$, (p. 156).

1. *Augite Gr.* Monoclinic.—Wollastonite, Pyroxene, Rhodonite, Spodumene, Hornblende, Acmite, Wichtyne, Sordawalite.
2. *Babingtonite Gr.* Triclinic.—Babingtonite.
3. *Beryl Gr.* Hexagonal.—Beryl, Eudialyte.

3. EULYTINE SECTION. Oxygen ratio 1 : $1\frac{1}{2}$, (p. 181).

Eulytine (?). Leucophane.

4. GARNET SECTION. Oxygen ratio 1 : 1;—varying to 1 : $\frac{3}{4}$ in Chondrodite, and 1 : $\frac{4}{3}$ in Scapolite.

1. *Chrysolite Gr.* Trimetric, (p. 184).—Chrysolite, Fayalite, Tephroite, Chondrodite.
2. *Phenacite Gr.* Hexagonal, (p. 189).—Willemite, Phenacite.

3. *Garnet Gr.* Monometric, (p. 190).—Garnet, Pyrope, Helvin.
4. *Scapolite Gr.* Dimetric, (p. 195).—Zircon, Idocrase, Sarcolite, Meionite, Scapolite, Mellilite, Dipyre (?).
5. *Epidote Gr.* Monoclinic, (p. 206).—Epidote, Allanite, Zoisite, Gadolinite.
6. *Axinite Gr.* Triclinic, (p. 212).—Danburite, Axinite.
7. *Iolite Gr.* (p. 214).—(Perhaps more related to mica section). Iolite.

5. MICA SECTION. Oxygen ratio for type 1 : 1,—varying to 1 : 1½. Structure micaceous, (p. 217).

Muscovite, Phlogopite, Biotite, Lepidolite, Lepidomelane.

6. FELDSPAR SECTION. Oxygen ratio for type 1 : 1,—varying to 1 : 3; oxygen ratio between protoxyds and peroxyds 1 : 3.

1. *Leucite Gr.* Monometric, (p. 229).—Sodalite, Lapis-lazuli, Hauyne, Nosean, Leucite.
2. *Nepheline Gr.* Hexagonal, (p. 232).—Nepheline, Cancrinite.
3. *Feldspar Gr.* Triclinic or Monoclinic, (p. 234).—Anorthite, Andesine, Labradorite, Oligoclase, Albite, Orthoclase.
4. *Petalite Gr.* Petalite.

7. ANDALUSITE SECTION. Oxygen ratio 1 to less than 1.

1. *Gehlenite Gr.* Dimetric, (p. 256).—Gehlenite.
2. *Andalusite Gr.* Trimetric, (p. 257).—Andalusite, Topaz, Staurotide, Lievrite (?).
3. *Kyanite Gr.* Triclinic, (p. 263).—Kyanite, Sillimanite.
4. *Euclase Gr.* Monoclinic, (p. 267).—Euclase, Sphene.
5. *Tourmaline Gr.* Hexagonal, (p. 270).—Tourmaline.

b. *Hydrous Silicates.*

A. MAGNESIAN HYDROUS SILICATES.

1. TALC SECTION. Oxygen ratio for bases and silica (water excluded) 1 : 3 to 1 : 2¼, (p. 275).

Talc, Meerschaum, Neolite, Spadaite, Chlorophæite, Crocidolite (?).

2. SERPENTINE SECTION. Oxygen ratio 1 : 2 to 1 : 1¼, (p. 279).

Picrophyll, Kerolite, Monradite, Aphrodite, Picrosmine, Antigorite, Saponite, Serpentine, Deweylite, Hydrophite.

3. CHLORITE SECTION. Oxygen ratio 1 : 1 to 1 : ½, (p. 289).

1. Oxygen ratio 1 : 1.—Hisingerite, Thuringite, Euphyllite, Pyrosclerite (A).
2. Oxygen ratio 1 : ¾.—Pyrosclerite (B), Clinochlore, Chlorite, Delessite.
3. Oxygen ratio 1 : ⅔.—Ripidolite, Aphrosiderite, Clintonite, Chloritoid (A).
4. Oxygen ratio 1 : ½.—Chloritoid (B), Cronstedite, Sideroschisolite, Margarite.

B. NON-MAGNESIAN HYDROUS SILICATES.

1. PYROPHYLLITE SECTION. Oxygen ratio between bases and silica, water excluded, 1 : 3 to 1 : 2½, p. 303. (Related to Edelforsite Section of Anhydrous Silicates.)

Pyrophyllite, Anthosiderite.

2. PECTOLITE SECTION. Oxygen ratio 1 : 2 to 1 : 2¼, p. 304. (Related to Augite Section of Anhydrous Silicates).

1. *Apophyllite Gr.* Apophyllite (?).
2. *Laumontite Gr.* Monoclinic and Augitoid.—Pectolite, Okenite, Laumontite, Catapleiite (?).
3. *Dioptase Gr.* Hexagonal and Berylloid.—Dioptase, Pyrosmalite.

3. CALAMINE SECTION. Oxygen ratio 1 : 1, p. 311. (Related to Garnet Section of Anhydrous Silicates).

1. *Tritomite Gr.* Monometric and Garnetoid.—Tritomite.
2. *Thorite Gr.* Thorite, Cerite.
3. *Calamine Gr.* Trimetric.—Calamine, Prehnite.

Appendix. Chlorastrolite, Savite, Schneiderite, Carpholite.

4. ZEOLITE SECTION. Oxygen ratio of protoxyds and peroxyds 1 : 3, p. 317, (as in Feldspar Section of Anhydrous Silicates).

1. *Analcime Gr.* Monometric and Leucitoid, (p. 318).—Analcime, Ittnerite.
2. *Chabazite Gr.* Hexagonal, (p. 319).—Chabazite, Gmelinite, Levyne.
3. *Gismondine Gr.* Dimetric, (p. 322).—Gismondine, Edingtonite, Faujasite.
4. *Thomsonite Gr.* Trimetric. $I : I$=90°–92°; rarely monoclinic, and when so, still homœomorphous with the trimetric species. No perfect pearly cleavage. (p. 323).—Harmotome, Phillipsite, Thomsonite, Natrolite, Scolecite, Sloanite.
5. *Stilbite Gr.* Monoclinic or trimetric; a perfect pearly cleavage, (p. 330).—Epistilbite, Heulandite, Brewsterite, Stilbite, Caporcianite.

5. DATHOLITE SECTION. Oxygen ratio 1 to less than 1. (Related to Andalusite Section of Anhydrous Silicates), p. 334.

Datholite; Allophane, Schrötterite.

Appendix to Hydrous Silicates, (p. 337).

c. *Unarranged Silicates containing Titanic Acid*, (p. 341).

Keilhauite, Tscheffkinite, Schorlomite, Mosandrite, Wöhlerite.

II. TANTALATES, COLUMBATES, (TITANATES), TUNGSTATES, MOLYBDATES, VANADATES, CHROMATES, (p. 344).

1. *Pyrochlore Gr.* Monometric.—Oxygen ratio 1 : 2.—Perofskite, Pyrochlore, Pyrrhite (?).
2. *Scheelite Gr.* Dimetric.—Oxygen ratio of bases and acid 1 : 3.—Scheelite, Scheeletine, Wulfenite, Azorite (?).
3. *Fergusonite Gr.* Dimetric. Oxygen ratio 2 : 1.—Fergusonite.
4. *Tantalite Gr.* Trimetric; $I . I$=100°–102°.—Tantalite, Wolfram, Columbite, Samarskite, Mengite.
5. *Polymignyte Gr.* Trimetric; $I ; I$=90½°–95°.—Polymignyte, Polycrase, Æschynite, Euxenite, Rutherfordite.
6. *Yttrotantalite Gr.* Oxygen ratio 1 : 1.—Yttrotantalite.
7. *Vanadates, Chromates.* Crocoisite, Melanochroite, Dechenite, Descloizite, Vanadinite, Volborthite, Aræoxene.

III. SULPHATES—SELENATES.

1. ANHYDROUS, (p. 364).

1. *Celestine Gr.* Trimetric.—Glaserite, Thenardite, Barytes, Celestine, Anhydrite, Anglesite, Almagrerite, Leadhillite,
2. *Dreelite Gr.* Rhombohedral.—Dreelite, Susannite.
3. *Glauberite Gr.* Monoclinic.—Glauberite, Lanarkite.

Appendix. Connellite, Selenate of Lead, Reussin.

2. HYDROUS, (p. 376).

Misenite; Polyhalite; Gypsum, Astrakanite; Mascagnine; Coquimbite; Cyanosite; Alunogen; Alum; Epsomite, Goslarite; Copperas, Bieberite, Pyromeline, Johannite; Glauber Salt; Botryogene; Copiapite; Apatelite; Alunite, Jarosite; Websterite; Pissophane; Linarite; Brochantite; Lettsomite; Medjidite, (p. 376–396).

IV. BORATES.

Boracite, Rhodizite; Hydroboracite; Hayesine; Borax; Lagonite; Larderellite; Warwickite, (p. 392–395).

2. *Acid of the Form* R^2O^5.

V. PHOSPHATES, ARSENATES, ANTIMONATES, NITRATES.

1. Anhydrous Phosphates, Arsenates, Antimonates.

1. *Apatite Gr.* Hexagonal.—Oxygen ratio of bases and acids, (exclusive of fluorid or chlorid), 3 : 5, (p. 396).—Apatite, Osteolite, Cryptolite, Zwieselite, Pyromorphite, Mimetene.
2. *Xenotime Gr.* Dimetric. Oxygen ratio 3 : 5, (p. 401).—Xenotime.
3. *Monazite Gr.* Monoclinic. Oxygen ratio 3 : 5 to 4 : 5, (p. 402).—Monazite, Wagnerite, Kühnite, (?) Lazulite.
4. *Triplite Gr.* Trimetric. Oxygen ratio 3 : 5 to 4 : 5, (p. 406).—Triphyline, Triplite.
5. *Fischerite Gr.** Trimetric. Oxygen ratio 6 : 5, (p. 408).—Fischerite, Peganite.
6. *Romeine Gr.* (p. 410). Romeine.

Appendix. Hopeite, Amblygonite, Herderite, Carminite.

2. Hydrous Phosphates, Arsenates.

Thrombolite; Stercorite; Struvite; Haidingerite; Pharmacolite, Vivianite, Erythrine, Nickel Green, Köttigite, Symplesite, Scorodite; Libethenite, Olivenite; Euchroite; Arseniosiderite; Pharmacosiderite; Beudantite; Wavellite, Cacoxene; Childrenite, Erinite; Cornwallite; Phosphochalcite; Tyrolite; Delvauxene; Dufrenite; Aphanesite; Chalcophyllite; Liroconite; Uranite, Chalcolite; Carphosiderite; Plumboresinite; Castelnaudite, (p. 412–432).

Sulphato-phosphates: Pitticite; Diadochite, (p. 432).

3. Nitrates.

Nitre; Nitratine; Nitrocalcite, (p. 433, 434.)

3. *Acid of the Form* $R\ O^2$.

VI. CARBONATES.

1. Anhydrous Carbonates.

1. *Calcite Gr.* Rhombohedral. $R:R$ =105°–108°, (p. 435).—Calcite, Magnesite, Dolomite, Breunnerite, Mesitine, Chalybite, Diallogite, Smithsonite.
2. *Aragonite Gr.* Trimetric. $I:I$=116°–119°, (p. 448).—Aragonite, Witherite, Strontianite, Bromlite, Manganocalcite, Cerusite.
3. *Barytocalcite Gr.* Monoclinic, (p. 453).—Barytocalcite.

2. Hydrous Carbonates.

Carbonate of Ammonia; Trona; Thermonatrite; Natron; Gaylussite; Lanthanite; Hydromagnesite; Malachite; Azurite; Aurichalcite; Zinc Bloom; Emerald Nickel; Remingtonite; Liebigite; Bismutite, (p. 454–457).

4. *Acid of the Form* R^2O^3.

VII. OXALATES.

Whewellite; Oxalite; Conistonite, (p. 464, 465).

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* This group (p. 408) should be transferred to the section of *Hydrous* Phosphates, &c.

V. RESINS—ORGANIC COMPOUNDS.

Amber; Copaline; Middletonite; Retinite; Scleretinite; Guyaquillite; Piauzite; Walchowite; Bitumen; Idrialine; Pyropissite; Brewstoline; Elaterite; Scheererite; Könlite; Fichtelite; Könleinite; Hartite; Hartine; Ixolyte; Hatchettine; Ozocerite; Chrismatine; Dopplerite; Dinite; Mellite.

III. NOMENCLATURE.

A systematic nomenclature like that for botany and zoology, is out of place in this science, except it be based upon relations among the whole range of inorganic products. Moreover, it is not necessary nor desirable.* The number of minerals known is less than seven hundred, and the double names of Natural History, therefore, can well be dispensed with. The addition of the termination *ite* or *lite*, (originally from λιθος, stone), answers sufficiently well the purposes of science.

The best names allude to some *prominent characteristic of the species;* others are given in *honor of those who have labored in the science*, or in reference to a *prominent locality* of a species. It should be remembered that the use of names of persons eminent in other sciences, or of such as are ignorant of all science, is wholly at variance with good usage and propriety; moreover, an attempted flattery of the politically distinguished is degrading to science, and cannot be too strongly discountenanced. It is important that the names when taken from a locality, or the name of a person, should retain their original orthography; and also when not thus derived, that they should be of Greek derivation.†

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* The author has here departed widely from principles deemed important in the first two editions of this treatise. The arrangement of Mohs, followed in the main in those editions, cannot stand the test of the developments of science. Even on its assumed ground of being a *natural* system, it is in many parts singularly artificial; being little better in some of its groupings than an ancient classification of plants which arranged the hard wood species in one group, the herbaceous in another, or collected together flowers of a color. For it is on no better ground that the diamond is placed alongside of topaz and sapphire; spathic iron near heavy spar, (instead of near calcite); graphite near psilomelane; allophane with green malachite; mica in the same order with cronstedite, spodumene with prehnite; iolite with quartz and chrysolite: and so on. Yet in justice to this Mineralogist of merited celebrity, it should be said, that very many natural groupings were embraced in his classification—far more, indeed, than in any of the *chemical* systems of that time, for the latter refusing almost all reference to physical characters, and considering only the elements present, instead of the mutual relations of the constituent elements, broke up species into fragments and strewed them about into most heterogeneous assemblages.

† Von Kobell has published a valuable work on Mineralogical Nomenclature, entitled, "Die Mineral-Namen," etc. München, 1853.

PART V.

DETERMINATIVE MINERALOGY.

In the following Tables for the Determination of Minerals, the student is supposed to have the requisite means for determining the blowpipe and ordinary chemical characters of minerals, so far at least as to be able to test—*

1. The effervescence or non-effervescence with the three mineral acids.
2. The solubility, more or less perfect, in these acids, cold or hot, or the insolubility of a mineral in the same reagents.
3. The presence of water by subjecting the mineral in a matrass or tube closed below, to the blowpipe heat.
4. The character of the water or fumes given off with the acids or heat, whether containing fluoric or other acids, or alkaline.
5. The blowpipe reactions for sulphur, phosphorus, boracic acid, and other cases of this kind.
6. The presence of arsenic, and each of the volatile metals; also of copper, lead, &c.

The student is advised to study well the use of the blowpipe, and the various effects of the fluxes; and for this purpose Whitney's translation of Berzelius on the Blowpipe, (published at Boston), will be found the best guide in the English language.†

Two tables are here given, one in which the general divisions are based on lustre, streak, and blowpipe and chemical characters; and another, in which the species are arranged under the several systems of crystallization.

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[*] It is obvious that for correct results, the testing should be carefully performed. It is not sufficient in trying for carbonic acid, to put a drop of dilute acid on the specimen; for carbonate of lime may be present as an impurity, and give rise to effervescence: a fragment should be tested in a test tube and its complete solution and effervescence to the end ascertained. To ascertain whether a mineral yields a malleable globule before the blowpipe with the fluxes, *soda* should be tried, if not successful with *borax*, and in some cases cupellation is necessary.

[†] Plattner's "Die Probirkunst mit dem Löthrohre" (3d edit., Leipzig, 1853) is a large and full work on the subject, giving the most recent facts, and including also reactions with acids and other chemical reagents.

Before presenting the Tables for determining species, a few facts upon some prominent minerals may be stated, that may aid the student in naming the specimens of his Cabinet.

1. *Quartz.*—No mineral is more common, or more varying in its colors, than quartz. It is the most abundant ingredient of gravel beds, of the pebbles of the fields, and of the sands of shores, as well as a characteristic ingredient of granite and many rocks. It will therefore be everywhere encountered by the student. He will hardly err in pronouncing a specimen to be quartz, whatever the color, if on trial he finds it equal to 7 in hardness, and therefore scratching glass with facility and not attacked by a file—not at all cleavable—infusible before the blowpipe—not acted upon by acids hot or cold—easily dissolved to a bead before the blowpipe with carbonate of soda—specific gravity not over 2·84. After a little experience, the hardness and absence of cleavage will suffice to determine it in almost all its varieties.

Calcite.—The mineral next in abundance to quartz, and as varied in its aspects, is limestone or calcite. Here—a knife-point easily scratches the surface—a drop of dilute muriatic acid causes an immediate effervescence—the blowpipe does not produce fusion, but gives an intense light, and the mineral after heating is alkaline, (being reduced to quicklime)—the specific gravity is not over 2·8—and when not compact massive, there is a very perfect cleavage.

Zeolites.—The hydrous silicates of alumina and some alkali or earth (potash, soda, or lime) are often called zeolites. They are most commonly found associated together in cavities or seams in amygdaloidal rocks, though occurring also in other rocks, as granite, &c. On page 317, Vol. II, several groups are mentioned. The Stilbite group is distinguished by its pearly cleavage; the forms are often laminato-radiate, and a drusy surface of a crystalline mass is made up of narrow oblong projections.

In Group IV, there is no perfect pearly cleavage; the forms are often acicular, and radiated masses consist of slender fibres, with the exterior often made of the squarish blunt or acute extremities of crystals. The other groups do not present fibrous forms; the species occur mostly in short and stout glassy crystals, analcime showing usually faces of the trapezohedron (f. 39) and chabazite often in rhombohedrons which are nearly cubes.

Hornblende, *Pyroxene*, *Epidote.*—These minerals fall among *anhydrous* species that are *fusible* before the blowpipe and have an *uncolored streak.* Epidote has commonly a characteristic *yellowish-green* color, and this variety is unlike any pyroxene or hornblende; it shades into brown, gray, and grayish-white, and may sometimes be red. Hornblende and Pyroxene vary from white to black through grass-green and olive-green shades. Hornblende and Pyroxene are distinctly cleavable, and prisms when broken longitudinally often show a cleavage plane or splintery look; Epidote has no very distinct cleavage, and the crystals and columnar forms have a more solid aspect, with a smoother surface, without any splintery appearance in the fracture or a tendency to further subdivision of the columns. In this last it resembles columnar Tourmaline, which is also distinct from Hornblende in its more compact look, with no vertical lines of cleavage in the several fibres or columns.

Hornblende and Pyroxene are often distinguished with difficulty when not in crystals, except by the aid of chemical analysis. The crystals of Hornblende are often six-sided prisms, with angles approaching 120° (two angles of 124½° and four of about 118°) or rhombic prisms of 124½°; while Pyroxene crystals are as commonly four-sided prisms near 90° in angles, (87° 6′ and 92° 54′), or eight-sided prisms near 135° in each angle of the prism.

Feldspars.—The feldspars are 6 to 7 in hardness, and occur either in tabular crystals or cleavable massive; never fibrous columnar and rarely granular; the lustre is vitreous, sometimes inclined to pearly, and the colors are white to flesh-red common; but sometimes bluish, greenish, and brown. There is one perfect cleavage, giving a smooth surface; another less perfect, at right angles, nearly or quite, with the former: if at right angles the species is Orthoclase; if varying three or four degrees from ninety, it is triclinic and therefore some other feldspar.

Spodumene is a whitish, grayish, or pale greenish mineral, resembling a feldspar; but it has two very distinct cleavages making between them an angle nearly of 135°.

Micaceous Minerals.—The following are the names of the only unmetallic minerals that are properly *micaceous* in any of their varieties—that is, which consist of very *thin*, *easily separable laminæ:*

1. *Muscovite*, *Phlogopite*, *Biotite*, *Lepidolite.*—Closely related, with laminæ elastic, unless they have undergone alteration—affording no water, or only a trace in a tube—B.B. fusing only on the edges; with acids, little or no action; with cobalt solution sometimes a clear blue, but usually dull. G.=2·75—3·2; H.=1·5—2. See further, pp. 221 to 227.

2. *Pyrophyllite*, *Margarite*, *Euphyllite.*—Laminæ, (excepting in Pyrophyllite), rather brittle, colors white or pale, affording water in a tube; B.B. fusing on thin edges; Pyrophyllite swells out. With acids, little or no action; a blue color with cobalt solution. G.=2·7—3·1; H.=3·5—4·5, (1·5 in Pyrophyllite.) See pp. 291, 300, 303.

3. *Chlorite*, *Ripidolite*, *Clinochlore*, *Pyrosclerite.*—Laminæ not elastic, flexible, affording water in a tube—feel often a little greasy—B.B. fusing on the edges, more easily than the preceding; in cobalt solution no blue color. Somewhat attacked by acids; colors mostly dark green, except pyrosclerite, which is often reddish. See further, pp. 291–296.

4. *Talc.*—Like the last in most of the characters, but laminæ more greasy, much softer, and less thin, and color mostly very

pale green; B.B. infusible, and with acids not dissolved; with cobalt solution, with some difficulty, a reddish color.

5. *Brucite.*—Somewhat like talc, whitish or greenish in color; B.B. infusible, heated in a tube affords water; in *the acids entirely soluble without effervescence.* See further, p. 133.

6. *Diallage*, *Hypersthene*, *Bronzite*, *Clintonite*, *Chloritoid.*—Often nearly *micaceous*, though more properly *foliated.* The laminæ are brittle, and do not separate easily. The same is true of Marmolite, which has some resemblance to talc, and differs from the species just enumerated in having a greasy feel.

7. *Gypsum.*—A crystallized variety: it is very soft, laminæ separable, hardly flexible without breaking, often transparent, and generally colorless. B.B. whitens and crumbles, but fuses only with difficulty.

8. *Uranite*, (p. 430), *Red Zinc Ore*, (p. 110), *Copper Mica*, (p. 428).—Uranite is bright green, or yellow; Red Zinc Ore is bright or deep red; Copper Mica is deep green. Crystals of Uranite are square tables, and those of Copper Mica hexagonal. Copper Mica gives a copper reaction; Red Zinc Ore is oxyd of zinc. Erythrine (Cobalt Bloom) is peach-blossom red in color, with often a bluish tinge. Pharmacolite and Vivianite have also a very perfect cleavage in one direction.

The classification in the body of the work may be conveniently used in determining species. A specimen, for example, may be easily ascertained to be a sulphate, and next a hydrous sulphate, if such; and then by turning to the section containing hydrous sulphates, a few further trials will enable the student to ascertain which of the species described he has in hand. To facilitate the use of the work in this way, a few remarks on certain compounds, in addition to those to be derived from the chapter on chemical tests and blowpipe analysis, are here offered, and also an index to some of the prominent classes of species.

Sulphurets, *Sulphates.*—Sulphurets may have a *metallic* lustre, or an *unmetallic* lustre with a *colored streak.* Only Blende (sulphuret of zinc) and Voltzite (an oxysulphuret of zinc) have an unmetallic lustre and an *uncolored* streak. Consequently, with these exceptions, *any unmetallic species with an uncolored streak which contains freely of sulphur, must be a sulphate.* The sulphates are all unmetallic in lustre, and they are often colorless. Helvin, Hauyne, and Nosean are silicates containing a very little sulphur.

Phosphates.—All the phosphates have an *unmetallic lustre.* The streak may be *colored* or *uncolored.* *None* of them are *soluble in water*, or have taste, excepting a single phosphate of ammonia; and the pure phosphates give *no odor in any way before the blowpipe.* Besides the direct test for phosphorus, the tests for carbonic acid, boracic acid, sulphur, separate them from the carbonates, borates, and sulphates; the test for fluorine from fluorids, although traces of fluorine often occur in phosphates; the complete solubility (without gelatinizing) in muriatic acid, hot or cold, distinguishes them from the silicates. There are the following exceptions to this last character: viz., Xenotime, Childrenite, Monazite, Turquois, Lazulite, which are also B.B. infusible.

Molybdates, *Tungstates.*—The Molybdates and Tungstates are *unmetallic in lustre.* The streak is *colored*, (yellow or yellowish, rarely red from chrome,) excepting in Scheelite, which is often white. Specific gravity never under 6.

Columbates, *Tantalates.*—Mostly submetallic in lustre, with an iron-black, velvet-black, or brownish black color. But Wöhlerite and Pyrochlore are yellow to brown, and Yttrocolumbite yellow to black; streak yellowish to nearly colorless.

See in the second volume for description of species of—

Sulphurets, not containing Arsenic, Bismuth, Selenium, or Antimony, pp. 37 to 56, 60, 66 to 71, 127.

Arseniurets, or Sulphurets containing Arsenic, Antimony, Bismuth, pp. 31—36, 41, 44, 52—63, 67, 73—88, 141.

Arsenic and Antimony Oxyds, pp. 139—142, 410.

Seleniurets, pp. 42, 43, 52.

Tellurets, pp. 21, 44, 64, 65.

Fluorids, Chlorids, Bromids, Iodids, pp. 89—98, 127, 128, 138, 463.

Sulphates, Anhydrous, p. 364; Hydrous, p. 376; Selenates, p. 375.

Arsenates, Phosphates, Anhydrous, p. 396; Hydrous, p. 411.

Borates, p, 392. See also Silicates containing Boracic Acid, Danburite, Axinite, Tourmaline, Datholite.

Nitrates, p. 433.

Carbonates, Anhydrous, p. 434; Hydrous, p. 454.

Vanadates, Chromates, pp. 359—364.

Columbates, Tantalates, Tungstates, Molybdates, pp. 345—358.

Ores of Silver, Sulphurets, pp. 37, 48; Sulpho-arseniurets, Arseniurets or Antimoniurets, pp. 35, 75—88; Seleniurets, p. 43; Tellurets, pp. 44, 64; Chlorid, Bromid, Iodid, pp. 92, 93, 95.

Ores of Quicksilver, Sulphuret, p. 48; Seleniuret, p. 52; Chlorid, Iodid, p. 89, 96.

Ores of Copper, Sulphurets, pp. 38, 46, 65, 68; Arsenical or Antimonial, pp. 36, 73, 77, 82, 84—88; Seleniurets, p. 43; Oxyds, pp. 101, 109, 117, 122; Oxychlorid, p. 138; Silicate, p. 309; Chromates, p. 360; Sulphates, pp. 375, 389, 391; Phosphates, Arsenates, pp. 412, 419—421, 425, 426, 428, 429; Carbonates, 458.

Ores of Lead, Sulphurets, pp. 39, 41; Seleniurets, p. 42; Tellurets, pp. 44, 65; Antimonial Sulphurets, pp. 74—88; Chlorid, p. 97; Oxyds, pp. 109, 117, 126; Oxychlorid, p. 127; Tungstate, p. 348; Molybdate, p. 349; Chromate, Vanadate, pp. 359—362; Sulphate, 370—374, 390; Selenate, p. 375; Phosphate, pp. 400, 431; Arsenate, p. 401; Carbonate, 452.

Ores of Cobalt and Nickel, Sulphurets, pp. 41, 42, 49, 67; Bismuth, p. 45; Antimonial or Arsenical, pp. 52, 53, 56—59, 61, 63, 67; Sulphate, p. 385; Arsenate, pp. 416, 418; Carbonate, 461.

Ores of Iron, Sulphurets, pp. 50, 54, 60, 68; Arsenical or Antimonial, pp. 61, 62, 73; Oxyds, pp. 102—106, 113—116, 129, 131; Sulphate, pp. 380, 383, 385, 387, 389; Borate, pp. 395,; Phosphate, pp. 399, 406—408, 415, 424, 427, 431; Arsenate, p. 418,422, 432; Carbonate, 444.

Ores of Zinc and Cadmium, Sulphuret, pp. 45, 51; Oxyd, p. 110; Oxysulphuret, p. 127; Silicate, pp. 156, 189, 313; Sulphate, p. 384; Phosphate, p. 409; Arsenate, p. 418; Carbonate, 447, 460.

Ores of Bismuth, Sulphurets, pp. 33, 73, 77, 88, 82; Telluric, 21; Silicate, 181; Oxyd, 141; Carbonate, 462.

Ores of Antimony, Sulphurets, p. 33; Oxyds, pp. 140—142, 410.

Ores of Arsenic, Sulphurets, pp. 31, 32; Oxyds, p. 139.

Ores of Manganese, Arsenical, p. 53; Sulphuret, p. 41, 56; Oxyds, pp. 118, 125, 130, 135, 136; Silicate, p. 167, 186; Phosphate, pp. 397, 406—408; Carbonate, 446, 452.

Ores of Molybdenum, Tungsten, Sulphuret, p. 66; Oxyd, pp. 143, 144.

Ores of Tin, Sulphuret, p. 70; Oxyd, p. 118.

Ores of Uranium, Oxyds, p. 107; Sulphate, pp. 386, 392; Phosphate, pp. 430; Carbonate, 461, 462.

Ores of Titanium, Oxyd, pp. 120—123; other ores, 115, 268, 345, etc.

The following are the Tables for the determination of Species. By *Infusible, or nearly so*, is meant either wholly infusible or fusing only with great difficulty on the thinnest edges. The abbreviations employed are explained beyond, (p. 264).

TABLE I.

I. SOLUBLE MINERALS: MINERALS SOLUBLE IN WATER AND HAVING TASTE.

I. Carbonates: effervescing with muriatic acid; fumes inodorous.

II. Nitrates: deflagrating more or less on burning coals; effervescing with sulphuric acid and not with nitric or muriatic.

III. Chlorids: effervescing and giving off suffocating fumes with sulphuric acid, and not with muriatic.

IV. Sulphates and Phosphates: no effervescence with either of the acids; B.B. a sulphur or phosphorus reaction.

1. Little or no metallic reaction.
2. Reaction of iron, manganese, cobalt, zinc, or copper.

V. Borates or Boracic Acid: not effervescing with the acids; B.B. boracic acid reaction.

VI. Arsenous Acid: B.B. on charcoal alliaceous fumes.

II. INSOLUBLE MINERALS.

I. LUSTRE UNMETALLIC.

A. STREAK UNCOLORED.

a. B.B. NO ODOROUS OR VISIBLE FUMES ON CHARCOAL, WITH OR WITHOUT FLUXES; GLOBULE OBTAINED BY REDUCTION NOT MALLEABLE.

1. *When pulverized, wholly soluble to a liquid state in one or more of the acids, (cold or hot); none gelatinizing.*

* B.B. infusible or nearly so, (p. 267).

† *Carbonates:* when pulverized, effervescing more or less in acids; fumes inodorous, reddening litmus paper.
†† *Sulphates, Phosphates, Oxyds:* no effervescence with acids.
††† *Fluorids, Borates, Oxalates.*

** B.B. fusible, (p. 269).

† *Carbonates:* when pulverized, effervescing as above.
†† *Phosphates, Sulphates:* no effervescence with acids; B.B. a sulphur or phosphorus reaction.
††† *Fluorids:* a fluorine reaction, and none of phosphorus.
†††† *Borates:* no effervescence; B.B. reaction of boracic acid.

2. *Soluble in acids; the silica gelatinizing: Silicates.*

* B.B. infusible or nearly so, (p. 271).
** B.B. fusible, (p. 271).

† Hydrous.
†† Anhydrous.

3. *Insoluble in acids, or partly soluble without gelatinizing.*

* B.B. infusible, (p. 274).

† B.B. reaction of sulphur, phosphorus or fluorine.
†† Hydrous: B.B. no phosphorus reaction; *Hydrous silicates of magnesia, alumina, or oxyd of iron, with opal and hydrates of alumina.*
††† Anhydrous, (p. 277).

** B.B. fusible; (includes no phosphates), (p. 280).

† *Sulphates:* sulphur reaction.
†† Hydrous; B.B. no sulphur reaction; G below 3·8.
††† Anhydrous: B.B. no sulphur reaction, (Helvin excepted), (p. 282).

b. B.B. EITHER FUMES, OR A MALLEABLE GLOBULE, (p. 286).

* B.B. globule of lead with the fluxes on charcoal if not without, and lead oxyd on charcoal; no fumes of Arsenic, Selenium, or Antimony.
** B.B. inodorous fumes of Zinc, Bismuth, Antimony, Tellurium.
*** B.B. odorous fumes of Arsenic or Selenium.
**** B.B. wholly vaporizable, with fumes of Quicksilver and Chlorine.

B. STREAK COLORED.

a. B.B. NO FUMES WITHOUT OR WITH THE FLUXES; GLOBULE NOT MALLEABLE.

* B.B. infusible or nearly so, (p. 288).

† Gelatinize with acids.
†† Not gelatinizing with acids.

** B.B. fusible, (p. 291).

† Gelatinize with acids.
†† Not gelatinizing with acids; B.B. phosphorus reaction.
††† Not gelatinizing with acids; B.B. no phosphorus reaction.

b. B.B. NO FUMES, EXCEPT SOMETIMES OF LEAD; A MALLEABLE METALLIC GLOBULE, (p. 294).

* B.B. infusible; a globule of tin or copper with soda.
** B.B. fusible; a globule of lead, copper, or silver; no fumes of Arsenic, Sulphur, Selenium, or Antimony.

† Gravity below 4·5; *Ores of Copper.*
†† Gravity above 4·5; *Ores of Lead, Copper, or Silver.*

c. B.B. VAPORIZING WHOLLY AND EASILY IN FUMES, LEAVING NO METALLIC GLOBULE, (UNLESS ANTIMONY OR BISMUTH), (p. 296).

d. B.B. FUMES OF ARSENIC, SULPHUR, ANTIMONY OR CHLORINE; LEAVING A GLOBULE WHICH IS NOT MALLEABLE, (p. 297.)

* B.B. fumes arsenical.
** B.B. fumes not arsenical.

e. B.B. FUMES OF SULPHUR, ARSENIC, ANTIMONY, CHLORINE, BROMINE, OR IODINE; A MALLEABLE GLOBULE OF COPPER OR SILVER, (p. 298).

* B.B. fumes of Arsenic, Sulphur or Antimony.
** B.B. fumes of Chlorine, Bromine, Iodine or Muriatic Acid.

II. LUSTRE METALLIC.

A. STREAK UNMETALLIC.

a. B.B. NO FUMES, (p. 300).

* B.B. infusible, or nearly so; colors steel-gray to black.

† With muriatic acid fumes of Chlorine; contain manganese.
†† No fumes of Chlorine with muriatic acid; (no hydrous species).

** B.B. fusible.

b. B.B. GIVING OFF FUMES, (p. 302).

* B.B. fumes of Arsenic associated sometimes with Sulphur; globule brittle; color whitish with sometimes a reddish or yellowish tinge, excepting Tennantite, which is black.
** B.B. fumes sulphurous or antimonial, not arsenical; globule brittle; colors rather pale, excepting Manganblende, which is black.
*** B.B. a malleable globule, or mineral wholly vaporizable, (p. 304).

† B.B. A globule of lead, silver or gold.
†† B.B. A globule of copper or tin.

B. STREAK METALLIC.

a. Not malleable, (p. 306).

* B.B. no fumes ; infusible.
** B.B. fumes ; globule not malleable.
*** B.B. fumes ; malleable globule, or mineral wholly vaporizable.

† B.B. wholly and easily vaporizable, (ores of lead not included).
†† B.B. a malleable globule ; fumes odorous.
‡ B.B. a globule of lead or silver, without copper or any copper reaction.
‡‡ B.B. a globule of copper, or of silver or lead along with copper ; a copper reaction.
††† B.B. a malleable globule ; fumes inodorous.

b. Malleable, (p. 309).

The following are the abbreviations used in the following pages.

Antim.	Antimony.	*Mur.*	Muriatic acid.
Arsen.	Arsenical.	*Nit.*	Nitric acid.
B, bh.	Blue, bluish.	Op.	Opaque.
BB	Before the Blowpipe.	*Phos.*	Salt of phosphorus.
Bn, bnh.	Brown, brownish.	P'ly.	Pearly.
Bk, bkh.	Black, blackish.	Pms.	Prisms.
Bor.	Borax.	R, rdh.	Red, reddish.
Cleav.	Cleavage, Cleavable.	Rad.	Radiated.
Cryst.	Crystals, Crystalline.	Ren.	Reniform.
Decrep.	Decrepitate.	*Soda,*	Carbonate of soda.
Dif.	Difficult, difficulty.	Sol.	Soluble, solution.
Efflor.	Effloresce.	Stalact.	Stalactitic.
Exfol.	Exfoliate.	Stel.	Stellate.
Fib.	Fibrous.	Strl.	Translucent on edges only.
Fol.	Foliated.	Strp.	Semitransparent.
Fus.	Fusible, Fusion.	Sulph.	Sulphureous.
Gelat.	Gelatinize.	Submet.	Submetallic.
Gn, gnh.	Green, greenish.	*Sul.*	Sulphuric acid.
Gran.	Granular.	Trl.	Translucent.
Gy, gyh.	Gray, grayish.	Trp.	Transparent.
Insol.	Insoluble.	Vit.	Vitreous.
Intum.	Intumesce.	W, wh.	White, whitish.
Met.	Metallic.	Yw, ywh.	Yellow, yellowish.

The constituents of the species are in all cases stated, and they are an indication of the blowpipe reactions, both as to whether a mineral affords water in a matrass or not, and the effects of the metallic oxyds and other ingredients present. The page on which the species is described at length is added, that the student may resolve his final doubts by a reference to the full descriptions.

The Roman numerals indicate the system of crystallization, in the order : I, Monometric ; II, Dimetric ; III, Trimetric ; IV, Monoclinic ; V, Triclinic ; VI, Hexagonal.

After each subdivision in the following Table, there is a catalogue of the species of the subdivision that occur foliated or fibrous in some or all varieties, also a list of the species arranged according to their specific gravities. As species often vary much, they sometimes fall into more than one of the sections in the following Table.

I. SOLUBLE MINERALS, HAVING TASTE.

I. Carbonates: effervescing with muriatic acid; fumes inodorous. B.B. either fuse, liquefy, or vaporize.

	Hardness.	
Carb. Ammonia,		Whitish crusts. Odor of Ammonia. 454.
Natron,	1—1·5	Crusts: G 1·423; w, gyh; taste alkaline; efflor; $\dot{\mathrm{N}}\mathrm{a}$, $\ddot{\mathrm{C}}$, Aq, 455. *Trona* has G 2·11, 454. *Thermonatrite* has G 1·5–1·6, 455.
Gay Lussite,	2—3	IV; cryst; G 1·9—2; ywh-w; vit; taste weak; B.B. decrep, opaque, like calcite. $\dot{\mathrm{N}}\mathrm{a}$, $\dot{\mathrm{C}}\mathrm{a}$, $\ddot{\mathrm{C}}$, Aq, 455.

II. Nitrates: deflagrating on burning coals; effervescing with sulphuric acid, but not with nitric or muriatic.

Nitrocalcite,		Silken tufts, efflor; vit; taste sharp, bitter; very deliq; BB slight deflagration, fuses and dries; $\dot{\mathrm{C}}\mathrm{a}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$, Aq, 434.
Nitratine,	1·5—2	VI; rhombohedral; efflor; mas; G 2—2·3; w, bnh, ywh; vit; trp; taste cooling; BB yw flame; $\dot{\mathrm{N}}\mathrm{a}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$, 433.
Nitre,	2	III; 120°; in crusts; acic cryst; G 1·937; w; vit; strp; taste saline cooling; BB flame not yw; $\dot{\mathrm{K}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$, 433.

III. Chlorids: effervescing with suffocating fumes with sulphuric acid, and not with muriatic.

Sal Ammoniac,	1—1·5	Whitish, ywh, gyh; crusts; pungent saline taste; odor of ammonia with soda, 92.
Sylvine,	2	I; mas; w; vit; taste saline; BB flame not yellow; K, Cl, 90.
Common Salt,	2·5	I; cryst; mas; w, ywh, rdh, bh; trp; taste saline; BB flame yellow; Na, Cl, 90.

IV. Sulphates and Phosphates: no effervescence with either of the acids. B.B. sulphur or phosphorus reaction.

1. B.B. little or no metallic reaction. (All but *Thenardite, Glauberite, Reussin* and *Glaserite,* contain water.)

Mascagnine,		In ywh crusts. *Odor of ammonia* with soda, 379.
Glauber Salt,	1·5—2	IV; efflor crusts; G 1·48; w, wh; taste cool saline, bitter; BB fuses, flame yw; $\dot{\mathrm{N}}\mathrm{a}$, $\dddot{\mathrm{S}}$, Aq, 386.
Alum,	2—2·5	I; fibrous; crusts; efflor; G 1·75—2; w, ywh, rdh; taste astringent; very soluble; BB intum, spongy; $\dddot{\bar{\mathrm{A}}}\mathrm{l}$, $\dddot{\mathrm{S}}$, Aq, with $\dot{\mathrm{K}}$, $\dot{\mathrm{N}}\mathrm{a}$, $\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{F}}\mathrm{e}$, $\dot{\mathrm{M}}\mathrm{n}$ or Am, 382.
Epsomite, Astrakanite,	2—2·5	III; mas; cryst; G 1·751; w; vit; taste bitter saline; BB deliq; flame not yw; $\dot{\mathrm{M}}\mathrm{g}$, $\dddot{\mathrm{S}}$, Aq, 384. Astrakanite, $\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{N}}\mathrm{a}$, $\dddot{\mathrm{S}}$, Aq, 379.
Polyhalite,	2—3	III; massive; subfibrous; G 2·7—2·8; rdh; trl, op; taste bitter astringent, very weak; BB fus!!; $\dot{\mathrm{K}}$, $\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{C}}\mathrm{a}$, $\dddot{\mathrm{S}}$, Aq, 377.

	Hardness.	
Thenardite,	2—2·5	III; cryst; G 2·73; w; vit; trl; effloresces; BB yw flame; $\dot{\mathrm{Na}}$, $\dddot{\mathrm{S}}$, 365.
Glauberite,	2—3	IV; cryst; G 2·7—2·9; ywh, gyh; vit; taste weak saline; BB decrep; trp glass; $\dot{\mathrm{Na}}$, $\dot{\mathrm{Ca}}$, $\dddot{\mathrm{S}}$, 374.
Reussin,		Prisms; acic; efflor; w; taste saline, bitter; $\dot{\mathrm{Mg}}$, $\dot{\mathrm{Na}}$, $\dddot{\mathrm{S}}$, 375.
Alunogen,	2—3	fib; massive; crusts; w, ywh, rdh; vit; silky; taste like alum; BB intum; fus! very sol; $\dddot{\bar{\mathrm{A}}}\mathrm{l}$, $\dddot{\mathrm{S}}$, H, 381.
Glaserite,	2—3	III; massive; crusts; G 1·7—1·75; w, bh; gnh; trl; taste saline, bitter; BB fus; no intum; $\dot{\mathrm{K}}$, $\dddot{\mathrm{S}}$, 365. *Misenite* is a sulphate of potash containing water, p. 365.

2. B.B. reaction of Iron (in Copperas, Botryogen, Iron alum), Manganese (in Manganese alum), Zinc (in Goslarite), Copper (in Cyanosite), Cobalt (in Bieberite), Uranium (in Johannite), and Nickel (in Pyromeline.)

Copperas, Copiapite, Coquimbite, Apatelite,	2	Crusts; massive; vit; gn, gnh-w; w on exposure; trp, trl; taste sweetish-astringent, met; BB magnetic; $\dot{\mathrm{Fe}}$, $\dddot{\mathrm{S}}$, Aq, 385. *Copiapite* is yellow; 387; *Coquimbite*, wh, ywh, bnh, 380.
Iron-Alum, Voltaite,	2·5	I; crust; G 2; ywh, gnh; taste met-astringent, or chalybeate; BB iron reaction; $\dot{\mathrm{Fe}}$, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$, $\dddot{\mathrm{S}}$, Aq, 383. Voltaite is sometimes black, 383.
Manganese Alum,	2·5	I; crusts; fibrous; G 2; ywh, rdh; taste met-astringent; BB manganese reaction; $\dot{\mathrm{Mn}}$, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$, $\dddot{\mathrm{S}}$, Aq, 382.
Goslarite,	2—2·5	III; incrustations, massive; w; vit; trp, trl; BB intum; taste astringent, met; $\dot{\mathrm{Zn}}$, $\dddot{\mathrm{S}}$, Aq, 384.
Cyanosite,	2·5	V; massive, earthy; G 2·213; *bright blue;* strp, trl; taste metallic, nauseous; BB on *charcoal* copper; $\dot{\mathrm{Cu}}$, $\dddot{\mathrm{S}}$, Aq, 380.
Bieberite,.		IV; stalact; crusts; *flesh* and *rose-red;* trp, trl; taste astringent; BB on *charcoal* sulph; with *bor* blue; $\dot{\mathrm{Co}}$, $\dddot{\mathrm{S}}$, Aq, 385.
Johannite,	2—2·5	IV; cryst, massive; G 3·19; vit; *emerald green*, gnh; *streak* paler; trp, trl, op; taste bitter; solution bn precip with infusion of nutgalls; $\dot{\mathrm{U}}$, $\dddot{\mathrm{S}}$, Aq, 386.
Pyromeline,		Capill cryst; also as a gnh-w efflorescence; taste met-astringent; contains nickel, $\dot{\mathrm{Ni}}$, $\dddot{\mathrm{S}}$, Aq. 386.
Botryogen,	2—2·5	IV; *deep hgacinth-red*, ywh; streak ochre yw; trl; taste slightly astringent. BB iron reaction; $\dddot{\bar{\mathrm{F}}}\mathrm{e}$, $\dddot{\mathrm{S}}$, $\bar{\mathrm{H}}$, 387.

V. Borates, or Boracic Acid: not effervescing with the acids; B.B. boracic acid reaction.

Sassolin,	1	Massive or in scales; G 1·48; w, ywh; p'ly; feel smooth; acidulous; BB fus!! flame gn; $\dddot{\mathrm{B}}$, Aq, 144.
Hydroboracite,	2	Fibrous and fol *like gypsum*; G 1·9; w; trl, op; BB fus! trp glass, flame gnh; slightly sol in water; in *mur* easily sol; $\dot{\mathrm{Ca}}$, $\dot{\mathrm{Mg}}$, $\dddot{\mathrm{B}}$, Aq, 393.

	Hardness.	
Borax,	2—2·5	IV; G 1·716; w, gyh, bh, gnh; vit; trl, op; taste feebly sweetish-alkaline; BB puffs up, then fuses to a glass; $\dot{N}a$, $\ddot{B}$, Aq, 394.

VI. Arsenous Acid: B.B. alliaceous fumes on charcoal.

Arsenolite,	1·5	IV; capillary; botryoidal, stalactitic; G 3·7; vit, silky; w, ywh, rdh; trp, op; taste astringent, sweetish, 139.

II. INSOLUBLE MINERALS, OR WITHOUT TASTE.

I. LUSTRE UNMETALLIC.

A. STREAK UNCOLORED.

a. B.B. NO ODOROUS OR VISIBLE FUMES ON CHARCOAL, WITH OR WITHOUT THE FLUXES; GLOBULE OBTAINED BY REDUCTION NOT MALLEABLE.

1. *When pulverized, wholly soluble in one or more acids* (*cold or hot*) *without gelatinizing*—Carbonates, Sulphates, Phosphates, Fluorids, Borates, Oxyds.

*†. Infusible or nearly so.

† *Carbonates:* when pulverized, effervescing more or less in acids; fumes inodorous.

Obs.—The species are all anhydrous excepting Hydromagnesite, Lanthanite, and Parisite; the last contains also fluorine. All but Lanthanite, Diallogite, and Spathic Iron give an alkaline reaction after strongly heating B.B.

Hydromagnesite,	2—3·5	Fibrous, subfol, earthy, crust; w; in *mur* efferv; $\dot{Mg}$, $\ddot{C}$, Aq, 456.
Lanthanite,	2·5—3	III; thin plates; earthy; gyh-w, ywh; dull, p'ly; La, $\ddot{C}$, $\dot{H}$, 456.
Calcite,	1—3·5	VI; *cleav* rhombohed; cryst, fibrous, massive; G 2·5—2·78; w, ywh, rdh, bn, bk; vit, subvit, earthy; trp, op; BB intense light, caustic; in *mur* easy efferv; columns of fibrous var, have *an oblique cross cleavage*, and in this unlike Aragonite, $\dot{Ca}$, $\ddot{C}$, 435.
Aragonite,	3·5—4	III; cryst, mas, fib; G 2·9—3; w, gyh, ywh; trp, trl; BB falls to powder; $\dot{Ca}$, $\ddot{C}$, 448.
Dolomite,	3·5—4	VI; 106° 15′; *cleav*; rhombohed, cryst, gran, mas; G 2·85—3·1; w, ywh, rdh, bn, bk; vit; strp, op; in *mur* slow efferv; $\dot{Ca}$, $\dot{Mg}$, $\ddot{C}$, with sometimes $\dot{Fe}$, and then bn on exposure, 441.
Barytocalcite,	4	IV; 106° 55′; *cleav;* G 3·6—3·7; w, gyh, gnh, ywh; trp, trl; BB with *bor* trp glass; $\dot{Ba}$, $\dot{Ca}$, $\ddot{C}$, 453; *Bromlite* is same compound trimetric, 451.

	Hardness.	
Diallogite,	3·5—4·5	VI; *cl R;* cleav massive; botryoid, fib; G 3·4—3·6; vit, p'ly; rose-rd; bn on exposure; trl, strl; BB bn, infus, decrep; in hot *mur* efferv; $\dot{\text{Mn}}$, $\ddot{\text{C}}$, 446. *Manganocalcite* (p. 452) is the same compound in rhombic prisms.
Magnesite,	4—5	VI; *cleav* R; cryst, fibrous, massive; G 2·8—3; w, ywh, rdh, bn; trp, op; in *mur* slow efferv; $\dot{\text{Mg}}$, $\ddot{\text{C}}$a, 414.
Spathic Iron,	3·5—4·5	VI; R *cleav,* massive, foliated; G 3·7—3·85, vit, pl'y; gyh-w, bnh, gnh-gy; bnh-r; trl, op; BB bk, magnetic; in *mur* sol dif; $\dot{\text{Fe}}$, $\ddot{\text{C}}$, often with $\dot{\text{Mn}}$, $\dot{\text{Mg}}$, $\dot{\text{Ca}}$, 444. *Breunnerite* is similar; G 3—363; w, ywh; bn on exposure Mg, $\dot{\text{Fe}}$, $\ddot{\text{C}}$, 443.
Parisite,	4·5	VI; *cleavage* basal! G 4·35; bnh-yw; *streak* wh, w; vit; BB bnh; with *bor* trp glass; in *mur* slow sol and efferv; $\dot{\text{Ce}}$, $\dot{\text{Ca}}$, $\ddot{\text{C}}$, F, Aq, 463.
Smithsonite,	5	VI; mas botryoid; p'ly, vit; wh, gyh, gnh, bnh; BB fumes of zinc; $\dot{\text{Zn}}$, $\ddot{\text{C}}$, 447.

a. Very distinctly foliated or fibrous in some varieties.

	Hardness.			Hardness.	
Hydromagnesite,	2·5	Fol, fib.	Aragonite,	3·5—4	Fib.
Calcite,	3—3·5	Fol, fib.	Diallogite,	3·5—4·5	Fib.
Magnesite,	3—4	Fib.	Spathic Iron,	3·5—4·5	Fol, fib.

β. Species arranged according to their specific gravity.

	Sp. Gravity.		Sp. Gravity.
Calc Sinter ($\dot{\text{Ca}}$ $\ddot{\text{C}}$)		Diallogite,	3·5—3·6.
Hydromagnesite,	2·1—2·2.	Barytocalcite	3·6—3·7.
Calcite,	2·5—2·78.	Bromlite,	3·7—3·72.
Magnesite,	2·8—3.	Spathic Iron,	3·7—3·82.
Dolomite,	2·85—3·1.	Lanthanite.	
Aragonite,	2·9—3.	Parisite,	4·35.
Breunnerite,	3—3·63		

†† *Phosphates,* (Childrenite, Cryptolite, Fischerite); *Sulphates,* (Alunite); *Oxyds,* Periclase; *or Hydrated Oxyds,* (Brucite, Völknerite); no effervescence with acids.

Brucite,	1·5	VI; tables; *foliated!* laminæ flexible; also fine fibrous; G 2·35; w, gyh; p'ly! trl, strl; in *nit* sol, no efferv; BB op, friable, alkaline; Mg, Aq, 133.
Völknerite,		VI; *cleav!* foliated, massive; G 2·04; w; p'ly; feel greasy; BB exfol; with *bor* intum, trp glass; in *acids* sol; $\dot{\text{Mg}}$, $\ddot{\text{Al}}$, Aq, 134.
Apatite,	4·5—5	VI; hexag prisms; also massive; G 3—3·3; green, bh, w, gnh, gyh, rh, bnh; vit, subres, brittle; BB fus difl!! in *mur* in powder sol; $\dot{\text{Ca}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, F, 396.
Childrenite,	4·5—5	III; only in cryst; yw, ywh, bnh; vit—res; trl; in *mur* sol after long ignition; Al, Fe, Mn, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, Ħ, 424.
Alunite, Jarosite,	5	VI; *cleav* basal; massive gran; G 2·5—2·8; w, gyh, rdh; vit, p'ly; trp—strl; BB decrep; in *sul* powder sol; $\ddot{\text{Al}}$, $\dot{\text{K}}$, $\dddot{\text{S}}$, Aq, 388. *Pissophane* is green, Al, Fe, $\dddot{\text{S}}$, $\dot{\text{Ħ}}$, 390.

	Hardness.	
Cryptolite,	5—5·5	Minute acic hexag pms; G 4·6—4·8; ywh or colorless. BB fus dif!! flame gnh; in *sul* sol; $\dot{\text{Ce}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, 399.
Fischerite, Variscite,		III; crystals; massive; dull gn trl; G 2·46; BB much water; $\dddot{\bar{\text{Al}}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, $\dot{\text{H}}$, 408. Variscite is apple-green, 408.
Periclase,	5—6	I; only in cubes or oct; *cleav* cub; G 3·674; gnh, gn; trp, trl; in *hot nit* sol, no efferv; $\dot{\text{Mg}}$, 101.

a. Very distinctly foliated or fibrous in some varieties.

Brucite,	Fol!, fib.	Völknerite,	Fol.

††† *Fluorids,* (Yttrocerite, Fluocerite),—*Borates,* (Warwickite),—*Oxalates,* (Whewellite).

Obs.—Parisite is a carbonate containing fluorine, and many phosphates also include a small per-centage. Topaz, Chondrodite, and some micas are infusible silicates containing fluorine. Danburite, Tourmaline, Axinite are silicates containing boracic acid.

Yttrocerite,	4—5	III?; massive, earthy, G 3·4—3·5, violet, gyh, wh, rdh-bn, vit, p'ly; BB with *bor* glass yw in outer flame while hot; in *mur* in powder sol yw; Ce, Y, Ca, F, 95.
Fluocerite,	4—5	VI; hexag pms and plates; massive; G 4·7, tile-rd, ywh; *streak* w, ywh; strl—op; BB darkens; Ce, Y, F, 96.
Warwickite,	3—4	Prismatic cryst, imbedded; G 3·188; submet, p'ly, often dull; bn, bkh, gyh, 395.
Whewellite,	2·5—3	IV; cryst and opaline incrust; lustre subadamantine, vitreous; in *mur* sol; oxalate of lime, 464, 465. *Conistonite* is similar, but trimetric, 465.

** Fusible. (Apatite fuses with great difficulty, and is placed above.)

† *Carbonates:* when pulverized, effervescing more or less; fumes inodorous.

Witherite,	3—3·75	III; cryst; massive, subfib; G 4·3; w, ywh, gnh; vit—res; strp, trl; BB fus! in *mur* efferv; $\dot{\text{Ba}}$, $\ddot{\text{C}}$, 449.
Strontianite,	3·5—4	III; cryst, massive, fibrous; G 3·6—3·72; gnh; w, gyh, ywh; trp, trl; BB fus dif, rdh flame; $\dot{\text{Sr}}$, $\ddot{\text{C}}$, 450.

†† *Phosphates and Sulphates:* no effervescence with acids; BB sulphur or phosphorus reaction. Nearly all the anhydrous species contain also some fluorine.

‡ Hydrous. (Altered Tryphyline falls here, see p. 407).

Websterite,	1—2	Massive, reniform; G 1·66; w; earthy; adheres to tongue; BB fuses dif; in *acids* sol, no efferv; $\dddot{\bar{\text{Al}}}$, $\dddot{\text{S}}$, Aq, 389.
Pissophane,	1—2	Massive, stalact; G 1·9—2; gn, gnh; trp, fragile; BB fus dif; in *mur* sol; BB bk; $\dddot{\bar{\text{Al}}}$, $\dddot{\bar{\text{Fe}}}$, $\dddot{\text{S}}$, Aq, 390.
Struvite,		III; in crystals; wh, yh, bnh; vit; BB water and ammonia, a colorless glass; in *acids* sol; Am, Mg, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, 413.
Hopeite,	2·5—3	III; cleav!; massive; G 2·76—2·9; vit; p'ly; gyh-w; bn; trp, trl; sectile; BB fus, flame gn; with *soda* fumes of zinc; in *mur* sol; $\dot{\text{Zn}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, Aq, 409.

	Hardness.	
Wavellite,	3—4	III; stellate fibrous, hemispheres; G 2·3—2·4; w, ywh, gnh, bnh, bk; vit—res; trl: BB w, intum; in hot *sul* sol; often fluorine; $\ddot{\text{Al}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, F, Aq, 423.
Cacoxene,	3—4	III; stellate fibrous; G 3·38; ywh, bnh, bn on exposure; resinous; trl; like wavellite; $\dddot{\text{Fe}}$, $\ddot{\text{Al}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, Aq, 424.

‡ Anhydrous.

Pyromorphite,	3·5—4	VI; hexag; ren, bot, fib, gran; G 6·5—7·1; bn, bright gn; orange; strp, strl; brittle; BB on *charcoal* fus, glob, cryst; in hot *nit* sol; $\dot{\text{Pb}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, Cl, F, 400.
Triphyline, **Triplite,**	4—5·5	III; often cleavable; massive; G 3·5—3·8; subres; bh, bn, dull b, bkh-bn; *streak* gyh; trl, strl; BB fus! magnetic; in *acids* sol, no efferv; $\dot{\text{Fe}}$, $\dot{\text{Mn}}$, $\dot{\text{Li}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, 406, 408.—Often altered and *hydrous.*
Herderite,	5	III; *cleav* imperf; G 2·98; ywh, gnh-w; vit, subres; trl; very brittle; BB fus dif w enamel; in hot *mur* sol; $\ddot{\text{Al}}$, $\dot{\text{Ca}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, F? 410.
Zwieselite,	5	Hexag? cleav; G 3·97; bn; *streak* gyh-w; BB decrep, fus bh-bk glass, *magnetic;* Fe, Mn, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, F, 399.
Wagnerite,	5—5·4	IV; massive; G 3; ywh, gyh; vit; trl; BB fus dif, gnh glass, with *bor* trp; in heated *nit* or dilute *sul* sol, no efferv; $\dot{\text{Mg}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, F, 403.
Amblygonite,	6	III? cryst; *cleav* brilliant; G 3—3·11; pale gn; vit, p'ly; strp—trl; BB fus! intum, w; in *sul* in powder sol; $\ddot{\text{Al}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$, $\dot{\text{L}}$, F, 409.

a. Species very distinctly foliated or fibrous in some varieties.

Wavellite,	Fib!	Pyromorphite,	Fibrous.
Cacoxene,	Fib!		

β. Species arranged according to their specific gravities.

	Sp. Gravity.		Sp. Gravity.
Websterite, 389.	1·66.	Wagnerite, 403.	3.
Pissophane, 390.	1·9—2.	Amblygonite, 409.	3—3·11.
Wavellite, 423.	2·3—2·4.	Cacoxene, 424.	3·38.
Hopeite, 409.	2·76—2·9.	Triphyline, 406, 408.	3·5—3·8.
Hederite, 410.	2·98.	Pyromorphite, 400.	6·5—7·1.

††† *Fluorids:* a fluorine reaction, and none of phosphorus.

Cryolite,	2·5	II?; massive, *cleav* rectang; G 2·9—3·1; w; vit, subp'ly; strp—trl; brittle; BB fus!!!; in *sul* soluble, fumes of fluorine; Na, Al, F, 97. *Chiolite* is very similar, 98.
Fluellite,	3	III; cryst; w; vit; trp; Al, F, 98.
Fluor Spar,	4	I; cryst; *cleav* oct!; massive granular; G 3·1—3·2; w, yw, gn, rdh, bh, purple; vit; trp, trl; brittle; BB phosphoresces fus dif, enamel; Ca, F, 94.

†††† *Borates:* no effervescence with acids. B.B. reaction of boracic acid.

Hydroboracite,	2	Foliated and fibrous like gypsum; G 1·9—2; wh; BB fus, clear glass; $\dot{\text{Ca}}$, $\dot{\text{Mg}}$, $\dot{\text{H}}$, $\dddot{\text{B}}$, 393.

	Hardness.	
Hayesine,		Masses made of interwoven fibres; w; Ċa, B̈, Aq, 393. Other hydrous borates, p. 394.
Boracite, Rhodizite,	7—8	I; small cubes, &c., hemihed; massive; G 2·9—3; w, gyh, ywh, gnh; vit; strp, trl; BB intum, glass, which is w when cold; in *mur* sol; Ṁg, B̈, 393.

2. *Soluble in acids, the silica gelatinizing either before or after the mineral has been heated;* Silicates.

B.B. infusible or nearly so.

Collyrite,	1—2	Like clay; *feel* greasy; adheres to the tongue; G 2—2·2; BB infus; in *nit* gelat; Al, Si, Aq, 338.
Nontronite,	2—3	Massive; *feel* unctuous; ywh, gnh; op, strp; fragile; BB infus, bh, bn; in *mur* gelat; Fe, Si, Aq, 338.
Allophane, Schrötterite,	3—3·5	Mas, or in hyaline crusts, and reniform; G 1·85—2·1; gnh, bh, ywh, w; BB flame commonly green with *bor* fus! glass; Al, Si, Aq, 336, 337.
Calamine,	4·5—5	III; mammillary, botryoid, massive; G 3·35—3·45; wh, bh, gnh, ywh, bnh; trp, trl; BB fus dif!!; with *bor* glass; with *soda*, fumes of zinc dif; in *mur* gelat!—Zn, Si, Aq, 313.
Willemite,	5·5	VI; in hexag pms and massive; G 3·9—4·2; wh, gnh, yw, gyh, bnh; trp, op; BB decrep, infus or fus dif!!; in powder in *mur* gelat; Żn, S̈i, 189.
Gehlenite,	5·5—6	II; in small glassy cryst; G 2·9—3·1; gnh, gyh, bnh; BB fus dif!! in *mur* gelat, 256.
Cerite,	5·5	VI; in hexag pms, mas, gran; G 4·912; dull adamantine, resinous; clove-bn, cherry-r, gyh; strl, op; BB infus; powder in dilute *mur* gelat easily; Ce, Fe, Si, Aq, 312.
Chrysolite,	6·5—7	III; glassy grains and crystals disseminated; G 3·3—3·5; green; trp—trl; BB with *bor* fus, iron bead; in *mur* insol; *sul* gelat; Mg, Fe, Si, 184.
Chondrodite,	6—6·5	III; opaque ywh or bn grains or masses dissem. in cryst limestone; also in cryst at Vesuvius; G 3·1—3·2; in *mur* gelat; fluorine reaction, 186.

** B.B. fusible.

† Hydrous. (Apophyllite and Analcime imperfectly gelatinize.)

Spadaite, Metachlorite,	2·5	Mas; rdh; p'ly; BB glassy enamel; in *mur* sol, imperf gelat; Mg, Si, Aq, 278. Metachlorite is dull leek-gn, in *mur* gelat; BB fus dif! 297.
Caporcianite,	2·5	IV; like Heulandite; also laminato-radiate; G 2·47; flesh-red; p'ly; BB no intum, w, enamel; in *acids* gelat!; Ca, Al, Si, Aq, 334.

	Hardness.	
Schneiderite,	3	Laminato-radiate; w; opaque; BB fus, intum; in *acids* gelat! Al, Ca, Mg, Si, Aq, 316.
Leonhardite,	3—3·5	IV; cryst, cleav; G 2·25; p'ly, vit, w, ywh, bnh; usually whitens and crumbles on exposure like Laumontite; BB exfol, intum, fus!; Ca, Al, Si, Aq; 308.
Sphærostilbite,	3·5	Glob, diverg, laminato-radiate; G 2·05—2·21; p'ly, vit; w, ywh, gyh; trl, strl; brittle; BB intum, fus; Al, Ca, Si, Aq; *Zeolite*, 333.
Laumontite,	3·5—4	IV; cryst, *cleav;* G 2·26—2·36; vit, p'ly; w, ywh, gyh; trp, trl; usually opaque and falls to powder on exposure; BB intum, fus; in *nit* or *mur* gelat; Al, Ca, Si, Aq, 307.
Mesole,	3·5—4	Globe, diverg, flat columnar; G 2·3—2·4; silky, p'ly; wh, ywh, rdh; trl; BB fus ; in *mur* gelat!; Al, Ca, Na, Si, Aq; *Zeolite*, 328.
Gismondine,	4·5	II; in octahedrons and mammillated forms, surface drusy; bh-w, gyh, rdh; splendent; trp, trl; BB intum, fus; Al, Ca, K, Si, Aq, 322.
Phillipsite,	4—4·5	III; in glassy cryst, often cruciform; cleav imperf; G 2—2·2; vit; w, rdh; trl, op; BB intum, fus; in *mur* in powder gelat!; Al, Ca, Si, Aq; *Zeolite*, 324.
Pectolite, Okenite,	4—5	IV; fibrous, acicular, radiate; G 2·25—2·74; w, gyh; subvit, p'ly; strl; op; tough; BB fus! enamel; in *mur* gelat after heating, (okenite before heating); Ca, Na, Si, Aq, 305; Okenite, Ca, Si, Aq, 306.
Gmelinite,	4·5	VI; in small glassy hexag crystals, w, or colorless; G 2·05—2·1; BB intum, fus; in *mur* gelat; Al, Ca, Na, Si, Aq; *Zeolite*, 321.
Apophyllite,	4·5—5	II; acute octahedrons and prisms, cleavage basal! also subfoliated; massive; G 2—2·4; w, gyh, gnh, ywh, rdh; trp, op; brittle; BB exfol, fus; in *nit* imperf gelat; Ca, K, Si, Aq, 304.
Thomsonite,	5—5·5	III; in glassy or somewhat p'ly cryst; also columnar diverg; G 2·3—2·4; vit, p'ly; w, bnh; trp, trl; brittle; BB intum, fus dif! in *mur* in powder gelat; Al, Ca, Na, Si, Aq; *Zeolite*, 325.
Analcime,	5—5·5	I; usual in glassy or whitish trapezohedrons; G 2·05—2·3; vit; sometimes gnh, ywh, rdh; trp, op; brittle; BB fus, no intum; in *mur* gelat; Al, Na, Si, Aq, 318; *Ittnerite* is similar in form, also massive; G 2·3—2·4; bh-gy, ash-gy; BB some sulphur; Na, Ca, Al, Si, S, Aq, 319.
Natrolite,	5—5·5	III; in acicular cryst; also diverg fibrous; G 2·1—2·25; vit, subp'ly; w, gyh, ywh; trp, trl; brittle; BB fus quietly; in *mur* gelat!; Al, Na, Si, Aq; *Zeolite*, 327.
Scolecite,	5—5·5	III; in acicular cryst, also diverg, fibrous; G 2·2—2·8; vit, p'ly; w, gyh, ywh; trp, trl; BB curls up like

	Hardness.	
		a worm, fus; in *mur* gelat!; Al, Ca, Aq; *Zeolite*, 328. Like Natrolite, but lustre more p'ly. *Sloanite* fuses without intumescence, 329.
Datholite,	5—5·5	IV; small glassy cryst; mas; G 2·9—3; w, gyh, gnh, ywh, purplish; trp, trl; BB intum, vit glob, flame gn; in *nit* gelat; $\dot{\text{C}}\text{a}$, $\ddot{\text{S}}\text{i}$, $\ddot{\text{B}}$, Aq, 334.

a. Species distinctly foliated or fibrous in some varieties.

Caporcianite, 334.	H.=2·5	Col.	Okenite, 306.	H=4·5—5	Fib.
Schneiderite, 316.	3	Fib.	Apophyllite, 304.	4·5—5	Fol.
Sphærostilbite, 333.	3·5	Fib.	Thomsonite, 325.	5—5·5	Fib.
Laumontite, 307.	3·5—4	Col.	Scolecite, 328.	5—5·5	Fib.
Mesole, 328.	3·5—4	Fib.	Natrolite, 327.	5—5·5	Fib.
Pectolite, 305.	4—5	Fib.			

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Collyrite, 338.	2—2·2.	Scolecite, 328.	2·2—2·28.
Spadaite, 297.		Laumontite, 307.	2·26—2·36.
Phillipsite, 324.	2—2·2.	Mesole, 328.	2·3—2·4.
Gmelinite, 321.	2·05—2·11.	Thomsonite, 325.	2·3—2·4.
Sphærostilbite, 333.	2·05—2·21.	Ittnerite, 319.	2·37—2·4.
Analcime, 318.	2·05—2·3.	Datholite, 334.	2·9—3.
Apophyllite, 304.	2—2·4.	Gehlenite, 256.	2·9—3·1.
Pectolite, 305.	2—2·74.	Chondrodite, 186.	3·1—3·2.
Natrolite, 327.	2·15—2·25.	Willemite, 189.	4—4·2.
Okenite, 306.	2·28—2·38.		

†† Anhydrous.

Wollastonite, Edelforsite,	4·5—5	IV; cleav, mas, sublamellar, subfib; G 2·75—2·9; w, gyh; ywh, rdh, bnh; strp, trl; subvit, p'ly; BB on *charcoal* fus, colorless bead; *mur* gelat; Ca, Si, 155, 156.
Mellilite,	5	II in small pms; G 2·9—3·15; vit; bnh, yw, gnh, rdh; trl, op; BB fus dif; in *acids* gelat; Al, Ca, Mg, Na, Fe, Si, 205.
Lapis Lazuli,	5·5	I; massive; dodec; G 2·3—2·5; vit; b; trl, op; BB fus; in *mur* gelat, 229.
Sodalite, Hauyne, Nosean,	5·5—6	I; dodec; G 2·2—2·4; vit; bn, gy, b, gn; trp, strl; BB fus dif; in *nit* or *mur* gelat; Al, Na, Si, Cl or $\ddot{\text{S}}$, 229, 230. *Skolopsite* (231) is similar.
Cancrinite,	5·5—6	VI; hexag, like Nepheline; massive; G 2·42—2·62; subvit, subp'ly; w, gy, yw, gnh, b, rdh; trl; BB fus! intum; in *mur* efferv, gelat after heating; Al, Na, Ca, Si, $\ddot{\text{C}}$, 233.
Nepheline,	5·5—6	VI; hexag pms; massive; G 2·5—2·65; vit, greasy; w, gyh, gnh, rdh, bnh; trp, strl; BB fus; in *acids* gelat!; Al, Na, K, Si, 232.
Barsowite,	5·5—6	Mas, gran; G 2·7—2·76; subp'ly; w; strl; BB fus dif; in *acids* gelat; Al, Ca, Si, 236.

	Hardness.	
Allanite, Orthite,	5·5—6	IV; broad or acic cryst, mas; G 3·3—4·2; pitch-black, bn, ywh; strl, op; brittle; *streak* gyh; BB intum, fus; in *acids* gelat; Al, Fe, Ce, Ca, Si, 208.
Sarcolite,	5·5—6	II; in small glassy cryst; G 2·545; flesh-r, rdh-w; trp, strp; brittle. BB fus w enamel; Ca, Al, Si, 200.
Indianite,	6	V; mas, gran; G 2·668; w, gyh; trl, strl; BB fus dif; acids gelat!; Al, Ca, Si, 235.
Eudialyte,	6	VI, R, *cleav* basal!; mas; G 2·89—2·91; vit; bnh-r; op, strl; BB fus gyh-gn scoria or op glass; in powder *acids* gelat; Zr, Fe, Ca, Na, Si, 181.
Tephroite,	6	Mas, gran; G 4—4·12; ash-gy; *streak* gyh; bn or bk on exposure; BB fus! bk scoria; in *mur* gelat!, not evolving chlorine; Mn, Si, 186.
Idocrase,	6·5	II; often in square prisms; *cleav* indist; mas; G 3·34—4·0; vit, res, often lustrous; bn, gn; yw, b; strp, strl; BB fus! intum; in *acids* after heating, soluble and gelat; Al, Ca, Fe, Si, 197.
Epidote, (in part),	6·7	IV; cryst; massive, subcolumn; G 3·25—3·5; vit, res; pistachio-gn, bn, gy; strp, op; BB fus; in *mur* after strong ignition sol and gelat; Al, Ca, Fe, Si, Mg, Ce, 206.
Chrysolite,	6·5—7	III; glassy grains, massive, resinous; G 3·1—3·6; green to black; Mg, Fe, Si, 184.

a Species distinctly fibrous in some varieties.

Edelforsite, 155. H=5·5 Fib. Wollastonite, 156. H=4·5—5.

β. Species arranged according to their specific gravity.

	Sp. gravity.		Sp. gravity.
Sodalite, 229.	2·2—2·4.	Barsowite, 236.	2·7—2·76.
Nosean, 230.	2·25—2·3.	Wollastonite, 156.	2·7—2·9.
Lapis Lazuli, 229.	2·3—2·5.	Eudialyte, 181.	2·9
Haüyne, 230.	2·4—2·5.	Mellilite, 205.	2·9—3·15.
Cancrinite, 233.	2·42—2·62.	Epidote, 206.	3·25—3·5.
Nĕpheline, 232.	2·5—2·65.	Chrysolite, 185.	3—3·6.
Skolopsite, 231.	2·53.	Allanite, 208.	3·3—4·2.
Sarcolite, 200.	2·545.	Idocrase, 197.	3·34—4·0.
Edelforsite, 155.	2·58.	Tephroite, 186.	4—4·12.
Indianite, 235.	2·668.		

3. *Insoluble in acids, or partly soluble, without gelatinizing.*

Obs.—The only species in this subdivsion in which G is above 4·8, are Scheelite, Plumboresinite, Cassiterite, and Yttrotantalite. See pp. 347, 359, and 431.

* Infusible, or nearly so.

† B.B. reaction of sulphur, phosphorus, or fluorine, (fluorine only in *fluocerite*).

Blende,	3·5—4	I; perfect cleavage dodec; massive; G 3·9—4·2; resin-yw, bn, bk, rdh, gnh; brittle. BB infus or fus dif!!; in *mur* sol, sulphur separating; Zn, S, 45.

	Hardness.	
Xenotime,	4—5	II; small octahed cryst; G 4·4—4·6; ywh-bn; *streak* pale; res; op; BB with *bor* uncol glob; in *acids* insol; Y, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, 401.
Fluocerite,	4—5	VI; in hexag pms; G 4·7; rdh, yw; *streak* w, ywh; strl, op; BB darkens; with *bor* sol, red in outer flame; Ce, F, Aq, 96.
Turquois,	6	Massive, stalact, reniform, no *cleavage;* G 2·6—2·85; bh-gn; waxy; strl, op; BB decrep, bn, gn flame; with *bor* fus; in *mur* insol; $\overset{\cdot\cdot\cdot}{\bar{\mathrm{A}}}\mathrm{l}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, Aq, 405.
Lazulite,	5—6	IV; cryst, massive; G 3—3·15; blue, gnh; vit, strl, op; BB blebby appearance; with *bor* trp glob; after heat-sol in *acids;* $\dot{\mathrm{M}}\mathrm{g}$, $\overset{\cdot\cdot\cdot}{\bar{\mathrm{A}}}\mathrm{l}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, Aq, 404.

No species in this subdivision is either fibrous or foliated, excepting Blende, which is sometimes imperfectly fibrous.

†† Hydrous; no phosphorus reaction. (Hydrous silicates of magnesia, alumina, or oxyd of iron, with opal and hydrates of alumina.)

Obs.—1. *Species giving a blue color with cobalt solution* are Pholerite, Halloysite, &c. Margarodite, Margarite, Pyrophyllite, Gibbsite, Diaspore; 2, *the remaining species give the reaction of magnesia or iron,* excepting Œrstedite, Opal, and Malacone; and Opal sometimes contains oxyd of iron when impure. *Schiller Spar* is altered pyroxene; and of similar nature are other hydrous substances, which if good species would fall here, as *Pyrallolite,* &c., (see p. 165). *Zircon* and *Kyanite* are also sometimes hydrous, (see pp. 195, 265).

Pholerite,	0·5—1	Soft pearly scales, w; massive; G 2·3—2·6; in dilute *nit* not sol; Al, Si, Aq, 251.
Halloysite, &c. Kaolin, Dillnite, Collyrite,	1	Clay-like, mass; G 1·5—2·1; w, bh; waxy; feel greasy; adheres to the tongue; strl, more trp in water; in *acids* decomp; Al, Si, Aq, 251, also 340. *Kaolin* differs in its harsh feel, 249. *Dillnite,* 338.
Pyrophyllite,	1	Foliated like talc, radiated; G 2·7—2·8; p'ly; gn, gnh, w, ywh; strp, trl; laminæ flexible; BB swells up!!, with *soda* fus; in *sul* partly sol; Al, Si, Aq, 303.
Vermiculite,	1—1·5	Scaly massive; scales foliated; G 2·756; olive gn, gnh; p'ly; strl; BB fus dif, swells out, worm-like!! in *mur* decomp; Mg, Al, Fe, Si, Aq, 292.
Saponite,	1—2	Massive; soft; G 2·26; w, ywh, bh, rdh; greasy; BB bkns, fus dif!!; in *sul* soluble; Mg, Al, Si, Aq, 282.
Neolite,	1—2	Fib, stel, mas; G 2·77; gn; silky or earthy; BB an iron reaction; Mg, Fe, Al, Si, Aq, 278.
Ripidolite, Chlorite, Clinochlore,	1—2	VI; hexag; foliated!; mas, gran; G 2·65—2·96; gn, olive-gn; p'ly; trl, strp; lam flexible, inelast; BB fus often dif!!; Mg, Fe, Al, Si, Aq, 293-296.
Talc, Margarodite,	1—1·2	III? foliated!!; also compact massive; G 2·55—2·85; gnh, gn, w; p'ly; feels greasy; laminæ flexible, inelastic; BB with *bor* intum, glass; acids no action; Talc $\dot{\mathrm{M}}\mathrm{g}$, $\ddot{\mathrm{S}}\mathrm{i}$, 275. Margarodite (223) is more like Mica, and gives a dull blue color with cobalt solution.

	Hardness.	
Steatite,		Is a massive talc; w, gyh, gnh, 275. *Meerschaum* is similar, gyh-w, earthy texture; H 2—2·5, 277. *Aphrodite* is allied, 276.
Kerolite,	2—2·5	Massive, reniform, foliated; G 2—2·4; vit, res; w, gnh, gn; trp—trl; feel greasy; BB bkns; Mg, Si, Aq, 280.
Chloropal, Pinguite,	2—3	Gives an iron reaction; color ywh-gn, gnh-yw; BB bkns; Fe, Si, Aq, 337.
Antigorite,	2·5	III; mas, fol!; G 2·622; bnh-gn, leek-gn; trp, trl; feel smooth, not greasy; BB fus dif!!; in *mur* decomp dif; Mg, Fe, Si, Aq, 281.
Groppite,	2·5	Mas, foliated; G 2·73; rose rd; trl; BB wns, fus dif!!; with *bor* sol, intum; Al, Fe, Mg, Si, Aq, 287.
Epichlorite,	2—2·5	Fib; G 2·76; dull leek-gn; greasy; strl; BB fus dif!!; Mg, Al, Fe, Si, Aq, 288.
Picrosmine, Picrophyll,	2·5—3	III; *cleavable* massive, fibrous; G 2·59—2·75; gnh-w, gn, gy; p'ly, vit; strl, op; odor argil if moist; BB intum; Mg, Si, Aq, 281, 280.
Serpentine,	2—4	Massive, foliated, or fibrous; green, ywh, bk, wh, bnh, bkh; subres; feel somewhat greasy; BB fus dif!! *bor* sol! *mur* sol; Mg, Si, Aq, 282. *Retinalite*, (283), and *Deweylite*, (285), have a pale resin-like look. *Chrysotile* or fibrous Serpentine is soft. *Metaxite* is related, 285. *Xylite* or *Xylotile* is wood-brown, 285.
Margarite,	3—4	Micaceous like Mica, but laminæ rather brittle; p'ly; G 2·9—3, 300. *Euphyllite* is similar, (291); BB fus dif.
Gibbsite,	3—4	VI; hexag tables with basal cleav; commonly stalactitic, surface smooth; G 2·3—2·4; gyh, gnh, w; p'ly, waxy; trl; tough; Ⱥ⃛l, Aq, 134.
Schiller Spar,	3·5—4	Foliated; G 2·5—2·8; gn, pinchbeck-bn; met-p'ly; lam brittle; BB fus dif!!; *sul* decomp; Mg, Fe, Si, Aq, 165.
Clintonite,	4—5	Foliated! massive; G 3·098; rdh-bn; copper-r; submet-p'ly; strl; laminæ brittle; BB wtns; with *bor* sol; in *acids* in powder some action; Al, Mg, Ca, Fe, Si, Aq, 297.
Bowenite,	5	Massive like nephrite; G 2·59—2·8; apple-gn; faint vit; trl; splintery, tough; BB unalt; in hot *mur* decomp, 283.
Monradite,	5—6	Mas, fol; G 3·2—3·3; ywh, w, rdh; vit; Mg, Fe, Si, Aq, 280.
Chloritoid, Sismondine,	5·5—6	Coarse fol or micaceous; G 3·4—3·56; gy, gyh-gn, gnh-bk; weak-p'ly; BB darkens, magnetic; with *bor* fus iron glass; in *acids* not sol; Al, Fe, Si, Aq, 298.
Opal,	5·5—6·5	Mas; G 1·9—2·3; w, yw, r, b, gn, gy, bn; vit, res, p'ly; BB yields some water, sometimes rdns when impure; with *soda* fus! S⃛i, Aq, 151.

Diaspore,	6—7	III; thin or acic cryst; foliated mas; G 3·3—3·5; gyh, gnh, bnh; p'ly, vit; trl, strl; brittle; BB decrep; with *soda* unalt; in *sul* no action; $\dddot{\bar{\mathrm{A}}}$l, Aq, 128.

a. Species distinctly foliated or fibrous in some varieties.

Pyrophyllite, 303.	H=1,	Fol!	Picrosmine, 281.	H.=2·5—3	Fib.
Talc, 275.	1—1·5	Fol!	Picrophyll, 280.		Fib.
Vermiculite, 292.	1—2	Fol.	Gibbsite, 134.	3—4	Fol.
Neolite, 278.	1—2	Fib.	Margarite, 300.	3—4	Fol.
Ripidolite, 293.	1—2	Fol.	Euphyllite, 291.	3·5—4	Fol.
Chlorite, 296.		Fol.	Schiller Spar, 165.	3·5—4	Fol.
Xylite, 285.		Fib.	Clintonite, 297.	4—5	Fol.
Metaxite, 285.		Fib.	Monradite, 280.	5—6	Subfol.
Serpentine, 282.	2—4	Fol, Fib.	Chloritoid, 298.	5·5—6	Subfol.
Kerolite, 280.	2—2·5	Fol.	Diaspore, 128.	6—6·5	Fol.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Halloysite, 251.	1·5—2·1.	Picrophyll, 280.	2·75.
Kerolite, 280.	2·0—2·2.	Pyrophyllite, 303.	2·7—2·8.
Opal, 151.	1·9—2·3	Antigorite, 281.	2·622.
Saponite, 282.	2·26	Groppite, 287.	2·73.
Gibbsite, 134.	2·3—2·4	Epichlorite, 288.	2·76.
Pholerite, 251.	2·3—2·6.	Vermiculite, 292.	2·76.
Retinalite, 283.	2·493.	Clintonite, 297.	3·098.
Talc, 275.	2·55—2·65.	Monradite, 280.	3·2—3·3.
Picrosmine, 281.	2·59—2·68.	Diaspore, 128.	3·3—3·5.
Bowenite, 282.	2·59—2·8.	Chloritoid, 298.	3·4—3·6.
Steatite, 275.	2·65—2·8.		

††† Anhydrous.

Obs.—Andalusite, Chiastolite, Kyanite, Sillimanite, Rubellite, Topaz, Chrysoberyl, Sapphire, and sometimes Leucite and Spinel, give a fine blue color with cobalt solution; Mica and Phenacite less clearly so. Chondrodite, Topaz and some Mica give a fluorine reaction.

	Hardness.	
Mica,	2—2·5	Micaceous; laminæ thin flexible, elastic; G 2·75—3·1; w, gy, gnh, ywh, bnh, bk; trp, trl, opaque. BB whitens, fuses on the edges; K, Mg, Al, Si; 217.
Chiastolite,	3—6·5	III; in stout prisms, nearly square, tesselated with gyh-w; dull, subvit; G 2·8—3·3; BB infus, with *bor* fus, dif!! Al, Fe, Si, 257.
Azorite,	4—4·5	II, like zircon; only in minute cryst; vit; colorless, ywh, gnh; trl, op; BB with *bor* sol dif!, with more *bor* op, on flaming; with *phos* slow solution; Ca, Ta (?) 350.
Knebelite,	5—6?	Mas; G 3·71; glistening; gy, r, bn, gn; BB alone unaltered, with *bor* fus dark olive-gn pearl; Mn, Si, 186.
Boltonite,	5·5	Disseminated grains, somewhat cleavable; G 2·8—3; dark gyh-bn, ywh-gy; ywh on exposure; vit; trl; BB bleached; with *bor* trp glass; Mg, Fe, Al, Si, 167.
Pyrochlore,	5—5·5	Only seen in small octahedral cryst; yw, bn; subres; G 3·8—4·35. BB fus dif!! with *bor* rdh, yw, 345.
Perofskite,	5·5	I; in cubes, hemihed; G 4·017; met-adamantine; gyh, iron-bk; strl, op; BB with *bor* glass, titanium reaction; Ca, Ti, 345.

	Hardness.	
Leucite,	5·5—6	I; in trapezohedrons; *cl* imperf; G 2·45—2·5; vit, not lustrous; w, gyh-w; trl, op; BB with *bor* fus dif; in *acids* decomp, silica pulv; Al, K, Si, 231.
Opal, (in part),	5·5—6·5	Never cryst, massive, crust, often opalescent; G 1·9—2·3; sometimes hyaline, also trl, strl; nearly opaque; BB with soda fus! 151.
Brookite, 123, Anatase, 121, Rutile, 120,	5·5—6·5	G 3·85—4·25; met-ad; bn, bh, gnh, black; BB unalt; T̈i. *Brookite* in trimetric crystals, H=5·5—6; G 3·8—4·18; *Rutile* in square prisms often geniculated, often acicular, G 4·18—4·25, H=6·5; *Anatase* in brown or dark bluish acute octahedrons, G 3·85—3·95, H=5·5.
Chondrodite,	6—6·5	III; disseminated in *granular limestone;* G 3·1—3·2: subvit, res; yw, wh, bnh; gnh, bkh; trl—sbtrl; very brittle; BB with *bor* ywh-gn; reaction of fluorine, Mg, Fe, F, Si, 186.
Chrysolite,	6—7	III; in green glassy grains and masses; G 3·3—3·6; rarely white; trp, trl; Fe, Mg, Si, 184.
Cassiterite,	6—7	II; cryst, mas, grains; G 6·3—7·1; ad, subvit, subres; bn, bk, rdh, gy, ywh; *st* gyh; strp—op; BB *char* reduc dif!, *bor* and *soda* reduced; *acids* insol; S̈n, 118.
Kyanite, Sillimanite,	6—7·25	V; in slender bladed cryst, common; bh, wh, deepest blue along the middle; rbc pms, bnh; gyh; also fib mas; G 3·5—3·7, Kyanite; 3·1—3·6 Sillimanite; vit, sbp'ly; trp—sbtrl; BB unalt; *bor* fus dif; Al, Si, 263, 265.
Andalusite,	6—7·5	III; prisms stout, nearly square, often tesselated; G 3·1—3·3; vit, weak; gyh, rdh, gnh; strl—op; tough; BB unalt, with *bor* fus dif!; Al, Si, 257.
Quartz,	7	VI; cryst, mas; G 2·6—2·7; w, yw, r, bn, gn, b, bk; trp—op; vit, subres; BB with *soda* fus! S⃛i 145.
Staurotide,	7—7·5	III; 129° 20′; always in crystals, prisms stout, often cruciform; G 3·5—3·75; subvit, vit; bnh, rdh, bn, bk, gy; trl, op; BB darkens, with *bor* fus dif gn glass; Al, Fe, Si, 261.
Chrome Garnet,	7·5	I; dodec; G 3·4184; vit; emerald-green; BB infus.; *bor* chrome-gn glass; Cr, Al, Ba, Si, 190.
Zircon,	7·5	II; always in crystals; G 4·5—4·75; vit-adamantine; bn, r, yw, gy, w, often bright; trp, strl; BB loses color; with *phos* and *soda* infus; in *acids* no action, or dif! Zr, Si, 195.
Rubellite,	7·5	VI; three or six-sided prisms; red, bh, wh; G=3—3·3; BB infus; Al B⃛, Si, 270.
Sapphirine,	7—8	Small grains, or gran mas; 3·4—3·5; vit; pale b, gn; trp, trl; BB infus, with *bor* iufus, unaltered; Mg, Al, Si, 266.
Beryl,	7·5—8	VI; in hexag pms; G 2·65—2·75; vit, subres; green, emerald-gn; ywh, bh, bnh; trp, strl; BB with *bor* clear glass; Be, Al, Si, 178.

	Hardness.	
Phenacite,	8	VI; in crystals, *cleav* R; G 2·9—3; vit; colorless, wine-yw; rdh; trp, op; BB with *bor* fus dif, trp glass; with *soda* w enamel; cobalt solution dull blue; Be, Si, 189.
Topaz,	8	III; usual in crystals; *cleav* basal!; sometimes massive, sub-fibrous; G 3·4—3·65; vit; yw, w, gnh, bh; trp, trl; BB with *bor* clear glass; Al, Si, F, 259.
Spinel, Automolite, Kreittonite, &c.,	8	I; usual in octahedrons; G 3·5—4·8; vit; r, gn, b, gy, bk, sometimes bright; trp, op; BB with *bor* fus dif; Mg, Al; Zn, Al; Mg, Fe, Al; Zn, Mn, Al, Fe; Zn, Fe, 103.
Chrysoberyl,	8·5	III; cryst; G 3·5—3·8; vit; bright green, ywh; rdh; trp, trl; BB unaltered, *soda* infus; *bor* fus dif!; Be, Al, 122.
Sapphire,	9	VI; in hexag crystals; mas; G 3·9—4·2; vit, p'ly; blue; r, yw, bn, gy, wh; trp, op; tough; BB *soda* unaltered; in *acids* no action; Äl, 111.
Diamond,	10	I; in crystals, rarely massive; G 3·4—3·6; w, b, r, gn, bn, gy, bk; adamantine; trp, strl, 24.

a. Species distinctly foliated or fibrous in some varieties.

Mica, 217.	H=2—3	Fol!!	Sillimanite, 265.	7—7·5	Fib.
Kyanite, 263.	6—6·75	Fib.			

β. Species observed always or mostly in distinct crystals.

Perofskite, I.
Chiastolite, III.
Azorite, II.
Leucite, I.
Brookite, III.
Anatase, II.
Rutile, II.
Andalusite, III.
Staurotide, III.
Chrome Garnet, I.
Zircon, II.
Beryl, VI.
Phenacite, VI.
Spinel, I.
Diamond, I.

γ. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Opal, 151.	1·9—2·3.	Kyanite, 263.	3·5—3·7.
Leucite, 231.	2·4—2·5.	Staurotide, 261.	3·5—3·75.
Quartz, 145.	2·6—2·7.	Spinel, 103.	3·5—4·8.
Beryl, 178.	2·65—2·75.	Topaz, 259.	3·4—3·85.
Boltonite, 167.	2·8—3.	Knebelite, 186.	3·71.
Andalusite, 257.	2·8—3·3.	Brookite, 123.	3·8—4·18.
Phenacite, 189.	2·969.	Anatase, 121.	3·85—3·95.
Rubellite, 270.	3—3·3	Pyrochlore, 345.	3·8—4·4.
Chondrodite, 186.	3·1—3·2.	Sapphire, 111.	3·9—4·2.
Sillimanite, 265.	3·1—3·5.	Perofskite, 345	4·017.
Chrysolite, 184.	3·3—3·6.	Rutile, 120.	4·18—4·25.
Chrome Garnet, 190.	3·418.	Azorite, 350.	
Sapphirine, 266.	3·4—3·5.	Zircon, 195.	4·3—4·75.
Diamond, 24.	3·4—3·6.	Cassiterite, 118.	6·3—7·1.

** Fusible. (Includes no Phosphates).

† *Sulphates:* Sulphur reaction. Anhydrous (excepting Gypsum).

	Hardness.	
Gypsum,	1·5—2	IV; 111° 14′; *cleav* crystals; *foliated!!* massive fibrous! G 2·26—2·36; w, gy; ywh, bn, bh, bk; trp, op; BB exfol, whitens, crumbles; fus dif!; Ċa, S⃛, Aq, 378.
Heavy Spar,	2·5—3·5	III; tabular cryst; also prismatic; also tabular and fibrous massive to compact; G 4·3—4·5; w, ywh, gyh, bnh; rdh; trp, trl, op; BB fus dif; Ḃa ,S⃛, 366.
Anhydrite,	3—3·5	III; rectang cleavages, lamellar; fib, massive; G 2·85—3; w, gyh, bh, rdh; vit-p'ly; trp, trl; BB not exfol, fus dif! Ċa, S⃛, 369.
Celestine,	3—3·5	III; prismatic cryst; also massive, fibrous; G 3·9—4; w, bh; vit, p'ly; trp; strl; brittle; BB decrep, fus; Ṡr, S⃛, 368.
Dreelite,	3·5	VI; rhombohedral; G 3·2—3·4; w; p'ly, splendent; Ċa, Ḃa, S⃛, 373.

Species distinctly foliated or fibrous in some varieties.

Gypsum, 378.	H=1·5—2	Fol! fib!	Anhydrite, 369.	H=3—3·5	Fol, fib.
Heavy Spar, 366.	2·5—3·5	Subfol, fib.	Celestine, 368.	3—3·5	Fib.

†† Hydrous; B.B. no sulphur or phosphorus reaction; G below 3·8, (excepting Plumboresinite).

Obs.—Of the included species, the *magnesian* are Chlorite, Spadaite, Pyrosclerite, Xylite; the *earthy aluminous* Halloysite and allied; the *crystallized aluminous or zeolites*, Stilbite, Heulandite, Epistilbite, Chabazite, Harmotome, Edingtonite, Apophyllite, Brewsterite, Faujasite, to which Savite, Chlorastolite, Apophyllite, and Prehnite are related; Crocidolite is asbestiform; Palagonite a tufa product; Ottrelite and Chloritoid more or less foliaceous, and of gray to green and black colors.

Halloysite, (in part),	1	Mas; earthy; G.1·6—2·1; w, bh; adheres to the tongue; waxy; strl, more trp in water, and increase in weight; *acids* decomp; Al, Si, Aq, 250. The Halloysites and allied species are generally infusble.
Chlorite, Ripidolite, Clinochlore, Chlorophæite,	1—2	Micaceous or massive; lam inelastic, p'ly; olive-gn, bn, wh; BB fus dif!—293—296. Chlorophæite fuses easily 278; *aphrosiderite* is a ferruginous ripidolite, 297.
Fahlunite, Gigantolite, Iberite,	2—3	Often in coarse hexag prisms, basal cleavage and sometimes foliated; G 2·7—2·9; gyh-gn, gnh bnh; sub-p'ly; sbtrl; BB fus dif; *bor* iron glass; *soda* insol; in *acids* insol; Al, Fe, Si, Aq, 216.
Spadaite,	2·5	Mas; rdh; p'ly; BB glassy enamel; in *mur* sol; imperf gelat; Mg, Si, Aq, 278.
Hydrophite,	2·5—3·5	Massive, fibrous; G 2·4—2·65, dark gn; BB bkns, becomes magnetic, fus bk glob, Mg, Fe, Si, Aq, 286.
Damourite,	2·5—3	Scaly massive, scales foliated, G 2·792; yw, ywh; p'ly; trl, scales trp; BB wns, fus dif!, with *bor* sol; in *mur* insol, in *sul* sol; Al, K, Si, Aq, 223.

	Hardness.	
Pyrosclerite,	3	III? ; foliated! ; mas, gran ; G 2·74—2·76; gn, gyh, wh, rdh; weak p'ly ; trl; feel somewhat greasy ; BB fus dif! ; in *mur* decomp ; Mg, Si, Aq, 291.
Margarite, Euphyllite,	3·5—4·5	Thin micaceous; G 2·9—3·032; pale gyh, wh, ywh; trl, strl; rather brittle ; BB intum, fus dif ; Al, Ca, Si, Aq, 300, 291. Ephesite is related, 301.
Plumboresinite,	4—4·5	Reniform, glob ; fib, massive ; G 4·9—6·4 ; res ; ywh, rdh-bn, ywh-w ; like gum arabic; Pb, Al, $\ddot{\mathrm{P}}$ (?) Aq, 431.
Savite,	3	II, Acicular pms ; G 2·45 ; colorless; trp ; BB fus dif; in acids soluble ; Mg, Na, Al, Si, Aq, 316.
Liebenerite,	3·5	VI; hexag pms; *cleav* indistinct ; G 2·814 ; greasy ; gnh-gy ; BB intum, fus dif no globule ; Al, K Si, Aq, 216.
Stilbite,	3·5	IV ; cryst, *a pearly cleavage ;* diverg, columnar, laminato-radiate ; G 2·05—2·21 ; p'ly, vit; w, ywh, gyh, rdh ; strp, strl ; brittle ; BB intum, fus ; in *acids* slimy ; Al, Ca, Si, Aq, 332.
Heulandite,	3·5—4	IV ; *a pearly cleavage ;* cryst; sometimes glob ; G 2·19—2·25 ; w, rdh, gyh, bnh ; trp, strl ; brittle ; BB intum, fus; in *mur* sol; Al, Ca, Si, Aq ; *Zeolite,* 330. *Epistilbite* is similar, but is trimetric, 330.
Crocidolite,	4	Fibrous like asbestus, fibres easily separable ; lavender-blue. BB fus! shining slag ; Fe, Si, Aq, 279.
Chabazite,	4—4·5	VI ; in R and hexag forms ; G 2·05—2·2 ; w, gyh, rdh; vit ; trp, trl; brittle ; BB intum, fus ; in *mur* in powder sol ; Al, Ca, Si, Aq, 319.
Harmotome,	4—4·5	III; in glassy cryst, often cruciform, *cleav* imperf ; G 2·35—2·5 ; w, ywh, rdh, bnh. trp, trl ; BB fus, no intum ; in *acids* not sol without heat ; Al, Ba, Si, Aq, 323.
Edingtonite,	4—4·5	II ; in cryst, hemihed ; G 2·7—2·8 ; vit ; w, gyh ; trl ; BB w, opaque, fus dif; Al, Ca, Na, Si, Aq ; *Zeolite,* 323.
Palagonite,	4—5	Massive, part of volcanic tufas, G 2·43 ; yw, ywh-bn ; trl ; resinous subvit ; BB fus ! ; in *mur* sol ; Al, Fe, Ca, Mg, Si, Aq, 166.
Apophyllite, Gyrolite,	4·5—5	II ; in acute octahedrons and prisms, a *pearly basal cleavage;* also subfoliated massive ; G 2—2·4 , w, gyh, gnh, ywh, rdh ; trp, op ; brittle ; BB exfol, fus ; in *nit* flaky, imperf gelat ; Ca, K, Si, Aq, 304.
Brewsterite,	4·5—5	IV ; cryst ; *a pearly cleavage ;* G 2·1—2·44 ; vit, p'ly ; w, ywh, gyh ; trp, trl ; BB froths, fus, in *mur* sol ; Al, Ba, Sr, Si, Aq, 332.
Faujasite,	5	II ; in octahedrons ; G 1·923 ; w, bnh ; vit ; trp, trl ; BB intum, fus ; in *mur* sol ; Al, Ca, Na, Si, Aq, 323.
Ottrelite,	5	Scales, micaceous, brittle disseminated through a slaty rock ; G 4·4 ; bkh-gy, gnh-gy ; BB fus dif, glob, bk, magnetic ; Al, Fe, Mn, Si, Aq, 287.

	Hardness.	
Carpholite,	5—5·5	Radiated, stell; G 2·9—2·95; straw-yw; silky; op; very brittle; BB intum, fus dif, bn, op; in *acids* hardly attacked; Al, Mn, Si, Aq, 316.
Allanite, (in part),	5·5	In slender cryst and massive; pitch-black, bnh-bk, dark ywh-brown, 208. *Erdmannite,* (p. 340) may belong here.
Chlorastrolite,	5·5—6	Massive, radiated fibrous or subfibrous, stell; p'ly; gn, pale bh-gn; BB fus! intum; in *mur* sol; Al, Ca, Fe, Si, Aq, 315.
Chloritoid, (Masonite),	5—6	Coarse foliated; G 3·4—3·5; gy, gyh-gn, gnh-bk; weak p'ly; BB mag; fus dif, dark gn; Al, Fe, Si, Aq, 298.
Prehnite,	6—6·5	III; botryoid, or thick and hard incrust, surface crystalline; G 2·8—3; vit, sbp'ly; gnh, wh; strp, trl; BB *intum,* fus; in *mur* sol slowly; Al, Ca, Si, Aq, 314.

a. Species foliated or fibrous in some varieties.

	Hardness.			Hardness.	
Ripidolite, 293.	1—2	Fol!	Margarite, 300.	3·5—4·5	Fol!
Chlorite, 295.	1·5—2	Fol!	Euphyllite, 291.	4—5	Fol!
Fahlunite, 216.	2—3	Fol.	Apophyllite, 304.	4·5—5	Subfol.
Iberite, 216.	2·5	Subfol.	Ottrelite, 287.	5	Fol.
Pyrosclerite, 291.	3	Fol.	Carpholite, 316.	5—5·5	Fib.
Stilbite, 332.	3·5	Fol!	Chlorastrolite, 315.	5·5—6	Subfib.
Heulandite, 330.	3·5—4	Fol!	Chloritoid, 298.	5·5—6	Subfol.

β Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Halloysite, 250.	1·6—2·1.	Fahlunite, 216.	2·7—2·9.
Faujasite, 323.	1·923.	Pyrosclerite, 291.	2·74—2·76.
Stilbite, 332.	2·0—2·21.	Vermiculite, 291.	2·756.
Chabazite, 319.	2·0—2·21.	Prehnite, 314.	2·8—3.
Apophyllite, 304.	2·0—2·4.	Iberite, 216.	2·89.
Heulandite, 330.	2·19—2·2.	Carpholite, 316.	2·9—2·95.
Brewsterite, 332.	2·1—2·44.	Margarite, 300.	3—3·1.
Harmotome, 323.	2·35—2·5.	Euphyllite, 291.	2·9—3·1.
Palagonite, 166.	2·4—2·7.	Chlorastrolite, 315.	3·18.
Spadaite, 278.		Chloritoid, 298.	3·4—3·5.
Chlorite, 293—296.	2·6—3.	Ottrelite, 287.	4·4.
Edingtonite, 323.	2·7—2·8.		

††† Anhydrous; no Sulphur reaction, (excepting in Helvin.)

Obs.—Of the following species, the only *micaceous* one is *Mica;* Diallage and Hypersthene are thin foliated; the only delicately fibrous, with separable flexible fibres, are included under *Asbestus;* the other fine fibrous, with brittle fibres or columns, are either *Pyroxene* or *Hornblende; Epidote* and *Tourmaline* are sometimes columnar, and rarely Idocrase. The only Tetrahedral species is *Helvin. Danburite* gives a strong boracic acid reaction, and *Tourmaline* and *Axinite* one less decided. Obsidian or black volcanic glass would fall in this division were it a simple mineral. (See p. 248.)

	Hardness.	
Asbestus,		Fib, sometimes like cotton, fibres separable or not; BB fus dif; in acids imperf soluble; same compound as pyroxene or hornblende, 158, 170.

	Hardness.	
Mica, Muscovite,* Phlogopite, Biotite, Lepidolite,	2—2·5	*Thin micaceous*, laminæ very thin, flexible, elastic, easily separable; G 2·75—3·1; w, gy, gnh, ywh, bnh, bk, rdh, purplish; trp—trl; BB whitens, sometimes fluorine reaction, fus dif; Al, K, Fe, Si; Al, Mg, Fe, Si; Al, Li, K, Si, F, 217–227.
Leucophane,	3·5—4	III; mas, columnar, cleavable; G 2·974; vit; dirty gn, wine yw; trp—trl; BB fus, violet glass; fluorine reaction; with *bor* amethystine glass; Be, Ca, Na, Si, F, 182.
Sphene,	5—5·5	IV; usual in thin acute-edged crystals; also massive; G 3·4—3·6; adamant, res; brown and black common; also gy, yw, gn; trp—op; BB fus dif intum, enam; with metallic tin a violet color; with *bor* clear glass; in *mur* heated, imperf solution; Ca, Ti, Si, 268.
Melinophane,	5	Massive, cleav; G 3·0; vit; yw; brittle; optically uniaxal, 183.
Wöhlerite,	5·5	Tabular cryst, massive; G 3·4; yw, bnh, gyh; BB ywh, glass; in *mur* sol; Zr, Na, Ca, Si, 343.
Babingtonite,	5·5—6	V; G 3·3—3·5; vit; gnh-bk; strl, op; BB fus! bead magnetic; Ca, Fe, Mn, Si, 178.
Glaucophane, Violan,	5·5	Prisms massive; G 3·108; vit, p'ly; b, lavender-b, bh-bk, gyh; *streak* gyh-b; trl—op; powder slightly magnetic; BB fus! gn glass; *acids* partly sol; Al, Fe, Mg, Na, Si, 177.
Scapolite, Meionite, Dipyre,	5—6	II; in square pms, large or small; massive; G 2·5—2·75; vit-p'ly, vit; w, gy, bh, gnh, rdh; trl, strl, op; BB fus intum; in *acids* decomp; Ca, Na, Al, Si, 200, 201, 205.
Pyroxene, Hornblende, Acmite,	5—6	IV; prisms, hornblende 124° 32′; acmite and pyroxene 87° 6′; massive, fib, gran, foliated; G 2·9—3·4; vit, p'ly; gn, w, bk; BB fus dif or easy; Ca, Si; Mg, Si; Fe, Si; Mn, Si, 158, 170, 176. Prismatic crystals of hornblende often hexagonal, with angles approaching 120°, while those of pyroxene are often 8-sided, with angles near 135°. Diallage and hypersthene are thin foliated and fus dif!!
Wichtyne,	5·5—6	Mas; G 3·03; dull; bk; BB fus bk, mag; *acids* not attacked; Al, Fe, Ca, Mg, Na, Si, 177.
Saussurite,	5·5—6	V? mas, cleav; G 3 2—3·7; p'ly, vit; w, gnh, gyh; strl; tough! BB fus dif; in *acids* insol; Al, Fe, Ca, Na, Si, 254.
Allanite, Orthite,	5·5—6	IV; cryst often tabular, prismatic or acic; mas; G 3·3—4·2; pitch-black or bn, ywh; strl, op; brittle; *streak*

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* These micas often contain some water. Margarodite, Margarite and Euphyllite are hydrous species, yet the amount of water is very small, being but 4 or 5 per cent. B.B. fus. often easily.

	Hardness.	
		gyh ; intum easily, fus; in *acids* sol or insol; Al, Fe, Ce, Ca, Si, 208, 210. *Erdmannite*, (p. 340), may be near orthite.
Latrobite,	5·5—6·5	V ; mas ; G 2·7—2·8 ; vit ; rose-r, pink ; strl, op ; BB fus dif! ; Al, Mn, Mg, Ca, K, Si, 235.
Rhodonite,	5·5—6·5	IV ; like Augite ; massive, cleavable or granular ; G 3·4—3·75 ; vit ; light rd ; gnh, ywh, when impure ; bk on exposure ; BB bn, rdh-bn glob ; in *mur* partly sol ; Mn, Si, 167.
Orthoclase,	6	IV ; in crystals ; cleavable, massive ; G 2·4—2·6 : vit, subp'ly ; w, rdh, gyh, gnh ; trp—sbtrl ; BB fus dif ; in *acids* insol ; Al, K, Si, 242.
Andesine, Labradorite, Vosgite, Bytownite, Cyclopite,	6	V ; massive feldsp cleav ; G 2·6—2·8 ; subvit, p'ly ; gy, bn, gnh, often a play of colors : trl, strl ; BB fus dif ; *Labradorite* in *mur* heated sol! *Andesine* attacked by acids ; *Bytownite* is granular massive, gnh-w, trl ; Al, Ca, Na, Si, 236, 237, 254.
Petalite,	6—6·5	Mas ; subcleav ; subfeldsp ; G 2·4—2·45 ; vit, glist, a little p'ly or greasy ; w, gy, rdh, gnh ; trl ; BB fus dif! w enamel, reaction of lithia ; in *acids* insol ; Al, Na, Li, Si, 253.
Albite, Oligoclase,	6—6·5	V ; feldsp ; G 2·6—2·69 ; vit, subp'ly ; ywh, gyh, w ; trp, strl ; BB fus quietly, flame ywh ; in *acids* insol ; Al, Na, Ca, Si, 239, 240. Oligoclase is a little more pearly or greasy in look usually than albite. The hardness of albite is sometimes 7. Albite and other triclinic feldspars differ from Orthoclase in having the two most perfect cleavages, (or planes *O* and *i*ì), not quite at right angles with one another, (85° to 87°.)
Anorthite,	6—7	V : in crystals ; G 2·65—2·78 ; w, gyh, rdh ; trp, trl ; BB fus dif ; with *soda* an enamel ; in *acids* sol ; Al, Ca, Si, 234.
Couzeranite,	6—6·5	II ? G 2·69 ; vit ; gy, gnh-gy, bk ; BB fus w enamel ; in *acids* insol ; Al, Ca, K, Na, Si, 206.
Pollux,	6—6·5	Mas, like quartz ; G 2·88 ; vit ; colorless ; trp ; BB fus, flame orange ; with *bor* glass easily ; in *acids* decomp ; Al, K, Li, Na, Si, 255.
Helvin,	6—6·5	I ; tetrahed ; G 3·1—3·3 ; vit ; subres ; wax-yw, bnh, gnh ; strl ; BB fus, intum, yw globule op ; with *bor* manganese reaction ; Be, Mn, Si, S, 194.
Fayalite,	6·5	Black, gnh, bnh, massive, glassy ; G 4·1. BB fus ! with *acids* easily attacked ; Fe, Mg, Si, 185.
Isopyre,	6·5	Massive, no cleav ; G 2·9—3 ; glassy black, gyh ; op, strl ; brittle ; BB fus. in acids decomp, dif ; Al, Ca, Fe, Si, 255.
Nephrite,	6—7	Mas, subgran ; G 2·9—3·1 ; subvit ; wh, gnh ; tough ; BB fus dif!! ; Mg, Ca, Si, 175.

	Hardness.	
Weissigite,	6·5	IV, in small indistinct crystals, *cleav* ; G 2·5—2·6 ; w, pale rose-red ; BB fus, w blebby enamel, outer flame weak red, yw at point ; Al, Na, Li, Si, 254.
Idocrase,	6·5	II ; often in four or eight-sided prisms ; *cleav* indist ; mas ; G 3·3 –4 ; vit, res, often brilliant ; bn, gn ; yw, b ; strp—strl ; BB fus ! intum ; in hot *acids* sol ; Al, Ca, Fe, Si, 197.
Epidote, Zoisite,	6—7	IV ; cryst ; massive, subcolumn, hardly cleavable ; G 3·2—3·5 ; vit—res ; pistachio-gn, bn, gy ; strp—op ; BB fus ; in *mur* more or less sol ; Al, Ca, Fe, Si, sometimes with Mn, Ce, 206.
Spodumene,	6·5—7	IV ; Massive, cleav ; G 3·1—3·2 ; subp'ly ; gyh—gyh-gn ; trl, strl ; BB fus, intum ; Al, Li, Si, 169.
Axinite,	6·5—7	V ; *crystals with sharp thin edges ;* G 3·2—3·3 ; vit ; bn, bh, gyh ; trp, trl ; BB fus ! ; Ca, Al, Fe, Si, B̈, 213.
Garnet,	6·5—7	I ; dodecahedrons ; trapezohedrons ; mas ; in grains ; G 3·5—4·3 ; vit, res ; r, bn, ywh-bn, yw, w, gn, bk ; trp—strl ; BB fus ; in *acids* more or less sol ; Ca, Al, Si ; Fe, Al, Si ; Al, Mn, Si ; Ca, Fe, Si, 190.
		Pyrope, G 3·69—3·8 ; in rounded grains ; BB fus dif ; *bor* emerald-green glob, 194.
Muromontite,	6—7	Grains ; G 4·263 ; bk, gnh-bk ; *streak* gyh-w ; strl, op ; BB fus dif, glows, flame yellow, 211.
Iolite,	7—7·5	III ; six and twelve-sided pms ; also massive ; G 2·55—2·68 ; glassy and dark blue ; trp, trl ; BB fus slow ; b glass ; in *acids* attack dif ! ; Al, Mg, Fe, Si, 214.
Danburite,	7—7·5	Disseminated cryst, sub-cleav mas ; G 2·8—3 ; pale ywh, wh ; vit ; trl, strl ; very brittle ; BB fus, strong reaction of boracic acid ; Ca, B̈, S̈i, 212.
Tourmaline,	7—7·5	VI ; usual in three or six-sided pms ; mas ; G 3—3·3 ; black common ; also b, gn, rd, w, bn ; vit, res ; trp, op ; BB fus or infus ; Al, Si, B̈, with often Fe, Ca, K, 270.
Euclase,	7·5	IV ; in cryst, also one perfect diag cleav ; G 3—3·1 ; vit ; pale gn, bh ; trp, strp ; very brittle ; BB intum ; fus dif ; w enamel ; with *bor* a clear glass ; electric by friction ! ; Be, Al, Si, 267.

β Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Petalite, 253.	2·39—3·45.	Dipyre, 205.	2·646.
Orthoclase, 242.	2·4—2·6.	Andesine, 236.	2·65—2·74.
Meionite, 200.	2·5—2·74.	Anorthite, 234.	2·65—2·78.
Weissigite, 254.	2·5—2·6.	Labradorite, 236.	2·68—2·76.
Iolite, 214.	2·55—2·7.	Couzeranite, 206.	2·69
Albite, 240.	2·59—2·65.	Vosgite, 237.	2·7—2·8.
Loxoclase, 244.	2·6—2·62.	Latrobite, 235.	2·7—2·8.
Hyposclerite, 242.	2·6—2·7.	Mica, 217-227.	2·75—3·1.
Scapolite, 200, 201.	2·6—2·75.	Danburite, 212.	2·8—3.
Oligoclase, 239.	2·63—2·69.	Pollux, 255.	2·88.

	Sp. gravity.		Sp. gravity.
Isopyre, 255.	2·9—3.	Pyroxene, 158.	3·23—3·5.
Nephrite, 175.	2·9—3·1.	Epidote, 206.	3·25—3·5.
Euclase, 267.	2·9—3·1.	Allanite, 208.	3·3—3·42.
Leucophane, 182.	2·973.	Idocrase, 197.	3·34—4.
Hornblende, 170.	2·9—3·3.	Wohlerite.	
Tourmaline, 270.	3—3·2.	Babingtonite, 178.	3·3—3·5.
Wichtyne, 177.	3·04.	Sphene, 268.	3·4—3·6.
Melinophane, 183.	3·0.	Rhodonite, 167.	3·4—3·7.
Glaucophane, 177.	3·108.	Garnet, 190.	3·5—3·8.
Helvin, 194.	3·1—3·3.	Pyrochlore, 345.	3·8—4·35.
Spodumene, 169.	3·15—3·2.	Fayalite, 185.	4·1.
Axinite, 213.	3·2—3·3.	Muromontite, 211.	4·263.
Saussurite, 254.	3·2—3·4.	Microlite, 397.	5·4.
Acmite, 176.	3·2—3·55.		

[NOTE.—The ores of lead, having an uncolored streak, as they yield a metallic malleable globule before the blowpipe, fall into the next subdivision.]

b. B.B. EITHER FUMES, OR A MALLEABLE GLOBULE, OR BOTH.

Obs.—There are no sulphurets here included. Blende and Voltzite do not give off the sulphur as fumes. Other sulphurets without a metallic lustre have a *colored streak.* Specific gravity of the included species above 4·8.

* Globule of lead or silver, with, or without, the fluxes; the lead passes off in fumes, and discolors the charcoal around the assay: no fumes of Arsenic, Selenium or Antimony.

	Hardness.	
Cotunnite,	1—2	III; acic cryst; adamantine, silky; w; BB fus! flame b; on *charcoal* w vapors, with *soda* lead; Pb, Cl, 97.
Kerargyrite,	1—1·5	I; like wax; sectile; G 5·3—5·6; pearl-gy, ywh, bnh; streak shining; trl—op; BB on *charcoal* fumes of chlorine, and silver glob; Ag, Cl, 92. *Embolite,* (p. 93), contains also bromine.
Matlockite,	2·5—3	II; tabular crystals; G 5·4—7·2; clear ywh, gnh; adamantine, or little p'ly; trp, trl; Pb, Cl, O, 127.
Cerasine,	2·5—3	II; G 6—6·3; adamantine; w, gyh, ywh; trp, trl; BB on *charcoal* fumes lead; *nit* efferv; Pb, Cl,$\ddot{C}$, 463.
Anglesite, Leadhillite,	2·5—3	III; cryst; mas; G 6·2—6·3; adamantine, vit, res; w, ywh, gyh, gnh; trp, op; brittle; BB fus!, on *charcoal* with *soda* lead; $\dot{Pb}$, $\dddot{S}$, 370; for Leadhillite Pb, $\dddot{S}$, $\ddot{C}$, 371. *Susannite* is the same, but *rhombohedral,* 373. *Lanarkite* is related, 374. *Caledonite* has a deep bluish green color and greenish streak.
Wulfenite,	2·5—3	II; square tables and octahedrons; also massive; G 6·3—6·9; res, adamantine; ywh, orange yw; strp, strl, brittle; BB decrep, fus dif; on *charcoal* with *soda* lead; in *mur* or *nit* in powder decomp; Pb, Mo, 349.
Lanarkite,	2—2·5	IV; *cleav* basal!; G 6·3—7; p'ly, adamantine; res; gnh-w, ywh, gyh; trp, trl; BB fus, w cold; on *charcoal* lead; in *nit* sol little efferv; $\dot{Pb}$, $\dddot{S}$, $\ddot{C}$, 374.

	Hardness.	
Vanadinite,	2·5—3	VI ; hexag prisms ; glob incrust ; G 6·6—7·3 ; res ; pale bnh-yw, straw-yw, rdh bn ; strl, op ; brittle ; BB fus ; on *charcoal* glob lead ; in *mur* sol gn, in *nit* yw ; $\dot{\mathrm{P}}\mathrm{b}$, Cl, $\dddot{\mathrm{V}}$, 362.
Mendipite,	2·5—3	III ; columnar, rad ; *cleav !* ; G 7—7·1 ; p'ly ; w, ywh, rdh ; sbtrl, op ; BB fus !, on *charcoal* w, fumes ; with *soda* lead ; Pb, Cl, O, 128.
Scheeletine,	2·5—3	II ; cryst ; G 7·8—8·12 ; res, subadamantine ; gn, gy, bn, rdh ; trl, strl ; BB fus ; on *charcoal* vapors of lead ; in *nit* sol, yw ; Pb, W, 348.
Cerusite,	3—3·5	III ; cryst ; mas ; G 6·4—6·5 ; earthy, 5·4 ; ad, vit, res ; w. gyh, bh ; sometimes bkh externally ; trp, strl ; brittle ; BB fus ! on *charcoal* lead ; in *nit* efferv ; $\dot{\mathrm{P}}\mathrm{b}$, $\ddot{\mathrm{C}}$, 452.

a. No foliated species in this division ; Mendipite is sometimes fibrous.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Cotunnite, 97.		Lanarkite, 374.	6·3—7.
Kerargyrite, 92.	5·3—5·6.	Caledonite, 372.	6·4.
Matlockite, 127.	5·4—7·2.	Cerusite, 452.	6·4—6·5.
Cerasine, 463.	6—6·1.	Susannite, 373.	6·55.
Leadhillite, 371.	6—6·5.	Vanadinite, 362.	6·6—7·3.
Anglesite, 370.	6·2—6·3.	Mendipite, 128.	7—7·1.
Wulfenite, 349.	6·3—6·9.	Scheeletine, 348.	7·9—8·2.

** B.B. Inodorous Fumes of Zinc, Bismuth, Antimony, Tellurium.

Bismuth Ochre,		Mass, earthy, pulv, somewhat fol ; G 4·36 ; gnh-yw, straw-yw ; gyh-w ; ad, earthy ; BB *char* met, then fumes ; Bi, O, 141.
Zinc Bloom,	2—2·5	Earthy ; G 3·5—3·6 ; dull ; w, gyh, ywh ; op ; BB on *charcoal* fumes of zinc ; in *mur* sol ; $\dot{\mathrm{Z}}\mathrm{n}$, $\ddot{\mathrm{C}}$, Aq, 460.
White Antimony, Senarmontite,	2—3	III ; lam ; mas, columnar, gran ; G 5·2—5·7 ; adamantine, p'ly ; w, gyh, rdh ; trl, strp ; BB fus ! ! !, volat, w fumes ; Sb, O, 140. *Senarmontite* is *octahedral*, 140.
Eulytine,		I ; hemihed, glob, columnar, lamellar, granular ; G 5·9—6·1 ; res, adamantine ; bn, ywh-gy, straw-yw ; strp, op ; BB fus ; fumes inodorous, on *charcoal* ywh-bn areola ; Bi, Si, 181.
Cervantite, Bleinierite, Volgerite,	4	Massive, earthy, incrust ; G 3·9—4·8 ; res, dull ; gy, bnh, ywh ; *st* gyh, ywh, op ; BB *char* fumes antim, sometimes arsen ; glob lead ; Pb, Sb, O, Aq, 141, 142.
Bismutite,	3·5—4·5	Acic, incrust ; massive ; G 7—7·7 ; vit, earthy ; w, gnh, ywh ; strl, op ; BB decrep, fus ! on *charcoal* met, fumes ; $\dddot{\mathrm{B}}\mathrm{i}$, $\ddot{\mathrm{C}}$, Aq, 462.
Smithsonite,	5	VI ; *cleav* rbdrl ; mas ; earthy ; G 4—4·5 ; vit, p'ly ; w, gyh, gnh, bnh ; strp, trl ; BB infus, zinc fumes ; in *nit* efferv ; $\dot{\mathrm{Z}}\mathrm{n}$, $\ddot{\mathrm{C}}$, 447.

a. No foliated species in this subdivision, excepting white antimony, which may be lamellar; this species and eulytine may occur columnar.

*** B B. odorous fumes of Arsenic or Selenium.

	Hardness.	
Haidingerite,	1·5—2·5	III; cleav!!; minute cryst, crusts, botryoid; G 2·848; w; vit; trp, trl; laminæ flexible; BB on *charcoal* arsenic; in *nit* sol, 413.
Pharmacolite,	2—2·5	IV; *cleav!!* fibrous, acic, stellate; massive; G 2·64—2·75; w, gyh; vit; p'ly; trl, op; laminæ flexible; BB fus w; on *charcoal* arsenic; in *acids* sol!; $\dot{\mathrm{Ca}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$, $\dot{\bar{\mathrm{H}}}$, 414.
Pitticite,	2—3	Reniform, massive; G 2·2—2·5; vit, greasy; ywh, rdh-bn, rd, w; trl, op; BB *char* arsen; $\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}\mathrm{e}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$, $\overset{\cdot\cdot\cdot}{\mathrm{S}}$, Aq, 432.
Mimetene,	3·5	VI; in hexag prisms; G 5·4—7·3; resinous; pale-yw, bnh, orange-yw; strp, trl; BB fus, bnh-yw; on *charcoal* arsen; in *nit* sol; Pb $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$, 401.
Selenate of Lead,	3—4	Botryoidal, glob; vit, greasy; sulphur yw; brittle; BB fus! bh slag; on *charcoal* selen; $\dot{\mathrm{Pb}}$, $\overset{\cdot\cdot\cdot}{\mathrm{Se}}$, 375.
Scorodite,,	3·5—4	III; cryst; G 3·1—3·3; vit, subadamantine; pale gn, bn; BB arsen, fus scoria, magnetic; in *mur* sol; $\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}\mathrm{e}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$, Aq, 419.
Kühnite,	5—6	Massive, one cleavage; G 2·52; wh, ywh; waxy; BB on *charcoal* arsenic; in *nit* sol; $\dot{\mathrm{Ca}}$, $\dot{\mathrm{Mg}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$, 404.

a. No foliated species in this group, but Pharmacolite and Haidingerite have a very perfect cleavage; Pharmacolite occurs fibrous.

**** B.B. wholly vaporizable with fumes of quicksilver and chlorine.

Calomel,	1—2	II; massive incrust; G 6·482; adamantine; ywh-gy, gy, wh; trl; strl; sectile; BB volat; Hg, Cl, 89.

B. STREAK COLORED.

a. B.B. NO FUMES WITHOUT OR WITH THE FLUXES; GLOBULE NOT MALLEABLE.

** B.B. infusible, or nearly so.

† Gelatinize with acids.

Obs.—Dioptase affords with soda a kernel of copper, but with difficulty.

Wolchonskoite,	2—3	Massive, compact; G 2—2·3; dull gn; trl, op; Chrysocolla: BB reaction of chrome; in *mur* gelat; Cr, Si, etc., 339.
Nontronite,	2·5—3	Massive; G 2·1—2·2; nearly dull; gn, gnh. *streak* paler; BB fus; with *bor* iron; in *mur* gelat; Fe, Si, Aq, 337.

	Hardness.	
Dioptase,	5	VI; in emerald-gn cryst; G 3·278; vit; *streak* gn; brittle; BB decrep, gn flame; with *bor* gn glob, copper; in *mur* gelat; Cu, Si, Aq, 309.
Tritomite,	5·5	Brown tetrahedrons; G 4·1—4·7; vit, submet; dark bn; *streak* ywh-bn; BB whitens; with *bor* a glass; in *mur* gelat; Ce, La, Ca, Si, Aq, 311.
Cerite,	5·5	VI; hexag pms; bn, cherry-red; G 4·9; *streak* grayish-white; brittle; Ca, Si, Aq, 312.
Thorite,	6	Massive, compact; G 4·6—5·4; vit to res; bnh-yw, bk, bn; *streak* dark-bn; BB bnh-r, infus; with *bor* fus! glass colored by iron; in *mur* gelat; Th, Fe, Mn, Si, Aq, 312.

a. No foliated or fibrous species in this subdivision.

†† Not gelatinizing with acids.

Obs.—Fluorids include, Fluocerine, Fluocerite; *Phosphates,* Xenotime, Monazite; *Oxalates,* Oxalite; *Tantalates,* Pyrochlore, Yttrotantalite, Fergusonite; *Carbonates,* Zippeite, Liebigite, Emerald Nickel, Parisite; *Oxyds,* Wad, Chrome Ochre, Red Iron Ore, Red Zinc, Limonite, Pitchblende, Brookite, Rutile; *Silicates,* Chloropal, Malacone; *Borate,* Warwickite. *Remingtonite* a carbonate of cobalt (p. 461) may belong in this section.

Wad,	0·5—3·5	Mas; earthy; G 3—3·7; bkh, dull bh, bnh; often soils; BB infus (or subfus); in *mur* fumes of chlorine; Mn, O, Aq; often with Co, or Cu, 136.
Oxalite,	2	Capillary, botryoid, earthy; yw; *streak* ywh; BB blackens and becomes magnetic; in *acids* sol; oxalate of iron, 464.
Chrome Ochre,		Mas; bh-gn, grass-gn; a chrome reaction with the fluxes, 339. *Miloschin* is indigo-blue to celandine-gn, 339.
Zippeite,		Earthy powder; sulphur yw, bnh, rdh; BB orange; BB in inner flame gn, infus; Ʉ̈, Ḣ, C̈, 461. *Voglite* contains Ċa, Ċu, C̈, Aq, 462.
Wolframine,		Bright yw powder, crust; BB infus; W⃛, 143; occurs with ores of tungsten, 143.
Liebigite,	2—2·5	Mamillary cleav; apple-gn; vit; trp; BB bkns; with *bor* yw in outer fl, gn glass in inner; in *acids* efferv, yw sol; U, Ca, Aq, 461.
Red Iron Ore,		Massive; lentic, earthy, &c.; G 4—5; often earthy, dull or bright red; *streak* the same; BB *bor* gn or yw glass; in hot *mur* sol; $Fe^2 O^3$, 113.
Chloropal,	2·5—3	Massive; G 1·7—2·2; nearly dull; gn, gnh; *streak* lighter; BB infus, bk, bn; with *bor* iron reaction; in *mur* partly sol; Fe, Si, Aq, 337. *Pimelite* is apple-gn, amorphous, and contains nickel; G 2·2—2·8; feel greasy; does not adhere to the tongue, 339.
Emerald Nickel,	3—3·5	Massive, crust; G 2·5—2·7; *emerald-gn; streak* gnh; Ni, C̈, Aq, 461.

	Hardness.	
Warwickite,	3—4	Oblong prisms, often slender, imbedded; G 3·188; submet-p'ly, subvit; bn, bkh, gyh; *streak* bh-bk; BB infus, reaction of boracic acid, 395.
Xenotime,	4—5	II; in small octahedrons; G 4·4—4·6; ywh-bn, *streak* pale; resinous; BB with *bor* uncolored glob; in *acids* insol; $\dot{\mathrm{Y}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, 401.
Red Zinc,	4—4·5	VI; *foliated;* G 5·4—5·6; subadamantine; deep-red; ywh; *streak* orange; trl, strl; brittle; BB with *bor* trp glass; Zn, O, 110.
Fluocerine, Fluocerite,	4·5—5	I; usually massive; yw, rdh, bnh; *streak* yw, bnh; strl, op; vit, res; BB bkns; with *bor* slow sol, red in outer flame; in *sul* sol, yw; Ce, F, Aq, 96.
Parisite,	4·5	VI; *cleav* basal!; G 4·35; bnh-yw; *streak* ywh-w; vit; BB bnh; with *bor* trp glass, yw hot; in *mur* slow sol, efferv; $\dot{\mathrm{C}}\mathrm{e}$, $\dot{\mathrm{C}}\mathrm{a}$, $\ddot{\mathrm{C}}$, F, 463.
Limonite,	3—5	Massive, stalactitic, incrust; G 3·5—4; earthy, silky; bn, yw, ochreous; *streak* ywh-bn; BB bkns, becomes magnetic; with *bor* iron; in hot *nitro-mur* sol; Fe, O, Aq, 131.
Pyrochlore,	5—5·5	In small bn or yw octahedral cryst; *streak* bn, ywh; BB fus dif!! Ce, Th, Ca, Ta, Ti, 345. *Pyrrhite* is also in small octahedral cryst; H=6; orange yw, 345.
Monazite,	5—5·5	IV; in small crystals, basal *cleav* perfect; rdh-bn, subresinous; G 4·9—5·3; BB with *bor* fus; in *mur* decomposed; Ce, La, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, 402.
Yttrotantalite,	5·5	G 5·395; submet; iron-bk; *streak* gy; op; BB with *soda* intum, fus; with *bor* sol; Y, Ca, Fe, Ta, W, U, 359.
Pitchblende,	5·5	I; massive, in grains; G 6·4—7·1; submet or dull; gyh-bk, bnh-bk, velvet-bk; op; *streak* bk, gnh; BB flame usually gn; with *bor* fus yw glass, gnh in inner fl; in *nit* pulv sol dif; U, O, 107. *Eliasite* is dull rdh-bn; G 4—4·25, 108.
Brookite,	5·5—6	III; cryst; G 3·8—4·18; met-adamantine, submet; bn, ywh, rdh, bk; *streak* gyh, ywh; BB like Rutile; $\ddot{\mathrm{T}}\mathrm{i}$, 123.
Fergusonite,	5·5—6	II; hemihed, *cleav* traces; G 5·8—5·85; vit, submet; bnh-bk, bn, ywh-bn; *streak* pale-bn; strl, op; BB loses color, with *bor* fus dif; with *soda* a slag; Y, Ce. Zr, Ta, 350. *Rutherfordite* is similar; G 5—5·5; 358.
Rutile,	6—6·5	II; cryst, often acic; mas; G 4·18—4·25; met-ad, subvit; rdh-bn, rd, ywh, bk; *streak* pale-bn; strp, op; BB unalt; *bor* red in outer flame; $\ddot{\mathrm{T}}\mathrm{i}$, 120.
Malacone,	6·5	II; cryst, like Zircon; G 4·047; vit, subres; bnh, rdh; bh-w within; *streak* bn; BB yields water; with *bor* sol dif; in powder in *acids* boiling sol dif; Zr, Si, Aq, 196.

a. There are no fibrous species in this subdivision, excepting Limonite, which is sometimes imperfectly so; and Red Zinc Ore is the only species that occurs distinctly foliated.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Chrome Ochre, 339.	——— ?	Red Iron Ore, 113.	4—5.
Zippeite, 462.	——— ?	Malacone, 196.	4·047.
Wolframine, 143.	——— ?	Rutile, 120.	4·18—4·25.
Liebigite, 461.	——— ?	Eliasite,	4—2·5.
Fluocerine, 96.	——— ?	Parisite, 463.	4·35.
Chloropal, 337.	2·1—2·2.	Xenotime, 401.	4·4—4·6.
Emerald Nickel, 461.	2·5—2·7.	Monazite, 402.	4·9—5·3.
Wad, 136.	3—3·7.	Rutherfordite,	5—5·5.
Warwickite, 395.	3·188.	Yttrotantalite, 359.	5·395.
Limonite, 131.	3·5—4.	Red Zinc Ore, 110.	5·4—5·6.
Brookite, 123.	3·8—4·3.	Fergusonite, 356.	5·8—5·9.
Pyrochlore, 345.	3·8—4·4.	Pitchblende, 107.	6·4—7·1.

** Fusible.

‡ Gelatinize with acids—(Silicates.)

	Hardness.	
Hisingerite,	1·5—2	Massive, cleav; G 3·045; bk; *streak* gnh-gy, bnh-yw; fracture earthy; sectile; BB fus bk magnetic slag; in *acids* sol, subgelat; Fe, Si, Aq, 290.
Thuringite,	2—2·5	Mas, cleav; G 3·1—3·2; p'ly; olive-gn; *streak* gnh; BB with *bor* iron; in *mur* gelat; Fe, Si, Aq, 290.
Sideroschisolite,	2·5	Crystals minute; G 3—3·4; velvet-bk, gnh-gy; *streak* leek-gn, gnh-gy; op; BB fus! magnetic; in *mur* sol, gelat; Fe, Si, Aq, 299.
Cronstedtite,	2·5	VI; hexag pms; also ren, mas; *cleav* basal!; G 3·348; vit!; bhn-bk, bh; *streak* dark leek-gn; thin laminæ elast; BB intum, froths; in *mur* in powder gelat; Fe, Mn, Si, Aq, 299.
Lievrite,	5·5—6	III; prisms, massive; G 3·8—4·2; submet, bh, gyh-bk; *streak* bk, gnh, bnh; brittle; BB fus, bk glob; with *bor* iron glass; in *mur* gelat; Fe, Ca, Si, 262.
Gadolinite,	6·5—7	V; massive, G 4—4·5; vit-pitchy; bk, gnh-bk; *streak* gnh-gy; strl, op; BB decrep, swells up, usually glows; in *mur* gelat; Y, Ce, Fe, Si, 211. *Tscheffkinite* is similar; streak dark-bn; G 4·5—4·6; BB intum; fus dif! bh glass; in *mur* gelat! 211.

a. No species in this subdivision are properly foliated or fibrous.

†† Not gelatinizing with acids; B.B. phosphorus reaction.

Obs.—All but Triplite and Zwieselite are hydrous species. Vivianite, Alluaudite, Dufrenite, Carphosiderite, Zweiselite, Triplite, afford B.B. a magnetic bead.

Vivianite,	1·5—2	IV; cryst, *cleav!* radiated fibrous, incrust, earthy; G 2·66; p'ly, vit; b, gn, dirty-gn; *streak* bh-w, b, bn; trp, trl; BB bn or bk scoria, magnetic; in *acids* sol; $\dot{\mathrm{Fe}}$, $\overset{:\cdot:}{\mathrm{P}}$, Aq, 415.

	Hardness.	
Uranite, Chalcolite,	2—2·5	II ; micaceous ; G 3—3·6 ; bright yw (*Uranite*), bright gn (*Chalcolite*), *streak* similar ; p'ly, ad ; lam, brittle ; BB fus bkh mas ; in *nit* yw, sol ; U, Ca, Cu, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, 430.
Dufrenite,	2—3	Fibrous, radiated ; G 3·2—3·4 ; weak, silky ; dull leek-gn, yw, bnh on exposure ; *streak* gn ; strl ; BB fus ! slag magnetic ; in *acids* sol ; $\overset{\cdot\cdot\cdot}{\mathrm{\bar{F}e}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, $\overset{\cdot\cdot\cdot}{\mathrm{\bar{M}n}}$, Aq, 427. *Delvauxene* is ywh-bn, bnh-bk, rdh ; G 1·85 ; $\dot{\mathrm{Fe}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, Aq, 427.
Carphosiderite,	4—4·5	Reniform ; G 2·5 ; res ; straw-yw ; *streak* ywh ; feel greasy ; BB magnetic bead ; $\dot{\mathrm{Fe}}$ or $\overset{\cdot\cdot\cdot}{\mathrm{\bar{F}e}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, Aq, 431.
Alluaudite, Hureaulite,	4·5 ?	Massive, sometimes cleav ; dull clove-bn, rdh-yw ; *streak* ywh , strl, op ; BB glob, bk, magnetic ; in *mur* sol ; $\overset{\cdot\cdot\cdot}{\mathrm{\bar{F}e}}$, $\dot{\mathrm{Mn}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, Aq, 407.
Zwieselite,	5	VI ? cryst, massive ; G 3·97 ; greasy ; clove-bn ; *streak* gyh-w ; BB decrep, bh-bk glass, magnetic ; $\dot{\mathrm{Fe}}$, $\dot{\mathrm{Mn}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, F, 399.
Triplite,	5—5·5	III ; cryst, massive ; G 3·4—3·8 ; resinous, adamantine ; bn, bkh-bn ; *streak* ywh-gy ; strl, op ; BB fus ! bk scoria ; in *nit* sol ; $\dot{\mathrm{Mn}}$, $\dot{\mathrm{Fe}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, 408.

α. Species distinctly foliaceous or fibrous in some varieties.

Vivianite, 415.	H=1·5—2	Fib, fol.	Chalcolite, 430.	H=2—2·5	Fol !
Uranite, 430.	2—2·5	Fol !	Dufrenite, 427.	2—3	Fib.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Delvauxene, 427.	1·85.	Dufrenite, 427.	3·2—3·4.
Hureaulite, 407.	2·27.	Alluaudite, 407.	3·468.
Carphosiderite, 431.	2·5.	Triplite, 408.	3·4—3·8.
Viviante, 415.	2·66	Chalcolite, 430.	3·5—3·6.
Uranite, 430.	3—3·2.	Zwieselite, 399.	3·97.

††† Not gelatinizing with acids ; B.B. no phosphorus reaction.

Obs.—Lepidomelane, Stilpnomelane, Limonite, Göthite, Crocidolite, Anthosiderite, afford B.B. a magnetic globule.

Molybdine,	1	Yw, powder or crust ; BB on *charcoal* slag ; in *mur* sol ; $\dddot{\mathrm{Mo}}$; occurs with Molybdenite, 144.
Chlorophæite,	1·5—2	Massive, or foliated granular ; G 2·02 ; dark-gn, bkh ; BB fus ; Fe, Si, Mg, Aq, 278.
Sordawalite	2·5	Pitch-bk, gyh-bk, massive ; G 2·5—2·6 ; *streak* liver-bn ; BB fus dif ; in *mur* partly sol ; Al, Fe, Si, H, 177.
Lepidomelane,	3	VI ; in small micaceous black scales or aggregations of scales ; G 3 ; ad, vit ; *streak* mountain-gn ; op, strl ; not flex ; BB fus, bk, op, magnetic ; with *bor* bottle-gn glass ; Fe, Al, K, Si, 227.
Stilpnomelane,	3	Foliated, rad, mas ; G 3—3·4 ; vit, p'ly ; bk, gnh-bk ; *streak* gnh ; BB fus dif bk glob ; in *acids* sol imperf ; Fe, Si, Al, Aq, 287.

	Hardness.	
Limonite,	3—5·5	Massive, botryoid, stalact, incrust, earthy; G 3·6—4; silky, dull; bn, ochreous; *streak* ywh-bn; BB bkns, magnetic; fus dif!; with *bor* iron; Fe, O, Aq, 131.
Mosandrite,	4	In prisms; also fibrous, cleav; G 2·9—3; vit, greasy; dull rdh-bn; *streak* gyh-bn; BB fus! bnh-gn pearl; with *soda* manganese; Ti, Ce, Mn, Si, Aq, 342.
Crocidolite,	4	Asbestiform; G 3·2—3·3; silky; bh, gnh; fibres separate easily; subelast; CB fus! magnetic; Fe, Na, Si, Aq, 279.
Göthite,	5—5·5	III; acic, capil, fibrous, reniform, mas; G 4—4·4; bn; rdh; *streak* bnh-yw; BB bkns magn; fus dif!; with *bor* iron; Fe, Aq, 129.
Pyrochlore,	5—5·5	I; in octahedral crystals; G 3·8—4·35; vit, res; ywh, bnh, dark-bn; *streak* ywh, bnh; strl, op; BB fus dif! with *bor* rdh-yw trp, on flaming op, with more borax w enamel; Ce, Th, Ca, Ta, Ti, 345.
Glaucophane,	5·5	Prism, massive; G 3·108; vit, p'ly; b, lavender-b, bh-bk, gyh; *streak* gyh-b; trl, op; powder slightly magnetic; BB fus! gn glass; in *acids* partly sol; Al, Fe, Mg, Na, Si, 177.
Catapleiite,	6	Prisms, cleav basal!; G 2·8; nearly dull; light ywh-bn; *streak* isabella-yw; opaque; BB fus, w enamel; in *mur* sol easily; Na, Zr, Si, Aq, 308.
Wöhlerite,	5·5	Tabular cryst, pms, massive; G 3·4; light-yw, bnh, gyh; *streak* ywh-w; vit, res; trp—strl; BB ywh glass; in *mur* sol; Zr, Ca, Na, Si, 343.
Keilhauite,	6·5	Massive, cleav; G 3·69; vit, res; bnh-bk; bnh-r in splinters; *streak* gyh-bn; BB fus! intum, slag; in *mur* sol; Ca, Y, Si, Ti, 341.
Anthosiderite,	6·5	Tufts, fibrous in structure; G 3·6; ochre-yw, bnh; *streak* same; tough; BB rdh-bn, fus dif, black magnetic slag; in *mur* sol; Fe, Si, Aq, 304.
Schorlomite,	7—7·5	Massive, no *cleav;* black, sometimes pavonine tarnish; G 3·78—3·81; vitreous; *streak* gyh-bk, bh; BB fus dif!! black mass; in *mur* partly soluble; Ti, Ca, Fe, Si, 342.

a. Species foliated or fibrous in some of their varieties.

Stilpnomelane, 287.	H=3	Fol.	Limonite, 131.	H=3—3·5,	Subfib.
Lepidomelane, 227.	3	Fol.	Crocidolite, 279.	4	Fib!
Mosandrite, 342.	4	Subfol, fib.	Anthosiderite, 304.	6·5	Fib!

a. Spccies arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Molybdine, 144.	———?	Crocidolite, 279.	3·2—3·3.
Chlorophæite, 278.	2·02	Wöhlerite, 343.	3·4.
Sordawalite, 177.	2·5—2·6.	Anthosiderite, 304.	3·1.
Catapleiite, 308.	2·8.	Limonite, 131.	3·6—4.
Mosandrite, 342.	2·9—3.	Keilhauite, 341.	3·69.
Lepidomelane, 227.	3	Schorlomite, 342.	3·7—3·81
Stilpnomelane, 287.	3—3·4.	Pyrochlore, 345.	3·8—5·4.
Glaucophane, 177.	3·108.	Göthite, 129.	4—4·4.

c. B.B. NO FUMES, (EXCEPT SOMETIMES OF LEAD); GLOBULE MALLEABLE.

* Infusible.

	Hardness.	
Chrysocolla,	2—3	Massive, and in seams; G 2—2·3; bh-gn; trl, op; BB with *bor* gn globule, and a grain of copper; in *mur* decomposed, silica deposited; Cu, Si, Aq, often with some C̈, 309.
Cassiterite,	6—7	II; cryst, massive; adamantine; subvit, subres; bn, bk; *streak* gyh, bnh; BB with *soda* tin, 118.
Dioptase,	5	VI; Emerald gn cryst; G 3·2—3·4; vit; trp, strl; BB bk; with *bor* gn globule, and finally copper; in *mur* gelat; Cu, S⃛i, Aq, 309.

** B.B. fusible; a globule of Lead, Copper, or Silver, with the fluxes, if not without. No fumes of Arsenic, Sulphur, Selenium, or Antimony.

† Gravity below 4·5; ores of Copper.

Obs.—Aurichalcite, Chalcolite, Thrombolite, Malachite, Azurite, Libethenite, and Phosphochalcite, are *hydrous* species; Aurichalcite, Malachite, and Azurite, are *carbonates*.

Aurichalcite,	2	Acicular, drusy; granular, lamellar; p'ly; verdigris-gn; trl; BB darker, slag; with *soda* and *bor* copper and zinc; in *mur* sol, efferv; Żn, Ċu, C̈, Aq, 460. *Buratite* is similar.
Chalcolite,	2—2·5	II; micaceous; G 3·5—3·6; emerald-gn; apple-gn; *streak* gnh; BB fus bk, flame bh-gn; in *nit* ywh-gn sol; U, Cu, $\overset{:\cdot:}{\mathrm{P}}$, Ḣ, 430.
Volborthite,	3—3·5	VI; mas; earthy; G 3·4—3·9; p'ly, vit; gn, gy; *streak* ywh, bnh-yw, bn, gy; strl; BB fus! no intum, slag; with *bor* chrome-gn glass; Ċu, Ċa, and Vanadic Acid, 362.
Thrombolite,	3—4	Amorphous; G 3·38—3·4; vit; emerald, dark-gn; op; BB flame b, gn; on *charcoal* fus! copper; Ċu, $\overset{:\cdot:}{\mathrm{P}}$, Aq, 412.
Malachite,	3·5—4	IV; mas, earthy, tuberose, incrust, compact fib; G 3·7—4·1; silky, adamantine, dull; gn; *streak* paler; trl, op; BB on *charcoal* fus! copper, flame gn; *acids* efferv; Ċu, C̈, Aq, 458.
Azurite,	3·5—4·5	IV; mas, earthy; G 3·5—3·9; vit; adamantine; bright deep-b; *streak* paler; trp, strl; brittle; BB on *charcoal* fus, copper, flame gn.; in *acids* efferv; Ċu, C̈, Aq, 459.
Libethenite,	4	III; G 3·5—3·8; resinous; olive-gn, dark; *streak* same; strl; BB fus bnh globule! on *charcoal* copper; Ċu, $\overset{:\cdot:}{\mathrm{P}}$, Aq, 420.

	Hardness.	
Phosphochalcite,	4·5—5	IV; mas; G 3·8—4·4; ad, vit; emerald, dark-gn, verdigris; *streak* paler; trl, strl; BB fus! on *charcoal* copper; in *nit* sol; $\dot{\mathrm{C}}\mathrm{u}$, $\overset{⁙}{\mathrm{P}}$, Aq, 425.

a. Species foliated or fibrous in some of their varieties.

Aurichalcite, 460.	H=2	Lam, fib.	Malachite, 458.	3·5—4 Fib.
Chalcolite, 430.	H=2—2·5	Fol!		

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Aurichalcite, 460.	3·2—3·4.	Azurite, 459.	3·5—3·9.
Buratite,	3·3—3·4.	Libethenite, 420.	3·5—3·9.
Thrombolite 412.	3·3—3·4.	Malachite, 458.	3·7—4·1.
Volborthite, 362.	3·4—3·9.	Phosphochalcite, 425.	3·8—4·4.
Chalcolite, 430.	3·5—3·6.		

†† Gravity above 4·5; ores of Lead, Copper, or Silver; colors various.

Minium,		Massive, earthy; G 4·6; bright red; BB fus; on *charcoal* lead; Pb, O, 126.
Plumbic Ochre,	2—3	Mas, scaly cryst; G 8; yw, ywh; BB fus! Pb, O, 109.
Melaconite,	2—6	I; mas; earthy; G 5·1—5·4; bk; *streak* bk; BB on *charcoal* no fumes; glob copper; Cu, O, 109.
Linarite,	2·5—3	IV; *cleav!* G 5·2—5·5; vit, ad; azure-b; *streak* paler; trl; BB fus; $\dot{\mathrm{P}}\mathrm{b}$, $\dot{\mathrm{C}}\mathrm{u}$, $\dddot{\mathrm{S}}$, Aq, 390.
Vauquelinite,	2·5—3	IV; reniform, botryoidal, gran; G 5·5—5·8; adamantine, res; dark-gn; bkh-gn; *streak* siskin gn, bnh; trl, op; BB fus, on *charcoal* gray, submet; some points of lead; in *nit* partly sol; $\dot{\mathrm{P}}\mathrm{b}$, $\dot{\mathrm{C}}\mathrm{u}$, $\dddot{\mathrm{C}}\mathrm{r}$, 360.
Crocoisite,	2·5—3	IV; cryst; massive; G 5·9—6·1; adamantine, vit; *bright hyacinth-red; streak* orange; trl; BB fus, on *charcoal* with *soda* lead; in *mur* sol, gn; $\dot{\mathrm{P}}\mathrm{b}$, $\dddot{\mathrm{C}}\mathrm{r}$, 359.
Caledonite,	2·5—3	III; G 6·4; resinous; verdigris-gn, bh-gn; *streak* gnh-w; trl; BB on *charcoal* lead; Pb, Cu, $\dddot{\mathrm{S}}$, $\ddot{\mathrm{C}}$, 372.
Melanochroite,	3—35	III; mas; G 5·75; res, ad; *bright red;* lemon-yw on exposure; *streak* brick-r; strl, op; BB fus! on *charcoal* lead; $\dot{\mathrm{P}}\mathrm{b}$, $\dddot{\mathrm{C}}\mathrm{r}$, 361.
Vanadate of Lead,	3·5—4	Cryst, massive; 5·8—7·2; color ywh, rdh-bn, dull red, (Dechenite and Vanadinite); bn, bk, wh, (Descloizite); deep red, (Aræoxene); BB fus easily; with *soda* lead, 361—364.
Red Copper,	3·5—4	I; octahedral, massive; earthy; G 5·85—6·15; adamantine, earthy; red, often bnh; *streak* bnh-r; strp-op; BB on *charcoal* copper; Cu, O, 101. *Chalcotrichite* is similar but capillary and trimetric, 122.

a. No species in this subdivision fibrous or foliated.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Minium, 126.	4·6.	Red Copper, 101, 126.	5·85—6·15.
Melaconite, 109.	5·1—5·4.	Vanadate Lead, 361, 364.	5·8—7·2.
Linarite, 390.	5·2—5·5.	Crocoisite, 359.	5·9—6·1.
Vauquelinite, 360.	5·5—5·8.	Caledonite, 372.	6·4.
Melanochroite, 361.	5·75.	Plumbic Ochre, 109.	8.

c. B.B. WHOLLY AND EASILY VAPORIZABLE IN FUMES, LEAVING NO METALLIC GLOBULE, (UNLESS ANTIMONY OR BISMUTH).

	Hardness.	
Coccinite,		Earthy particles, rdh-bn ; BB violet; Hg, I, 96.
Sulphur,	1·5—2·5	III; crystals, massive; G 2—2·1; yw; trp, trl; BB sulph fumes, 22.
Selensulphur,	1·5—2·5	Massive; G 2·1—2·5; orange or bnh; on *char* sulph and selen fumes, 24.
Selenium,		Incrust; G 4·3—4·8; gyh, bnh; red in splinters; powder red; selen fumes, 23.
Ammiolite,		Red powder consisting of antimonous acid and quicksilver, 142.
Orpiment, Dimorphine,	1·5—2	III; cleav !, submicaceous, laminæ flexible, inelastic; G 3·4—3·5; p'ly; lemon-yw; *streak* ywh; strp, strl; BB fus, burns b flame, fumes alliaceous; As, S, 32. Dimorphine no *cleav*, 32.
Realgar,	1·5—2	IV; cleav; massive; G 3·4—3·6; res; bright-rd; *streak* ywh—rdh; trp—trl; sectile; BB fus! burns b flame, fumes alliaceous; As, S, 31.
Kermesite,	1—1·4	IV; capillary cryst in tufts; 4·4—4·6; adamantine; cherry-rd; *streak* bnh-r; trl, strl; sectile; BB on *charcoal* fus, vol, sulph fumes; Sb, O, S, 141.
Cinnabar,	2—2·5	VI; mas; earthy; G 8·5—9; adamantine, in crystals, submet; also dull earthy; cochineal-r, bnh-r; *streak* scarlet; strp, op; BB volat, sulph; in a matrass with soda, quicksilver; Hg, S, 49.
Bismutite,	4—4·5	Acic, incrust; vit; earthy; w, gnh, ywh; *streak* gnh-gy; strl—op; BB decrep, fus! on *charcoal* met, fumes; Bi, $\ddot{C}$, Aq, 462.
Cervantite,	5·5	Mas; G 5·28; greasy; ywh; *streak* ywh, shining; trp; BB on *charcoal* fumes inod; Sb, O, H, 141.

α. Species foliated or fibrous in some of their varieties.

Orpiment, 32.	Fol!

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Coccinite, 96.	——— ?	Selenium, 23.	4·3—4·8.
Ammiolite, 142.	——— ?	Kermesite, 141.	4·4—4·6.
Sulphur, 22.	2—2·1.	Cervantite, 141.	5·28.
Selensulphur, 24.	2·1—2·5.	Bismutite, 462.	6·8—7·7.
Orpiment, 32.	3·4—3·5.	Cinnabar, 49.	8—9·1.
Realgar, 31.	3·4—3·6.		

d. B.B. FUMES OF ARSENIC, SULPHUR, ANTIMONY, OR CHLORINE; A GLOBULE WHICH IS NOT MALLEABLE.

* B.B. fumes arsenical. Species all contain water.

	Hardness.	
Annabergite,	2	IV; capil; mas; fine apple-gn; *streak* gnh-w; BB on *charcoal* arsenic; Ṅi, Äs, Aq, 418.
Pitticite, Diadochite,	2—3	Reniform, mas; G 2·0—2·5; vit, greasy; ywh, rdh-bn, r, w; *streak* yw; trl, op; BB on *charcoal* arsenic; F̶e, Äs, S̈, Aq, 432, 433.
Arseniosiderite,	1—2	Fib; diverg; G 3·5—3·9; yw, golden; *streak* ochreous; fibres separable!; BB fus bk; with *soda* arsen; in hot *nit* or *mur*, sol; F̶e, Ċa, Äs, Aq, 422.
Erythrine,	1·5—2·5	IV; cleav!! laminæ flexible; earthy; G 2·948; p'ly, earthy; peach-r, crimson; gyh; *streak* paler lavender-blue; trp, strl; BB on *charcoal* arsenic; in *acids* sol; Ċo, Äs, Aq, 416.
Symplesite,	2·5	IV; cleav!; G 2·957; p'ly, vit; indigo, gn; *streak* bh-w; strp—trl; BB on *charcoal* arsen; bk, without melting, magnetic; F̶e or Ḟe, Äs, Aq, 418.
Pharmacosiderite, Beudantite,	2·5	I; cubes, etc; G 2·9—3; adamantine; olive-gn, ywh, bnh, rdh, gn; *streak* gn, bn, yw; strl; BB on *charcoal* arsen, magnetic; Ḟe, Äs, Aq, 422.
Köttigite,	2·5—3	IV; *cleav!*; crusts; G 3·1; silky; light rd; *streak* rdh-w; trl, sbtrl; BB on *charcoal* fus, arsen; in *acids* sol!; Żn, Ċo, Äs, Aq, 418.

a. Species foliated or fibrous in some of their varieties.

Arseniosiderite, 422.	Fib.	Erythrine, 416.	Fol.

** Fumes of Chlorine, Sulphur or Antimony.

Greenockite.	3—3·5	VI; hexag cryst; G 4·5—5; adamantine; honey-yw, orange; *streak* yw rdh; strp, trl; BB on *charcoal* ywh ring; in *mur* sol; Cd, S, 51.
Hauerite,	4	I; G 3·463; met-adamantine; rdh-bh, bnk-bk; *streak* bnh-r; BB on *charcoal* sulphur; Mn, S, 56.
Pyrosmalite,	4—4·5	VI; hexag; *cleav* basal; mas; G 3—3·1; p'ly, vit; pale liver-bn, gy, gnh; gnh-yw within; BB on *charcoal* fumes of chlorine, fus slag, magnetic; in *nit* perfectly sol; F̶e, M̶n, Cl, S̈i, Aq, 310.
Voltzite,	4·5	Implanted glob; G 3·66; vit, p'ly; rdh, ywh, bnh; op, strl; BB on *charcoal* zinc fumes; in *mur* sulph hyd; Zn, S, O, 127.
Romeine,	5—6	II; octahed; hyacinth or honey-yw; BB fus bkh slag; in *acids* insol; Ca, Sb, O, 410.

a. None of the species of this subdivision are foliated or fibrous.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Romeine, 410.	———?	Voltzite, 127.	3·66.
Pyrosmalite, 310.	3—3·1.	Greenockite, 51.	4·8—5.
Hauerite, 56..	3·463.		

e. B.B. FUMES OF SULPHUR, ARSENIC, ANTIMONY, CHLORINE, BROMINE OR IODINE; A MALLEABLE GLOBULE OF SILVER OR COPPER.

* Arsenical, Sulphur, or Antimony fumes.

	Hardness.	
Tyrolite,	1·5—2	III; reniform, mas; drusy; p'ly, vit; G 3—3·1; pale apple-gn, bh; *streak* paler; trl, strl; laminæ flexible; BB on *charcoal* fus, arsen; Ċu, Äs, Aq, 426.
Covelline,	1·5—2	VI; incrust; mas; G 3·7—3·9; res, faint; indigo-b; *streak* lead gray, shining; BB on *charcoal* fus, sulphur, copper; Cu, S, 65.
Lettsomite,		Drusy, velvety crusts; clear smalt blue; p'ly; BB on *charcoal* copper; Ċu, Äl, S̈, Aq, 392.
Chalcophyllite,	2	VI; *cleav* basal!!, foliated!; G 2·4—2·7; p'ly, vit; emerald, grass gn; *streak* paler; BB decrep, on *charcoal* arsen, fus; with *soda* copper; in *acids* sol; Ċu, Äs, Aq, 428.
Xanthocone,	2	VI; reniform, massive, cryst structure within; G 5—5·2; dull-rd, clove-bn; *streak* yw; sbtrl, edges orange; BB on *charcoal* sulph, arsen, silver; Ag, S, As, 87.
Fireblende,	2	IV; G 4·2—4·3; p'ly adamantine; hyacinth-r; trl; sectile and somewhat flexible; Ag, S, Sb, 88.
Liroconite,	2—2·5	III; rarely gran; G 2·8—3; vit, res; sky-b, verdigris; *streak* same; BB on *charcoal* arsen, bk scoria; with *bor* gn, partially reduced; in *nit* sol; Ċu, Äl, Äs, Aq, 429.
Miargyrite,	2—2·5	IV; *cleav* imperf; G 5·2—5·4; submet-adamantine; iron-bk; *streak* dark cherry-red; thin splinters red; sectile; BB on *charcoal* antim, sulph, silver; Ag, S, Sb, 74.
Proustite,	2—25	VI; crystals and massive; 5·4—5·5; adamantine; cochineal-r; *streak* bright red; strp, trl; BB on *charcoal* sulphur, arsen, silver; Ag, As, S, 78.
Pyrargyrite,	2—2·5	VI; crystals and massive; G 5·7—5·9; met-adamantine; bk, rdh; *streak* cochineal-r; trl, op; sectile; BB on *charcoal* sulphur, antim, silver; Ag, S, Sb, 77.
Aphanesite,	2·5—3	IV; massive, rad hemispher; G 4·19—4·36; p'ly; dark verdigris; *streak* same; strl; BB on *charcoal* fus, deflag, arsen; Ċu, Äs, Aq, 428.
Olivenite,	3	III; glob, reniform, fibrous; massive; G 3·9—4·4; ad, vit, p'ly; olive-gn, leek-gn; wood-bn; *streak* gn, bn; strp, op; BB on *charcoal* fus, deflag!, arsen; in *nit* sol; Ċu, Äs, Aq, 420.

	Hardness.	
Carminite,	2·5	In clusters of fine needles; carmine to tile-red; BB on *charcoal* arsenic; with soda lead; $\dot{\mathrm{Pb}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$, $\dot{\mathrm{Fe}}$? 410.
Brochantite,	3·5—4	III; G 3·8—3·9; vit; emerald, bkh-gn; *streak* paler; trp; BB on *charcoal* fus, copper; $\dot{\mathrm{Cu}}$, $\dddot{\mathrm{S}}$, Aq, 391.
Euchroite,	3·5—4	III; G 3·389; vit; bright emerald, leek-gn; *streak* paler; trp, trl; BB on *charcoal* fus, deflag, copper, arsen; $\dot{\mathrm{Cu}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$, Aq, 421.
Erinite,	4·5—5	Mammillary, massive; G 4·043; dull, res; fine emerald-green, *streak* paler; strl, op; BB arsen, copper; $\dot{\mathrm{Cu}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$, Aq, 425.
Conichalcite,	4·5	Massive, reniform; G 4·123; pistachio-gn; *streak* same, $\dot{\mathrm{Cu}}$, $\dot{\mathrm{Ca}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, $\dot{\mathrm{H}}$, 421.

a. Species foliated or fibrous in some of their varieties.

Chalcophyllite, 428.	H=2	Fol!	Aphanesite, 428.	H=2·5—3	Fib.
Lettsomite, 392.		Drusy fib.	Olivenite, 420.	3	Fib.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Lettsomite, 392.	———?	Erinite, 425.	4·043.
Chalcophyllite, 428.	2·4—2·7.	Conichalcite, 421.	4·123.
Liroconite, 429.	2·8—3.	Aphanesite, 428.	4·19—4·36.
Tyrolite, 426.	3—3·1.	Fireblende, 88.	4·2—43.
Euchroite, 421.	3·389.	Xanthocone, 87.	5—5·2.
Brochantite, 391.	3·7—3·9.	Miargyrite, 75.	5·234.
Covelline, 65.	3·8—3·9.	Proustite, 78.	5·4—5·6.
Olivenite, 420.	3·9—4·4.	Pyrargyrite, 77.	5·7—5·8.
Carminite, 410.			

** Fumes of Chlorine, Bromine, Iodine, or Muriatic Acid.

Iodyrite,		VI; thin plates, lam; G 5·504; resinous; pale citron-yw, ywh-gn; trl; *streak* submet; plates flexible; BB fus!!, on *charcoal* fumes of iodine, violet flame, silver; Ag, I, 95.
Kerargyrite,	1—1·5	I; like wax; G 5—5·6; pearl-gy, gnh; bn on exposure; *streak* shining; sectile; BB fumes of muriatic acid; on *charcoal* silver; Ag, Cl, 92.
Bromyrite,	1—2	I; concretions; G 5·8—6; splendent; often gn without, yw within; BB fus; fumes of bromine; silver glob; Ag, Br, 93.
Percylite,	?	I; in cubes; sky-blue; BB emerald-gn easily! b on cooling; flame gn, fus!, on *charcoal* fumes; Pb, Cu, Cl, O, see *Appendix.*
Embolite,	2	I; oct; mas; G 5·3—5·8; yw, gn; adamantine; fracture hackly; BB fus! fumes of bromine and chlorine; silver glob; Ag, Br, Cl, 93.
Connellite,		VI; vit; fine blue; trl; BB on *charcoal* fumes; glob copper; Cu, S, Cl, 375.

	Hardness.	
Atacamite,	3—3·5	III; mas; G 3·7—4·3; adamantine, vit; olive-gn, bright gn; *streak* paler; trl, strl; BB gn or b flame, fumes of muriatic acid; on *charcoal* copper; Cu, Cl, O, Aq, 138.

a. None of the species in this subdivision are properly foliated or fibrous.

II. LUSTRE METALLIC OR SUBMETALLIC.

A. STREAK UNMETALLIC.

a. B.B. NO FUMES.

* B.B. Infusible, or nearly so. Colors steel-gray to black.

† With muriatic acid, fumes of chlorine: contain manganese.

Obs.—Wad, Psilomelane and Manganite, are the only *hydrous* species included.

	Hardness.	
Wad,	0·5—3·5	Mas; earthy; incrust; G 3—3·7; submet, dull; bk, bh or bnh; BB infus or subfus; Mn, O, H; sometimes Mn, Cu, O, H, or Mn, Co, Ni, O, H, 136.
Pyrolusite, Polianite,	2—2·5	III; also divergent columnar; mas; G 4·8—5; submet; bk, gyh; *streak* bk; brittle; BB infus; Mn, O, 122, 5 131.
Manganite,	4	III; prismatic, columnar, radiated; gran; G 4·2—4·4; submet; steel-gy, bk; *streak* rdh-bn, nearly bk; BB infus; Mn, O, H, 130.
Hausmannite,	5—5·5	II; G 4·722; submet; bnh-bk; *streak* bn; BB infus; Mn, O, 118.
Psilomelane,	6—6	Mas, bot; G 4—4·4; submet; iron-bk, gy; *streak* bnh-bk, shining; BB infus; Mn, O, H, 135.
Braunite,	6—6·5	II; massive and in crystals; G 4·7—4·9; submet; bnh bk; *streak* dark bnh-bk; brittle; BB infus; Mn, O, 117. *Heteroclin* (p. 127) and *Crednerite* (p. 126) are other manganese ores, with black streak. H=4·5—5.

†† No fumes of chlorine with muriatic acid.

Pitchblende, Coracite,	5·5	I; massive; in grains; submet or dull; G 6·4—8; velvet-bk, bnh; *streak* bk; BB flame usually gn; with *bor* fus yw glass, gnh in inner flame; in *nit* in powder slowly soluble; U, O, 107. Coracite contains water, 107.
Limonite,	4—5·5	Massive, stalact, botryoid; G 3·6—4; submet; bk, bn; *streak* bn; BB bkns, magnetic; Fe, O, Aq, 131.

	Hardness.	
Chromic Iron,	5·5	I; oct, massive; G 4·3—4·5; iron bk, gyh-bk; *streak* bn; brittle; sometimes magnetic; BB infus; with *bor* fus dif, beautiful gn glob; Fe, Cr, O, 106.
Yttrotantalite,	5·5	G 5·395; submet; iron-bk; *streak* gy; Y, Ca, Fe, Ta, W, 359.
Columbite, Mengite,	5—6	III; mas, uncleav; G 5·4—8·0; bk; submet; often a steel tarnish; *streak* bk, to bnh-red; brittle; BB infus, with *bor* fus slow, bkh-gn glass; Fe, Mn, Cb, 353. *Mengite* contains Zr, Fe, Ti, 356.
Tantalite,	5—6	III; cryst, mas; G 7·1—8; bk; *streak* rdh-bn; brittle; BB like Columbite; Fe, Mn, Ta, 351.
Fergusonite,	5·5—6	II; hemihed; *cleav* traces; G 5·8—6; submet, vit; bnh-bk, bnh; *streak* bnh; strl, op; BB infus; with *bor* fus dif; Y, C, Ta, 350.
Specular Iron, Ilmenite, Martite, Iserine,	5·5—6·5	VI; cryst, massive; and Specular Iron is sometimes micaceous, &c.; Martite and Iserine, I, oct.; G 4·5—5·3; steel-gy, often splendent; BB infus; *bor* gn or yw glass; in hot *mur* sol; *streak* of Spec. Iron red; of Ilmenite black or nearly so, or submet; 113, 115: Martite is the same as Specular Iron, except it is *octahedral*, 102. Iserine is similar to Martite, 102.
Franklinite,	5·5—6·5	I; oct, massive, gran; G 5—5·1; bk; *streak* dk rdh-bn; slightly magn; BB infus; on *charcoal* oxyd zinc at high heat; with *bor* manganese reaction; Fe, Mn, Zn, O, 106.
Euxenite, Polymignyte, Æschynite,	6·5	III; massive without cleav; G 4·6—4·9; submet, vit; bnh-bk, rdh-bn! *streak* rdh-bn; BB infus; with *bor* fus; Y, U, Ce, Ti, 358, 356. *Polycrase* similar; G 5·1; in *sul* sol, 357. *Æschynite* BB intum on thin edges, but infus, 357.
Irite,		Octahedral; G 6·506; contains Iridium and Osmium, with Iron and Chromium, 103.

a. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Wad, 136.	3—3·7	Polymignyte, 356.	4·77—4·85.
Limonite, 131.	3·6—4.	Polianite, 131.	4·8—4·9.
Psilomelane, 135.	4—4·4.	Æschynite, 357.	4·9—5·14.
Manganite, 130.	4·2—4·4.	Franklinite, 106.	5—5·1.
Chromic Iron, 106.	4·3—4·5.	Polycrase, 357.	5·1.
Hausmannite, 118.	4—722.	Yttrotantalite, 359.	5·395.
Ilmenite, 115.	4·5—5.	Columbite, 353.	5·4—6·4.
Pyrolusite, 122.	4·8—5.	Mengite, 356.	5·48.
Specular Iron, 113.	4·5—5·3.	Fergusonite, 350.	5·8—6.
Martite, 102.	3·8—5·3.	Tantalite, 351.	7—8.
Euxenite, 358.	4·6—4·9.	Pitchblende, 107.	6·4—8.
Iserine, 102.	4·8—5·1.	Irite, 103.	6·507.

** Fusible. Colors steel-gray to black.

Obs.—Tenorite and Melaconite afford a globule of copper; Magnetite fuses with difficulty; Crednerite contains manganese. No species fibrous.

	Hardness.	
Tenorite,		VI; scales; dark steel-gy; *streak* bk; BB on *charcoal* no fumes, copper globule; Cu, O, 117.
Melaconite,	3—6	I; mas; G 5·1—5·4; earthy; bk; *streak* bk; BB on *charcoal* no fumes, copper glob; Cu, O, 109.
Crednerite,	4·5	IV; cleav; G 4·9—5; met; iron-bk, gy; *streak* bk, bnh; BB fus dif! Mn, Cu, O, 126.
Wolfram,	5—5·5	III; cryst; mas; uncleav; G 7·1—7·6; submet; gyh-bk, bnh-bk; *streak* dark rdh-bn; BB fus dif, magnetic globule; with *bor* gn bead; Fe, Mn, W, 351.
Samarskite,	5·5	III; in grains; G 4—5·7; bk; *streak* dark rdh-bn; BB burns like Gadolinite, fus dif! to a steel-gy mass; with *bor* fus! Fe, U, Y, Cb, 355.
Lievrite,	5·5—6	III; rbc prism; massive; G 3·8—4·2; submet; bk, bnh; brittle; BB fus bk glob; in *mur* sol, gelat; Fe, Ca, Si, 262.
Magnetite,	5·5—6·5	I; octahedrons, &c.; massive, gran; G 4·9—5·2; bk; *streak* bk; magnetic; BB fus dif! loses magnetism; in hot *mur* sol; Fe, O, 105.

b. B.B. GIVING OFF FUMES.

* B.B. fumes of Arsenic, and sometimes also of Sulphur; globule brittle. Color whitish, with sometimes a reddish or yellowish tinge, excepting Tennantite, which is black. No species fibrous.

Obs.—*Tennantite*, *Leucopyrite*, and *Mispickel* alone afford B.B. a magnetic globule; of the other species, *Kaneite* gives a manganese reaction, and the rest a reaction of Cobalt or Nickel.

Tennantite,	3·5—4	I; G 4·3—4·5; bkh lead-gy, iron-bk; *streak* dark rdh-gy; BB burns b flame, arsen, bk scoria magnetic; Cu, Fe, S, As, 84.
Leucopyrite,	5—5·5	III; cryst, mas; G 7·0—7·4; tin-w, gyh; *streak* gyh-bk; BB on *charcoal* fumes of arsenic, mag glob; Fe, As, 61.
Copper Nickel,	5—5·5	VI; massive; G 7·3—7·7; copper-r, gyh or bkh tarnish; *streak* pale bnh-bk; brittle; BB on *charcoal* arsen; fus w glob; in *nit* gn coating; Ni, As, 52.
Kaneite,	above 5?	Massive, botryoidal; fol or gran; gyh-w, bkh tarnish; BB b flame, on *charcoal* arsen; *nit-mur* sol wholly; Mn, As, 53.
Gersdorffite,	5·5	I; cleav cubic; massive; G 5·6—6·9; silver-w, gyh; tarnish gy, gyh-bk; *streak* gyh-bk; BB on *charcoal* arsen; Ni, As, S, Fe, 58.

	Hardness.	
Smaltine, Chloanthite,	5·5	I; in crystals; massive; G 6·46—7·2; tin-w, gyh; *streak* gyh-bk; brittle; BB on *charcoal* arsen, w glob; Co, Ni, As, Fe, 56. *Rammelsbergite* is similar, but trimetric, 61.
Cobaltine,	5·5	I; hemihed; massive; G 6—6·3; silver-w, rdh; *streak* gyh-bk; brittle; BB on *charcoal* arsen, bk mag glob; Co, As, S, Fe, 57.
Mispickel, Glaucodot,	5—6	III; crystals; usually massive; G 6·0—6·4; silver w, gyh; *streak* dark gyh-bk; BB on *charcoal* arsen fumes; mag glob; Fe, As, Co, S, 62, 63.
Skutterudite,	6	I; *cleav* cubic; G 6·7—6·9; gyh tin-w; BB on *charcoal* arsen; Co, As, 67.

Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Tennantite, 84.	4·3—4·5.	Skutterudite, 67.	6·7—6·9.
Gersdorffite, 58.	5·6—6·9.	Smaltine, 56.	6·4—7·2.
Glaucodot, 63.	5·9—6·1.	Chloanthite, 56.	6·4—7·2.
Cobaltine, 57.	6—6·3.	Leucopyrite, 61.	7·0—7·4.
Mispickel, 62.	6·0—6·4.	Copper Nickel.	7·3—7·7.
Ullmannite, 59.	6·2—6·5.	Kaneite, 53.	

** Fumes sulphurous or antimonial, not arsenical; globlule brittle. Colors rather pale, (excepting Manganblende, which is black).

Obs.—Berthierite, *Pyrrhotine*, *Pyrites*, and *Marcasite* afford B.B. a magnetic globule; *Manganblende*, a manganese reaction; the others reactions of Cobalt or Nickel. *Breithauptite* contains Antimony. *Erubescite*, *Cuban*, and *Chalcopyrite*, also afford BB a magnetic globule, but with borax or soda they yield a globule of copper, and they are consequently not included in this subdivision.

Syepoorite,		Massive; G 5·45; steel-gy, ywh; Co, S, 41.
Berthierite,	2—3	Long prisms or massive plumose; G 4—4·3; dark steel-gy; pinchbeck-bn; BB fus! antim fumes, bk magnetic slag; Fe, S, Sb, 73.
Millerite,	3—3·5	VI; capillary; G 4·61—5·65; brass-yw, tarnish gy, irid; brittle; *streak* bright; BB fus, brittle glob; warm *nit* gyh or pale-gn sol; open tube sulph; Ni, S, 49.
Manganblende,	3·5—4	I; *cleav* cubic; mas; G 3·9—4·1; submet; iron-bk, bn on exposure; *streak* gn.; BB on *charcoal* fus dif!; in *mur* sul-hyd; Mn, S, 41.
Pyrrhotine,	3·5—4·5	VI; hexag, mas.; G 4·4—4·7; bronze yw, rdh; *streak* dark gyh-bk; magnetic; BB nearly like Pyrites; Fe, S, 450.
Grünauite,	4·5	I; *cleav* octahed; G 5·13; pale steel-gy, silver-w; tarnish ywh, gyh; brittle; *streak* dark-gy; BB on *charcoal* sulph, coal ywh; Ni, Bi, Fe, S, 44.
Ullmannite,	5—5·5	I; *cleav* cubic; mass; G 6·4—6·55; wh steel-gy; brittle; BB on *charcoal* fumes antim, sulph; Ni, Sb, S, 59.
Linnæite,	5·5	I; *cleav* cubic; G 4·8—5·0; pale steel-gy, copper-r tarnish; *streak* bkh-gy; BB on *charcoal* sulphur; Co, S, 67.

	Hardness.	
Breithauptite,	5·5	VI, thin plates; arborescent; G 7·5—7·6; light copper rd, violet; *streak* rdh-bn; brittle; BB on *charcoal* antim; Ni, Sb, 53.
Pyrites,	6—6·5	I; cubes, &c.; also massive; pale brass-yw; *streak* dark bnh-bk; G 4·5—5·1; BB on *charcoal* fumes sulph; mag glob; *nit* sol; Fe, S, 54.
Marcasite,	6—6·5	III; in thin crystals, often crested; also massive; G 4·65—4·85; pale ywh-bronze, ywh, gyh; *streak* gyh-bk; BB like Pyrites; Fe, S, 60.

Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Manganblende, 41.	3·9—4·1.	Grünauite, 44.	5·13.
Berthierite, 73.	4—4·3.	Syepoorite, 41.	5·45.
Pyrrhotine, 50.	4·4—4·7.	Millerite, 49.	4·6—5·65.
Marcasite, 60.	4·6—4·9.	Ullmannite, 59.	6·4—6·6.
Pyrites, 54.	4·8—5·1.	Breithauptite, 53.	7·5—7·6.
Linnæite, 67.	4·8—5·0.		

*** B.B. with the fluxes, if not without, a malleable globule, or mineral wholly vaporizable.

† Globule of Lead, Silver or Gold. (*Aikinite* and *Cuproplumbite*, afford a globule of lead containing copper.)

Obs.—Sulphur fumes, Cuproplumbite; *Antimony or bismuth fumes, often with sulphur*, Heteromorphite, Miargyrite, Pyrargyrite, Kobellite, Aikinite, Tannenite; *Selenium fumes*, Clausthalite.

Heteromorphite,	1—3	Capillary, plumose; massive, gran; G 5·6—5·9; dark lead-gy, steel-gy; BB fus!!, on *charcoal* antim, sulph; Pb, S, Sb, 76. For other *antimonial ores of lead*, see p. 72, etc.
Miargyrite,	2—2·5	IV; *cleav* imperf; G 5·234; submet ad; iron-bk; *streak* dark cherry-red; op, thin splinters red; sectile; BB on *charcoal* antim, sulph, silver; Ag, S, Sb, 74.
Pyrargyrite,	2—2·5	VI; massive; G 5·7—5·9; met-adamantine; bk, rdh; *streak* cochineal-red; trl, op; sectile; BB on *charcoal* sulph, antim, silver; Ag, S, Sb, 77.
Kobellite,	soft	Like Stibnite; radiated columnar; G 6·29—6·32; bkh lead-gy to steel-gy; *streak* bk; BB fus, charcoal yellow, w glob; Pb, S, Bi, Sb, little Fe, 82.
Aikinite,	2—2·5	III; acicular cryst; mas; G 6·1—6·8; bkh-lead-gy, pale rdh tarnish; BB on *charcoal* fumes sulph; Bi, Pb, Cu, S, 81.
Tannenite,		Thin prisms; bright metallic; gyh to tin white; BB sulphur, on *charcoal* with *soda* copper, fumes of bismuth; Cu, Bi, S, 73.
Cuproplumbite,	2·5	I; *cleav* cubic!; mas; G 6·4—6·45; bkh-lead-gy; *streak* bk; BB on *charcoal* lead, sulph; Pb, Cu, S, 41.

	Hardness.	
Dufrénoysite,		I; dodec; G 5·55; steel-gy; *streak* rdh-bn; brittle; BB on *charcoal* arsen, sulph, lead; in *acids* sol; Pb, S, As, 77.
Clausthalite,	2·5	I; granular mas; G 7—8·8; lead-gy, bh; *streak* dark gy; BB on *charcoal* selen, lead; Pb, S, with sometimes Co, Ag, Cu, 42.

†† Globule of copper or tin with soda.

Obs.—Sulphur fumes alone, Erubescite, Chalcopyrite, and Tin Pyrites; *Antimony* or *bismuth fumes*, Wölchite, Wolfsbergite, Wittichite; *Arsenical fumes* Domeykite, Tennantite, Enargite.

Erubescite,	3	I; cryst mas; G 5—5·1; pinchbeck bn, tarnishes reddish and bluish; lustre bright; *streak* pale gyh-bk; brittle; BB on *charcoal* sulph; *nit* partly sol; Cu, S, 38. *Barnhardtite:* see *Appendix.*
Wölchite,	3	III? cryst, and mas; G 5·7—5·8; bkh-lead-gy; brittle; BB on *charcoal* antim, sulph; Pb, Cu, S, Sb, 82.
Domeykite,	3—3·5	Massive, reniform; G 4·5; tin-w, ywh tarnish; BB fus arsen; in *mur* partly sol; Cu, As, 36.
Wolfsbergite,	3—4	III; G 4·748; lead-gy, iron-gy; *streak* bk; BB decrep, fus!, on *charcoal* antim, copper; Cu, S, Sb, 73.
Wittichite,	3·5	III; acic, columnar; G 5; steel-gy, tin-w, tarnish lead-gy; *streak* bk; BB fus! sulph fumes; Bi, Cu, S, 88.
Enargite,	3	III; massive, gran or fib; G 4·3—4·5; iron-bk; *streak* same; BB on *charcoal,* arsen, sulphur, with *bor* copper; Cu, As, S, 87.
Tennantite,	3·5—4	Tetrahed; G 4·37—4·5; bkh-lead-gy, iron bk; *streak* dark rdh-gy; BB decrep, burns with b flame, arsen fumes, magnetic globule; Cu, Fe, S, As, 84.
Chalcopyrite, Cuban,	3·5—4	II; tetrahed; mas; G 4·1—4·3; steel-gy, brass-yw; *streak* gnh-bk; BB on *charcoal* sulph; fus mag glob; in *nit* partly sol; Cu, Fe, S, 68. Cuban is cubic, 68.
Tin Pyrites,	5	II; massive; G 4·3—4·52; steel-gy, bkh, ywh; *streak* bk; BB on *charcoal* sulph, scor glob bk; *nit-mur* sol, 70.

Species arranged according to their specific gravities.

	Sp. Gravity.		Sp. Gravity.
Cuban, 68.	4·0—4·2.	Miargyrite, 74.	5·234.
Chalcopyrite, 68.	4·1—4·3.	Dufrénoysite, 77.	5·55.
Tin Pyrites, 70.	4·3—4·52.	Heteromorphite, 76.	5·6—5·9.
Tennanite, 84.	4·3—4·5.	Pyrargyrite, 77.	5·7—5·9.
Enargite, 87.	4·3—4·5.	Wölchite, 82.	5·7—5·9.
Domeykite, 36.	4·5.	Aikinite, 81.	6 1—6·8.
Wolfsbergite, 73.	4·75.	Cuproplumbite, 41.	6·4—6·5.
Wittichite, 88.	5.	Kobellite, 82.	6·29 —6·32.
Erubescite, 38.	5—5·1.	Clausthalite, 42.	7—8·8.

B. STREAK METALLIC.

a. NOT MALLEABLE.

* B.B. no fumes with fluxes, or without; infusible.

	Hardness.	
Graphite,	1·0—2·0	VI; foliated!, mas, gran; G 2—2·1; steel gy, bkh; sectile; soils; *nit* no action; BB infus, 29.

** B.B. fumes; globule not malleable.

Molybdenite,	1—1·5	VI; fol!, G 4·44—4·8; lead-gy; laminæ flexible; inelast; sectile; a trace on paper; BB on *charcoal* sulph; in *nit* sol; Mo, S, 66.
Irite,		Grains or scales; G 6·506; black; magnetic; BB with nitre reaction of osmium; Ir, Os, Cr, Fe, 103.
Iridosmine,		VI; also I; scales; G 19—22; tin-w; light-steel gy; BB infusible, with nitre odor of osmium, 19.
Berthierite,	2—3	Prism, mas, cleav; plumose; gran; G 4—4·3; dark steel-gy, tarnishes; BB fus! fumes antim sulph; *mur* sol; Sb, Fe, S, 73.
Millerite,	3·5	VI; Acicular crystals; 4·6—5·7; nearly brass-yellow, tarnish gyh; brittle; BB fus, magnetic glob; Ni, S, 49.

*** B.B. fumes; a malleable globule, or wholly vaporizable.

† Easily and wholly vaporizable, (ores of lead not included).

Stibnite,	2	III; in prisms; cleav; also fib, massive; G 4·5—4·65; lead-gy; *streak* lead-gy; tarnish dark; sectile; BB fus!; on *charcoal*, fumes, sulph; in *mur* sol; Sb, S, 33.
Tellurium,	2—2·5	VI; cleav hexag; gran; G 6·1—6·3; tin-w; *streak* tin-w; brittle; on *charcoal* fus! gnh-flame; w vapors, 20.
Tetradymite,	2	VI; *cleav* basal!! mas, fol, gran; G 7·2—8·5; pale steel-gy; laminæ elastic; soils paper; G fus!! flame b on *charcoal* wh or ywh, fumes; Bi, Te, with often S or Se, 21.
Bismuthine,	2—2·5	III; acicular cryst; cleav; also mas, fol, fib; G 6·4—6·6; lead-gy—tin-w, ywh or iridescent tarnish; sectile; BB fus!, on *charcoal* vol, yw areola; sulph fumes; in hot *nit* sol; Bi, S, 33.
Bismuth,	2—2·5	VI; R, cleav! mas; G 9·7—9·8; rdh-silver-w, tarnishes; sectile; brittle; BB fus; on *charcoal* yellow areola, 20.
Antimony,	3—3·5	VI; cleav!; massive, lamellar; G 6·6—6·72; tin-w rather brittle; BB fus! w fumes, inod, 21.

	Hardness.	
Native Arsenic,	3·5	VI; massive, reniform gran; G 5·8—6; tin-w, gy; *streak* the same; BB volat; w fumes, alliaceous; As, 22.
Arsen. Antimony, Allemontite,	3·5	VI; reniform massive; G 6·1—6·21; tin-w, rdh, gyh; tarnished bnh-bk; BB fus, fumes arsen, antim; Sb, As, 22.

Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity
Stibnite, 33.	4·5—4·65.	Bismuthine, 33.	6·4—6·6.
Arsenic, 22.	5·8—6.	Antimony, 21.	6·6—7·2.
Allemontite, 22.	6·1—6·21.	Tetradymite, 21.	7·2—8·5.
Tellurium, 20.	6·1—6·3.	Bismuth, 20.	9·7—9·8.

†† B.B. a malleable globule; fumes odorous.

‡ A globule of lead or silver, without copper or a copper reaction.

Nagyagite,	1—1·5	II, foliated! laminæ flexible; also granular; G 6·85—7·2; bkh lead gy; BB on *charcoal* tellurium, flame b, sometimes sulphur fumes; Pb, Au, Te, S, 65.
Bismuth Silver,		Acic; massive; tin-w, gyh, tarnishes; sectile; BB fus! on *charcoal* lead, bismuth, silver; sectile; Ag, Bi, Pb, S, 16.
Sylvanite,	1·5—2	III, massive; often like writing characters; G 5·7—8·3; steel-gy, silver-w, or ywh; *streak* same; very sectile; BB fus; flame gnh-b, malleable globule; *nit* sol; Au, Ag, Te, 64.
Silver Glance,	2—2·5	I; no cleav; G 7·19—7·37; streak and color bkh lead gy; *streak* shining; bkh tarnish; *sectile!!*; Ag, S, 37.
Stephanite,	2—2·5	III; massive; G 6·269; iron-bk; *streak* same; sectile; BB on *charcoal* antim, sulph; with *soda* silver; Ag, S, Sb; some As, 86.
Freislebenite,	2—2·5	IV; *cleav;* G 6—6·4; steel-gray; wh; dark gyh; *streak* same as color; BB on *charcoal* antim, sulph, lead, silver; Ag, Pb, S, Sb, 79.
Sternbergite,		III; *cleav basal !!!*; foliated; pinchbeck-bn; G 4·215; *streak* bk; thin lam flexible like tinfoil; traces on paper; BB on *charcoal* sulphur, b flame, silver, Ag, Fe, S, 71.
Plagionite,	2—5	IV; tabular crystals; massive; G 5·4; bkh-lead-gy; *streak* same; brittle; BB fus!!; sulphur, antim, lead; Pb, S, Sb, 75.
Naumannite,	2·5	I; *cleav* cubic; massive; iron-bk, splendent; G 8·0; *streak* iron-bk; BB on *charcoal* fus!, selen; with *soda* silver; Ag, Se, 43. *Riolite: see Appendix.*
Geocronite,	2—3	III; cryst; massive; G 6·4—6·6; light lead-gy, bh; *streak* same; Pb, S, Sb, As, 85.

Boulangerite, Jamesonite, Heteromorphite,	2·5—3	Plumose, columnar; gran; G 5·7—6 , bh-lead-gy; BB on *charcoal* sulph, antim; Pb, S, Sb, 81. *Jamesonite* has a basal cleavage! p. 75.
Galena, Steinmannite,	2·6—3	I; cleav! cubic; massive granular; G 7·2—7·7; lead-gy; brittle; BB on *charcoal* sulph, lead; Pb, S, 39. Steinmannite gives antim fumes, 41.
Zinkenite,	3—3·5	III; hexag; G 5·3—5·4; steel-gy; *streak* same; BB decrep, fus!!; on *charcoal* antim, lead; Pb, S, Sb, 74.
Brongniardite,	above 3	Massive, no cleav; G 5·95; steel-gy; *streak* gyh-bk; BB on *charcoal* decrep, fus!, sulphur, w fumes, silver; Pb, Ag, S, Sb, 76.
Chiviatite,		Cleav massive; G 6·92; lead-gy; BB sulph, Bi, trace of copper; Pb, Bi, S, 77.

Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Sternbergite, 71.	4·215.	Geocronite, 85.	6·4—6·6.
Zinkenite, 74.	5·3—5·4.	Chiviatite, 77.	6·92.
Plagionite, 75.	5·4.	Steinmannite, 41.	6·833.
Jamesonite, 75.	5·5—5·8.	Nagyagite, 65.	6·8—7·2.
Heteromorphite, 76.	5·6—5·9.	Sylvanite, 64.	5·7—8·3.
Boulangerite, 81.	5·7—6.	Silver Glance, 37.	7·19—7·4.
Brongniardite, 76.	5·95.	Galena, 39.	7·2—7·7.
Freislebenite, 79.	6—6·4.	Naumannite, 43.	8·0.
Stephanite, 86.	6·269.	Bismuth Silver, 16.	

‡‡ Globule of Copper, or of Silver or Lead along with Copper; BB a Copper reaction.

Obs.—Polybasite, *Bournonite*, and *Stromeyerite* afford a copper reaction, and on cupellation a globule of silver; *Tetrahedrite* is sometimes argentiferous.

Berzelianite,		Dendritic crusts; silver-w; BB selen; fus gy bead; with *soda* copper; Cu, Se, 43.
Eucairite,	2—2·5	Mas; films; silver-w, lead-gy; *streak* shining; sectile; BB on *charcoal* fus! selen!; Cu, Ag, Se, 43.
Polybasite,	2—3	VI; tabular; massive; G 6·214; iron-bk; *streak* same; BB fus!; on *charcoal* sulph, antim; with *soda* arsen; Ag, Cu, Sb, S, As, 85.
Copper Glance,	2·5—3	III; in crystals, and massive; G 5·5—5·8; bkh lead-gy; *streak* same; BB on *charcoal* sulph, flame bh; copper; hot *nit* a gn solution; Cu, S, 46.
Bournonite,	2·5—3	III; cruciform and wheel-shaped cryst; massive; G 5·7—5·0; steel-gy, bkh; *streak* same; brittle; BB decrep, fus!; on *charcoal* antim, sulph; lead fumes on char; Pb, Cu, S, Sb, 80.
Stromeyerite,	2·5—3	III; massive; G 6·2—6·3; dark steel-gy; *streak* shining; sectile; BB fus!; glob little malleable; on *charcoal* sulph; with lead, silver; Ag, Cu, S, 48.
Tetrahedrite,	3—4	I; tetrahed; massive; G 4·5—5·2; steel-gy, bkh; *streak* same as color, or bnh; BB antim; on *charcoal* copper; in powder sol *nit* bnh-gn; Cu, S, Sb, sometimes with Ag or Hg, 82.

Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Berzelianite, 43.		Bournonite, 80.	5·7—5·9
Eucairite, 43.		Polybasite, 85.	6·214.
Tetrahedrite, 82.	4·5—5·3.	Stromeyerite, 48.	6·2—6·3.
Copper Glance, 46.	5·5—5·8.		

††† B.B. a malleable globule ; fumes inodorous.

	Hardness.	
Nagyagite,	1—1·5	III ; Laminæ flexible, foliated ! ; also gran ; G 6·85—7·2 ; bkh lead-gy ; BB on *charcoal* tellur, flame b, (sometimes fumes of sulphur) ; Pb, Au, Te, 65.
Amalgam, Arquerite,	3—3·5	I ; dodecahedrons ; massive ; silver-w ; brittle ; G 10·5—14 ; quicksilver fumes, silver globule ; Ag, Hg, 15.
Hessite,	2—3·5	Granular massive ; G 8·3—8·9 ; lead-gy and steel-gy ; slightly malleable ; Ag, Te, 44.
Altaite,	3	I ; *cleav* cubic, massive ; G 8·16 ; tin-w, sectile ; Pb, Te, 44.
Discrasite,	3·5—4	III ; mas ; G 9·4—10 ; silver-w, tin-w ; tarnish yw, bkh ; BB antim, glob not malleable ; on *charcoal* silver ; Ag, Sb, 35.
Gold Amalgam,		Small w grains, easily crumbling ; BB fumes of mercury, and a globule of gold left ; Hg, Au, 15.

Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Nagyagite, 65.	6·8—7·2.	Amalgam, 15.	10·5—14
Altaite, 44.	8·16.	Arquerite, 15.	
Hessite, 44.	8·3—8·9.	Gold Amalgam, 15.	
Discrasite, 35.	9·4—10.		

b. MALLEABLE.

Obs.—Palladium, Platinum, and Iridosmine are infusible. Native Bismuth, Bismuth Silver, and Silver Glance, not here included, are somewhat malleable. Iridosmine is imperfectly malleable.

	Sp. gravity.	
Tin,	7·285	II ; gyh-w ; BB fus !, 19.
Iron,	7·3—7·8	I ; iron-gy ; H 4—5 ; BB fus dif, no fumes ; magnetic, 17.
Lead,	11·445	I ; lead-gy ; BB fus ! !, fumes, 17.
Copper,	8·5—9	I ; copper-rd ; ductile, malleable ; H 2·5—3 ; BB fus, flame gn ; in *nit* sol, and solution with ammonia blue, 17.
Silver,	10—11·1	I ; H 2·5—3 ; silver-w ; BB fus, no fumes ; *nit* sol, 15.
Palladium,	11·5—12·5	I also VI ; scales ; H 4·5—5 ; wh steel-gy ; ductile ; malleable ; BB infus, 14.
Gold,	15·6—19·5	I ; massive, grains, leaves ; H 2·5—3 ; gold-yw, sometimes wh ; BB fus ; in *nit* insol ; in *nit-mur* sol, 7.
Quicksilver,	13·6	Liquid down to — 39° F. ; tin-white, 14.
Platinum,	16—19	I ; massive ; grains ; no cleav ; H 4—4·5 ; whitish steel-gy ; ductile ; BB infus ; in *nit* insol ; in hot *nit-mur* sol, 12.

	Sp. gravity.	
Iridosmine,	19—21·5	I, also VI; scales; H 6—7; tin-w; steel-gy; imperfectly malleable; BB infus; with *nitre* odor of osmium; in *nit* insol: in hot *nit-mur* sol, 19.

TABLE II.

MINERALS ARRANGED ACCORDING TO THEIR CRYSTALLIZATION.*

I. CRYSTALLIZATION MONOMETRIC.

I. LUSTRE UNMETALLIC.

	Hardness.	
Kerargyrite,	1—1·5	*Cl* none; wax-gy, etc.; G 5·3—5·6, 92.
Bromyrite,	1—2	*Cl* none; gn, yw; G 5·8—6, 93.
Arsenolite,	1·5	Whitish; G 3·698, 139.
Sal Ammoniac,	1·5—2	*Cl* oct; G 1·528; taste saline, pungent, 92.
Sylvine,	2	*Cl* cubic; G 1·9—2; taste saline, 90.
Embolite,	2	*Cl* cubic, traces; yw, gnh; G 5·75—5·85, 93.
Senarmontite,	2—2·5	Oct; w; G 5·2—5·3, 140.
Common Salt,	2·9	*Cl* cubic!; G 2·257; taste saline, 90.
Pharmacosiderite,	2·5	*Cl* cubic; G 2·9—3; gn, bn, rdh, 422.
Alum,	2—3	Oct; *cl* oct perf; taste alum, iron varieties inky, 382.
Percylite,		Cubes; sky-blue.
Manganblende,	3·5—4	*Cl* cubic!; bk, bn; *submetallic;* G 3·9—4·1, 41.
Blende,	3·5—4	Tetrahed; *cl* dodec!; yw, bn, bk, etc; res; G 4—4·2, 45.
Red Copper,	3·5—4	*Cl* oct; red; G 5·8—6·15, 101.
Fluor,	4	*Cl* oct perf!; G 3·14—3·18; vit, 94.
Hauerite,	4	Pyritohed; *cl* cubic; G 3·463; bn, rdh, bk, 56.
Eulytine,	4·5	Hemihed; *cl* dodec; bn, ywh, gy, yw; G 5·9—6·1, 181.
Analcime,	5—5·5	Trapezohed; cubic; *cl* indistinct; G 2—2·3, 318.
Haüyne,	5—5·5	Dodec; *cl* usually indist; b, gnh; G 2·4—2·5, 230.
Pyrochlore,	5—5·5	Oct; *cl* imperf; yw, bnh; G 3·8—5, 345.
Nosean,	5·5	Dodec; gyh, bh, bnh; G 2·2—2·3, 230. *Skolopsite* similar; G 2—2·3, 231.
Sodalite,	5·5—6	*Cl* dodec; gy, bn, b, gn; G 2·2—2·4, 229.
Lapis Lazuli,	5·5	Dodec; b; G 2·3—2·5, 229.

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* In this table the angles of a pyramid given are first the pyramidal angles, and then the basal; the angle of a dome mentioned is that over *O*, unless otherwise mentioned. In the dimetric and following systems, the figure 1 preceding the angles stands for the octahedron 1, (P in Naumann's system); and so on.

	Hardness.	
Ittnerite,	5·5	Dodec; *cl* dodec: gy, bh; G 2·35—2·4, 319.
Perofskite,	5·5	Cubes; *cl* cubic imperf; G 4·017; gyh-bk, 345.
Tritomite,		Tetrahedral; dull-brown; G 4·1—4·7, 311.
Leucite,	5·5—6	Trapezohedrons; w, gyh-w; G 2·4—2·5, 231.
Periclase,	6	*Cl* cubic; G 3·674; gyh, gn, 101.
Pyrrhite,	6	Oct; *cl* not observed; color orange-yw, 346.
Helvin,	6—6·5	Tetrahed; *cl* oct traces; G 3·1—3·3, 194.
Garnet,	6·5—7·5	Dodec; trapezohed, etc.; *cl* dodec; G 3·5—4·3, 190.
Boracite,	7—8	Tetrahed; *cl* oct dif!; G 2·9—3, 393.
Rhodizite,	8	Tetrahed; *cl* oct dif?; G 3·3—3·5, 393.
Spinel,	8	Oct; *cl* indistinct; G 3·5—4·9, 103.
Diamond,	10	*Cl* oct, perf; G 3·5—3·6, 24.

II. LUSTRE METALLIC.

Dufrénoysite,	2	*Cl* indistinct; G 5·549; gy, 77.
Silver Glance,	2—2·5	*Cl* dodec imperf; gy; G 7·15—7·4, 37.
Cuproplumbite,	2·5	*Cl* cubic!; bkh gy; G 6·4—6·45, 41.
Steinmannite,	2·5	*Cl* cubic; G 6·883; gy, 41.
Galena,	2·5—3	*Cl* cubic!!; lead-gy; G 7·25—7·7, 39.
Clausthalite,	2·5—3	*Cl* cubic; gy, bh; G 7—8·8, 42.
Naumannite,	2·5	*Cl* cub; bk; G 8·0, 43.
Copper,	2·5—3	Oct; r; G 8—9, 17.
Silver,	2·5—3	*Cl* none; w; G 10—11, 15.
Gold,	2·5—3	*Cl* none; yw; G 19·5—20, 7.
Erubescite,	5	*Cl* dif!; rdh or bronze yw, tarnishes; G4·4—5·1, 38.
Altaite,	3	*Cl* cubic; w; G 8·159, 44.
Amalgam,	3—3·5	*Cl* dodec, imperf; G 10—14; w, 15.
Tetrahedrite,	3—4	Tetrahed; *cl* oct imperf; gray; G 4·5, 82.
Tennantite,	3·5—4	*Cl* dodec, imperf; bkh-gy; G 4·3—4·5, 84.
Melaconite,	3—6	Cub; bk; G 5·1—5·2, 109.
Cuban,	4	Cubes; G 4—4·17; rdh bronze, bk, 68.
Platinum,	4—4·5	White, gyh; malleable; G 16—19, 12.
Grünauite,	4·5	*Cl* oct; w, gyh; G 5·13, 44.
Iron,	4·5	Iron-gray; G 7·3—7·8, 17.
Palladium,	4·5—5	Gyh-w; G 11—12·5, 14.
Ullmannite,	5—5·5	*Cl* cubic!; G 6·4—6·51; gyh, w, 59.
Perofskite,	5·5	Cubes; bk, gyh; G 4·017, 345.
Chromic Iron,	5·5	Oct; *cl* oct.; gyh-bk; G 4·3—4·5, 106.
Gersdorffite,	5·5	Pyritohed; *cl* cubic; G 5·6—6·9; w, gyh, 58.
Cobaltine,	5·5	Pyritohed; *cl* cubic!; G 6—6·3; w, rdh, 57.
Linnæite,	5·5	*Cl* cubic; gyh-w; G 6·3—6·4, 67.
Smaltine,	5·5—6	*Cl* oct imperf; w, gyh; G 6·4—7·2, 56.
Pitchblende,	5·5	Oct; *cl* none; G 6·4—8; bk; submetallic, 107
Chloanthite,	5·5—6	W, gyh; G 6·4—6·8, 56.

	Hardness.	
Magnetite,	5·5—6·5	Oct, dodec, &c.; *cl* oct; gyh-bk; G 4·9—5·2, 105. Martite is similar; G 3·8—4·82, 102.
Franklinite,	5·5—6·5	Oct, *cl* oct; gyh-bk; G 5—5·1, 106.
Skutterudite,	6	*Cl* cubic; w, gyh; G 6·7—6·9, 67.
Iserine,	6—6·5	Oct; *cl* none; G 4·7—5·1; gyh-bk, 102.
Pyrites,	6—6·5	Pyritohed; ywh; G 4·8—5·1, 54.
Iridosmine,	6—7	W, gyh; G 19—22, 19.
Platiniridium,	6—7	W; G 22·6—23, 13.
Irite,		Octahedrons; black, 103.

II. CRYSTALLIZATION DIMETRIC.

I. LUSTRE UNMETALLIC.

Calomel,	1—2	*O* : 1 119° 51′, *O* : 1*i* 129° 4′; *cl I;* G 6·4—6·5, 89.
Uranite,	2—2·5	*O* : 1*i* 128° 35′; *cl* basal!!; G 3—3 6; gn, yw, 430.
Cerasine,	2·5—3	*O* : 1 123° 61′; *cl I*; G 6—6·3; w, gy, yw, 463.
Wulfenite,	2·5—3	1 99° 40′, 131° 35′; *cl* oct; G 6·3—6·9; yw, gn, wh, 349.
Matlockite,	2·5—3	*O* : 2*i* 111° 50′, *O* : 1 119° 34′; yw; G 7·21, 127.
Scheeletine,	2·5—3	1 99° 44′, 131° 25′; 2 92° 40′, 154° 36′; *cl* basal imperf; gn, gy, bn, r; G 7·9—8·2, 348.
Savite,	3	Acic pms; colorless; G 2·45, 316.
Chiolite,	4	Snow white; G 2·7—2·9, 98.
Edingtonite,	4—4·5	Hemihed; pms 92° 41′, 129° 8′; *cl I* perf; G 2·7—2·8, 323.
Xenotime,	4—5	1 124° 26′, 82° 30′; *cl I;* G 4·4—4·6, 401.
Gismondine,	4·5	1 118° 30′ and 92° 30′; bh-w, gyh, rdh; G 2·265, 322.
Azorite,	4 5	1 123° 15′; nearly colorless; *cl* none, 350.
Apophyllite,	4·5—5	1 104° 2′, 121°; *cl* basal!!; G 2·2—2·4, 304.
Scheelite,	4·5—5	1 100° 40′, 129° 2′; 1*i* 108° 12′, 112° 2′; *cl* oct,i mperf; G 6—6·1, 347.
Mellilite,	5	1*i* 134° 48′, 65° 30′; *cl* basal; G 2·9—3·1, 205.
Faujasite,	5	1*i* 111° 30′, 105° 30′; bn, w, G 1·923, 323.
Gehlenite,	5—5·5	*Cl* basal, hardly distinct; G 2·9—3·1, 256.
Dipyre,	5—5·5	Like Scapolite; G 2·646, 205.
Scapolite,	5—6	1 136° 7′, 63° 48′; *cl ii* and *I;* G 2·6—2·75, 201.
Romeine,	5—6	1 (basal) 111°; yw, rdh; G 4·6—4·72, 410.
Meionite,	5·5	1 136° 11′ and 63° 40′; w; G 2·5—2·74, 200.
Œrstedite,	5·5	1 123° 16½′; G 3·629, 197.
Anatase,	5·5—6	1 97° 55′, 136° 30; *cl* 1 and *O* perf; G 3·8—4, 389.
Sarcolite,	6	*O* : 1*i* 156° 5′. *O* : 2 128° 33′; w, rdh; G 2·545, 200.
Rutile,	6—6·5	1 123° 8′, 84° 40′; 1*i* 134° 58′, 65° 35′; *cl* lat; G 4·1—4·3. 120.
Idocrase,	6·5	1 129° 29′, 74° 14′; *cl* imperf; G 3·3—3·5, 197.
Cassiterite,	6—7	1 121° 40′, 87° 7′; 1*i* 132° 31′, 67° 50′; *cl* imperf; G 6·5—7, 118.
Zircon,	7·5	1 123° 19′, 84° 20′; *cl* imperf; gy, bn, r, etc; G 4·0—4·8, 195.

II. LUSTRE METALLIC.

	Hardness.	
Nagyagite,	1—1·5	2*i* (bas) 137° 52′; *cl* basal!!; bkh-gy; G 6·8—7·2, 65.
Chalcopyrite,	3·5—4	Tetrahed; 1, 109° 53′, 108° 40′; *cl* imperf; yw; G 4·1 —4·3, 69.
Tin Pyrites,	4	Steel-gray, ywh, bkh, 70.
Hausmannite,	5·5—6	*O* : 1 121° 3′, *O* : 1*i* 130° 25′; bnh-bk; G 4·7—4·8, 118.
Fergusonite,	5·5—6	1 100° 54′, 128° 28′; *cl* basal imperf; G 5·8—5·9, 350.
		Submetallic.
Braunite,	6—6·5	1 109° 53′, 108° 39′; bnh bk; G 4·7—4·9, 117.

III. CRYSTALLIZATION TRIMETRIC.*

I. LUSTRE UNMETALLIC.

Thermonatrite,	1—1·5	107° 50′, 83° 50′; *cl* brachyd imperf; G 1·5—1·6, 455.
Tyrolite,	1—1·5	Gn, bh: G 5—3·1, 426.
Orpiment,	1·5—2	*I*, 100° 40′; 1*ĭ* 83° 30′; fol!; yw, 32.
Sulphur,	1·5—2·5	*cl* oct; *I* 101° 46′; Oct 1 106° 25′, 85° 07′, 143° 23′; G 2·072, 23.
Haidingerite,	1·5—2·5	*I* 100°; 1*ĭ* 126° 58′; *cl* brachyd perf!; G2·8—2·9, 413.
Conistonite,	2	*I* 97° 5′, 1*ĭ* 86° 30′; colorless; G 2·0; 465.
Struvite,	2	*I* 101° 42′, *ĭ*2 63° 8′, 1*ĭ* 96° 50′; ywh, bnh; G 1·6—1·7, 413.
Nitre,	2	*I* 118° 50′; G 1·9—2; taste saline, cooling, 433.
Mascagnine,	2—2·5	*I* 107° 40′; *cl* brachyd; taste pungent, 379.
Epsomite,	2—2·5	*I* 90° 34′; hemihed; G 1·75, 384.
Goslarite,	2—2·5	*I* 90° 42′; *cl* brachyd!; w; G 2—2·1, 384.
Thenardite,	2—2·5	*cl O*; taste alkaline; G 2·73, 365.
Mica,	2—2·5	*I* 120°; cleav basal, micaceous! lam elastic; G 2·7—3·1, 221. Phlogopite, and Lepidolite similar, 224, 226.
Clinochlore,	2—2·5	*I* 120°; cleav basal, micaceous! lam flex, inelast; G 2·7 —2·8; green, 293.
Liroconite,	2—2·5	*I* 119° 20′; 1*ĭ* 72° 22′; b, bh-gn; G 2·8—3, 429.
Glaserite,	2—3	*cl* macrod; taste saline, bitter, 365.
Bromlite,	2·5	*I* 118° 50′; *cl* imperf; G 3·7—3·72, 451.
Leadhillite,	2·5	*I* 103° 16′; *cl* *iĭ* perf!; G 6·2—6·5; w, ywh, gnh, 371.
Polyhalite,	2·5—3	*I* 115°; *cl* imperf; taste bitter, weak; G 2·78, 377.
Picrosmine,	2·5—3	*I* 126° 52′; 1*ĭ* (bas) 62° 11′; G 2·55—2·7, 281.
Hopeite,	2·5—3	*I* 101°; *cl* brachyd!; gyh-w, bnh, 409. *Fischerite*, G 2·46, 408.
Lanthanite,	2·5—3	*I* 93°-94°; gyh, ywh, 456.
Valentinite,	2·5—3	*I* 136° 58′; 1*ĭ* 70° 32′; w, G 5—5·6, 140.

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* In this system, Mica, Margarite, Clinochlore, Chondrodite, Datholite, Phosphocalcite, are hemihedral and have a *Monoclinic* form.

	Hardness.	
Anglesite,	2·5—3	*I* 103° 38′, 1ĭ (bas) 104° 31′ ; w, gyh ; G 6·2—6·3, 370.
Mendipite,	2·5—3	*I* 102° 36′ ; *cl I!;* w, ywh ; G 7—7·1, 128.
Heavy Spar,	2·5—3·5	*I* 101° 40′ ; 1ĭ(bas) 105° 24′ ; G 4·3—4·8, 366.
Caledonite,	2·5—3	*I* 95° ; cleav indistinct ; gn, bh ; G 6·4, 372.
Fluellite,	3	*I* 105° ; w ; trp, 98.
Olivenite,	3	*I* 92° 30′, 1ĭ 110° 50′ ; *cl* imperf ; G 4·1—4·4, 420.
Stilbite,	3·5	*I* 94° 15′ ; in rectang pms ; *cl* brachyd ! ! p'ly ; G 2—2·2, 332.
Anhydrite,	3—3·5	*I* 102° 56′ ; *cl O* perf! *iĭ* perf, *iĭ* less so ; w, bh, gyh ; G 2·9—3, 369.
Celestine,	3—3·5	*I* 104°—104½° ; 1ĭ (bas) 104° 8′ ; G 3·9—4, 368.
Witherite,	3—3·75	*I* 118° 30′ ; *cl I,* imperf ; w, gnh ; G 4·3, 449.
Cerusite,	3—3·5	*I* 117° 13′ ; *cl I* imperf ; w, gyh ; G 6·4—6·5, 452.
Atacamite,	3—3·5	*I* 112° 20′, 1ĭ 105° 40′ ; green, bkh ; G 4—4·3, 138.
Descloizite,	3·5	*I* 100° 28′, occurring prisms 122° 6′, 116° 25′ ; bk, olive, yw, bnh ; G 5·839, 362.
Serpentine,	3—4	Angles of Chrysolite (pseudomorphs?) ; G 2·2—2·6, 282.
Cotunnite,		*I* 99° 46′, *i*2̆ 118° 38′ ; w ; G 5·24, 97.
Wavellite,	3—4	*I* 126° 25′, 1ĭ 106° 46′ ; *cl I* imperf ; G 2·3—2·4, 423.
Aragonite,	3·5—4	*I* 116° 10′ ; 1ĭ (bas) 108° 26′ ; G 2·9—3·0, 448.
Scorodite,	3·5—4	*I* 98° 2′, *i*2̆, 120° 10′ ; gn, bn ; G 3·1—3·3, 419. *Dufrenite,* leek-gn, 427.
Euchroite,	3·5—4	*I* 92° 8′, 1ĭ 117° 20′ ; *cl I,* 1ĭ imperf ; gn ; G 3·384, 421.
Strontianite,	3·5—4	*I* 117° 19′ ; *cl I;* G 3·6—3·75, 450.
Brochantite,	3·5—4	*I* 104° 10′, 2ĭ 114° 29′ ; 1ĭ 151° 52′ ; *cl iĭ !;* gn ; G 3·7—3·9, 391.
Margarite,	3·5—4·5	*I* 120° ; Micaceous ; lam, rather brittle ; w ; G 3, 300.
Libethenite,	4	*I* 92° 20′, 1ĭ 109° 52′ ; *cl* imperf ; dark gn ; G 3·6—3·8, 420.
Epistilbite,	4	*I* 135° 10′ ; *cl* brachyd ! w ; bh, ywh ; G 2·2—2·3, 330.
Harmotome,	4—4·5	1 121° 6′, 119° 4′, 89° 52′ ; 1ĭ 110° 26′ ; *cl* imperf ; G 2·35—2·5, 323. Phillipsite, similar ; G 2·2, 324.
Phosphocalcite,	4·5—5	Hemihed, monoclinic ; gn ; G 4—4·4, 425.
Manganocalcite,	4—4·5	*I* near Aragonite, 452.
Sloanite,	4·5	*I* 105° ; white ; G 2·441, 329.
Childrenite,	4·5—5	*I* 111° 54′, 2ĭ 75° 46′ ; *cl* imperf ; G 3·1—3·3, 424.
Calamine,	4·5—5	*I* 103° 54′ ; *cl I!;* w, gyh, gnh ; G 3·3—39, 313.
Triphyline,	5	*I* 94°, *i*2̄ 130° ; gnh, gy, bh ; G 3·45—3·65, 406.
Göthite,	5	*I* 94° 52′, *i*2̆ 130° 40′ ; bn ; G 4—4·4, 129.
Portite,	5	*I* 120° ; white ; G 2·4, 311.
Herderite,	5	*I* 115° 53′ ; *cl* imperf ; G 2·9—3, 410.
Natrolite,	5—5·5	*I* 91° ; w ; gyh ; G 2·1—2·27, 327. Scolecite is similar, 328.
Thomsonite,	5—5·5	*I* 90° 40′ ; w ; bnh ; G 2·3—2·4, 325.
Triplite,	5—5·5	bn, bkh-bn ; G 3·4—3·8, 408.
Datholite,	5—5·5	*I* 115° 26′ ; *i*2̆ 76° 44′ ; *cl* indistinct ; w ; G 2·9—3, 334.
Æschynite,	5—6	*I* 90° 34′ ; *i*2̆ 127° 19′ ; *cl* imperf ; G 4·9—5·2, 357.

	Hardness.	
Wöhlerite,	5·5	*I* 90° 54′, *O* : 1ī 144° 1′ ; cleav; yw, bnh, gyh ; G 3·41, 343.
Lievrite,	5·5—6	*I* 111° 12′; 1 138° 26′, 117° 34′, 77° 50′; gyh-bk; G 3·8—4·2, 262.
Brookite,	5·5—6	*I* 100° ; bn, bk ; *cl* indistinct ; G 3·8—4·2, 123.
Amblygonite,	6	*I* 106° 10′ ; *cl I* perf; 3—3·15, 409.
Chondrodite,	6—6·5	*I* 94° 26′, hemihed ; yw, bn ; G 3·1—3·25, 186.
Keilhauite,	6·5	*I* 122° 30′ ; bnh-bk, 341.
Prehnite,	6—6·5	*I* 99° 56′ ; *cl* basal ; gnh, w, ywh ; G 2·8—3, 314.
Diaspore,	6—7	*I* 93° 52′, *i*2̆ 129° 54′; *cl* brachyd ! ! G 3·3—3·5, 128.
Chrysolite,	6—7	*I* 94° 3′, *i* 2̄ 130° 2′ ; green, glassy ; G 3·3—3·5, 184.
Iolite,	7—7·5	*I* 119° 10′ ; *cl* indistinct ; G 2·5—2·67, 214.
Staurotide,	7—7·5	*I* 129° 20′; *cl* brachyd, imperf; G 3·5—3·375, 261.
Andalusite,	7·5	*I* 90° 44′ ; *cl I*; G 3·1—3·3, 257.
Topaz,	8	*I* 124° 19′ ; *ĭ*2 93° 8′ ; *cl* basal ! ; yw, bnh, bh, gnh, w ; G 3·4, 259.
Chrysoberyl,	8·5	*I* 119° 46′, 3ĭ 70° 40′; *cl* brachyd, imperf; G 3·5—3·8, 122.

II. LUSTRE METALLIC.

Sternbergite,	1—1·5	*I* 119° 30′ ; *cl* basal ! ! ; bnh bronze ; 4·2—4·3, 71.
Sylvanite,	1·5—2	*I* 110° 48′, 1ĭ 78° 34′ ; gy ; G 5·7—8·5, 64.
Stibnite,	2	*I* 90° 45′ ; *cl* brachyd ! ; G 4·5—4·7, 33.
Pyrolusite,	2—2·5	*I* 93° 40′ ; *cl I, iĭ;* G 4·8—5, 125.
Jamesonite,	2—2·5	*I* 101° 20′ ; *cl* basal ! ; gy ; G 5·5—5·8, 75.
Aikinite,	2—2·5	*I* 110° ; long acic, cryst ; gy ; G 6·1—6·8, 81.
Bismuthine,,	2—2·5	*I* 91° 30′ ; *cl iĭ !* ; lead-gy ; 6·4—6·6, 33.
Stephanite,	2—2·5	*I* 115° 39′ ; 2ĭ 72° 12′ ; *cl* 2ĭ, *iĭ* ; bk ; G 6·2—6·3, 86.
Geocronite,	2—3	*I* 119° 44′ ; *cl* one perf ; gy ; G 6·4—6·6, 85.
Copper Glance,	2·5—3	*I* 119° 35′ ; 2ĭ 125° 28′ ; *cl I* dif! gy ; G 5·5—5·8, 46.
Bournonite,	2·5—3	*I* 93° 40′; 1ĭ 96° 12′ ; gy, dark ; G 5·7—5·8, 80.
Stromeyerite,	2·5—3	*I* 119° 35′ ; gy ; G 6·2—6·3, 48.
Enargite,	3	*I* 98° 11′; bk ; G 4·4—4·6, 87.
Wolchite,	3	dark-gy ; G 5·7—5·8, 82.
Zinkenite,	3—3·5	*I* 120° 39′, Rose ; G 5·3—5·4, 74.
Wolfsbergite,	3—4	*I* 101°, *i*2 138° 12′ ; gy ; G 4·748, 73.
Manganite,	3·5—4	*I* 99° 40′ ; *cl* brachyd ! ; gyh-bk ; G 4·3—4·4, 130.
Discrasite,	3·5—4	*I* 119° 59′ ; often in hexag twins ; w ; G 9·4—10·0, 35.
Glaucodot,	6	*I* 112° 36′ ; *cl* basal ! ; G 5·9—6·1 ; gyh-w, 63.
Leucopyrite,	5—5·5	*I* 111° 30′, (122° 26′) ; cleav ; w ; G 7·0—7·4, 61.
Wolfram,	5—5·5	*I* 101° 5′ ; 1ĭ 99° 12′ ; bk, 351.
Columbite,	5—6	*I* 100° 40′ ; *cl iī, iĭ* imperf ; bk ; G 5·4—6·4, 353. *Mengite* similar, 356.
Tantalite,	5—6	*I* 101° 32′ ; occurring prism 122° 54′ ; *cl* imperf; bk ; G 7·1—8, 351.

	Hardness.	
Samarskite,	5·5	*I* 101°, *ĭ*3̆ 135° to 136°; *cl* imperf; G 5·3—5·7; *submetallic*, 355.
Mispickel,	5·5—6	*I* 111° 53′; 1ĭ 80° 8′; *cl I*; G 5·9—6·2, 62.
Rammelsbergite,	5·5—6	*I* 123° to 124°; w; G 7—7·2, 61.
Marcasite,	6—6·5	*I* 106° 5′, 1ĭ 80° 20′; ywh; G 4·6—4·9, 60.
Euxenite,	6·5	*I* 120°; *cl* none; G 4·6—4·8; *submetallic*, 358.
Polymignyte,	6·5	*I* 91° 44′; 1ĭ 109° 46′, 2ĭ 70° 30′; *cl* imperf; G 4·7—4·9, 356. Polycrase is related, 357.
Polianite,	6·5—7	*I* 92° 52′, *O* : 1ĭ 147° 43′; bkh; G 4·8—4·9, 131.

IV. CRYSTALLIZATION MONOCLINIC.

I. LUSTRE UNMETALLIC.

Talc,	1·0	Hexag tables; *I* 120° nearly; angle between the optical axes 7° 24′; *cl* basal!!; G 2·55—2·85, 275.
Natron,	1—1·5	*I* 76° 28′; taste alkaline, 455.
Kermesite,	1—1·5	*cl* basal; r; G 4·4—4·6, 141.
Glauber Salt,	1·5—2	*I* 86° 31′; *cl* clinod perf, 386.
Gypsum,	1·5—2	prisms 111° 42′, 143° 42′; *cl iì* perf!!; G 2·3—2·35, 377.
Vivianite,	1·5—2	*I* 111° 12′, *C* 71° 25′; 1 119° 10′; bh; G 2·66, 415.
Realgar,	1·5—2	*I* 74° 26′; *i*2 113° 6′; r, rdh-yw; G 3·4—3·6, 31.
Copperas,	2	*I* 82° 21′; gn, w; G 1·8—1·9; taste inky, 385.
Fireblende,	2	*I* 139° 12′; hyacinth-red; G 4·2—4·3; 88.
Borax,	2—2·5	*I* 87°; taste sweetish, alkaline, feeble; G 1·716, 394.
Botryogen,	2—2·5	*I* 119° 56′; *i*2̆ 98° 16′; bn; G 2—2·1, 387.
Pharmacolite,	2—2·5	*I* 111° 6′; 1 117° 24′; *cl* clinod perf!!; G 2·6—2·75, 414.
Bieberite,		Like Copperas; rdh, 385.
Erythrine,	2—2·5	*I* 111° 16′, C 70° 54′; *cl* clinod!!; rdh; G 2·9—3·1, 416.
Lanarkite,	2—2·5	One perf cleav; *O* : 1*i* 120° 45′; G 6·3—7; gyh-w, ywh, gyh, 374.
Johannite,	2—5·5	*I* 69°; *C* 85° 40′; *cl I*; G 3·19; gn, 386.
Miargyrite,	2—2·5	*I* 39° 38′, *i*3 90° 30′; bk; G 5·2—5·4; *submetallic*, 74.
Gay-Lussite,	2—3	*I* 68° 50′, *C* 78° 27′; *cl I;* ywh-w; G 1·9—2, 455.
Vauquelinite,	2·5—3	bkh-gn, dark-gn; G 5·5—5·8, 360.
Whewellite,	2·5—3	*I* 100° 36′; *cl O*; w, 464.
Trona,	2·5—3	*C* 103° 15′; taste alkaline; G 1·9—2, 454.
Glauberite,	2·5—3	*I* 83° 20′; *cl O* perf, G 2·6—2·9, 374.
Köttigite,	2·5—3	Like Cobalt Bloom; G 3·1; rdh, 418.
Linarite,	2·5—3	*I* 61°; *cl ii* perf!; azure b; G 5·2—5·5, 390.
Crocoisite,	2·5—3	*I* 93° 44′; rd; G 5·9—6·1, 359.
Aphanesite,	2·5—3	*I* 56°; gn, b; G 4·15—4·4, 428.
Hydromagnesite	3·5	*I* 87° 52′; w; G 2·14—2·18, 456.
Heulandite,	3·5—4	*I* 136° 4′; *cl* clinod!! p'ly; G 2·15—2·2, 330.

	Hardness.	
Laumontite,	3·5—4	*I* 86° 16′, *cl ii*!!; G 2·25—2·4, 307. Leonhardite resembles Laumontite, 308.
Stilbite,	3·5—4	*I* 94° 16′, cleav clinod! p'ly w, rdh, yw; G 2—2·2, 332.
Azurite,	3·5—4	*I* 99° 32′; b; G 3·5—3·9, 459.
Malachite,	3·5—4	*I* 103° 42′; *cl* basal!; gn; G 3·7—4·1, 458.
Barytocalcite,	4	*I* 106° 54′; *C* 73° 52′; G 3·6—3·7, 453.
Turnerite,	above 4	*I* 96° 10; *O* : *I* 90° 40′; *cl* diagonals, one perf.
Brewsterite,	4·5—5	*I* 136°; *O* : *ii* 93° 40′; *cl* clinod p'ly; G 2·1—2·5, 332.
Wollastonite,	4·5—5	*I* 87° 28′, 2*i* 95° 36′; cleav; G 2·75—3, 156.
Pectolite,	5	near Augite in form; w; G 2·6—2·8, 305.
Monazite,	5	*I* 93° 10′, *C* 103° 46′; *cl* basal!; G 4·8—5·25, 402.
Scolecite,	5—5·5	Monoclinic, according to Rose; *I* 91°—91° 35′; G 2·1—2·25, 328.
Wagnerite,	5—5·5	*I* 95° 25′; *C* 71° 53′; *cl* imperf; G 3·068, 403.
Sphene,	5—5·5	Angles of dif prisms, 136° 4′, (or 136° 48′); 133° 48′, (or 133° 56′); *cl* imperf; G 3·4—3·6, 268.
Rhodonite,	5·5—6·5	*I* 87° 6′, like Augite; *cl I*; rdh; G 3·4—3·7, 167.
Hornblende,	5—6	*I* 124° 30′; *cl I*, perf; colors various, w to gn to bk; G 2·8—3·2, 272.
Lazulite,	5—6	*I* 91° 30′; *C* 88° 15′; *cl I* indist; G 3—3·15, 404.
Pyroxene,	5—6	*I* 87° 6′; *cl I*, and diags; also *O* sometimes; G 3·2—3·5, 158.
Allanite,	5·5—6	1*i* 70° 51′; *O* : *ii* 114° 55′; G 3·3—4·2; bk, gnh, bnh, gyh, 208.
Orthoclase,	6	*I* 118° 48′; *cl O* perf, *ii* nearly perf; w, rdh, bh; G 2·4—3·6, 242.
Petalite,	6—6·5	Cleav 142°; w, gyh; G 2·4—2·45, 253.
Acmite,	6—6·5	*I* 86° 56′; G 3·2—3·6, 176.
Epidote,	6—7	*I* 63° 8′; 1 70° 33′, 1*i* 70° 9′ *O* : *ii* 115° 24′; *cl* imperf; G 3·2—3·5, 206.
Zoisite,	6—6·5	*I* 116° 16′; gy, bnh, 211.
Weissigite,	6·5	White, rdh; G 2·5—2·6, 254, (perhaps Orthoclase).
Spodumene,	6·5—7	*I* 87°; *cl I* and *ii* perf; G 3·1—3·2, 169.
Gadolinite,	6·5—7	*I* 115°; *cl* imperf; G 4—4·5, 211.
Euclase,	7·5	*I* 115°; *cl* clinod!; G 3—3·1, 267.

II. LUSTRE METALLIC.

Freislebenite,	2—2·5	*I* 119° 12′, ½*i* 132° 16′; gy, wh; G 6—6·4, 79.
Miargyrite,	2—2·5	*I* 39° 38′, 1*i* 38° 18′; *cl* imperf; bk; lustre submet; G 5·2—5·4, 75.
Plagionite,	2·5	2 120° 49′; *O* : 2 138° 52′; *cl* 2 perf; gy; G 5·4, 75.
Crednerite,	4·5	*Cl* basal perf!; bk, gyh; G 4·9—5·1, 126. Heteroclin is similar, 127.
Wolfram (in part)	5—5·5	*I* 101°, *C* 91° 59′, according to Descloizeaux.
Allanite,	5·5—6	See above; sometimes submetallic.

V. CRYSTALLIZATION TRICLINIC.

	Hardness.	
Sassolin,	1	*I*: *I'* 118° 30′, *O* : *I* 95° 3′; cleav basal!, 144.
Cyanosite,	2·5	109° 32′, 127° 40′, 123° 10′; cleav imperf; b; G 2·2—2·3, 380.
Babingtonite,	5·5	Different prism, angles 89° 20′, 92° 34′, 112° 30′; 88° between cleavages; one *cl* perfect; G 3·4—3·5, 178.
Latrobite,	5·5—6·5	93° 30′, 91° 9′, 98° 30′; cleav 3 unequal; G 2·7—2·8, 235.
Albite,	6	*I* : *I'* 122° 15′; *O* : *iĭ* 93° 36′; G 2·55—2·65, 240.
Oligoclase,	6	*I* : *I'* 120°; *O* : *iĭ* 93° 15′; G 2·6—2·7, 239.
Labradorite,	6	*I* : *iĭ* 119° 16′; *O* : *iĭ* 86° 32′; G 2·65—2·8, 237.
Andesine,	6	Like Albite; but *cl* less perfect; G 2·65—2·74, 236.
Anorthite,	6—7	*I*: *I'* 120° 30′; *O* : *iĭ* 85° 48′; G 2·65—2·78, 234.
Kyanite,	6—7·5	*O* : *iī* 100° 50′, *iī* : *iĭ* 106° 15′; *I* : *I'* 97° 4′; *cl* macrod; G 3·1—3·7, 263.
Axinite,	6·5—7	134° 40′, 115° 17′, 135° 10′; bn, gyh, bk; G 3·271, 213.
Sillimanite,	6·5—7·5	*I* : *I'* 98° varying to 110°; *cl* macrod!; G 3·2—3·6, 265.
Danburite,	7	110°, 54°, 93°; *cl* dist; ywh, pale; G 2·9—3, 212.

VI. CRYSTALLIZATION HEXAGONAL.

I. LUSTRE UNMETALLIC.

Iodyrite,		Hexag pms, *O* : 1 136° 46′; yw, 95.
Ripidolite,	1—2	Hexag; *cl* basal!!; lam flex; G 2·7—3, 296.
Brucite,	1·5	Hexag tables; *cl* basal!!; G 2·35, 133.
Nitratine,	1·5—2	*R* 106° 33′; *cl R* perf; G 2—2·3; taste cooling, 433.
Chlorite,	1·5—2	Tab; *cl* basal!!; lam flex; G 2·6—2·9, 294.
Chalcophyllite,	2	*R* 69° 48′; *cl* basal!!; gn; G 2·4—2·7, 428.
Xanthocone,	2	*R* 71° 34′, *O* : *R* 110° 30′; rd, bn; G 5—5·2, 87.
Coquimbite,	2—2·5	Hexag; *O* : 1 151°; w, bh; taste copperas; G 2—2·1, 380.
Proustite,	2—2·5	*R* 107° 48′; *cl R*; rd; G 5·4—5·6, 78.
Pyrargyrite,	2—2·5	*R* 108° 42′; ½ *R* 137° 58′; *cl R*; bk, rdh; G 5·7—5·9, 77.
Cinnabar,	2—2·5	*R* 92° 46′; 2 *R* 71° 48′; *cl I*; r; G 8—8·1, 48.
Cronstedtite,	2·5	Hexag; *cl* basal!; bnh-bk; G 3·3—3·4, 299.
Susannite,	2·5	2 *R* 72° 30′; *cl O* easy; w, gn, ywh, bnh; G 6·55, 373.
Pyrosclerite,		*Cl* basal!!; lam flex; G 2·6—2·8, 291.
Biotite (Mica),	2·5—3	Hexag; *cl* basal!!; G 2·8—3·1, 225.
Calcite,	3	*R* 105° 5′; *cl R* perf; G 2·5—2·8, 435.
Volborthite,	3—3·5	Hexag; *cl* one perf; yw, ywh-gn; G 3·4—3·9, 362.
Greenockite,	3—3·5	Hexag pms; honey yw, 51.
Vanadinite,		Hexag; yw, bn; G 6·6—7·3, 362.
Gibbsite,	3—4	Hexag; *cl* basal; G 2·3—2·4, 134.

	Hardness.	
Magnesite,	3—4	*R* 107° 29′; *cl R* perf; G 2·8—3, 441.
Dreelite,	3·5	*R* 93° to 94°; *cl R* traces; w; G 3·2—3·4, 373.
Mimetene,	3·5	Hexag; *O* : 1 139° 6′; yw, rdh; G 7·1—7·25, 401.
Dolomite,	3·5—4	*R* 106° 15′; *cl R* perf; G 2·8—3·1, 441.
Alunite,	3·5—4	*R* 89° 10′; *cl* bas!; w; gyh, rdh; G 2·5—2·8, 388.
Jarosite,		*R* 88° 58′; *cl* bas; ywh; G 3·2—3·3, 389.
Pyromorphite,	3·5—4	Hexag; *O* : 1 139° 38′; *cl* imperf; gn, yw; G 6·9—7·1, 400.
Diallogite,	3·5—4·5	*R* 106° 51′, (107° 20′); *cl R !*; rdh, bnh; G 3·4—3·6, 446.
Chalybite,	3·5—4·5	*R* 107°; *cl R !*; gnh, bnh; G 3·7—3·9, 444.
Connelite,		Hexag; b; trl, 375.
Chabazite,	4—4·5	*R* 94° 46′; *cl R,* also hexag; w, rdh; G 2—2·2, 319.
Pyrosmalite,	4—4·5	Hexag; *O* : 1 148° 30′; *cl* basal!; bn, gy, gn; G 3—3·1. 310.
Breunnerite,	4—4·5	*R* 107° 23′; *cl R* perf; G 3—3·63, 443.
Parisite,	4·5	Hexag; 1 120° 34′, 164° 58; *cl* basal! bnh-yw; G 4·35, 463.
Clintonite,	4—5	Hexag tables; *cl* basal!!; lam brittle; G 3—3·1, 297.
Fluocerite,	4—5	G 4·7; ywh-bn, 96.
Zinc,	4—4·5	Hexag; *cl* basal!!; rd, G 5·4—5·6, 110.
Apatite,	5	*O* : 1 139° 47′; *O* : 22 124° 30′; *cl* indistinct; G 3—3·3, 397. *Cryptolite* in acic hexag pms; G 4·6, 399.
Dioptase,	5	*R* 126° 24′; 2 *R* 95° 58′; *cl R !;* gn; G 3·2—3·4, 309.
Smithsonite,	5	*R* 107° 40′; *cl R ;* w, gyh, gnh; G 4—4·5, 447.
Willemite,	5·5	*R* 115°; ¾*R* 128° 30′; ⅓*R* 142° 52′; *cl* basal and lateral; G 3·9—4·2, 189.
Cerite,	5·5	Hexag; bn, r; G 4·912, 312.
Cancrinite,	5·5—6	Hexag; *O* : ½ 154° 7′; *cl I* imperf; G 2·4—2·65, 233.
Nepheline,	5·5—5·6	Hexag; *O* : 1 136° 2′, *O* : ½ 154° 15′; *cl I, O;* G 2·5—2·65, 232.
Eudialyte,	6	*R* 126° 25′, 4 *R* 73° 30′; *cl* basal! *R* imperf; G 2·85—3, 181.
Quartz,	7	*R* 94° 15′; hexag; *cl* indistinct; colors various; G 2·6—2·7, 145.
Tourmaline,	7—7·5	2 *R* 133°; *cl* imperfect; bk, bn, b, gn, rd; G 3—3·3, 270.
Beryl,	7·5—8	Hexag; *O* : 1 150° 3′; *cl* basal not very distinct; G 2·6—2·7, 178.
Phenacite,	8	*R* 116° 40′; *cl R;* G 2·9—3, 189.
Corundum,	9	*R* 86° 4′; *cl* basal; G 3·0—4·2, 111.

II. LUSTRE METALLIC.

Molybdenite,	1—1·5	Hexag tables; *cl* basal!!; G 4·1—4·8, 66.
Graphite,	1—2	Hexag tables; *cl* basal!!; G 2·0891, 29.
Covelline,	1·5—2	Hexag; dark b; G 3·8—3·9, 65.
Tetradymite,	2	2 *R* 66° 40′; *R* 81° 2′; *cl* basal!; gyh; G 7—8·4, 21.

	Hardness.	
Tellurium,	2—2·5	*R* 86° 57′; G 6·1—6·3; tin-w, 20.
Bismuth,	2—2·5	*R* 87° 40′; G 9·727; tin-w, rdh, 20.
Tenorite,		Scales; G 5—5·5; lead-gy, 117.
Polybasite,	2—3	Hexag, *O* : 1 121° 30′, tabular; *cl* indist; bk; G 6·214, 85.
Millerite,	3—3·5	*R* 144° 8′; *cl R;* yw; G 5·2—5·7, 49.
Allemontite,	3—3·5	Rhombohedral; *cl* basal!; w; G 6·1—6·2; arsenical antimony, 22.
Antimony,	3—3·5	*R* 87° 35′; $\frac{1}{2}R$ 117° 7′; *cl* basal!; w; G 6·6—6·8, 21.
Arsenic,	3·5	*R* 85° 41; w, gy; G 5·6—6, 22.
Pyrrhotine,	4—4·5	Hexag pms; *cl* basal; bronze; G 4·4—4·7, 50.
Copper Nickel,	5—55	Hexag; *cl* imperf; rdh; G 7·3—7·7, 52.
Ilmenite,	5—6	*R* 85° 40′-86° 10′; *cl* imperf; gyh-bk; G 4·5—5·1, 115. *Crichtonite* 5 R 61° 29′, 115.
Breithauptite,	5·5	Hexag; rdh; G 7 541, 53.
Hematite,	5·5—6·5	*R* 86° 10; *cl* imperf; gyh-bk; G 4·8—5·3, 113.
Iridosmine,	6—7	*R* 84° 52′; w, gyh; G 19—22, 19.

A

SYSTEM

OF

MINERALOGY,

COMPRISING THE

MOST RECENT DISCOVERIES:

INCLUDING

FULL DESCRIPTIONS OF SPECIES AND THEIR LOCALITIES, CHEMICAL ANALYSES
AND FORMULAS, TABLES FOR THE DETERMINATION OF MINERALS,
WITH A TREATISE ON MATHEMATICAL CRYSTALLOGRAPHY
AND THE DRAWING OF FIGURES OF CRYSTALS.

ILLUSTRATED BY NUMEROUS WOOD CUTS.

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"*Hæc studia nobiscum peregrinantur, rusticantur.*"

FOURTH EDITION,
REWRITTEN, REARRANGED, AND ENLARGED.

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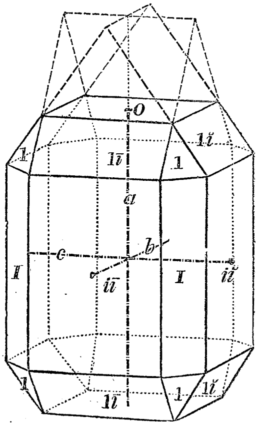
INTRODUCTORY REMARKS.

In the Descriptions of Species, the characteristics are mentioned in the following order:—1, Structure; 2, Hardness, Specific gravity, Lustre, Color, Diaphaneity, etc.; 3, Chemical Composition and reactions, etc.; 4, Geological position; 5, Localities and Mineral associates, etc.; 6, Altered Forms.

Under Structure are included, the system of crystallization, axial dimensions, occurring forms and angles, cleavage, modes of composition, and semi-crystalline aggregations.

To avoid any ambiguity in the angles and prisms referred to in the following pages, and render the subject intelligible to those who may not be familiar with crystallographic language, a few explanations are here given in recapitulation of some of the principles more fully elucidated in the chapters on Crystallography. The annexed figure represents a rectangular prism with replaced edges and angles. *O* is the basal plane of the prism; *iī* the larger lateral plane, parallel to the *longer* lateral axis; *iĭ* the smaller lateral plane, parallel to the *shorter* lateral axis. *a*, *b*, *c*, are the axes, of which *a* is the vertical, *b* the shorter lateral or brachydiagonal, *c* the longer lateral or macrodiagonal. *I* are planes on the edges of the rectangular prism, which when extended would form a vertical rhombic prism, having its axes *b* and *c* in the ratio of 1*b* : 1*c*. It is therefore the *unit* or *fundamental vertical prism*. 1*ī* are planes parallel to the *longer* lateral axis, and having for the axes *a*, *b*, the ratio 1*a* : 1*b*; extended upwards they form a *dome*, (so named from *domus*, a house), which is called the *macrodome*. The planes 1*ĭ* in a similar manner form what is called a *brachydome*, they being parallel to the *shorter* lateral axis; its axes *a*, *c*, have the ratio 1*a* : 1*c*, that is, the two diagonals of this horizontal prism have this ratio. These two domes are there-



fore the *unit domes.* The planes 1 on the eight angles are planes of an octahedron, having for the axes a, b, c, the ratio $1a : 1b : 1c$. It is therefore the unit or fundamental octahedron, (1). Its pyramidal edges, if the octahedron were completed, as in f. 13, would be of two kinds, two at each extremity opposite to the axis c, the longer lateral axis, and two opposite to b, the shorter lateral axis. The former is the macrodiagonal edge, the latter the brachydiagonal.

By doubling the length of the vertical axis, the lateral being fixed, we form the octahedron 2; by trebling it the octahedron 3; by halving it the octahedron $\frac{1}{2}$; and so for the domes, doubling the vertical axis we have the dome $2\bar{i}$ or $2\breve{i}$; by halving the same, the dome $\frac{1}{2}\bar{i}$ or $\frac{1}{2}\breve{i}$, and so on. The letter i stands for infinity, and means that the plane is parallel to one of the axes; $\bar{i}$, that it is parallel to the longer lateral axis; $\breve{i}$, that it is parallel to the shorter lateral axis: i or I alone, or as the initial letter in a symbol, signifies that the plane is parallel to the vertical axis. A plane $i\bar{i}$ is parallel both to the vertical and longer lateral; $i\breve{i}$, both to the vertical and shorter lateral.

The octahedrons alluded to above have for the axes b, c, the ratio $1b : 1c$, and belong to what is called the *fundamental* series. But others may exist with different ratios for b and c, and any value for a. If the ratio for b, c, is $1b : 2c$, then as b is the *shorter* lateral axis, if the vertical axis is $1a$, the octahedron is $1\bar{2}$; or if the vertical axis is $3a$ the plane is $3\bar{2}$, or if $\frac{1}{2}a$, it is $\frac{1}{2}\bar{2}$. So for the ratio $3b : 1c$; if the vertical axis is $1a$, the octahedron is $1\breve{3}$, or if $2a$, it is $2\breve{3}$; and if the vertical axis is infinite, the plane is *parallel* to the vertical axis, and the symbol is $i\breve{3}$. The first figure or letter in these symbols always refers to the vertical axis, and the second to one of the lateral axes.

The planes may thus be viewed as lying in vertical zones, a different zone for every ratio of the lateral axes $b : c$. Each series, or zone, terminates *above* in the basal plane of the prism, for which $a=0$, and *below* in a vertical prism, for which a is infinite.

The small tables inserted in connection with the crystalline forms of many of the species consist of the vertical *zones* of occurring planes. The planes of a vertical zone have mutual *horizontal intersections* in the crystal. Consequently in a crystal not oblique the inclination of the basal plane, O, on any plane in a zone, subtracted from 270°, gives the inclination of the prismatic plane of the same zone on that plane, and the tangents of the supplemental angles of O on the planes of a zone vary as the coefficient of the vertical axis for each plane. Thus, suppose there are the planes $1\bar{i}$, $2\bar{i}$, $3\bar{i}$, take the supplement of $O : 1\bar{i}$, (which, if $O : 1\bar{i}$ is 124°, equals $180^\circ - 124^\circ = 56^\circ$); then the tangent of this angle, doubled, will be the tangent of the supplement of $O : 2\bar{i}$, and trebled, of the supplement of the angle of $O : 3\bar{i}$. The same for the planes 1, 2, 3, or $1\breve{2}$, $2\breve{2}$, $3\breve{2}$; and so on.

In these tables, the column of the fundamental series of octahedrons is distinguished from the other columns by being enclosed by heavier lines. Reading *across* the tables, planes with the vertical axis equal, (that is, with the initial figure of the symbol the same), are in the same horizontal line; and the planes in any one of these transverse lines between the fundamental column and the right-hand column have their mutual intersections parallel; and so also with planes between it and the left. The horizontal line made up of the symbols of the vertical prisms is also enclosed by heavier lines. For further elucidation of these tables, see page 58, etc., under Crystallography.

In the Dimetric System, the lateral axes are equal, and there is no distinction of longer and shorter axis. The symbols $1i$, $2i$, apply to planes about the base of a square prism parallel to either lateral axis, as in figure 83, p. 40.

In the Monoclinic System, the planes above the middle horizontal section in front differ from those below, on account of the obliquity of the crystal, and those of one set are +, and the other —.

In the Rhombohedral section of the Hexagonal System, the planes 1, 2, 3, $\frac{1}{2}$, etc. are planes of rhombohedrons, having for the vertical axis, $1a$, $2a$, $3a$, $\frac{1}{2}a$, etc., $1a$ being the value of the axis in the fundamental rhombohedron, (R). The angle of a Rhombohedron mentioned, is always that over a *terminal* edge, as that between the upper planes R of figure 26, p. 30. On gradually shortening the rhombohedron in figure 26, it may become $\frac{1}{2}R$, $\frac{1}{4}R$, and so on, till the length becomes 0, and the rhombohedron is reduced to a flat plane. Hence starting from this plane, (which corresponds to the basal plane of the rhombohedron or hexagonal prism), the rhombohedron as it elongates reaches the form of figure 26; and continuing the elongation, the vertical axis doubles,—trebles,—and so on, till finally, it becomes infinite and the rhombohedron is then a six-sided prism. If a diminution in length now commences by planes inclined to the opposite extremities of the vertical axis, these planes correspond to another series of rhombohedrons which are distinguished by a minus (—). The planes,

$$O \ldots . \tfrac{1}{4} \ldots 1 \ldots 2 \ldots I \ (\text{or } \infty) \ldots . -2 \ldots -1 \ldots -\tfrac{1}{2} \ldots . O,$$

lie in a single vertical zone; and the same relation exists for the tangents of the supplemental angles of the inclination on O, as is mentioned above.

In the Hexagonal prism, the tables include one sixth of either extremity of the prism, commencing with the fundamental series or zone, $m \ldots I$, and continuing around 30 degrees to the intermediate series $m2 \ldots i2$; the prism $i2$ truncates the lateral edges of prism I, as shown in figure 121.

The above explanations may suffice to give a general idea of the system of notation used in this work and the principles on which it is based; and they will subserve completely their end if they tempt the reader to study carefully the chapters on Crystallography, the difficulties in which with most persons are more imaginary than real.

The angles of the domes mentioned (in the descriptions of species) are the angles at *top*, unless otherwise stated. Those of the octahedral forms, are the angle at the macrodiagonal edge, as the angle 1 : 1 in the preceding figure over 1ī, (indicated by the syllable *mac.*); that at the brachydiagonal edge, or 1 : 1 *over* 1ĭ, (*brach.*); that at the basal edge or 1 : 1 *over the base*, (*bas.*) Those of the vertical prism, may similarly be either the *mac*rodiagonal (over *iī*) or *brach*ydiagonal, (over *iĭ*).

The angles of Monometric forms are mentioned in a table on pages 70, 71.

The dimensions of the axes given in the following pages are those that correspond to the values of the angles mentioned in the same line of the text. But in very many species, these angles admit of variations from change of temperature, and often still wider variations from other causes. They are therefore to be regarded only as approximations, or the best mean results that have been arrived at.

In the classification of the mineral species here adopted, the grand subdivisions are as follows:

I. Native Elements.
II. Combinations with Elements of the Sulphur and Arsenic Sections.
    1. Binary Compounds.
    2. Double Binary Compounds.
III. Fluorids, Chlorids, Bromids, Iodids.
    1. Binary Compounds.
    2. Double Binary Compounds.
IV. Oxygen Compounds.
    1. Binary Compounds.
    2. Double Binary Compounds.
V. Organic Compounds, as Resins, etc.

Under the second subdivision of the Oxygen Compounds, fall the *Silicates*, *Titanates*, *Columbates*, *Tungstates*, *Sulphates*, *Phosphates*, *Carbonates*, and other related groups of Salts.

PART VI.

DESCRIPTIVE MINERALOGY.

I. NATIVE ELEMENTS.

I. Hydrogen Group.—Oxyds either RO, R^2O^3, or RO^2.
  1. Iron Section.—Monometric; sometimes dimorphous, and both monometric and hexagonal.
  2. Tin Section.—Dimetric.

II. Arsenic Group.—Oxyds include the compounds RO^3 or R^2O^5.
  1. Arsenic Section.—Mostly hexagonal.
  2. Sulphur Section.—Trimetric or monoclinic.

III. Carbon Group.—
  1. Diamond Section.—Monometric.
  2. Graphite Section.—Hexagonal.

I. HYDROGEN GROUP.

1. Iron Section: Gold, Platinum, Palladium, Platin-iridium, Quicksilver, Silver, Amalgam, Copper, Lead, Iron, Nickel; and to this section also belong the elements Chromium, Manganese, Cobalt, Calcium, &c.

2. Tin Section: Native Tin.

GOLD. Gediegen Gold, *W.* Or Natif, *H.* Sol, *Alchym.* Rex Metallorum.

Monometric. Observed planes, *O*, *I*, 1, 33, 42, *i*2. Fig. 1, 11, 14, 15 to 19, 32, 33, 40, 45, and the following. Edges of crystals often salient. Cleavage none. Twins, composition as in f. 200. Common in filiform, reticulated, and arborescent shapes; also in thin laminæ; often in flattened grains or scales, and in rolled masses in gravel or sand detritus.

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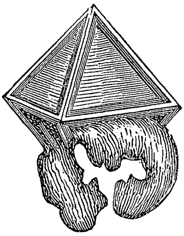

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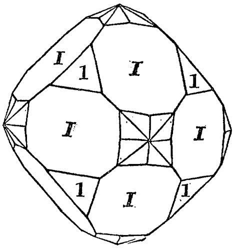

H.=2·5—3. G.=15·6—19·5: 19·30—19·34, when quite pure, G. Rose. Lustre metallic. Color and streak various shades of gold-yellow, sometimes inclining to silver-white. Opaque. Very ductile and malleable.

Composition.—Gold with silver in different proportions. The ratio 6 : 1 contains 84·6 of gold; 8 : 1, 88 of gold; 12 : 1, 91·6; 18 : 1, 94·2 of gold. The proportion of silver in the *electrum* of Klaproth, is gold 64, and silver 36, or two of gold to one of silver.

The following are analyses by G. Rose, (Pogg. xxiii, 161); Boussingault, (Ann. Ch. Phys. xxxiv, 408); Awdejew, (Pogg. liii, 153); Rivot, (Ann. d. Mines, [4], xiv, 67); T. M. Henry, (Phil. Mag. xxxiv, 205, 1849); Hoffmann, (Ann. d. Ch. u. Pharm. lxx, 255); E. T. Teschemacher, (Quart. J. Chem. Soc. ii, 193); F. Oswald, (Pogg. lxxvii, 96); T. S. Hunt, (Logan's Rep. Geol. Canada, and Amer. Jour. Sci. [2], xv, 448); A. Levol, (Ann. Ch. Phys. [2], xxvii, 310); A. D. Thomas, (Phil. Mag. [4], i, 261); Kerl, (B. u. H. *Z*tg. 1853, No. 3):

		Gold.	Silver.	Proportion.
1.	Linarowski, Altai,	60·08	39·38, Cu 0·33=98·79, Rose.	2 : 1
2.	Vöröspatak, Transylvania,	60·49	38·74=99·23, Rose.	"
3.	Santa Rosa,	64·93	35·07=100, Boussingault.	"
4.	Transylvania,	64·52	35·48=100, Bouss.	"
5.	Katharinenburg, G.=15·627,	70·86	28·30, Cu, Fe, loss 0·84, Awd.	2½ : 1
6.	Marmato, G.=12·666,	73·45	26·48=99·93, Bouss.	3 : 1
7.	Titiribi, Columbia,	73·40	26·00=100, Bouss.	"
8.	Guamo,	73·68	26·32=100, Bouss.	"
9.	Titiribi, Columbia,	74·00	26·00=100, Bouss.	"
10.	Katharinenburg, G.=16·03,	79·69	19·47, Cu, Fe and loss 0·84, Awd.	
11.	Trinidad,	82·40	17·60=100, Bouss.	5 : 1
12.	Ojas Anchas,	84·50	15·50=100, Bouss.	6 : 1
13.	Senegal,	84·50	15·30, Cu, 0·20=100, A. Levol.	
14.	Nischne Tagilsk,	83·85	16·15=100 Rose.	
15.	Santa Barbara, Transylvania,	84·80	14·68, Cu 0·04, Fe 0·13=99·65, Rose.	
16.	Goruschka, near N. Tagilsk,	87·31	12·12, Cu 0·08=99·51, Rose.	8 : 1
17.	Petropawlowski,	86·81	13·19, Cu 0·3, Fe 0·24, Rose.	
18.	Near Miask,	87·40	12·07, Cu 0·09=99·56, Rose.	
19.	Chaudière, Canada,	86·73	13·27=100, Hunt.	
20.	Senegal,	86·80	11·30, Cu 0·90=100, A. Levol.	
21.	California, G.=15·63,	86·57	12·33, Cu 0·29, iron 0·54=99·73, Henry.	
22.	Senegal, Africa,	86·97	10·53=97·50, Darcet.	
23.	Rio Sucio, near Mariquita,	87·94	12·06=100, Bouss.	
24.	Chaudière, G.=17·60,	87·77	12·23=100, T. S. Hunt.	
25.	Baia, near Pamplona,	88·15	11·85=100, Bouss.	

		Gold.	Silver.	Proportion.
26.	Malpaso, near Mariquita,	88·24	11·76=100, Bouss.	8 : 1
27.	Llana, near Vega de Supia,	88·54	11·42=99·96, Bouss.	
28.	Near Miask,	89·35	10·65=100, Rose.	
29.	Chaudière, fine scales, G.=16·57,	89·24	10·76=100, T. S. Hunt.	
30.	California, G.=17.4,	87·6	8·7, F̈e, Äl, Ċa 1·7, S̈i, ign. loss 2·0=100, O.	
31.	California, G.=14·6, fused, 17·48,	90·70	8·80, Fe 0·38=99·88, Rivot.	
32.	California, G.=15·96,	90·01	9·01, Cu with Fe *trace* 0·86=99·88, Hen.	
33.	California,	89·61	10·05, Cu and Fe undet.=99·66, Hofmann.	
34.	Boruschka, near N. Tagilsk,	90·76	9·02=99·78, Rose.	
35.	Beresof,	91·88	8·03, Cu 0·02, Rose.	12 : 1
36.	Katharinenburg, G. 17·74–18·35,	91·21	8·03, Cu, Fe and loss 0·76, Awd.	
37.	Bogota,	92·00	8·00=100, Bouss.	
38.	California, G.=16·33,	92·00	7·00=99, Teschemacher.	
39.	California,	92·70	6·90, Cu 0·40=100, A. Levol.	
40.	Perroe-Pawlowsk, near Kath.,	92·60	7·08=99·78, Rose.	
41.	Czarewo-Nikolajewsk,	92·47	7·27=99·74, Rose.	
42.	Katharinenburg, G. 18·11—18·4,	92·23	6·17, Cu, Fe and loss 1·6, Awd.	
43.	"	92·80	7·02, Fe 0·08, Rose.	
44.	"	93·34	6·28, Cu 0·06, Fe 0·32=99·94, Rose.	
44½.	California,	93·53	6·47=100, A. D. Thomas.	
45.	Katharinenberg,	93·75	6·01, Cu, Fe and loss 0·24, Awd.	
46.	"	94·09	5·55, " " 0·36, Awd.	
47.	Brazil,	94·00	5·85=99·85, Darcet.	18 : 1
48.	Senegal, irregular grains,	94·00	5·85, Platinum, 0·15=100, A. Levol.	
49.	Boruschka,	94·41	5·23, Cu, 0·39, Fe 0·04=100·07, Rose.	
50.	Katharinenburg, G. 18·77—18·89,	95·5	4·0, Cu, Fe and loss 0·5, Awd.	
51.	Australia,	95·48	3·59, Quartz 0·10=99·17, Kerl.	
52.	Katharinenburg, G. 18·79,	95·81	3·58 Cu, Fe and loss 0·61, Awd.	
53.	California,	96·42	3·58=100, A D. Thomas.	
54.	Schabrowski, near Katharinenburg, G.=19·099	98·96	0·16=99·12, Rose.	

The Californian gold averages 875 to 885 thousandths in gold, and the Australian 960 to 966 thousandths.

The Chilian gold afforded Domeyko 84 to 96 per cent. of gold and 15 to 3 per cent. of silver, (Ann. d. Mines, [4], vi).

Copper is occasionally alloyed with gold, and also palladium and rhodium. A Brazilian specimen of *Palladium* gold (*Porpezite*) from a place called Porpez, afforded Berzelius, Gold 85·98, palladium 95·8, silver 4·17. Gold amalgam has been reported from California, especially near Mariposa.

Rhodium gold has the specific gravity 15·5—16·8. It is brittle, and contains, according to Del Rio, 34 to 43 per cent. of rhodium. The mineral nagyagite contains 8 to 9 per cent. of gold.

Native gold is largely obtained from alluvial washings. It is also found disseminated in certain rocks, especially the quartz veins that intersect talcose, mica, and argillaceous schists. It is sometimes found also in gneiss, granite, and porphyry. It is often contained in pyrites, constituting the *auriferous* pyrites. The detritus affording gold dust has proceeded from some gold-bearing-rocks.

Gold is widely distributed over the globe. It occurs in Brazil, (where formerly a greater part of that used was obtained), along the chain of mountains which runs nearly parallel with the coast, especially near Villa Rica, and in the province of Minas Geraes; in New Grenada at Antioquia, Choco, and Giron; in Chili; sparingly in Peru; in Mexico; in New Mexico, near Santa Fe, Cerillos, Avo; in Guatemala, and near Panama; in the Rocky Mountains, near the Great Salt Lake; in California, between the Sierra Nevada and the Sacramento and San Joaquim; in the southern of the United States. In Europe it is most abundant in Hungary at Konigsberg, Schemnitz, and Felsobanya, and in Transylvania at Kapnik, Vöröspatak, and Offenbanya; it occurs also in the sands of the Rhine, the Reuss, and the Aar; on the southern slope of the Pennine Alps from the Simplon and Monte Rosa to the valley of Aosta; in Piedmont; in Spain, formerly worked in Asturias; in many of the streams of Cornwall; near Dolgelly and other parts of North Wales; in Scotland, in considerable amount, near Leadhills, and in Glen Coich and other parts of Perthshire; in the county of Wicklow, Ireland; in Sweden, at Edelfors.

In the Urals are valuable mines at Beresof, and other places on the eastern or Asiatic flank of this range, and the comparatively level portions of Siberia; also in the Altai mountains. Also in the Cailas mountains in Little Thibet.

There are mines in Africa, at Kordofan, between Darfour and Abyssinia; also south of Sahara in the western part of Africa, from the Senegal to Cape Palmas; also in the interior on the Somat, a day's journey from Cassen; also along the coast opposite Madagascar, between 22 and 35 degrees south latitude, supposed to have been the *Ophir* of the time of Solomon. Other regions are China, Japan, Formosa, Ceylon, Java, Sumatra, western coast of Borneo, and the Philippines.

The gold of commerce comes mostly from Asiatic Russia, Australia, Brazil, Bohemia, Transylvania, Africa, the East India Islands, California, and the southeastern parts of the United States.

The Russian mines, until the discovery of the mines of California and Australia, were the most productive in the world. They are principally alluvial washings, and these washings seldom yield less than 65 grains of gold for 4000 pounds of soil; never more than 120 grains. The alluvium is generally most productive where the loose material is most ferruginous. The mines of Katherinenburg are in the parent rock—a quartz constituting grains in a half decomposed granite called "beresite," which is connected with talcose and chloritic schists. The shafts are sunk vertically in the beresite, seldom below 25 feet, and from them lateral galleries are run to the veins. These mines afforded between the years 1725 and 1841, 679 poods of gold, or about 30,000 pounds troy. The whole of the Russian mines yielded in 1842, 970 poods of gold, or 42,000 pounds troy, half of which was from Siberia, east of the Urals. In 1843, the yield was nearly 60,000 pounds troy, or about $13,000,000; in 1845, it amounted to $13,250,000; and in 1846, to 1722·746 poods, equal to 75,353 troy pounds, and $16,500,000; in 1851, $15,000,000. Fig. 263 is by G. Rose from a Ural crystal.

At the Transylvania mines of Vöröspatak, the gold is obtained by mining, and these mines have been worked since the time of the Romans.

The annual yield of Europe, exclusive of Russia, is not above $1,000,000. Austria afforded in 1844, 6785 marks. The sands of the Rhone, Rhine, and Danube, contain gold in small quantities. The Rhine has been most productive between Bâle and Manheim; but at present only $9000 are extracted annually. The sands of the richest quality contain only about 56 parts of gold in a hundred millions; sands containing less than half this proportion are worked. The whole amount of gold in the auriferous sands of the Rhine is estimated at $30,000,000, but it is mostly covered by soil under cultivation.

Africa yields annually at least 4500 pounds troy, ($850,000), and Southern Africa, 1250 pounds, ($235,000).

The mines of South America and Mexico were estimated by Humboldt to yield annually about $11,500,000; but the amount has much diminished. Brazil of late has furnished about 17,500 pounds troy. It is estimated that between 1790 and 1830, Mexico produced $31,250,000 in gold, Chili $13,450,000, and Buenos Ayres $19,500,000, making an average annual yield of $16,050,000.

The mines of Australia yield 60 or 80 millions of dollars a year. They are situated mostly in southeastern Australia, especially about Mt. Alexander, in lat. 37° S., long. 144° 20′ E; the valleys of Forest Creek and Fryer's Creek are most productive.

The mines of the Southern United States have produced till recently about a million of dollars a year. They are mostly confined to the States of Virginia, North and South Carolina, and Georgia, or along a line from the Rappahannock to the Coosa in Alabama. But the region may be said to extend north to Canada; for gold has been found at Albion and Madrid in Maine, Canaan, N. H., Bridgewater, Vermont, Dedham, Mass., and on the Chaudière river, and elsewhere in Canada. Traces occur also in Franconia township, Montgomery Co., Pennsylvania.

In *Virginia*, the principal deposits are in Spotsylvania county, on the Rappahannock, at the United States mines, and at other places to the southwest; in Stafford county, at the Rappahannock gold mines, ten miles from Falmouth, in the Culpepper county, at Culpepper mines, on Rapidan river; in Orange county, at the Orange Grove gold mine, and at the Greenwood gold mines; in Goochland county, at Moss and Busby's mines; in Louisa county, at Walton's gold mine; in Buckingham county, at Eldridge's mine. In *North Carolina*, the gold region is mostly confined to the three ranges of counties between Frederick and Charlotte, which are situated about in a line running northeast and southwest, parallel nearly with the coast.

The mines of Mecklenburg are principally vein deposits; those of Burke, Lincoln, and Rutherford, are mostly in alluvial soil. The Davidson county silver mine had afforded $7000 of gold in 1844. In *Georgia*, the Shelton gold mines in Habersham county have long been famous; and many other places have been opened in Rabun and Hall counties, and the Cherokee country. In *South Carolina*, the principal gold regions are the Fairforest in Union district, and the Lynch's creek and Catawba regions, chiefly in Lancaster and Chesterfield districts; also in Picken's county, adjoining Georgia. There is gold also in eastern *Tennessee.* In Canada, it occurs at St. Francois Beauce, Aubert, Gallion, Sherbrooke, Melbourne, etc., with some platinum and iridosmine.

Viewing the gold region of the Eastern United States as a whole, it is perceived that it ranges along the Appalachians, particularly the eastern slope, from Maine to Alabama, having nearly a northeast and southwest course.

Gold also occurs in Arkansas, Texas, and the Rocky Mountains.

The California mines are mostly alluvial. They yield 50 millions of dollars annually. The gold is found in the gravel and sand of the valleys, and beds of streams leading from the Sierra Nevada into the adjoining valley of the Sacramento and San Joachim. Pebbles of quartz abound over the region, and magnetic iron sand is also abundant. All the tributaries of these rivers have their auriferous sands, and the dry valleys and gorges, (runs of water only in the wet season), also yield it abundantly. In the higher country, or along the dry ravines, the gold is in larger pieces, or grains, and occasionally cavities in the surface of the subjacent rocks, (called pockets), are laid open, which afford large quantities of the metal. Lower down the streams, the gold is in finer grains, usually flattened scales, a form which partly results from the condition in laminæ in the original rock, and partly from the trituration the grains are subjected to among the gravel under the action of running water; for as in other regions of alluvial gold, the auriferous earth, or gravel, has resulted from the wear of auriferous rocks, and water has been some way concerned in producing, transporting, and distributing it. The gold being specifically four or five times heavier than ordinary pebbles, it settles high up the streams, and only the small particles are carried far below. The scales have been observed by Mr. J. E. Teschemacher to be sometimes hexagonal plates. Zircons have been observed in the auriferous sands, and also platinum; diamonds have been reported. Fig. 262 represents a crystal of gold of natural size, as published by F. Alger. C. U. Shepard describes another crystal from California which is a pentagonal dodecahedron two fifths of an inch in diameter. The color of the grains varies from a pale to a deep yellow, the shade depending mainly on the proportion of silver present; there is generally great uniformity in the appearance of the grains of the same locality,

The gold rock of the United States is to a great extent a micaceous or talcose schist, with veins or beds of quartz. The gold is mostly confined to these veins, though also found to some extent in the rock either side. The schist is often half decomposed or rusted. The quartz is usually more or less cellular, or wanting in perfect compactness, and sometimes tabular; yet it is at times quite solid. Iron pyrites is frequently present, and by decomposition it stains the rock with iron rust. Other minerals often associated with the gold, are copper pyrites, blende, galena, anglesite, zircons, sulphur, (in minute crystals, proceeding from the decomposition of pyrites). Heavy spar is sometimes a large constituent of the vein, and fluor spar is now and then present. The peculiar appearance of the quartz, somewhat cellular, more or less rusted, and its position in veins, through an imperfect shale, and generally not firmly attached to the enclosing walls, afford the best indications of the presence of gold, though the absence of all these conditions is not evidence that no gold is to be found. The grains of gold may sometimes be seen in the cavities of the quartz, or it sparkles on a surface of fracture. But very commonly a mass of quartz that shows nothing to the eye, yields gold on trial.

The same kinds of rock and veins of quartz were observed by the author in 1842 near the Umpqua river, Southern Oregon, and pebbles from similar rocks were met with along the Sacramento; and the resemblance to other gold districts was remarked at the time; but there was no opportunity for exploring the country where gold has since been found.

Masses of gold of considerable size have been found in North Carolina. The largest was discovered in Cabarras Co.; it weighed twenty-eight pounds avoirdupois, ("steel-yard weight," equals 37 lbs. troy), and was 8 or 9 inches long by 4 or

5 broad, and about an inch thick. The largest mass yet reported from California weighed 20 pounds. In Paraguay, pieces from 1 to 50 pounds weight were taken from a mass of rock which fell from one of the highest mountains. Several specimens weighing 16 pounds have been found in the Ural, and one of 27 pounds; and in the valley of Taschku Targanka, in 1842, a mass was detached, weighing very nearly 100 pounds troy. This mass is now in the Museum of Mining Engineers at St. Petersburgh. A mass found recently in Australia had the enormous weight of 134 lbs. 7 oz., and afforded 109 lbs. 11 oz. of fine gold; it sold for £5,532. Another of 27 lbs. 6 oz. 15 dwts. was obtained at Forest Creek, South Australia.

An examination of a gold rock for gold is a simple process. The rock is first pounded up fine and sifted; a certain quantity of the sand thus obtained is washed in a shallow iron pan, and as the gold sinks, the material above is allowed to pass off into some receptacle. The largest part of the gold is thus left in the angle of the pan; by another similar process a further portion is obtained; and when the bulk of sand is thus reduced to a manageable quantity, the gold is amalgamated with clean mercury; the amalgam is next strained to separate any excess of mercury, and finally is heated and the mercury expelled, leaving the gold. In this way, by successive trials with the rock, the proportion of gold is quite accurately ascertained. It is the same process used with the larger washings, though on a small scale. Mercury unites readily with gold, and thus separates it from any associated rock or sand; and it is employed in all extensive gold washings, though much gold may be often obtained by simple washing without amalgamation.

The operation of hand washing is called in Virginia *panning*. With a small iron pan, they wash the earth in a tub or in some brook, and thus extract much gold from the gravel or soil, which is said to *pan well* or *pan poorly*, according to the result. Masses of quartz, with no external indication of gold, examined in the above way at a Virginia mine, afforded an average of more than eight dollars to the bushel of gold rock.

When gold is alloyed with copper or silver, the mode of assay for separating the copper depends on the process of cupellation; and that for separating the silver, on the power of nitric acid to dissolve silver without acting on gold. (See chapter on chemical reactions).

The uses of gold are well known; and also that it owes a great part of its value to its extreme malleability, and the fact of its not tarnishing on exposure. Although a costly metal, it is one of the cheapest means of ornament, on account of the thinness of the leaves into which it may be beaten. A grain of the metal may be made to cover 56¾ square inches of surface, and the thinnest leaf is but 1,280,000th of an inch thick.

Perfectly pure gold is denominated gold of 24 *carats*, or *fine* gold. If it contains 22 parts of pure gold to 2 of silver, or 1 of copper and 1 of silver, it is said to be 22 carats fine; so also for 20 carats fine, it contains 20 parts of pure gold. The carat is divided into $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$ parts, for a more minute specification of the quantity of gold.

The standard of gold of the United States consists of 900 parts of gold to 100 of an alloy of copper and silver. The eagle (10 dollars) contains 232 grains of fine gold.

PLATINUM. Gediegen Platina, *W.* and *L.* Polyxen, *Haus.* Platine Natif, *H.*

Monometric. Rarely in cubes, usually in grains, and occasionally in irregular lumps. Cleavage none.

H.=4—4·5. G.=16—19, 17·862, 17·759, two masses, G. Rose, 17·200, a smaller; 17·108, small grains, Breit.; 17·608, a mass, Breit.; 17·60, large mass from Nischne Tagilsk, Sokoloff. Lustre metallic. Color and streak whitish steel-gray; shining. Opaque. Ductile. Fracture hackly.

Composition.—Platinum combined with iron, iridium, and other metals. Analysis; 1—4, Berzelius, (K. V. Ac. H. 1828, 113); 5, 6, Osann, (Pogg. viii, 505, xi, 411, xiii, 283, xiv, 329, xv, 158); 7, 8, Svanberg, (Jahresb. xxiii, 273):

	Plat.	Fe	Irid.	Rhod.	Pal.	Os	Cu	
1. Columbia,	84·30	5·31	1·46	3·46	1·06	1·03	0·74,	quartz 0·6, Ċa 0·12=98.08, Berz.
2. Goroblago't,	86·50	8·32	——	1·15	1·10	——	0·45,	Ir. Os 1·40=98·92,[a] Berzelius.
3. N. Tagilsk,	78·94	11·04	4·97	0·86	0·28	——	0·70,	" 1·96=98·75,[a] Berzelius.
4. "	73·58	12·98	2·35	1·15	0·30	——	5·20,	" 2·30=97·86,[a] Berzelius.
5. "	83·07	10·79	1·91	0·59	0·26	——	1·30,	" 1·80=99·72, Osann.
6. Ural,	80·87	10·92	0·06	4·44	1·30	——	2·30,	" 0·11=100,, Osann.
7. Choco,	86·16	8·03	1·09	2·16	0·35	0·97	0·40,	" 1·91, Mn 0·10=101·17, Sv.
8. Pinto ?	84·34	7·52	2·52	3·13	1·66	0·19	*trace*,	" 1·56, " 0·31=101·23, Sv.

[a] Loss partly osmium.

Svanberg makes the Platinum of Nos. 2, 7, 8=Fe Pt^3; of No. 1, (Barbaçoa, Columbia), Fe Pt^4; of 3, 4, 5=Fe Pt^2. The last is called Iron Platinum (Eisenplatin) G.=14·6—15·8, H.=6.

B.B. infusible. Soluble only in heated nitro-muriatic acid. Acts slightly on the magnet; but this property depends on the amount of iron it contains.

Platinum was first found in pebbles and small grains, associated with iridium, rhodium, osmium, palladium, gold, copper, and chrome, in the alluvial deposits of Brazil, Choco, and Barbaçoa, in South America, where it received its name, *platina*, from *plata, silver*, of which word platina is a diminutive. Occurs at Nischne Tagilsk, and Goroblagodat, in the Ural, here, (as elsewhere), in alluvial or drift material; the gravel has been traced to a great extent up Mount La Martiane, which consists of crystalline rocks. It has been formed into coins of eleven and twenty-two rubles each, by the Russians, which are not a legal tender, but pass conventionally, and principally in the southern provinces of the empire. Russia affords annually about 800 cwt. of platinum, which is nearly ten times the amount from Brazil, Columbia, St. Domingo, and Borneo. The amount coined from 1826 to 1844, equaled 2½ millions of dollars. Platinum is also found on Borneo; in the sands of the Rhine; at St. Aray, val du Drac; county of Wicklow, Ireland; on the river Jocky, St. Domingo; in the California gold region; in traces with gold in Rutherford Co., North Carolina; at St. Francois Beauce, etc., Canada East. Borneo affords 600 to 800 pounds per year.

Although platinum generally occurs in quite small grains, masses are sometimes found of considerable magnitude. A mass, weighing 1088 grains, was brought by Humboldt from South America, and deposited in the Berlin museum; specific gravity 18·94. In 1822 a mass from Condoto was deposited in the Madrid museum, measuring two inches and four lines in diameter, and weighing 11,641 grains. A specimen was found in the year 1827, in the Ural, not far from the Demidoff mines, which weighed 10 $\frac{9}{16}$ Russian pounds, or 11·57 pounds troy, and similar masses are not uncommon; the largest yet seen weighed 21 pounds troy, and is in the Demidoff cabinet.

The infusibility of this metal, and its property of resisting the action of the air and moisture, and nearly all chemical agents, render it highly valuable for the construction of philosophical and chemical apparatus; for vessels for the concentration of sulphuric acid; for crucibles and capsules in chemical analysis; for covering other metals, and for painting on porcelain. It may be drawn into wire of extreme tenuity; Dr. Wollaston succeeded in obtaining a wire not exceeding the two thousandth of an inch in diameter.

The metal platinum was first discovered by Ulloa, a Spanish traveler in America, in the year 1735.

This metal fuses readily before the "compound blowpipe;" and Dr. Hare succeeded in 1837 in melting twenty-eight ounces into one mass. The metal was almost as malleable and as good for working as that obtained by the other process; it had a specific gravity of 19·8. He afterwards succeeded in obtaining from the ore masses which were 90 per cent. platinum, and as malleable as the metal in ordinary use, though somewhat more liable to tarnish, owing to some of its impurities.

PLATINIRIDIUM, *Svanberg*. Native Iridium.

In small grains with Platinum; sometimes in cubes with truncated angles, (f. 15). H.=6—7; G.=22·6—23. Color white.

Composition.—Platinum and iridium in different proportions. Analyses by Svanberg, (Jahresb. xv, 205):

	Irid.	Plat.	Pallad.	Rhod.	Fe	Cu	Os
1. N. Tagilsk,	76·80	19·64	0·89	——	——	1·78	——=99.11.
2. Brazil,	27·79	55·44	0·49	6·86	4·14	3·30	*trace*=98·02.

Prinsep, in a specimen from Ava in India, found 60 of iridium and 20 of platinum. If platinum and iridium are isomorphous, it is probable that the proportions of these metals are indefinite. Dr. Genth, after some trials, considers some grains occurring with the California gold to be Platiniridium. Am. J. Sci. [2], xv, 246.

PALLADIUM.

Monometric. In minute octahedrons, Haid. Mostly in grains sometimes composed of diverging fibres.

H.=4·5—5. G.=11·8, Wollaston; 12·14, Lowry. Lustre metallic. Color whitish steel-gray. Opaque. Ductile and malleable.

Composition.—Palladium, alloyed with a little platinum and iridium. Infusible alone before the blowpipe, but fuses readily with sulphur. By continuing the heat, the sulphur is driven off, and a globule of palladium obtained.

Palladium occurs with platinum, in Brazil. Quite large masses of the metal are brought from that country. It is extracted from the auriferous sands by first fusing it with silver, and consequently forming a quaternary alloy of gold, palladium, silver, and copper, which is granulated by projecting it into water. By means of nitric acid all but the gold is dissolved; and from the solution, the silver is first precipitated by common salt as an insoluble chlorid, and then, after separating the chlorid, the palladium and copper are precipitated by plates of zinc. This precipitate is redissolved in nitric acid, an excess of ammonia added, and then hydrochloric acid sufficient to saturate; a double chlorid of palladium and ammonium is deposited as a crystalline yellow powder, which on calcination produces spongy palladium. The metal is malleable and when polished has a splendid steel-like lustre, which does not tarnish. A cup weighing 3¼ pounds was made by M. Breant for the mint of Paris, and is now in the *garde-meuble* of the French government. One part fused with six of gold forms a white alloy; and this compound was employed at the suggestion of Dr. Wollaston, for the graduated part of the mural circle, constructed by Troughton for the Royal Observatory at Greenwich. It has been employed for balances and mathematical and surgical instruments.

A brown ochreous substance associated with the Palladium Gold of Brazil, has been considered a *Palladium Ochre* or oxyd. It is soluble in muriatic acid. Detected by Johnson and Lampadius, (J. f. pr. Chem. xi, 309).

HEXAGONAL PALLADIUM.—The native palladium also occurs in small hexagonal tables, with perfect lateral cleavage: Color pale steel-gray; lustre bright. Occurs at Tilkerode. It is the Selenpalladite of Zinken.

QUICKSILVER. Native Mercury. Gediegen Quecksilber. Mercure Natif, *H.* Hydrargyrum. Argentum Vivum. Spuma argenti. Liquor Æternalis, *Pliny.* Mercurius of the Alchemists.

Monometric. Occurs in small fluid globules scattered through its gangue.

G.=13·568. Lustre metallic. Color tin-white. Opaque.

Composition.—Pure mercury, (Hg); with sometimes a little silver.

Entirely volatile before the blowpipe, vaporizing at 662° F.: becomes solid at —39° F., and may be crystallized in octahedrons. Dissolves readily in nitric acid.

Mercury in the metallic state is a rare mineral; the quicksilver of commerce is mostly obtained from cinnabar, one of its ores. Its most important mines are those of Idria in Carniola, and Almaden in Spain. At Idria it occurs interspersed through a kind of clay slate, from which it is obtained by washing. It is found in small quantities at Wölfstein and Mörsfeld, in the Palatinate, in Carinthia, Hungary, Peru, and other countries; also at Peyrat le Chateau, in the department of the Haute Vienne, in a disintegrated granite, unaccompanied by cinnabar; in California.

AMALGAM. Mercure argentif, *H.* Naturlich Amalgam, *W.*

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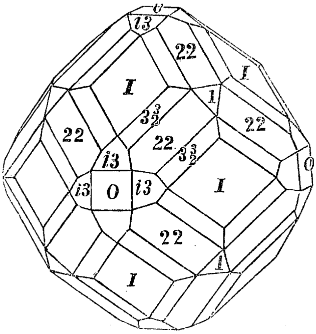

Monometric. Observed planes, as in the annexed figure, with also plane 2. Figure 14 common; also 17, 18, 19, 37, 43, 44. Cleavage: dodecahedral, in traces. Also massive.

H.=3—3·5. G.=10·5—14; 13·755, Haid. Color and streak silver-white. Opaque. Fracture conchoidal, uneven. Brittle, and giving a grating noise when cut with a knife.

Composition.—Both $Ag\ Hg^2$ (=Silver 34·8, quicksilver 65·2), and $Ag\ Hg^3$ (=Silver 26·25, and quicksilver 73·75), are here included as afforded by the following analyses: 1, Klaproth, (Beit. i, 182); 2, Cordier, (Jour. d. Mines, xii, 1, and Phil. Mag. xix, 41); 3, Heyer, (Crell's Annal. ii, 90):

		Silver.	Mercury.
1. $Ag\ Hg^2$,	Moschellandsberg	36	64 =100, Klaproth.
2. $Ag\ Hg^3$,	Allemont?	27·5	72·5=100, Cordier.
3. "	Moschellandsberg,	25·0	73·3=98·3, Heyer.

B.B. the mercury volatilizes and silver is left. Dissolves in nitric acid. Rubbed on copper it gives a silvery lustre.

From the Palatinate at Moschellandsberg, in fine crytals, and said to occur where the veins of mercury and silver intersect one another. Also reported from Rosenau in Hungary, Sala in Sweden, Allemont in Dauphiné, Almaden in Spain, and in crystals in Chili.

ARQUERITE, *Berthier.*—The arquerite is a silver amalgam from the mines of Arqueros near Coquimbo. Occurs crystallized. According to Domeyko, (Compt. Rend. xiv, 567), it has the formula $Ag^6\ Hg$=Silver 86·49, mercury 13·51=100.

GOLD AMALGAM, *H. Schneider*, J. f. pr. Chem. xliii, 317.

In small white grains as large as a pea, easily crumbling.

Composition.—$(Au, Ag)^2\ Hg^5$. Analysis by Schneider,

Mercury 57·40, Gold 38·39, Silver 5·0.

From the platinum region of Columbia, along with platinum. Reported from California, especially near Mariposa.

SILVER. Gediegen Silber, *W.* Argent Natif, *H.*

Monometric. Observed planes *O*, 1, *I*, *i*2, *i*4, 33. Figs. 1, 11, 15, 16, 33, 40. Cleavage none. Compound crystals, f. 200. Usually coarse and fine filiform, reticulated or arborescent; also in plates, and in superficial coatings.; also in masses.

H.=2·5—3. G.=10·1—11·1, when pure 10·5. Lustre metallic. Color and streak silver-white; subject to tarnish, by which the color becomes grayish-black. Ductile.

Composition.—Silver, with some copper, gold, platinum, antimony, and other metals. Berthier found in a specimen from Curcy, near Caen, (Ann. d. Mines, xi, 72), silver 90, copper 10. Fordyce found in an alloy, silver 72, gold 28; and Klaproth, silver 36, gold 64; and under gold, many other combinations of these metals are given. John detected 1 per cent. of antimony in silver from Johanngeorgenstadt, besides traces of copper and arsenic. A *bismuth-silver* from Copiapo, S. A., contained 16 per cent. of bismuth. The Kongsberg native silver contains some per cent. of mercury, which accounts for its whiteness, and perhaps for its fine crystallization, (Sæmann).

B.B. fuses rather easily, and often crystallizes on cooling. Soluble in nitric acid, and again deposited by a plate of copper.

Native silver occurs in masses or in aborescences and filiform shapes, in veins of calcareous spar or quartz, traversing gneiss, slate, and other ancient rocks. The filiform varieties are often composed of one or more series of octahedrons, either closely united or arranged linearly in straight rows. This structure is apparent in most of the Norwegian and Mexican varieties.

The mines of Kongsberg in Norway, have afforded magnificent specimens of native silver. One specimen among the splendid suite from this locality in the royal collection at Copenhagen, weighs upwards of 5 cwt., and recently two masses have been obtained weighing severally 238 and 436 pounds. The principal Saxon localities are at Freiberg, Schneeberg, and Johanngeorgenstadt; the Bohemian, at Przibram, and Joachimstahl. It also occurs in small quantities with other ores, at Andreasberg, in the Hartz, in Suabia, Hungary, at Allemont in Dauphiny, in the Ural near Beresof, in the Altai at Schlangenberg, and in some of the Cornish mines.

Mexico and Peru are at present the most productive countries in silver. In Mexico it has been obtained mostly from its ores, while in Peru it occurs principally native. A Mexican specimen from Batopilas weighed when obtained 400 pounds; and one from Southern Peru, (mines of Huantaya), weighed over 8 cwt. During the first eighteen years of the present century, more than 8,180,000 marks of silver were afforded by the mines of Guanaxuato alone.

In the United States it is disseminated through much of the copper of Michigan, occasionally in spots of some size, and sometimes in cubes, according to J. D. Whitney, at Copper Falls Mine. It has been observed at a mine a mile south of Sing Sing prison, which was formerly worked for silver; at the Bridgewater copper mines, New Jersey; in interesting specimens at King's mine, Davidson Co., N. C.; at Prince's location, Lake Superior, Canada.

Altered Forms.—Pseudomorphs, consisting of horn silver and silver glance. The last may proceed from the action of hydrosulphurets or sulphuretted hydrogen.

BISMUTH SILVER. Bismuthic Silver Ore. Wismuthsilbererz. Wismuthbleierz, *Haus.* Silberwismuthglanz. Bismuth Sulfuré Plombo-Argentifère, *Levy.*

Rarely presents acicular or capillary crystallizations; generally amorphous.

Soft. Lustre metallic. Color tin-white or grayish; subject to tarnish. Opaque. Fracture uneven. Sectile.

Composition.—Analysis by Klaproth, (Beit. ii, 291),

Bismuth 27, Lead 33, Silver 15, Iron 4·3, Copper 0·9, Sulphur 16·3.

Soluble in nitric acid. B.B. fuses readily to a silver button, covering the charcoal with the oxyds of lead and bismuth, and giving fumes of sulphur.

Bismuth silver accompanies copper pyrites, in amorphous masses, at Schapbach, in Baden; also in the cupreous shale of Mansfeld, Thuringia. It was formerly worked as an ore of silver.

A *bismuth silver* from the mine of San Antonio, near Copiapo, Chili, afforded Domeyko, (Ann. d. Mines, [4], vi, 165),

Silver	Bismuth	Copper	Arsenic	
60·1,	10·1,	7·8,	2·8,	gangue 19·2.

It occurs disseminated and has one or more perfect cleavages, and is probably either monometric or rhombohedral.

COPPER. Gediegen Kupfer. Cuivre Natif, *H.* Venus, *Alchem.*

Monometric. Observed forms O, 1, I, $i2$, $i\frac{5}{2}$, 33. Fig. 1, 11, 14, 15, 16, 17, 18, 32, 33, and others. Cleavage none. Twins, composition-face octahedral. Usually massive and also arborescent, filiform, or in films.

H.=2·5—3. G.=8·94, when pure. Lustre metallic. Color copper-red. Streak metallic shining. Ductile and malleable. Fracture hackly.

Composition.—Pure Copper; but often containing native silver disseminated through it. B.B. fuses readily; on cooling, it is covered with a coating of black oxyd. Dissolves readily in nitric acid, with the extrication of the red fumes of nitrous acid, and produces a blue solution with ammonia.

Copper occurs in beds and veins accompanying its various ores, and sometimes associated with iron. It is frequently found in loose masses imbedded in the soil.

In Siberia, and the island of Nalsoe, in Faroe, it is associated with mesotype, in amygdaloid, and though mostly disseminated in minute particles, sometimes branches through the rock with extreme beauty. Common in Cornwall, at many of the mines near Redruth; and also in considerable quantities at the Consolidated mines, Wheal Buller, and others. Brazil, Chili, and Peru afford native copper; a mass now in the museum at Lisbon, supposed to be from a valley near Bahia, weighs 2616 pounds.

This metal has been found native throughout the red sandstone region of the eastern United States, particularly in Massachusetts, Connecticut, and more abundantly in New Jersey, where it has been met with sometimes in fine crystalline masses, especially at Brunswick, Somerville, Schuyler's mines, and Flemington. One mass from near Somerville, on the premises of J. C. Van Dyke, Esq., of Brunswick, weighed 78 pounds, and is said originally to have weighed 128. Near Brunswick a vein or sheet of copper, a line or so thick, has been traced for several rods. Near New Haven, Conn., a mass was formerly found weighing 90 pounds.

No known locality exceeds in the abundance of native copper, the Lake Superior copper region, near Kewenaw Point, where it exists in veins that intersect the trap and sandstone. Masses of great size were observed in this district near the Ontanagon river, by Mr. Schoolcraft, in 1821. A large mass was thrown down in the Lake Superior region, July 8th, 1853, at the North American mine; it was about 40 feet long, and its estimated weight was 200 tons. This copper contains intimately mixed with it about $\frac{3}{10}$ per cent. of silver; often this metal is in visible grains, lumps, or strings, and occasionally a mass of copper when polished, appears sprinkled with large silver spots, resembling, as Dr. Jackson observes, a porphyry with its feldspar crystals. The copper occurs in trap or sandstone, near the junction of these two rocks, and has probably been produced through the reduction of copper ores. Strings of copper often reticulate through crystals of analcime and prehnite.

The copper of Chili also contains silver, and sometimes 7 to 8 per cent.

NATIVE LEAD. Plomb Natif, *H.* Gediegen Blei, *W.*

Monometric. Found in thin plates and small globules.

H.=1·5. G.=11·445, when pure. Lustre metallic. Color lead-gray. Malleable and Ductile.

Composition.—Pure lead. Fuses easily, covering the charcoal with a yellow oxyd.

This species is reported as occurring in globules in galena at Alstonmoor; in lava in Madeira, Rathke; at the mines near Carthagena in Spain; in carboniferous limestone near Bristol, and at Kenmare, Ireland; recently, according to R. P. Greg, Jr., in thin sheets in red oxyd of lead near a basaltic dyke in Ireland.

IRON. Gediegen Eisen, *W.* and *L.* Fer Natif, *H.* Mars, *Alchem.*

Monometric. Cleavage octahedral.

H.=4·5 G.=7·3—7·8; rarely as low as 6 in meteorites; 7·318 a partially oxydized fragment of a crystal of meteoric iron from Guilford Co., N. C. Lustre metallic. Color iron-gray. Streak shining. Fracture hackly. Ductile. Acts strongly on the magnet.

Native iron, supposed to be of terrestrial origin, has been observed at Canaan, Conn., (Am. Jour. Sci. xii, 154, and [2], v, 292), where it is said to have been found in a vein or plate, two inches thick, attached to a mass of mica-slate rock. It contained graphite in the broad laminæ into which it was divided; and it had no obvious crystalline structure, nor was any developed by etching with nitric acid, as in most meteoric irons.

Foreign specimens are also reported to have been found. Cramer describes one weighing four pounds, obtained in the mine of Hackenburg. It is said to have been observed in thin laminæ in an iron stone conglomerate in Brazil and in lava in Auvergne; also in the keuper in Thuringia, in an argillaceous sandstone, containing fossils. It afforded but a trace of nickel: G.=5·24, (Pogg. lxxxviii, 1853, 145, where other localities are mentioned).*

The presence of metallic iron in grains in basaltic rocks (from Giant's Causeway, etc.,) has been announced by Dr. Andrews. After pulverizing the rock and separating by means of a magnet the grains that were attracted by it, he subjected the grains to the action of an acid solution of sulphate of copper in the field of a microscope, which salt, when there is a trace of *pure* iron present, gives a deposit of copper; and in his trials there were occasional deposits of copper in crystalline bunches.

Meteoric iron usually contains 1 to 20 per cent. of nickel, besides a small per centage of other metals, as cobalt, manganese, tin, copper, chromium; also phosphorus common as a phosphuret, sulphur in sulphurets, carbon in some instances, chlorine.

For a review of papers on meteoric iron, see Rammelsberg's Handwörterbuch of Chemical Mineralogy, 422, and Supplements, ii, 90, iii, 80, iv, 151, v, 1, especially the last, which is a general account of the subject with full citations of analyses; also Kengott's Mineralogischen Forschungen, for 1844—1849, p. 222, and 1850—1851, p. 135; also Dissertation on Meteoric Irons, by W. S. Clarke, Lieb. u. W. Ann. lxxxii, 367, reviewed in Am. J. Sci. [2], xv, 7; various papers in Am. J. Sci. by C. U. Shepard, especially, in [2] vols. ii, iv, vi, x; and a recent paper by J. Lawrence Smith in vol. xvii. The following are a few analyses; 1, Berzelius, (K. V. Ac. H. 1834, Pogg. xxxiii, 123); 2, Bergemann, (Pogg. lxxviii, 406); 3, W. S. Clarke, (loc. cit.), 4, v. Holger, (Baumg. Zeits. ix, 323, and Pogg. xxvii, 118).

	1 Siberia.	2 Zatatecas, Mexico.	3 Lenarto.	4 Bohumilitz.
Iron,	88·042	85·09	90·153	86·67
Nickel,	10·732	9·89	6·553	8·12
Cobalt,	0·455	0·67	0·502	0·59
Manganese,	0·132	——	0·145	0·46
Copper, Tin,	0·066	0·03	0·080	Be 0·12
Magnesium,	0·050	0·19	0·082	Al 0·32
Carbon,	0·043	C, Fe 0·33	——	Ca 0·41
Sulphur,	*tr*	0·84	0·482	——
Fe, Ni, P.,		1·65	1·226	——
Chromiron,		1·48	——	——
Gangue,	0·480	——	——	1·34
	100·000	100·33	99·223	98·16

One of the most extraordinary of these iron meteorites, preserved in any collection, is now in the Yale College cabinet. It weighs 1635 lbs.; length three feet four inches; breadth two feet four inches; height one foot four inches. It has been analyzed by C. U. Shepard, (Am. Jour. Sci. xvi, 217), also by B. Silliman, Jr., and

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* The supposed terrestrial native iron of Schooley's mountain referred to in this paper is known to be nothing but a furnace slag.

found to contain Iron 90·02 to 92·912, nickel 8·80 to 9·674. The crystalline structure of this iron is very remarkable as developed by nitric acid on a polished surface. Silliman has observed that the nickel is segregated along the lines of crystallization, and that it is not uniformly alloyed with the iron, as had been previously supposed, (communicated to the author). It was brought from Red river. Still more remarkable masses exist in South America; one was discovered by Don Rubin de Celis in the district of Chaco-Gualamba, whose weight was estimated at 30,000 lbs., and another was found at Bahia in Brazil, whose solid contents are at least twenty-eight cubic feet, and weight 14,000 lbs. The Siberian meteorite, discovered by Pallas, weighed originally 1600 lbs. and contained imbedded crystals of chrysolite. Smaller masses are quite common. Meteoric iron is perfectly malleable, and may be readily worked into cutting instruments, and put to the same uses as manufactured iron.

M. Bahr has observed grains of native iron in a fragment of petrified wood. The iron was mixed with limonite and organic matter, and is supposed to have been produced by the deoxydation of a salt of iron by the organic matter of the wood. He calls the iron *Sideroferrite.*

NATIVE TIN.

Dimetric. 1 : 1 (over basal edge)=57° 13′, over pyramidal =140° 25′, $1i : 1i$ (over basal edge)=42° 11′, over pyramidal=150° 31′; a=0·38566. Reported as occurring in small grayish-white metallic grains along with the Siberian gold.

Composition.—Tin with some lead. *Hermann,* J. f. pr. Ch. xxxiii, 300.

The above angles are from artificial crystals galvanically deposited, measured by Miller.

ARSENIC GROUP.

1. Arsenic Section: Hexagonal or rhombohedral. Iridosmine, including Newjanskite, (Ir, Rh) Os, and Sisserskite, $Ir\,Os^4$; Tellurium, Te; Bismuth, Bi; Tetradymite, (Te, Bi); Antimony, Sb; Arsenic, As; Arsenical Antimony, (Sb, As.)
2. Sulphur Section: Trimetric or monoclinic. Sulphur, S; Selenium, Se.

IRIDOSMINE. Native Iridium. Osmium-Iridium. Irid-osmium. Newjanskite, *Haid.* Sisserskite, *Haid.*

Hexagonal. Rarely in hexagonal prisms with replaced basal edges; pyramidal angle, 127° 36′, basal, 124°. Commonly in irregular flattened grains.

H.=6—7. G.=19·3—21·12. Lustre metallic. Color tin-white, and light steel-gray. Opaque. Malleable with difficulty.

Composition.—Analyses:

1.—Iridium 46·77, osmium 49·35, iron 0·74, rhodium 3·15, *Berzelius,* (Pogg. xxxii), corresponding to Ir Os [=Iridium 49·78, osmium 50·22=100]. This variety occurs in flat scales. H.=7. G.=19·386—19·471. Color tin-white. From Katharinenburg.

2.—Iridium 25, osmium 75=100, corresponding to $Ir\,Os^3$ [=Iridium 24·83, osmium 75·17=100]. In flat scales, often six-sided. This compound may be a mixture.

3.—$Ir\,Os^4$=Iridium 19·86, osmium 80·14=100. In six-sided scales. Color steel-gray. H.=7. G.=21·118, *Rose.* From Nischne-Tagilsk.

4.—Iridium 72·9, osmium 24·5, Fe 5·6=100, *Thomson.* From Brazil. Color steel-gray. G.=19·5.

No. 1 is Haidinger's *Newjanskite,* and 2 and 3 his *Sisserskite,* names derived from the names of localities.

At a high temperature the Sisserskite gives out osmium, but undergoes no further change. The Newjanskite is not decomposed and does not give an osmium odor. With nitre, the characteristic odor of osmium is soon perceived, and a mass obtained soluble in water, from which a green precipitate is thrown down by nitric acid.

It occurs with platinum in the province of Choco in South America, and in the Ural mountains. It was first distinguished by Dr. Wollaston, who discovered that the specimens were an alloy of iridium and osmium. It is rather abundant with the alluvial gold of California, occurring in small bright lead-colored scales, sometimes six-sided. Also found in the gold-washings on the rivers du Loup and des Plantes, Canada.

TELLURIUM. Gediegen Sylvan, *W.* Gediegen Tellur, *Haus.* and *L.* Tellure Natif Auro-ferrifère, *H.*

Hexagonal $R:R=86^\circ\ 57'$, G. Rose; $O:R=123^\circ\ 4'$, $a=1{\cdot}3302$. Observed planes, R, $-R$, I, O; $R:-R$ (over base) $=113^\circ\ 52'$. In six-sided prisms, with basal edges replaced. Cleavage: lateral perfect, basal imperfect. Commonly massive and granular.

H.=2—2·5. G.=6·1—6·3. Lustre metallic. Color and streak tin-white. Brittle.

Composition.—According to Klaproth, (Beit. iii, 2), Tellurium 92·55, iron 7·2, and gold 0·25. A specimen from Nagyag afforded Petz, (Pogg. lvii, 1842, 447), Tellurium 97·215, and gold 2·785, with a trace of iron and sulphur. It fuses readily on charcoal, burning with a greenish flame, and volatilizes almost entirely in white vapors, forming a white areola on the charcoal, red at the border.

Native tellurium occurs at the mine of Maria Loretto, near Zalathna, in Transylvania, in sandstone, accompanying quartz, iron pyrites, and gold. About forty years since it was found in considerable abundance, and was melted to extract the small quantity of gold it contains.

BISMUTH. Gediegen Wismuth, *W.* Bisemutum, *Agricola.* Plumbum Cinereum. Tectum Argenti. Antimonium Femininum.

Hexagonal. $R:R=87^\circ\ 40'$, G. Rose; $O:R=123^\circ\ 36'$; $a=1{\cdot}3035$. Observed planes, R, $-R$, O, 2, and -2; $2:2=69^\circ\ 28'$. Cleavage: basal, perfect, 2, —2, less so. Also in reticulated and arborescent shapes; foliated and granular.

H.=2—2·5. G.=9·727. Lustre metallic. Streak and color silver-white, with a reddish hue; subject to tarnish. Opaque. Fracture not observable. Sectile. Brittle when cold, but when heated somewhat malleable.

Composition.—Pure Bismuth, excepting occasionally a slight admixture of arsenic. Fuses readily; fusing temperature 476° F. B.B. evaporates, and leaves a yellow coating on the charcoal. Dissolves in nitric acid; subsequent dilution causes a white precipitate. Crystallizes readily from fusion.

Bismuth occurs in veins in gneiss and clay slate accompanying various ores of silver, cobalt, lead, and zinc. It is most abundant at the silver and cobalt mines of Saxony and Bohemia, Schneeberg, Altenberg, Joachimstahl, Johanngeorgenstadt, &c. It has also been found at Modum in Norway, and Fahlun in Sweden. At Schneeberg it forms aborescent delineations in brown jasper. At Huel Sparnon, near Redruth, and elsewhere in Cornwall, and at Carrack Fell in Cumberland, it is associated with ores of cobalt; formerly from near Alva in Stirlingshire.

At Lane's mine in Monroe, Conn., it is associated in small quantities with wolfram, tungstate of lime, galena, blende, &c., in quartz; also at Brewer's mine, Chesterfield district, South Carolina.

TETRADYMITE. Telluric Bismuth. Tellurwismuth. Bornite.

Rhombohedral. $O : R = 118° \ 38'$, $R : R = 81° \ 2'$; $a = 1·5865$. $-2 : -2 = 66° \ 40'$, $O : -2 = 105° \ 16'$. Crystals often tabular. Cleavage: basal, very perfect. Also massive, foliated or granular.

H.=1·5—2. G.=7·2—8·44. Lustre metallic splendent. Color pale steel-gray. Not very sectile. Laminæ elastic. Soils paper.

Composition.—Bi and Te in different proportions according to G. Rose, the two being isomorphous, and the other ingredients unessential. Hausmann sustains the same view.

Analyses: 1, Wehrle, (Schw. J. lix, 482); 2, Berzelius, (K. V. Ac. H. 1823, 183); 3, Wehrle, (Baumg. Zeit. ix, 144; 4–5, C. Fisher, Jr., (Am. J. Sci. [2], vii, 282); 6, C. T. Jackson, (This. Min. 3d edit.., p. 712); 7, F. A. Genth, (Am. Jour. Sci. [2], xvi, 81); 8–9, Damour, (Ann. Ch. Phys. [3], xiii, 372).

1.	Schubkau,	Te 34·6	S 4·8	Se *trace*	Bi 60·00=99·4, Werhle.
2.	"	36·05	4·32	——	58·30, gangue 0·75=99·42, Berzelius.
3.	Deutsch-Pilsen,	29·74	2·33	——	61·15, Ag 2·07=95·29, Werhle.
4.	Fluvanna Co., Va.,	35·77	——	6·81	51·65, Fe 1·25, $\ddot{\text{Si}}$ 3·86=99·34, Fisher.
5.	"	37·96	——	7·23	54·81=100, Fisher.
6.	Whitehall, Va.,	35·05	3·65	——	58·80, Au, $\ddot{\bar{\text{F}}}\text{e}$, $\ddot{\text{Si}}$ 2·70=100·20, Jackson.
7.	Davidson Co., N. C.	33·84	5·27	*trace*	61·35=100·46, Genth; G=7·237.
8.	Brazil *Bornite*,	15·93	3·15	1·48	79·15=99·71, Damour.
9.	"	15·68	4·58		78·40=98·66, Damour.

Dr. F. A. Genth finds no sulphur and little selenium in the Fluvanna Co. mineral.

B.B. fuses instantly, tinging the flame blue, and covering the charcoal with a whitish or yellow color, red at the margin in the seleniferous variety. In an open tube gives off white fumes; also a reddish sublimate, and the odor of selenium from the Virginian ore.

Occurs at Schubkau near Schemnitz; at Retzbanya; at Tellemark in Norway; at Bastnaes, Sweden; at Deutsch-Pilsen in Hungary. San José in Brazil (Damour's analysis). In the United States, at the Whitehall gold mines, Spotsylvania Co., at Monroe mine, Stafford Co., and Tellurium mine, Fluvanna Co., Virginia, associated with native gold; in Davidson Co., North Carolina, about five miles west of Washington mine, in foliated scales and lamellar masses along with gold, copper pyrites, magnetite, epidote, limonite, etc.; it was partly altered to a combination of tellurous acid and oxyd of bismuth, with but little of carbonate of bismuth (Genth, loc cit.)

ANTIMONY. Gedigen Antimon. Spiesglas, *W.* Antimoine Natif, *H.*

Rhombohedral. $R : R = 87° \ 35'$, Rose, $O : R = 123° \ 32'$; $a = 1·3068$. Observed planes, R, O, $\frac{1}{4}$, -2, $i2$; $O : \frac{1}{2}$ (cleavage plane) $= 142° \ 58'$, $\frac{1}{2} : \frac{1}{2} = 117° \ 7'$, $2 : 2 = 89° \ 25'$, $\frac{1}{4} : \frac{1}{4} = 144° \ 24'$, $O : \frac{1}{4} = 159° \ 26'$, $O : 2 = 108° \ 20'$. Cleavage: basal, highly perfect;—$\frac{1}{2}$ distinct. Generally massive, lamellar; sometimes botryoidal or reniform with a granular texture.

H.=3—3·5. G.=6·646—6·72, 6·65—6·62, crystals, Kengott. Lustre metallic. Color and streak tin-white. Rather brittle; not ductile.

Composition.—Antimony, containing sometimes silver, iron, or arsenic. Analysis by Klaproth, (Beit. iii, 169): from Andreasberg, Antimony 98, silver 1, iron 0·25 =99·25.

B.B. soon melts to a globule, which continues to burn though the heat be removed; a continuation of the heat causes it to evaporate in white fumes, which are deposited around the globule. Under the microscope, yellowish-white octahedrons are seen to be first formed, and subsequently, prismatic crystals of oxyd of antimony, with which at last the whole globule is covered. Crystallizes readily from fusion.

Occurs in lamellar concretions in limestone at Sahlberg, near Sahl in Sweden; at Andreasberg in the Hartz; in argentiferous veins in gneiss at Allemont in Dauphiny; at Przibram in Bohemia; in Mexico, and other places.

Altered Form.—Oxydizes on exposure and forms Valentinite, ($\ddot{\mathrm{S}}\mathrm{b}$).

ARSENIC. Gediegen Arsenik, *W.* Arsenicum. *Αρρενικον, Αρσενικον.*

Rhombohedral. $R : R = 85° \; 41'$, $O : R = 122° \; 9'$, $a = 1{\cdot}3779$. Observed forms $R, -\frac{1}{2}, O$; $-\frac{1}{2} : -\frac{1}{2} = 113° \; 21'$. Cleavage: basal, imperfect. Often granular massive; sometimes reticulated, reniform, and stalactitic. Structure rarely columnar.

H.=3·5. G.=5·93. Lustre nearly metallic. Color and streak tin-white, tarnishing soon to dark-gray. Fracture uneven and fine granular.

Composition.—Arsenic, often with some antimony and traces of iron, silver, gold, or bismuth.

B.B. volatilizes in white fumes, having the odor of garlic; if heated nearly to redness it burns with a pale bluish flame, giving out alliaceous fumes.

Native arsenic commonly occurs in veins in crystalline rocks and the older schists, and is often accompanied by ores of antimony, red silver ore, realgar, blende, and other metallic minerals.

The silver mines of Freiberg, Annaberg, Marienberg, and Schneeberg, afford this metal in considerable quantities; also Joachimstahl in Bohemia, Andreasberg in the Hartz, Kapnik in Transylvania, Orawitza in the Bannat, Kongsberg in Norway, Zimeoff in Siberia, in large masses, and St. Maria aux Mines in Alsace. In the United States it has been observed by Jackson at Haverhill, N. H., on the estate of Mr. Francis Kimball, in thin layers in dark-blue mica slate, stained by plumbago, and containing also white and magnetic pyrites; also at Jackson, N. H.

The name Arsenic is derived from the Greek *αρρενικον* or *αρσενικον*, *masculine*, a term applied to orpiment or sulphuret of arsenic, on account of its potent properties. Breithaupt's *arsenglanz* from Marienberg, is arsenic impure with 3 per cent. of Bismuth. G.=5·36—5·39. H.=2.

Altered Forms.—Oxydizes on exposure, producing a black crust, which is a mixture of arsenic and arsenolite ($\ddot{\mathrm{A}}\mathrm{s}$), and also pure arsenolite.

ARSENICAL ANTIMONY. Arsenikantimon. Antimon-arsen, *Naum.*

Rhombohedral. In reniform masses and amorphous; structure curved lamellar; also fine granular.

H.=3·5. G.=6·13, Thomson; 6·203, Rammelsberg. Lustre metallic, occasionally splendent; sometimes dull. Color tin-white, or reddish-gray; often tarnished brownish-black.

Composition.—SbAs^3=Arsenic 63·62, antimony 36·38. Analysis by Rammelsberg of the Allemont ore (1st Supp. 13): Arsenic 62·15, antimony 37·85=100.

B.B. emits fumes of arsenic and antimony, and fuses to a metallic globule, which takes fire and burns away, leaving oxyd of antimony on the charcoal.

It occurs sparingly at Allemont; also at Przibram in Bohemia, where it was observed by Zippe in metallic veins, associated with blende, antimony, spathic iron, &c.; at Schladming in Styria, and Andreasberg in the Hartz.

NATIVE SULPHUR. Natürlicher Schwefel. Soufre, *H.*

Trimetric. $I : I = 101° \; 46'$, $O : 1\bar{i} = 113° \; 6'$; $a : b : c = 2{\cdot}344 : 1 : 1{\cdot}23$.

$O : \frac{1}{3} = 134° 47'$. $O : 1\breve{3} = 115° 53'$. $1 : 1$ (mac.) $= 106° 25'$.
$O : \frac{1}{2} = 123° 30'$. $O : 1\breve{i} = 117° 41'$. $1 : 1$ (brach.) $= 85° 07'$.
$O : 1 = 108° 19'$. $O : \frac{2}{3}\breve{i} = 128° 12'$. $1 : 1$ (bas.) $= 143° 23'$.

Cleavage: *I*, and 1, imperfect. Twins, composition-face, *I*, sometimes producing cruciform crystals. Also massive, sometimes consisting of concentric coats. H.=1·5—2·5. G.=2·072, of crystals from Spain. Lustre resinous. Streak sulphur-yellow, sometimes reddish or greenish. Transparent—subtranslucent. Fracture conchoidal, more or less perfect. Sectile.

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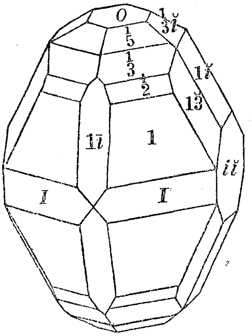


O				
	$\frac{1}{5}$			
$\frac{1}{3}\bar{i}$	$\frac{1}{3}$			$\frac{1}{3}\breve{i}$
	$\frac{1}{2}$			
			$\frac{3}{5}\breve{3}$	
				$\frac{2}{3}\breve{i}$
$1\bar{i}$	1		$1\breve{3}$	$1\breve{i}$
	I	$i\breve{2}$		

Observed Planes.

Composition.—Pure sulphur, but often contaminated with clay or bitumen; burns with a bluish flame at a low temperature, with the strong odor of sulphurous acid; becomes resinously electrified by friction; is insoluble in water, and not acted on by the acids.

Sulphur is dimorphous, the crystals being obtuse oblique rhombic prisms, of 90° 32′, and inclination of the vertical axis=95° 46′, when formed at a moderately high temperature, (125 C., according to Frankenheim).

The great repositories of sulphur are either beds of gypsum and the associate rocks, or the regions of active and extinct volcanoes. In the valley of Noto and Mazzaro in Sicily, at Conil near Cadiz in Spain, Bex in Switzerland, and Cracow in Poland, it occurs in the former situation. Sicily, and the neighboring volcanic isles, the Solfatara near Naples, the volcanoes of the Pacific ocean, &c., are localities of the latter kind. The crystals from Sicily are sometimes two or three inches in diameter. It is also deposited from hot springs in Iceland; and in Savoy, Switzerland, Hanover, and other countries, it is met with in certain metallic veins; near Cracow and in Upper Egypt there are large deposits. A fibrous variety is found near Siena in Tuscany.

Sulphur is found near the sulphur springs of New York, Virginia, &c., and also in coal deposits and elsewhere, where sulphuret of iron is undergoing decomposition; also in microscopic crystals at some of the gold mines of Virginia and North Carolina; and as a powder in the Western lead regions in fissures in the limestone. It occurs in small masses in limestone on the Potomac, twenty-five miles above Washington.

The sulphur mines of Sicily, the crater of Vulcano, and the Solfatara near Naples, afford immense quantities of sulphur for commerce. It is also largely obtained in roasting the sulphurets of iron and copper.

This species is homœomorphous with Barytes and Marcasite if $\frac{2}{3}\bar{i}$ be taken as the unit macrodome. The above figure is by Scacchi of Naples.

NATIVE SELENIUM.

Monoclinic, according to Mitscherlitch. In incrustations of a submetallic lustre, and grayish or brownish black color; translucent and red in thin splinters. Powder deep red. H.=2·0. G.=4·3—4·32. Brittle.

Observed by Del Rio, at Culebras in Mexico.

SELENSULPHUR.

Resembling sulphur, but of an orange or brownish color.

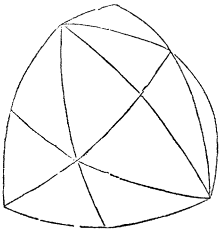
B.B. on charcoal burns readily, yields fumes of selenium and sulphurous acid. From Vulcano, one of the Lipari Islands. Also observed by the author at Kilauea, Hawaii.

CARBON GROUP.

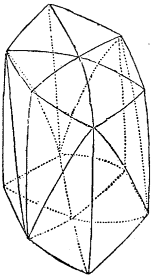
DIAMOND. Adamant. Demant, *W.* Diamant, *L.* and *H.* 'Αδάμας.

Monometric. Observed planes, 1, 2, *I*, *O*, $3\frac{3}{2}$, $i\frac{3}{2}$, $i\frac{4}{3}$; often tetrahedral in planes 1, 2, and $3\frac{3}{2}$. The annexed figures, (266, 267, planes $3\frac{3}{2}$); also f. 11, 14, 15, 19, 49, 51, $i\frac{4}{3}$, similar to f. 33; 65, 66, 185. The faces often convex. Cleavage: octahedral, highly perfect. Twins, f. 200, plane of composition octahedral; also f. 185, of the same kind, but the crystal shortened in the direction of an octahedral axis; also f. 267A, same repeated. Rarely massive.

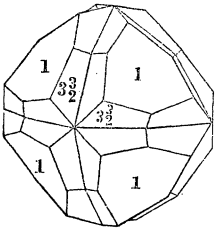
266



267



267 A



North Carolina.

H.=10. G.=3·5295, Thompson; 3·55, Pelouze. Lustre brilliant adamantine. Color, white or colorless: occasionally tinged yellow, red, orange, green, brown, or black. Transparent; translucent when dark colored. Fracture conchoidal.

Composition.—The diamond is pure carbon crystallized. It burns, and is wholly consumed at a temperature of 14° Wedgewood, producing carbonic acid gas. It is not acted on by acids or alkalies. Exhibits vitreous electricity when rubbed.

Index of refraction 2·439. The refraction of light by the diamond is often irregular, probably arising from the cause which has produced the convex forms. In some plates from crystals, Descloiseaux has observed a fixed star of six symmetrical rays, and in others, allied in character, the rays were replaced by three large elliptical areas. Descloiseaux shows that the rays are symmetrical with reference to the faces of the octahedron, and supposes them to be due to foreign matter.

The diamond appears generally to occur in regions that afford a laminated granular quartz rock, called *itacolumite,* which pertains to the talcose series, and owes its lamination to a little talc or mica. This rock is found at the mines of Brazil and the Urals; and also in Georgia and North Carolina, where a few diamonds have been found. It has also been detected in a species of conglomerate, composed of rounded siliceous pebbles, quartz, chalcedony, &c., cemented by a kind of ferruginous clay. Diamonds are usually, however, washed out from the soil. According to M. Denis (Ann. des M. [3], xix, 602) the diamond in Minas Geraes, Brazil, is found in two different deposits; one called gurgulho, consisting of broken quartz, and covered by a thin bed of sand or earth; the other, cascalho, of *rolled* quartz pebbles, united by a ferruginous clay, resting usually on talcose clays, the whole, the debris from talcose rocks. The first deposit affords the finest diamonds, and both contain also gold, platinum, magnetic iron, rutile, &c. The most celebrated mines are on the rivers Jequitinhonha and Pardo, north of Rio Janeiro, where the sands (the waters being turned off) are washed by slaves. It has lately been found in Bahia, on the river Cachoeira, at the mines of Surua and Sincora; and Damour has recognized in the sand of the locality, quartz, feldspar, rutile, brookite, anatase, zircon crystals, diaspore, magnetic iron, gold in grains, anhydrous phosphate of alumina and lime, a silicate of yttria, and a hydro-phosphate of yttria. At Bagagem, Minas Geraes, an enormous diamond of 247½ carats has recently been found.

The Ural diamonds occur in the detritus along the Adolfskoi rivulet, where worked for gold, and also at other places.

In India, the diamond is met with at Purteal, between Hyderabad and Masulipatam, where the famous Kohinoor was found; but there are now only two places of exploration, and these are let to some of the natives for less than 25 francs a year; and if the hands find a stone worth four or five rupees ($2 to $2½) a month, they consider themselves fortunate. To such a state are the famous mines of Golconda now reduced. Found also near Parma in Bundelcund, where some of the most magnificent specimens have been found; also on the Mahanuddy near Ellore. The locality on Borneo is at Pontiana, on the west side of the Ratoos mountain. The river Gunil, in the province of Constantine in Africa, is reported to have afforded some diamonds. In the United States, a few crystals have been met with in Rutherford Co., N. C., and Hall Co., Ga. (Am. J. S. [2], ii, 253, and xv); in Australia, on the banks of the Turon.

The diamond has been found massive in Brazil, in small black pebbles, having the specific gravity 3·012—3·416. They proved on trial to be pure carbon excepting 2·07 to 0·27 per cent. This compact diamond is sold in the region at 75 cents the carat of three and one-sixth grains troy.

The largest diamond of which we have any knowledge is mentioned by Tavernier, as in possession of the Great Mogul. It weighed originally 900 carats, or 2769·3 grains, but was reduced by cutting to 861 grains. It has the form and size of half a hen's egg. It was found in 1550 in the mine of Colone. The Pitt or Regent diamond weighs but 136·25 carats, or 419¼ grains; but is of unblemished transparency and color. It is cut in the form of a brilliant, and is estimated at £125,000. The Kohinoor measured on its arrival in England about 1⅝ inches in its greater diameter, over ⅝ of an inch in thickness, and weighed 186$\frac{1}{61}$ carats. It has since been recut and reduced to a diameter of 1$\frac{7}{16}$ by 1⅜ nearly; and thus diminished over one-third in its weight. It is supposed by Mr. Tennant to have been originally a dodecahedron, and he suggests that the great Russian diamond and another large slab weighing 130 carats were actually cut from the original dodecahedron. Tavernier gives the original weight at 787½ carats. The Rajah of Mattan has in his possession a diamond from Borneo, weighing 367 carats. The mines of Brazil were not known to afford diamonds, till the commencement of the 18th century. Maure mentions one crystal from these mines of 120 carats, but they rarely exceed 18 or 20.

Colorless diamonds are most highly esteemed. When cut and polished, a diamond of the purest water in England, weighing one carat, is valued at £8; and the value of others is calculated by multiplying the square of the weight in carats by 8, except for those exceeding 20 carats, the value of which increases at a much more rapid rate. This rule is scarcely regarded in market, as the standard of purity and taste for different countries differs, and the slightest tinge of color affects greatly the commercial value.

The method of polishing diamonds was discovered in 1456, by Louis Berquen, a citizen of Bruges, previous to which time, the diamond was known only in its uncut state.

The diamond is valuable for the purposes of engraving and cutting glass, and the curvature of the crystalline faces much improves it for this purpose. It is also used in powder for polishing and cutting other gems, and in splinters for drilling. It has been used for lenses for microscopes, on account of its slight chromatic aberration, and the large field it consequently affords; but the crystals often have an irregularity of internal structure, even when clear, which unfits them for this purpose.

The diamond is supposed to be of vegetable origin. It has probably proceeded from the slow decomposition of some vegetable material or bituminous matter. Black specks, like charcoal, have been observed in some crystals; but this proves nothing necessarily respecting their origin, since this is the form which carbon uncrystallized assumes, whatever its source.

MINERAL COAL. *Bituminous*—Bituminous Coal. Common Coal. Brown Coal. Black Coal. Cherry Coal. Splint Coal. Cannel Coal. Jet. Lignite. Braunkohle. Pechkohle. Blätterkohle. Bituminöses Holz. Houille. Jayet.—*Non-bituminous*—Anthracite, *H.* Glance Coal. Mineral Carbon. Blind Coal. Columnar Coal. Kilkenny Coal. Stangenkohle. Glanzkohle, *W.* Anthrazit, *Haus.* Kohlenblende, *L.*

H.=1—2·5. G.=1·2—1·75. Lustre more or less resinous, sometimes submetallic. Streak and color black or brown: often grayish when impure, sometimes iridescent. Opaque. Fracture conchoidal—uneven. Brittle, or sectile. No distinct crystallization.

Composition.—Carbon, with usually a few per cent. of silica and alumina, and sometimes oxyd of iron; often contains a large proportion of bitumen. Potash and soda have also been detected.

The bituminous varieties burn with a bright yellow flame and bituminous odor; while those destitute of bitumen afford only a pale blue flame arising from the decomposition of the water present, and the formation of the gas carbonic oxyd.

The bituminous and non-bituminous varieties are usually arranged as distinct mineral species, although more properly but one.

VARIETIES. 1. *Without bitumen.*

Anthracite.—H.=2—2·5. G.=1·32—1·7, Pennsylvania; 1·81, Rhode Island; 1·26—1·36, South Wales. Lustre bright, often submetallic, iron-black, and frequently iridescent. Opaque. Fracture conchoidal. Usually contains 80 to 90 per cent. of carbon, 4 to 7 of water, with some earthy impurities.

The anthracites of Pennsylvania contain 85 to 92 per cent. of carbon; those of South Wales, 88 to 95; of France, 80 to 83; of Saxony, 81; of Russia, sometimes 94 per cent.

Anthracites differ much in hardness and readiness of combustion. The softer are called free-burning coals, and contain a trace of bitumen.

Fossil Coak.—More compact than artificial coak, and some varieties contain considerable bitumen. From the Edgehill mines near Richmond, Va., according to Genth, who attributes its origin to the action of a trap eruption on bituminous coal.

II. *Bituminous Coal.*—The proportion of bitumen is indefinite, varying from 10 to 60 per cent., and the coal is said to be *Dry* or *Fat*, according to the amount of bitumen. The coal is softer than anthracite, less highly lustrous, of a more purely black or brownish-black color, and the specific gravity varies between 1·14 and 1·5; 1·26—1·37, Pennsylvania; 1·27, Newcastle, England; 1·199, Lancashire cannel; 1·27—1·32, Scotland; 1·2—1·33, France; 1·27—1·3, Belgium; Albert coal, Hillsboro, 1·129; Jet coal, Grayson Co., Ky., 1·166; ib. Breckenridge Co., Ky., 1·14—1·16.

Of bituminous coal, there are several varieties.

Pitch or *caking coal*, when heated, breaks into small pieces, which, on raising the heat, unite in a solid mass. Its color is velvet black, or grayish-black. Specific gravity, 1·269. It burns readily, with a yellow flame, but requires frequent stirring to prevent its caking, by which the ingress of air for combustion is prevented.

Cherry coal resembles caking coal, but does not soften and cake, when heated. It is very frangible, and hence, in mining it, there is considerable waste. Near Birmingham, the loss in mining, including the pillars, amounts to two-thirds of the whole. It burns more rapidly than caking coal, with a clear yellow flame.

Splint coal is a dry coal, harder than the cherry coal; it is a coarse kind of cannel coal.

There are other varieties which are still less bituminous; the *flint coal* of England is of this kind, and approaches anthracite; the *flew coal* of Wedgebury in Staffordshire is of a similar nature; and the *crow coal* of Cumberland at Alston Moor is almost without bitumen.

Cannel coal has a dark grayish-black or brownish-black color, a fine compact texture, a large conchoidal fracture, and receives a good polish. It burns readily, without melting, with a clear yellow flame, and it has been used as a substitute for candles, whence its name. It abounds at Lesmahago, about twenty miles from Glasgow, also in different parts of Ayrshire, where it is made into inkstands, snuff-boxes, and other similar articles.

The Albert coal of Nova Scotia has the appearance of asphaltum, and is partially soluble, (about 20 per cent.), but it has not the fusibility of asphaltum. It is the *melanasphalt* of Wetherill. The Jet Coal of Breckenridge and Grayson Cos., Kentucky, is like jet in compactness and beauty, and is worked with tools like Cannel Coal. Both this variety and the Albert Coal are strongly electrical when rubbed.

Jet resembles cannel coal, but is blacker, and has a more brilliant lustre. It occurs in detached pieces in clay, on the coast near Whitby in Yorkshire, and at Ballard Point, and elsewhere. It is the *Gagates* of Dioscorides and Pliny, a name derived from the river Gagas in Syria, near the mouth of which it was found.

Brown coal is more recent in origin than the carboniferous era of geologists. It sometimes closely resembles common bituminous coal. Other varieties have a brownish-black color, bright coal-like lustre, with something of the texture of wood remaining; and often the form and fibre of the original tree is retained: this is called *Lignite*. Lignite burns with an empyreumatic odor. Brown coal occurs in beds, usually of small extent, and is seldom as pure from pyrites as the more ancient bituminous coal. There are, however, some workable mines.

Professor W. R. Johnson obtained the following results in his analyses of coals:

	Moisture.	Vol. combustible matter.	Fixed carbon.	Ash and clinkers.
1. Pennsylvania anthracites,	1·34	3·84	87·45	7·37
2. Maryland free-burning bituminous coal,	1·25	15·80	73·01	9·74
3. Pennsylvania free-burning bituminous coal,	0·82	17·01	68·82	13·35
4. Virginia bituminous,	1·64	36·63	50·99	10·74
5. Cannelton, Indiana, bituminous,	2·20	33·99	58·44	4·97

The following are other analysis: 6—13, by B. Silliman, Jr.; 14, Frazer, (Am. J. Sci. [2], xi, 301).

	Vol. matter.	Fixed carbon.	Ash.
6. Grayson Co., Jet Cannel,	61·95	30·07	7·98=100·08
7. " "	65·59	27·22	7·27= 99·91
8. Breckenridge Co., Jet Cannel,	64·30	27·16	8·48= 99·93
9. Grayson Cannel, G.=1·371,	62·03	14·36	23·62=100·00
10. " bitum.,	41·06	54·94	4·11=100·11
11. Albert Coal,	61·74	36·04	2·22=100·00
12. Boghead Cannel, (Scotch,)	66·35	30·88	2·77=100·00
13. Pittsburgh bitum.,	32·95	64·72	2·31= 99·98
14. Cowlitz, Oregon, (Brown coal),	49·5	42·9	2·7, water 4·9=100

In the Albert coal, Prof. Booth found 59·75 per cent. of volatile matter, and Dr. Jackson 58·8 to 61·67 per cent. Dr. Wetherill obtained, (Trans. Amer. Phil. Soc. x, 353), Carbon 82·670, H 9·141, O, N, 8·189=100; and he states that 4 parts were soluble in ether and 30 in turpentine.

For the geological evidence distinguishing coal of the true carboniferous era, reference may be made to geological treatises.

The beds of coal occur interstratified with clay slate, and sandstone, or grit rock, forming distinct layers, varying from a fraction of an inch to 30 feet or more in thickness. In the United States, the anthracites occur east of the Alleghany range, in rocks that have undergone great contortions and fracturings, while the bituminous are found farther west in rocks that have been less disturbed; and this fact and other observations have led some geologists to the view that the anthracites have lost their bitumen by the action of heat.

Extensive beds of mineral coal occur in Great Britain, covering about one-tenth the whole area, or 11,859 square miles; in France; in Spain; in Belgium, covering one twenty-second the whole area, or 518 square miles; in Netherlands, Prussia, Bavaria, Austria, Northern Italy, Silesia, Spain, Russia on the south near the Azof. It is found in Asia, abundantly in China, in Persia in the Cabul territory, and in the Khorassan or Northern Persia, in Hindostan, north of the gulf of Cutch, in the province of Bengal (the Burdwan coal field) and Upper Assam, in Borneo, Labuan, Sumatra, several of the Philippines, Formosa, Japan, New South Wales and other parts of New Holland, New Zealand, Kerguelen's Land; in America, besides the United States, in Chili, at the Straits of Magellan, Northwest America on Vancouver's Island near the harbor of Camosack, at Bellingham Bay in Puget's Sound, at Melville Island in the Arctic seas, and in the British Provinces of Nova Scotia, New Brunswick and Newfoundland.

In the United States there are four extensive coal areas. One of these areas, the Apalachian coal field, commences on the north, in Pennsylvania and southeastern Ohio, and sweeping south over western Virginia and eastern Kentucky and Tennessee, to the west of the Apalachians, or partly involved in their ridges, it continues to Alabama near Tuscaloosa, where a bed of coal has been opened. It has been estimated to cover 65,000 square miles. It embraces several isolated patches in the eastern half of Pennsylvania. The whole surface in Pennsylvania has been estimated at 15,437 square miles, or one-third the whole area of the State. A second coal area (the Illinois) lies adjoining the Mississippi, and covers the larger part of Illinois, the western part of Indiana, and a small northwest part of Kentucky; it is but little smaller than the preceding. A third occupies a portion of Missouri and Iowa west of the Mississippi. The second and third are separated by only a narrow belt of silurian rock, and properly belong together as one; and the united area is half larger than that of the Apalachian coal field. A fourth covers the central portion of Michigan. Besides these, there is a smaller coal region (a fifth) in Rhode Island, which crops out across the north end of the island of Rhode Island, and appears to the northward as far as Mansfield, Massachusetts. Out of the borders of the United States, on the northeast, commences a sixth coal area, that of Nova Scotia and New Brunswick, which covers, in connection with that of Newfoundland, 18,000 square miles, or 2-9ths the whole area of these Provinces.

The mines of western Pennsylvania, commencing with those of the Blossburg basin, Tioga Co., those of the States west, and those of Cumberland or Frostburg, Maryland; Richmond or Chesterfield, Va., and other mines south, are *bituminous.* Those of eastern Pennsylvania, constituting several detached areas,—one the *Schuylkill* coal field, on the south, worked principally at Mauch Chunk on the Lehigh, and at Pottsville on the Schuylkill; another, the *Wyoming* coal field, worked at Carbondale, in the Lackawanna region, and near Wyoming, besides others intermediate, those of Rhode Island and Massachusetts, and some patches in Virginia, are *anthracites.* Cannel coal is found near Greensburg, Beaver Co., Pa. in Kenawha Co., Va., at Peytona, etc.; also in Kentucky, Ohio, Illinois, Missouri, and Indiana.

In England, the principal coal fields are the Manchester of Lancashire and Cheshire; the Great Central of South Yorkshire, Nottingham, and Derby; that of South Wales, Glamorganshire, &c.; the Newcastle field of northern England. In Scotland, a range of beds extends across from the Firth of Forth to the Firth of Clyde; whole area 1650 square miles. In Ireland, the three are the Limeric fields about the mouth of the Shannon, the Kilkenny fields to the eastward, and those of Ulster on the north.* Mineral coal occurs in France, in small basins, 88 in number, and covering in all, according to Taylor, 1-117th of the whole surface. The most important are the basin of the Loire, between the Loire and the Rhone, and that of Valenciennes on the north, adjoining Belgium. In Belgium, it occupies a western and eastern division, the western in the provinces of Namur and Hainault, and the eastern extending over Liege.

Coal beds more recent than the true coal era are sometimes worked. That of

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* For full statistics with reference to coal and coal fields, reference may be made to the very complete work on coal by R. C. Taylor, 754 pp. 8vo. *Philadelphia,* 1848. Also, for results of investigations into the values of different coals, to a Report to the Navy Department of the United States on American Coals applicable to Steam Navigation, and to other purposes, 600 pp. 8vo., Washington, 1844, and Am. Jour. Sci. xlix, 310; also to Memoirs Geol. Survey of Great Britain by De La Beche, vol. ii. Also, on Coals for making Gas, by A. Fyfe, Jameson's Jour. 1848, and Amer. Jour. Sci., [2], vii, 77, 157.

Richmond, Virginia, is supposed to be of the lias era; the coal of Brora, in Sutherland, and of Bovey, Yorkshire, are oolitic in age. Tertiary coal occurs on the Cowlitz, in Oregon, (anal. 14).

Bituminous coal, Carboniferous in age, (See J. Hall, in Rep. of Stansbury's Exped. 1852, 401), occurs on the Rocky Mountains, according to Lieut. Abert, near the Raton Pass—lat. 37° 15′, long. 104° 35′—also according to Fremont, and probably of the same age, near lat. 41½°, long. 111°, on Muddy river.

R. C. Taylor, in his extensive work on coal gives the following table showing the proportional areas of coal land in Europe and America, p. xv.

COUNTRIES.	Entire area each country. Sq. miles English.	Area of coal land. Square miles.	Proport'ns of coal to their whole areas.	Relative parts in 1000 of coal areas.
Great Britain, Ireland, Scotland and Wales,	120,290	11,859	1-10	64
Spain, [Asturias region],	177,781	3,408	1-52	18
France, [area of fixed concessions] in 1845,	203,736	1,719	1-118	9
Belgium conceded lands,	11,372	518	1-22	3
Pennsylvania, United States,	43,960	15,437	1-3	84
British Provinces of New Brunswick, Nova Scotia, Cape Breton, and Newfoundland,	81,113	18,000	1-4½	98
Prussian Dominions,	107,937			
Austrian Prov. containing coal or lignite,	150,000			
The United States of America,	2,280,000		1-17	
The twelve principal coal-producing States,	565,283	133,132	1-4	724
		184,073		1000

GRAPHITE. Black Lead. Plumbago. Carburet of iron.

Hexagonal. In flat six-sided tables, (*O*, *I*), having the basal planes (*O*) striated parallel to the alternate edges. Cleavage: basal, perfect. Commonly in imbedded, foliated, or granular masses.

H.=1—2. G.=2·0891. Lustre metallic. Streak black and shining. Color iron-black—dark steel-gray. Opaque. Sectile; soils paper. Thin laminæ flexible. Feel greasy.

Composition.—Carbon and usually a variable quantity of iron, which is mechanically mixed with the carbon. The following are a few of the analyses:

	Scheele.	Berthollet.	Vauquelin.	Saussure.	Vanuxem.	Prinsep.
Carbon,	81	90·0	92	96	94·4	98·9
Iron,	10	9·0	8	4	oxyd 1·4	—
Oxygen,	97	—	—	—	silica 2·6	alumina 1·2

Fuchs obtained from a graphite from Wunsiedel only 0·33 per cent. of ash, (J. f. pr. Ch. vii, 353).

At a high temperature it burns without flame or smoke, leaving usually some red oxyd of iron. B.B. infusible, both alone and with reagents. Unaltered by acids.

Graphite occurs in beds and imbedded masses, laminæ, or scales, in granite, gneiss, mica slate, crystalline limestone, and gray-wacke, and is sometimes connected with deposits of coal; also met with in greenstone.

A fine variety of graphite occurs at Borrowdale in Cumberland, in nests in trap, which occurs in clay slate. In Glenstrathfarrar in Invernesshire, it forms nests in gneiss, and is associated with garnet. At Arendal in Norway, it is found in quartz. It occurs at Pargas in Finland, in various parts of Austria, Prussia, France. At Craigman in Ayrshire, it occurs in coal beds, which have been formed by contact with trap. Large quantities are brought from the East Indies.

Graphite is disseminated in large masses forming veins in gneiss, at Sturbridge, Mass., where it presents a structure between scaly and fine granular, and an occasional approximation to distinct crystallizations; also at North Brookfield, Brimfield, and Hinsdale, Mass.; extensively in Cornwall, near the Housatonic, and in Ashford, Conn.; also in Brandon, Vt.; at Grenville, C. E., associated with sphene and tabular spar in granular limestone; in Wake, N. C.; on Tyger river, and at Spartenburgh near the Cowpens Furnace, S. C. Foliated masses of graphite occur near Ticonderoga, on Lake George, upon Roger's Rock, associated with pyroxene and sphene. Near Amity, Orange Co., N. Y., it is met with in white limestone, accompanying spinel, brucite, hornblende, &c.; at Rossie, St. Lawrence, Co., N. Y., with iron ore, and in gneiss; also in Bucks Co., Penn., three miles from Attleboro', associated with tabular spar, pyroxene, and scapolite; and one and a half miles from this locality, it occurs in abundance in syenite, at Mansell's black lead mine. There is a large deposit at St. John, New Brunswick.

Graphite is used for pencils, crucibles, and for diminishing friction in heavy machinery, &c.

In the United States, the mines of Sturbridge, Mass., of Ticonderoga and Fishkill, N. Y., of Brandon, Vt., and of Wake, N. C., are worked; and that of Ashford, Conn., formerly afforded a large amount of graphite.

The name *black lead,* applied to this species, is inappropriate, as it contains no lead. The name graphite is derived from *γραφω*, *I write.* Graphite has probably the same vegetable origin as mineral coal.

Tremenheerite, Piddington, appears to be an impure variety of graphite, or it is between coal and graphite. It is scaly in structure, deep black, and highly metallic in lustre. It burns with great difficulty, reddening only at first, and is long in consuming. It afforded Piddington Carbon 85·70, water and sulphur 4·00, peroxyd of iron 2·50, earthy impurities, chiefly silica, 7·50, water and loss 0·30=100; the iron occurs as sulphuret. *Tenasserim,* Rev. F. Mason, Maulmain, 1852, p. 52.

II. COMBINATIONS WITH ELEMENTS OF THE ARSENIC GROUP.

1. *Binary Compounds.*

I. Compounds of Elements of the Arsenic Group with one another—Elements of the *Arsenic Section* of the Arsenic Group being combined with elements of the *Sulphur Section.*

II. Compounds of Elements of the Arsenic Group with those of the Hydrogen Group.

2. *Double Binary Compounds.*

III. Compounds in which the persulphuret is a sulphuret of elements of the Hydrogen Group, as Iron, Cobalt, Nickel.

IV. Compounds in which the persulphuret is a sulphuret of elements of the Arsenic Group.

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* Under this head, the Atomic weights of Arsenic, Antimony and Bismuth are taken at half the value given in the table under Chemical Mineralogy, as it is in this state that they approximate to Sulphur in the forms and relations of their compounds.

I. BINARY COMPOUNDS.

I. COMPOUNDS OF ELEMENTS OF THE ARSENIC GROUP WITH ONE ANOTHER.

REALGAR GROUP. Composition RS. Crystallization Monoclinic.
Realgar, $As\,S$.
ORPIMENT GROUP. Composition $R^2\,S^3$. Crystallization Trimetric.
Orpiment, $As^2\,S^3$. Bismuthine, $Bi^2\,S^3$.
Dimorphine, Stibnite, $Sb^2\,S^3$.

REALGAR. Red Orpiment or Ruby Sulphur, *J.* Red Sulphuret of Arsenic. Rothes Rauschgelb, *W.* Arsenic Sulfuré Rouge, *H.* Risigallo. Arsenicum Sandaraca, *Linn.* Σανδαρακη, *Theoph.* *Discor.* Sandaraca, *Plin.* *Vitr.*

Monoclinic. $C=66^\circ\ 5'$, $I:I=74^\circ\ 26'$ (Marignac, Sccachi) $O:1\grave{i}=138^\circ\ 21'$; $a:b:c=0{\cdot}6755:1:0{\cdot}6943$.

$O:I=104^\circ\ 12'$. $O:\grave{i}\grave{i}=113^\circ\ 55'$. $\grave{i}\grave{i}:\ 1=133^\circ\ 1'$.
$O:1\grave{i}=139^\circ\ 38'$. $i2:i2=113^\circ\ 6'$. $\grave{i}\grave{i}:12=115^\circ\ 1'$.

Cleavage: $\grave{i}\grave{i}$, O rather perfect; I, ii in traces. Also granular, coarse or fine; compact.

O									
$\frac{1}{2}\grave{i}$					$-\frac{1}{2}2$				
$1\grave{i}$					-12				
$\frac{3}{2}\grave{i}$									
$\grave{i}\grave{i}$	$i\grave{2}$	$i\grave{\frac{3}{2}}$	I	$i\frac{4}{3}$	$i2$	$i\frac{5}{2}$	$i4$		ii
					42				
								36	
							24		$2i$
$\frac{3}{2}\grave{i}$		$\frac{3}{2}\grave{\frac{3}{2}}$							
$1\grave{i}$			1		12		14		$1i$
$\frac{1}{2}\grave{i}$									

Observed Planes.

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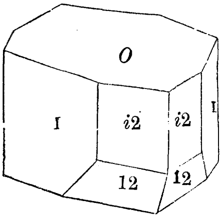

H.$=1{\cdot}5$—2. G.$=3{\cdot}4$—$3{\cdot}6$. Lustre resinous. Color aurora-red or orange-yellow. Streak varying from orange-red to aurora-red. Transparent—translucent. Fracture conchoidal, uneven. Sectile.

Composition.—As S=Sulphur 29·91, arsenic 70·09=100.

B.B. fuses readily, burns with a blue flame, and is dissipated in fumes of an alliaceous odor, with some sulphurous acid.

Fine crystallizations of this species have been observed with ores of silver and lead, at Felsobanya in Upper Hungary, at Kapnik and Nagyag in Transylvania, at Joachimsthal in Bohemia, at Schneeberg in Saxony, at Andreasberg in the Hartz. At Tajowa in Hungary, it occurs in beds of clay; at St. Gothard it Switzerland, imbedded in dolomite; near Julamerk in Koordistan; also in the Vesuvian lavas, in minute crystals. Strabo speaks of a mine of *sandaraca* (the ancient name of this species) at Pompeiopolis in Paphlagonia.

Realgar artificially prepared has long been used as a pigment.

Altered Forms.—Changes, on exposure, to Orpiment ($As^2 S^3$) and Arsenolite ($As^2 O^3$), 6 of As S becoming 2 $As^2 S^3$, and 2 As being set free which changes to $As^2 O^3$ or Arsenolite, (Volger). A black crust sometimes forms on Realgar, which is supposed by Volger to be a sulphuret containing less sulphur than Realgar.

ORPIMENT. Yellow Sulphuret of Arsenic. Gelbes Rauschgelb, *W.* Rauschgelb, *Haus.* Operment. Auripigment, *L.* Arsenic Sulfuré Jaune, *H.* Resigallum. Auripigmentum, *Vitr.* Αρσενικόν, *Dioseor.* Αρρενἴκον, *Theoph.* Arsenicum, *Plin.*

Trimetric. $I : I = 100° 40'$, $O : 1\bar{i} = 126° 30'$: $a : b : c = 1{\cdot}3511 : 1 : 1{\cdot}2059$. Observed planes as in the annexed figure.
$O : 1\breve{i} = 131° 45'$. $\breve{i}$: $i\breve{2}$ (ov. $i\breve{i}$) $= 117° 49'$. $1\breve{i} : 1\breve{i} = 83° 30'$.
$O : 2\breve{2} = 127° 27'$. 2 : $2\breve{2}$ (adj.) $= 94° 20'$. $\breve{2}$: $2\breve{2}$ (ov. $1\breve{i}$) $131° 36'$.

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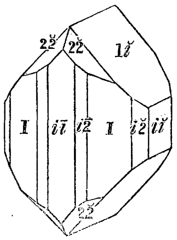


Cleavage: $i\bar{i}$ highly perfect, $i\breve{i}$ in traces. $i\breve{i}$ longitudinally striated. Also massive, foliated, or columnar, sometimes reniform.

H. $= 1{\cdot}5$—2. G. $= 3{\cdot}48$, Haidinger: 3·4, Breithaupt. Lustre pearly upon the faces of perfect cleavage; elsewhere resinous. Color several shades of lemon-yellow. Streak yellow, commonly a little paler than the color. Subtransparent—subtranslucent. Sectile. Thin laminæ obtained by cleavage, flexible but not elastic.

Composition.—$As^2 S^3$ = Sulphur 39 and arsenic 61. B.B. burns with a blue flame on charcoal, and emits fumes of sulphur and arsenic. Dissolves in nitromuriatic acid or ammonia.

Orpiment in small crystals is imbedded in clay, at Tajowa, near Neusohl in Lower Hungary. It is usually in foliated and fibrous masses, and in this form is found at Kapnik in Transylvania, at Moldawa in the Bannat, and at Felsobanya in Upper Hungary, where it exists in metalliferous veins, associated with realgar and native arsenic; at Hall in the Tyrol it is found in gypsum; at St. Gothard in dolomite; at the Solfatara near Naples, it is the result of volcanic sublimation; in brown coal of Fohnsdorf, Styria. Near Julamerk in Koordistan, there is a large Turkish mine. Small traces are met with in Edenville, Orange Co., N. Y., on arsenical iron.

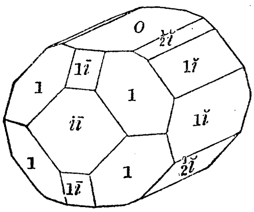
The name orpiment is a corruption of its Latin name aurigmentum, "*golden paint*," which was so called in allusion to its color, and also because it was supposed to contain gold.

It it used as a pigment, but is usually prepared artificially for that purpose.

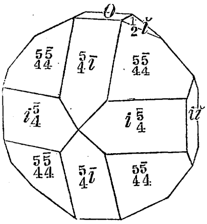
DIMORPHINE. *Scacchi*, Mem. Geol. sulla Campania, Napoli, 1849.

Trimetric. Two types; (A) $I : I = 98° 6'$; $O : 1\bar{i} = 127° 50'$, $a : b : c = 1{\cdot}2876 : 1 : 1{\cdot}1526$; (B) common form, $I : I = 100° 32'$, $O : 1\bar{i} = 127° 1'$, $a : b : c = 1{\cdot}3262 : 1 : 1{\cdot}203$. Observed planes as in the annexed figures.

270 A



270 B



In A, $O : 1 = 120° 23'$, $O : 1\breve{i} = 131° 50'$, $O : \frac{1}{2}\breve{i} = 150° 49'$, $1\breve{i} : 1\breve{i}$ (over O) $= 83° 40'$, $1 : 1$ (ov. $1\bar{i}$) $= 111° 10'$.

In B, $O : \frac{5}{4}\bar{i} = 121° 6'$,

$O : \frac{1}{2}\breve{\imath}=151° 7'$, $O : \frac{5}{4}\,\bar{\frac{5}{4}}=116° 40'$, $\dot{\imath}\bar{\frac{5}{4}} : \dot{\imath}\bar{\frac{5}{4}}=112° 45'$. Cleavage none. Crystals minute.

H.=1·5. G.=3·58. Lustre splendent adamantine. Color orange-yellow: powder saffron-yellow. Translucent and transparent. Fragile.

Composition.—From imperfect trials by Scacchi, perhaps $\mathrm{As}^4\,\mathrm{S}^3$=Sulphur 24·55, Arsenic 75·45. Heated in a porcelain crucible with a spirit lamp, affords an agreeable odor and becomes red; with more heat becomes brown, gives off yellow fumes, and evaporates, leaving no residue; with soda a garlic odor. Completely soluble in nitric acid.

From a fumarole of the Solfatara, Phlegræan fields. Crystals not over half a millimeter in their longest direction.

BISMUTHINE, *Beud.* Sulphuret of Bismuth. Wismuthglanz. Bismuth Sulphuré, *H.*

Trimetric. $I : I=91° 30'$. Observed planes I, $i\bar{\imath}$, $i\breve{\imath}$, $i\breve{3}$, Brooke. Cleavage: brachydiagonal perfect; macrodiagonal less so; basal perfect. In acicular crystals. Also massive, with a foliated or fibrous structure.

H.=2—2·5. G.=6·4—6·549. Lustre metallic. Streak and color lead-gray, inclining to tin-white, with a yellowish or iridescent tarnish. Opaque. Sectile.

Composition.—$\mathrm{Bi}^2\,\mathrm{S}^3$=Sulphur 18·4, bismuth 81·6; isomorphous with Stibnite. Analyses: 1, H. Rose, (Gilb. Ann. lxxii, 192); 2, Wehrle, (Baumg. Zeits. x, 385); 3, Scheerer, (Pogg. lxv, 299); 4, Hubert, (Haid. Ber. iii, 401); 5, Rammelsberg, (5th Suppl., 261).

	S	Bi
1. Riddarhyttan,	18·72	80·98=99·70, Rose.
2. Retzbanya,	18·28	80·96=99·24, Wehrle.
3. Gjellebäk,	19·12	79·77, Fe 0·15, Cu 0·14=99·18, Scheerer; G. 6·403.
4. Orawitz,	19·46	74·55, Fe 0·40, Cu 3·13, Au 0·53, Pb 2·26=100·33, Hubert.
5. Cornwall,	18·42	78·00, Fe 1·04, Cu 2·42=99·88, Rammelsberg.

Fuses in the flame of a candle. B.B., is volatilized, and covers the charcoal with yellow, throwing out small drops in a state of incandescence. Dissolves readily in hot nitric acid, and a white precipitate falls on diluting with water.

Accompanies molybdenite and apatite in quartz, at Caldbeckfell in Cumberland, having a foliated structure; near Redruth; at Botellach near Land's End; at Johanngeorgenstadt, Altenberg, Schneeberg, in limestone; with cerium ore at Bastnäs, Sweden. Shepard reports its occurrence with Chrysoberyl at Haddam, Ct.

STIBNITE. Stibine, *Beud.* Antimony Glance. Sulphuret of Antimony, *P.* Gray Antimony, Antimonite, *Haid.* Grauspiessglaserz, *W.* Grauspiessglanzerz, *Haus.* Antimonglanz. Antimoine Sulfuré, *H.* Stibium. Στιμμι. Πλατυόφθαλμον. Leo Ruber. Plumbum Nigrum, *Vetr.* Lupus Metallorum, *Alchem.*

Trimetric. $I : I=90° 45'$, $O : 1\bar{\imath}=134°$; $a : b : c=1·0352 : 1 : 1·0132$.

$O : \frac{1}{3}=154° 7'$. $O : 1\breve{\imath}=134° 23\frac{1}{2}$. $1 : 1$ (mac.)$=109° 16'$.
$O : 1=124° 31'$. $\dot{\imath}\bar{2} : \dot{\imath}\bar{2}$ (mac.)$=127° 28'$. $1 : 1$(brach.)$=108° 10'$.
$O : 2\breve{2}=113° 36'$. $1\breve{\imath} : 1\breve{\imath}$ (top) $=88° 47'$. $1 : 1$ (bas.)$=110° 58'$.

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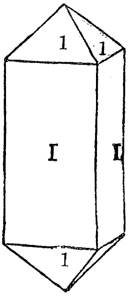

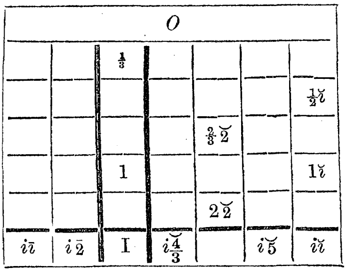

Observed Planes.

Lateral planes deeply striated longitudinally. Cleavage: $\breve{i}\breve{i}$ highly perfect. Often columnar, coarse or fine; also granular to impalpable.

H. = 2. G.=4·516, Haüy; 4·62, Mohs.—Lustre metallic. Color and streak lead-gray, inclining to steel-gray: subject to blackish tarnish, sometimes iridescent. Fracture small subconchoidal. Sectile. Thin laminæ a little flexible.

Composition.—$Sb^2 S^3$=Sulphur 27·12, antimony 72·88. Analyses: 1, Bergman, (Chem. Opus. ii, 167); 2, J. Davy, (Phil. Trans. 1812, 196); 3, Thomson, (Min. i, 86); 4, Brandes, (Trommsdorff's N. J. iii, 252):

Antimony,	74	74·06	73·77	73·5
Sulphur,	26=100, Berg.	25·94=100, D.	26·23=100, T.	26·5=100, Brandes.

Fuses readily in the flame of a candle, coloring it greenish. B.B. on charcoal emits white fumes and a strong sulphurous odor, and yields a white slag. When pure perfectly soluble in muriatic acid.

Gray antimony occurs with spathic iron in beds, but generally in veins. It is often associated with blende, heavy spar, and quartz.

It is met with in veins at Wolfsberg, in the Hartz, and at Pösing, near Presberg in Hungary. Its most celebrated localities, however, are Felsobanya, Schemnitz, and Kremnitz in Hungary, where it often occurs in diverging prisms, several inches long, accompanied by crystals of heavy spar and other mineral species. In Dumfriesshire it occurs fibrous and laminated; in Cornwall massive; and compact at Magurka in Hungary. Also abundant in Borneo.

In the United States, it occurs at Carmel, Penobscot Co., Me., and at Cornish and Lyme, N. H.; also at "Soldier's Delight," Md.

This ore affords nearly all the antimony of commerce. The crude antimony of the shops is obtained by simple fusion, which separates the accompanying rock. From this product most of the pharmaceutical preparations of antimony are made, and the pure metal extracted.

This ore was employed by the ancients for coloring the hair, eyebrows, &c., to increase the apparent size of the eye; whence they called the ore πλατυόφθαλμον, from πλατυς, *broad*, and οφθαλμος, *eye*. According to Dioscorides, it was prepared for this purpose by enclosing it in a lump of dough, and then burning it in the coals till reduced to a cinder. It was then extinguished with milk and wine, and again placed upon coals and blown till ignition; after which the heat was discontinued, lest, as Pliny says, "plumbum fiat," *it become lead*. It hence appears that the metal antimony was occasionally seen by the ancients, though not distinguished from lead.

ALTERED FORMS.—Changes on exposure by partial oxydation to *Antimony Blende*, ($2\,Sb^2 S^3 + Sb^2 O^3$), and by further oxydation to *Valentinite*, ($Sb^2 O^3$); *Antimony Ochre*, ($Sb^2 O^3 + Sb^2 O^5$), and also $Sb^2 \ddot{O}^5 + 5\dot{H}$, are other results of alteration.

II. BINARY COMPOUNDS OF THE ARSENIC GROUP WITH THE OTHER ELEMENTS.

1. *Discrasite Division.* Composition R^2 A.*

1. Discrasite Group.—Composition R^2 Sb. Trimetric.

2. *Galena Division.* Composition R A.

1. Galena Group.—Composition R (S, Se, Te). Monometric, holohedral.

2. Blende Group.—Composition R S. Monometric, tetrahedral.

3. Stromeyerite Group.—Composition R S. Trimetric.

4. Pyrrhotine Group.—Composition R (S, Se), or R (As, Sb). Hexagonal.

3. *Pyrites Division.* Composition R A^2.

1. Pyrites Group.—Composition R S^2, or R, $(As, Sb)^2$, or R, $(S, As, Sb)^2$. Monometric.

2. Marcasite Group.—Composition R S^2, R $(As, Sb)^2$, or R$(S, As, Sb)^2$. Trimetric.

3. Nagyagite Group.—Composition R $(Te, S)^2$. Dimetric.

4. Covelline Group.—Composition R S^2. Hexagonal.

4. *Skutterudite Division.* Composition R A^3.

1. Skutterudite Group. Monometric.

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1. DISCRASITE DIVISION.

The Discrasite Group here included contains the species Discrasite, (Ag^2 Sb). Domeykite, which follows, may belong to a separate section, but is of somewhat uncertain constitution.

DISCRASITE, *Frobel.* Antimonial Silver. Antimoniet of Silver. Spiesglas-Silber, *W.* Silber-Spiessglanz, *Haus.* Antimon-silber, *L.* Argent Antimonial, *H.*

Trimetric. $I : I = 119° 59'$; $O : 1\bar{i}$ $130° 41'$; $a : b : c = 1{\cdot}1633 : 1 : 1{\cdot}7315$.
$O : \frac{1}{2} = 146° 7'$. $O : 1\breve{i} = 146° 6'$. $1 : 1$ (brach.) $= 92°$.
$O : \bar{1} = 126° 40'$. $O : 2\breve{i} = 126° 39\frac{1}{2}'$. $i\breve{2} : i\breve{2} = 98° 13\frac{1}{2}'$.
$O : 1\breve{3} = 142° 12'$. $1 : 1$ (mac.) $132° 42'$. $i\breve{3} : i\breve{3} = 120° 1'$.

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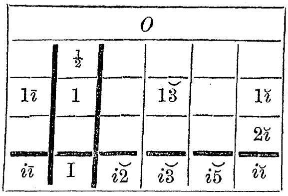
* A is put for any element of the Arsenic Group. We repeat that the halved atomic weights of As, Sb, Bi are here adopted, as well as beyond. R S^2 and R As^2, or R S and R As, are then approximately isomorphous.



Observed Planes.

Cleavage: basal distinct; 1ĭ also distinct; *I* imperfect. Twins: stellate forms and hexagonal prisms. Also massive, granular; particles of various sizes, weakly coherent.

H.=3·5—4. G.=9·44—9·8; 9·4406, Haüy. Lustre metallic. Color and streak silver white, inclining to tin-white; sometimes tarnished yellow or blackish. Opaque. Fracture uneven.

Composition.—$Ag^2 Sb$=Antimony 23, silver 77=100. Also $Ag^3 Sb$=Antimony 16·6, silver 83·4. Analyses: 1, 2, 5, Klaproth, (Beit. ii, 298, iii, 173); 3, Vauquelin, (Haüy's Min. iii, 392); 4, Abich, (Crell's Ann. 1798, ii, 3):

1. Wolfach, *coarse granular,*	Antimony 24·	Silver 76=100,	Klaproth.
2. Andreasberg *foliated granular,*	23·	77=100,	Klaproth.
3. "	22·	78=100,	Vauquelin.
4. "	24·25	75·25=99·5,	Abich.
5. Wolfach, *fine granular,*	16·	84=100,	Klaproth.

B.B. fumes of antimony are given off, and a gray metallic globule, which is not malleable, is left. By continuing the heat, on charcoal, silver is obtained. Soluble in nitric acid, leaving oxyd of antimony.

Occurs in veins at Altwolfach in Baden, Wittichen in Suabia, and at Andreasberg in the Hartz, associated with several ores of silver, native arsenic, and galena, and other species; also at Allemont in Dauphiné, Casalla in Spain, and near Coquimbo, S. A.

If less rare, this would be a valuable ore of silver. Named from δις, *two-fold*, κρασις, *mixture.*

ARSENIC SILVER, (Arseniksilber) from Andreasberg, is shown to be a mixture of mispickel, arsenical iron, and discrasite, (Pogg. lxxvii, 262).

DOMEYKITE, *Haid.* Arsenical Copper. Cuivre Arsenical, *Duf.* Weisskupfererz, *W.* Arsenikkupfer. Condurrite, *Faraday.*

Reniform and botryoidal; also massive and disseminated.

H.=3—3·5. Lustre metallic. Color tin-white, a slightly yellowish or iridescent tarnish. Fracture uneven. Also black and soft, soiling the fingers (*Condurrite*) when impure.

Composition.—$\text{Ȼu}^3 As^2$=Arsenic 28·3, copper 71·7. Analyses: 1, 2, Domeyko, (Ann. d. Mines, [4], iii, 5); 3, 4, Rammelsberg, (Pogg. lxxi, 305); 5, Blythe, (J. of Chem. Soc. i, 213):

1. Calabazo, Chili,	As 28·36	Cu 71·64=100,	Domeyko.		
2. Copiapo, "	23·29	70·70	Fe 0·52	S 3·87=98·38,	Domeyko.
3. Cornwall, *Condurrite,*	18·70	70·51	0·66,	Rammelsberg.	
4. " "	17·84	70·02	——	gangue 1·07,	Rammelsberg.
5. " "	19·51	60·21	0·25,	S 2·33, $\dot{H}$ 2·41, C 1·62, H 0·44, N 0·06, O 13·17=100,	Blythe.

The *Condurrite* is a mixture of the Domeykite with red copper ore, and arsenous acid, or arsenite of copper. Rammelsberg treated one specimen with muriatic acid, and analyzed the soluble and insoluble portions separately, obtaining

1. Soluble, As 13·89, Cu 12·81, S 2·20, $\ddot{A}s$ 3·70, Ȼu 62·29, $\dot{H}$ 5·33, gangue 0·70=101·42.
2. Insoluble, 13·89 4·16, Sulphuret of Copper 10·85.

Kobell, (J. f. pr. Ch. xxxix, 204), with the same treatment of another specimen, found the composition of the soluble part, $\ddot{\mathrm{As}}$ 8·03, $\dot{\text{Ȼ}}\mathrm{u}$ 79·00, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 3·47, $\dot{\mathrm{H}}$ 9·50=100; and the insoluble, consisted of arsenic and some sulphuret of copper in grains.

Blythe concludes, as a mean of many analyses, that the arseniuret of copper contained in Condurrite consists of Arsenic 28·85, copper 71·15, which corresponds with the Domeykite. Faraday's analysis (Phil. Mag. 1827, 286) leads to the same result, or Arsenic 29·88, copper 70·11.

B.B. fuses easily, with the odor of arsenic. Not dissolved in muriatic acid. The *Condurrite* affords in a tube fumes of arsenous acid and water, and with soda and borax yields a globule of copper.

From the Calabazo mine near Coquimbo, and also from Antonio mine, Copiapo, Chili; also from the Condurrow mine near Helstone, and according to Lettsom, the Huel Druid mine at Carn Brae, near Redruth, Cornwall.

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2. GALENA DIVISION.

1. GALENA GROUP.—Monometric, holohedral.

SILVER GLANCE,	$\mathrm{Ag\,S}$.	CLAUSTHALITE,	$\mathrm{Pb\,Se}$.
ERUBESCITE,	$(\mathrm{Fe}, \text{Ȼ}\mathrm{u})\,\mathrm{S}$.	TILKERODITE,	$(\mathrm{Pb}, \mathrm{Co})\,\mathrm{Se}$.
GALENA,	$\mathrm{Pb\,S}$.	NAUMANNITE,	$\mathrm{Ag\,Se}$.
CUPROPLUMBITE,	$(\text{Ȼ}\mathrm{u}, \mathrm{Pb})\,\mathrm{S}$.	?BERZELIANITE,	$\text{Ȼ}\mathrm{u\,Se}$.
MANGANBLENDE,	$\mathrm{Mn\,S}$.	?EUCAIRITE,	$(\text{Ȼ}\mathrm{u}, \mathrm{Ag})\,\mathrm{Se}$.
SYEPOORITE,	$\mathrm{Co\,S}$.	?HESSITE,	$\mathrm{Ag\,Se}$.
SCHEERERITE,	$(\frac{1}{3}\,\mathrm{Ni}+\frac{2}{3}\,\mathrm{Fe})\,\mathrm{S}$.	ALTAITE,	$\mathrm{Pb\,Te}$.

2. BLENDE GROUP.—Monometric, tetrahedral.

BLENDE,	$\mathrm{Zn\,S}$, or $(\mathrm{Zn}, \mathrm{Fe}, \mathrm{Cd})\,\mathrm{S}$.

3. STROMEYERITE GROUP.—Trimetric.

COPPER GLANCE,	$\text{Ȼ}\mathrm{u\,S}$.	STROMEYERITE,	$(\text{Ȼ}\mathrm{u}, \mathrm{Ag})\,\mathrm{S}$.

4. PYRRHOTINE GROUP.—Hexagonal.

CINNABAR,	$\mathrm{Hg\,S}$.	?ONOFRITE,	$\mathrm{Hg}\,(\mathrm{S}, \mathrm{Se})$.
MILLERITE,	$\mathrm{Ni\,S}$.	COPPER NICKEL,	$\mathrm{R}\,(\mathrm{As}, \mathrm{Sb})$.
PYRRHOTINE,	$\mathrm{Fe\,S}\ [+\frac{1}{5}\,\mathrm{Fe^2\,S^3}]$.	BREITHAUPTITE,	$\mathrm{Ni\,Sb}$.
GREENOCKITE,	$\mathrm{Cd\,S}$.	?KANEITE,	$\mathrm{Mn\,As}$.

SILVER GLANGE. Argyrose, *Beud.* Vitreous Silver. Sulphuret of Silver. Glaserz, *Haus.* Silberglanz, *L.* Argent Sulfuré, *H.* Argentite, *Haid.*

Monometric. Observed planes *O*, *I*, 1, 2, 22. Figs. 1, 11, 14 to 19, 37, 38, 39, 47. Cleavage: dodecahedral in traces. Also reticulated, arborescent, and filiform; also amorphous.

H.=2—2·5. G.=7·196—7·365. Lustre metallic. Streak and color blackish lead-gray; streak shining. Opaque. Fracture small subconchoidal, uneven.

Composition.—$\mathrm{Ag\,S}$=Sulphur, 12·9, silver 87·1=100. Analysis by Klaproth, (Beit. i, 158), Sulphur 15, silver 85=100.

B.B. intumesces, and on charcoal soon affords a globule of silver. Soluble in dilute nitric acid, sulphur being deposited.

This important ore of silver occurs in Europe, principally at Annaberg, Joachimstahl, and other mines of the Erzgebirge, at Schemnitz and Kremnitz in Hungary, and at Freiberg. At the last place it accompanies other silver ores, in veins traversing gneiss. It is abundant also in Mexico and Peru. Found also in Cornwall.

A mass of sulphuret of silver is stated by Troost to have been found in Sparta, Tennessee; it also occurs with native silver and copper in Northern Michigan. A silver ore not yet analyzed, occurs, according to Jackson, with gray antimony, at Cornish, N. H.

A "silver ore" from Prince's mine, on the north shore of Lake Superior, fifteen miles west of Sturgeon Bay, afforded E. L. Seymour S 1·78, Ag 2·58, Zn 3·15, Cu 0·81, Pb 0·26, Fe 0·13, Au 0·02, gangue or rock 91·27=100. The average of three assays gave 4 per cent. of silver. Sulphuret of silver is said to occur at this mine with gray copper, vitreous copper, and argentiferous copper.

ERUBESCITE. Bornite, *Haid.* Variegated Copper. Purple Copper, *P.* Liver-colored Copper Ore. Phillipsite, *Duf.* Buntkupfererz, *W.* and *L.* Bunter Kupferkies, *Haus.* Cuivre Pyriteux Hepatique, *H.*

Monometric. Observed planes *O*, *I*, 1, 22. Fig. 1, 11, 14, 38, 43. Cleavage: octahedral in traces. Twins: f. 200. Imperfect crystallizations, structure granular, strongly connected.

H.=3. G.=4·4—5·003. Lustre metallic. Color between copper-red and pinchbeck-brown; speedily tarnishes. Streak pale grayish-black, and slightly shining. Fracture small conchoidal, uneven. Brittle.

Composition.—$\mathrm{Fe\,S}+2\cancel{\mathrm{C}}\mathrm{uS}$ or $(\mathrm{Fe}, \cancel{\mathrm{C}}\mathrm{u})\,\mathrm{S}$, Berzelius=Sulphur 23·7, copper 62·5, iron 13·8. $3\cancel{\mathrm{C}}\mathrm{u\,S}+\mathrm{Fe}^2\mathrm{S}^3$, Ramm.=Sulphur 28·1, copper 55·5, iron 16·4, but mixed often with copper glance. Analyses: 1, 2, Berthier, (Ann. d. Mines, [3], iii, 48, vii, 540, 556); 3, Phillips, (Ann. Phil. 1822, 297;) 4, Brandes, (Schw. J. xxii, 354); 5—9, Plattner, (Pogg. xlvii, 351); 10, Varrentrapp, (ib); 11, Hisinger, (Afh. i Fys. iv, 362); 12, Chodnew, (Pogg. lxi, 395;) 13, Bodemann, (Pogg. lv, 115); 14, Staaf, (Ofv. K. V. Ak. Förh. 1848, 66); 15—18, C. Bechi, (Am. J. Sci. [2], xiv, 61); D. Forbes, (Jameson's J. l, 278).

		S	Cu	Fe
1.	Montecastelli, Tuscany,	21·4	67·2	6·8, gangue 4·0=99·4, Berthier.
2.	St. Pancrasse,	22·8	59·2	13·0, gangue 5·0=100, Berthier.
3.	Ross I., L. Killarney,	23·75	61·07	14·0, quartz 0·5=99·32, Phillips.
4.	Siberia,	21·65	61·63	12·75, " 3·5=99·53, Brandes.
5.	Sangerhausen, *massive*,	22·58	71·00	6·41=99·99, Plattner.
6.	Eisleben, *massive*,	22·65	69·73	7·54=99·91, Plattner.
7.	Woitzki, White Sea, *mass.*,	25·06	63·03	11·56=99·65, Plattner.
8.	Condurra M., Cornw. *cryst.*,	28·24	56·76	14·84=99·84, Plattner.
9.	Dalarne, *massive*,	25·80	56·10	17·36, $\ddot{\mathrm{S}}\mathrm{i}$ 0·12=99·39, Plattner.
10.	"	26·98	58·20	14·85=100·03, Varrentrapp.
11.	Vestanforss, Westmannland,	24·70	63·33	11·80=99·83, Hisinger.
12.	Redruth, *cryst.*,	26·84	57·89	14·94, gangue 0·04=99·71, Chodnew.
13.	Bristol, Ct., *massive*,	25·70	62·75	11·64, quartz 0·04=100·13, Bodemn.
14.	Westmannland,	——	60·56	10·24, gangue 4·09=99·11, Staaf.
15.	Mt. Catini,	24·93	55·88	18·03=98·84, Bechi.
16.	"	23·36	59·47	13·87, gangue 0·75 $\ddot{\cancel{\mathrm{F}}}\mathrm{e}$ 1.50=98·95, B.
17.	Miemo,	23·98	60·16	15·09=99·23, Bechi.
18.	Ferriccio,	24·70	60·01	15·89=100·60, Bechi.
19.	Espedal, Norway,	24·49	59·71	11·12, Mn 0·1, $\ddot{\mathrm{S}}\mathrm{i}$ 3·83=99·15, Forbes —G.=4·432.

B.B. blackens and becomes red on cooling; at a higher temperature fuses to a globule, attracted by the magnet. Mostly dissolved by nitric acid.

Occurs with other copper ores. Crystalline varieties are found in Cornwall, and mostly in the mines of Tincroft and Dolcoath near Redruth, where it is called by the miners "horse flesh-ore." Other foreign localities of massive varieties are at Ross Island in Killarney, in Ireland, in cupriferous shale in the Mansfeld district, Germany, and in Norway, Siberia, Silesia, and the Bannat.

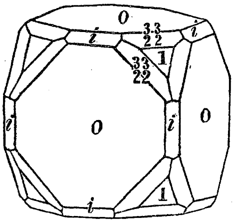
Massive varieties of erubescite are found in the United States at Mahoopeny, near Wilkesbarre, Penn., and in other parts of the same State, in cupriferous shale, associated in small quantities with vitreous copper; also in granite at Chesterfield, Mass., also in New Jersey. At the copper mine Bristol, Conn., it is abundant, and occurs in fine crystallizations, (f. 1, 14, 43, and 43 with planes *O*). At Cheshire, it is met with in cubes, along with heavy spar, malachite, and vitreous copper.

This species is a valuable ore of copper. Its name alludes to its liability to tarnish, thus receiving a reddish hue.

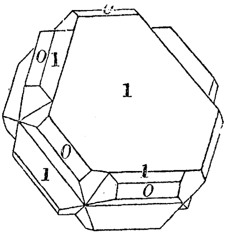
GALENA. Sulphuret of Lead. Blue Lead. Bleiglanz. Blau-Bleierz, *W.* Plomb Sulfuré, *H.*

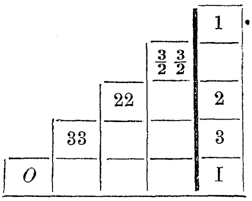
Monometric. Figs. 1, 11, 14 to 19, 47 with planes 1. Cleavage, cubic, perfect and easily obtained. Twins, like f. 200; the same kind of composition repeated, (f. 272A), flattened parallel to 1. Also reticulated, tabular, and coarse or fine granular, sometimes impalpable; occasionally fibrous.

272



272 A





Observed Planes.

H.=2·5—2·75. G.=7·25—7·7. Lustre metallic. Color and streak pure lead-gray. Surface of crystals occasionally tarnished. Fracture flat subconchoidal, or even. Frangible.

Composition.—Pb S=Sulphur 13·4, lead 86·6; contains also at times some selenium, (ore from Fahlun, *Berz.*), zinc or sulphuret of zinc, silver, antimony, copper: and platinum is reported to have been found in a galena from the Department of Charente, France. Analyses: 1, Thomson, (Phil. Jour. 1829, 256); 2, 3, Lerch, (Ann. d. Ch. u. Pharm. xlv, 325):

1. Durham, S 13·02 Pb 85·13 Fe 0·50=98·65, Thomson.
2. Przibram, G.=7·252, 14·41 81·80 Zn 3·59=99·80, L. Pb S to Zn S as 6 : 1.
3. " G.=7·324, 14·18 83·61 2·18=99·97, L. Pb S to Zn S as 12 : 1.

The silver present is detected easily by cupellation. The galena of the Hartz affords ·03 to ·05 per cent. of silver; the English ·02 to ·03; that of Leadhills, Scotland, ·03 to ·06; of Monroe, Ct., 3 per cent.; Eaton, N. H., 0·1, C. T. Jackson; Shelburne, N. H., 0·15; Arkansas, ·003 to ·05. Silliman, Jr., 44–71 oz. to the ton, Mather; Middletown, Ct., 40–70 oz. to the ton.

The following from Tuscany, contain antimony and silver, (C. Bechi, Am. Jour., Sci. [2], xiv, 60):

	S	Pb	Sb	Fe	Cu	Zn	Ag
1. Bottino,	12·840	80·700	3·307	1·377	0·440	0·024	0·325= 99·013
2. "	15·245	78·238	4·431	1·828	*trace.*	——	0·485=100·227
3. "	15·503	78·284	2·452	2·811	——	——	0·560= 99·610
4. Argentiera,	16·780	72·440	4·308	1·855	4·251	——	0·650=100·289
5. "	15·62	72·90	5·77	1·77	1·11	1·33	0·72 = 98·22

No. 5 is the *Jargionite* of M. Bechi; it is near the *Bleischweif* of the Germans, and may be identical with *Steinmannite;* it occurs in octahedrons; G.=6·932.

B.B. on charcoal decrepitates unless heated with caution, fuses, gives off sulphur, and at last affords a globule of pure lead.

Galena occurs in beds and veins, both in crystalline and uncrystalline rocks. It is often associated with blende, iron, and copper pyrites, the carbonate and other lead ores, and occurs in a gangue of heavy spar, calc spar or quartz.

At Freiberg in Saxony, it occupies veins in gneiss; in Spain in the granite hills of Linares, and also in Catalonia, Grenada, and elsewhere; at Clausthal and Neudorf in the Hartz, and at Przibram in Bohemia, it forms veins in clay slate; in Styria it occurs in the same kind of rock in beds; at Sala in Sweden, it forms veins in granular limestone; through the gray-wacke of Leadhills and the killas of Cornwall, are disseminated veins of this ore; and in mountain limestone occur the rich repositories of Derbyshire, Cumberland, and the northern districts of England, as also those of Bleiberg, and the neighboring localities of Carinthia. In the Isle of Man, cubes 12 inches across occur. In the English mines it is associated with calcareous spar, pearl spar, fluor spar, heavy spar, witherite, calamine, and blende. Other localities are Joachimstahl, where it is worked principally for the silver; in Bohemia southwest of Prague; in the Daouria mountains, Siberia; in Algeria; near Cape of Good Hope; in Australia.

Extensive deposits of this ore in the United States exist in Missouri, Illinois, Iowa, and Wisconsin. The ore occurs in what has been called "cliff" limestone, associated with blende, calamine, ("dry-bone" of the miners), carbonate and sulphate of lime, pyrites, and often an ore of copper and cobalt. The mines of Missouri were discovered in 1720, by Francis Renault and M. la Motte; they are situated in the counties of Washington, Jefferson, and Madison. The lead region of Wisconsin, according to D. D. Owen, comprises 62 townships in Wisconsin, 8 in Iowa, and 10 in Illinois, being 87 miles from east to west, and 54 miles from north to south. Throughout this region there is scarcely a square mile in which traces of lead may not be found. The occurrence of calc spar in the soil, or sink holes in lines, are considered indications of lead. The diggings seldom exceed 25 or 30 feet in depth. From a single spot, not exceeding 50 yards square, 3,000,000 lbs. of ore have been raised. The mines of the Upper Mississippi afforded in 1847 about 77,000 pigs of 70 pounds, and in 1850, 570,000; those of Missouri 125,000 to 150,000 pigs.

Galena occurs also at Cave-in-Rock, in Illinois, associated with fluor spar. Veins at Rossie, in St. Lawrence Co., N. Y., traverse, nearly perpendicularly, the gneiss of the region, and vary from one to three or four feet in width. Crystals often very large, (like f. 272, without *i*). It occurs with calcite, iron and copper pyrites, and some blende and celestine. Near Wurtzboro, Sullivan Co., a large vein occurs in millstone grit; it is associated with blende, iron and copper pyrites. The Ancram lead mines, Columbia Co., have afforded considerable lead. In Maine, veins of considerable extent exist at Lubec, where the ore is associated with copper pyrites and blende; also less extensively at Blue Hill Bay, Bingham, and Parsonsfield; in New Hampshire at Eaton, with blende and copper pyrites, and also at Haverhill, Bath, and Tamworth; in Vermont at Thetford; in Connecticut at Middletown, in a vein in argillite, massive and crystalline. Southampton, Leverett, and Sterling, Mass., afford small quantities of galena; also Austin's mines in Wythe Co., Walton's gold mine in Louisa Co., and other places in Virginia; at Brown's Creek, and at Haysboro, near Nashville, it occurs with blende and heavy spar; in the region of Chocolate river and elsewhere, and Lake Superior copper districts.

Argentiferous galena occurs at Monroe and Middletown, Ct.; Bath, Haverhill, Eaton, Shelburne, and other places in New Hampshire, (C. T. Jackson). Galena in cubes is sometimes a furnace product, (Hausmann).

Altered Forms.—Minium, anglesite, cerusite, pyromorphite, wulfenite, gray copper, dialogite, quartz, limonite, pyrites, calamine, occur as pseudomorphs after galena, partly from alteration and partly through removal and substitution. A change to the carbonate (cerusite) with the setting free of sulphur, is the most common. The *supersulphuretted* lead of Johnston is galena mixed with free sulphur. He obtained Pb S 90·38, S 8·71.

STEINMANNITE, *Zippe.*

Described as occuring at Przibram in octahedrons with cubic cleavage and massive; H.=2·5; G.=6·833, Zippe; color lead gray.

On charcoal gives fumes of sulphurous acid and antimony, and finally a globule of lead containing some silver.

CUPROPLUMBITE, *Breit.* Kupferbleiglanz.

Tesseral. Occurs massive granular; cleavage cubic.

H.=2·5. G.=6·408—6·428. Lustre metallic. Color blackish lead-gray. Streak black. Rather sectile and brittle.

Composition.—ꞒuS+2PbS, or (Ꞓu, Pb) S=Sulphur 15·1, lead 65·0 copper 19·9. Analysis by Plattner, (Pogg. lxi, 671):

S (loss) 15·1 Pb 64·9 Cu 19·5 Silver 0·5=100.

B.B. on charcoal surrounds the assay with an areola of oxyd of lead and sulphate of lead; with soda affords a globule of metal. In an open tube fuses and gives off sulphurous fumes.

From Chili.

MANGANBLENDE, *Breit.* Sulphuret of Manganese, *P.* Alabandine, *Beud.* Schwarzerz, *Haus.* Manganglanz, *L.* Manganése Sulfuré, *H.*

Monometric. In cubes and octahedrons. Cleavage: cubic, perfect. Usually granularly massive.

H.=3·5—4. G.=3·95—4·014. Lustre submetallic. Color iron-black, tarnished brown on exposure. Streak green. Fracture uneven.

Composition.—MnS=Sulphur 36·7, manganese 63·3. Analysis by Arfvedson, (K. V. Ac. H. 1822):

Sulphur 37·90, Manganese 62·10=100.

A specimen from Siebenburg afforded Klaproth, (Beit. iii, 35), Mn 82, S 11, C 5=98; and in another Vauquelin found, Mn 85, S 15=100. In one from Mexico, Del Rio found, S 39·0, Mn 54·5, S̈i 6·5=100.

B.B. on charcoal fuses on the thinnest edges. When pulverized and thrown into muriatic acid, or dilute sulphuric acid, sulphuretted hydrogen is evolved.

Manganblende occurs in veins in the gold mines of Nagyag in Transylvania, associated with tellurium, carbonate of manganese, and quartz.

SYEPOORITE, *Nicol.* Sulphuret of Cobalt. Kobaltsulfuret, *Ramm.* Graucobalterz.

Massive, disseminated in grains or veins.

G.=5·45. Color steel-gray, inclining to yellow.

Composition.—Co S=Sulphur 35·2, cobalt 64·8. Analysis by Middleton, (Phil. Mag. [3], xxviii, 352):

Sulphur 35·36, Cobalt 64·64=100.

From Syepoor, near Rajpootanah in North West India, where it occurs in ancient schists with magnetic pyrites. It is employed by the Indian jewelers to give a rose color to gold.

SULPHURET OF IRON AND NICKEL. Eisennickelkies, *Scheerer.*

Monometric. Cleavage octahedral. Massive, granular.

H.=3·5—4. G.=4·6. Color light bronze yellow. Streak light bronze brown. Not magnetic.

Composition.—($\frac{1}{3}$ Ni+$\frac{2}{3}$ Fe) S=Sulphur 36·0, iron 41·9, nickel 22·1=100. Analysis by Scheerer, (Pogg. lviii, 315):

Sulphur 36·86, Iron 40·86, Nickel 22·28.

Occurs with copper pyrites in a hornblende rock near Lillehammer in Southern Norway. The ore is valuable for the extraction of nickel, this metal being now in great demand. An impure variety, slightly mixed with magnetite, is found at Inverary, in Argyleshire, Scotland.

CLAUSTHALITE. Seleniuret of Lead. Seleniet of Lead. Selenblei. Plomb Seleniurè, *Levy.* Tilkerodite, *Haid.* Raphanosmite, *Kob.* Zorgite, *B.* and *M.*

Monometric. Occurs commonly in fine granular masses; some specimens foliated. Cleavage cubic.

H.=2·5—3. G.=7—8·8. Lustre metallic. Color lead-gray, somewhat bluish; cupreous varieties yellowish. Streak darker. Opaque. Fracture granular and shining. Rather sectile.

Composition.—Pb Se=Selenium 27·6, lead 72·4, with part of the lead often replaced by silver. Analyses: 1, H. Rose, (Pogg. ii, 415, iii, 281); 2, Stromeyer, (Pogg. ii, 403); 3, Rammelsberg, (2d Supp. 127); 4, 5, 6, H. Rose, (Pogg. iii, 288); 7, 8, Kersten, (Pogg. xlvi, 265):

1.	Tilkerode,		27·59	71·81, Rose.		
2.	Clausthal,		28·11	70·98	Co 0·83=99·92, Stromeyer.	
3.	Tilkerode,		26·52	60·15	Ag 11·67=98·34, Rammelsberg.	
4.	Clausthal,	(*selenkobaltblei*),	31·42	63·92	Co 3·14, Fe 0·45=98·93, Rose.	[R.
5.	Tilkerode,	(*selenbleikupfer*),	34·26	47·43	Cu 15·15 Ag 1·29 $\ddot{\mathrm{Fe}}$ and Pb 2·08=100·51,	
6.	"	(*selenkupferblei*),	29·96	59·67	7·86 Fe 0·33, Fe and Pb 0·44, *undecomp.* 1·00=99·26, Rose.	
7.	Glasbach,	"	30·00	53·74	8·02, Ag 0·05 $\ddot{\mathrm{Fe}}$ 2·00, S *trace*, quartz 4·5=98·31, Kersten.	
8.	"	"	29·35	63·82	4·00 0·07, Fe and S *trace*, quartz 2·06=99·35, Kersten.	

In No. 3 part of the lead is replaced by silver=(Pb, Ag) Se.

Nos. 5 to 8 contain copper, and may be distinct species as they have been considered; but it may be more correct to view them as varieties of Clausthalite, in which copper replaces part of the lead.

No. 4 is *Tilkerodite*, Haid.; 5, 6, *Raphanosmite*, Kobell; 4, 5, 6, are called *Zorgite* by Brooke and Miller.

No. 5 gives the formula, Pb Se+Cu Se; G.=5·6.

Nos. 6, 7=2 Pb Se+Cu Se; G.=6·9—7·04.

No. 8=4 Pb Se+Cu Se; G.=7·4—7·45. Color dark lead-gray; powder grayish black.

No. 4 corresponds to 6 Pb Se+Co Se^2.

B.B. in addition to the usual phenomena arising from the presence of lead, it gives off the odor of horseradish, and deposits on the charcoal a reddish brown substance. Heated in a glass tube closed at one end, the selenium almost immediately sublimes, forming a red ring within the tube, and on heating the tube to redness, the ore fuses and the red ring partially disappears, and a white crystalline deposit remains. The ores containing copper, give a copper reaction.

Claustbalite much resembles a granular galena; but its color is somewhat peculiar in its slight tinge of blue. It occurs massive in a vein of hematite, near Harzgerode in the Hartz, at Clausthal, Tilkerode, Zorge, and Lehrbach; and at Reinsberg near Freiberg, in Saxony.

LEHRBACHITE, B and M.—Selenid of Mercury and Lead, (Selenquecksilberblei). From Tilkerode and Lehrbach, and may be a mechanical mixture of Clausthalite and Selenid of Mercury. It is described as having the structure and color of Clausthalite. G.=7·3. Analyses by Rose:

Se 24·97 Pb 55·84 Hg 16·94=97·75.
27·98 27·33 44·69=100.

B.B. gives the odor of selenium and affords mercury with soda.

NAUMANNITE, *Haid.* Selensilber, *Rose.* Silberphyllinglanz, *Breit.*

Monometric; in cubes. Cleavage: cubic, perfect. Also massive, granular, and in thin plates.

H.=2·5. G.=8·0. Lustre metallic, splendent. Color and streak iron-black.

Composition.—$Ag\,Se$=Selenium 26·8, silver 73·2. Analysis by G. Rose, (Pogg. xiv, 471):

Selenium 29·53, Silver 65·56, Lead 4·91=100.

B.B. on charcoal it melts easily in the outer flame; in the inner, with some intumescence. With soda and borax it yields a bead of silver.

Occurs at Tilkerode in the Hartz.

According to Del Rio, another selenid of silver occurs at Tasco in Mexico, crystallized in hexagonal tables.

The *Silberphyllinglanz*, according to Plattner, is a mixture of selensilver and selenmolybdena, containing a little gold. H.=1—2. G.=5·8—5·9. Color dark gray. Foliated, with one perfect cleavage. From Deutsch-Pilsen, Hungary, in gneiss.

BERZELIANITE. Selenid of Copper. Seleniuret of Copper. Selenkupfer, *M.* Cuivre Sélénié, *H.* Berzeline, *Beud.*

In thin dendritic crusts. Soft. Lustre metallic. Color silver-white. Streak shining.

Composition.—$\bar{C}u\,Se$=Selenium 38·4, copper 61·6. Analysis by Berzelius, (Afhandl. vi, 42):

Selenium 40, Copper 64.

B.B. the odor of selenium and fuses to a gray bead. With soda slowly reduced.

Occurs at Skrikerum in Sweden, and also near Lehrbach in the Hartz. Beudant gave the name *Berzeline* to this species, which, as it has other applications in the science, we have changed to another form, as above.

EUCAIRITE, *Berz.* Seleniuret of Silver and Copper, *P.* Argentiferous Seleniet of Copper. Selenkupfersilber. Cuivre Sélénié Argental, *H.* Eukairit.

Massive; in black metallic films, staining the calcareous spar in which it is contained.

Soft; easily cut by the knife. Lustre metallic. Color between silver-white and lead-gray. Streak shining.

Composition.—$\bar{C}u\,Se+Ag\,Se=(\bar{C}u,\,Ag)\,Se$=Selenium 31·6, copper 25·3, silver 43·1. Analysis by Berzelius, (Afhandl. vi, 42):

Selenium 26·00, Copper, 23·05, Silver 38·93, gangue 8·90=96·88.

B.B. gives copious fumes of selenium, and on charcoal fuses readily to a gray metallic globule, leaving a bead of selenid of silver. With borax, a copper reaction. Dissolves in boiling nitric acid.

It has been found only in small quantities in the Skrikerum copper mine in Smaoland, Sweden, in a kind of rock, imbedded in calcareous spar. It was discovered and analyzed by Berzelius, and named from ευ and καιρος, *opportunely*, because the mineral was found soon after the discovery of the metal selenium.

HESSITE, *Fröbel.* Telluric Silver. Petzite, *Haid.* Bitelluret of Silver, *Thomson.* Tellursilber *of the Germans.*

Monometric? In coarse-grained masses, and granular.

H.=2—3·5. G.=8·3—8·9. Lustre metallic. Color between lead-gray and steel-gray. Slightly malleable.

Composition.—$AgTe$=Tellurium 37·2, silver 62·8 Analyses: 1, 2, G. Rose, (Pogg. xviii, 64); 3, 4, Petz, (Pogg. lvii, 467); 5, Rammelsberg, (4th Supp. 220):

1. Savodinsky, Altai,	Te 36·96	Ag 62·42	Fe 0·24=99·62, Rose.
2. " "	36·89	62·32	0·50=99·71, Rose.
3. Nagyag, G.=8·31—8·45,	37·76	61·55,	Au 0·69, Fe, Pb, S, *trace*=100, Petz.
4. " G.=8·72—8·83,	34·98	46·76	18·26 " " =100, Petz.
5. Retzbanya,	27·96	54·67,	Foreign substances 15·25=97·88, Ramm.

No. 4 is the *Petzite* of Haidinger, (*Tellurgoldsilber* of Hausmann); owing to the gold, the specific gravity is high.

B.B. on charcoal fuses to a black globule, which on cooling, after the action of the reducing flame, presents points or dendrites of silver on its surface. When heated in a glass tube it melts and gives a yellow color to the glass. Fused with carbonate of soda a globule of pure silver is obtained.

It occurs in the mine of Savodinski, about forty wersts from the rich silver mine of Siränowski, in Siberia, in a talcose rock, with iron pyrites, black blende, and copper pyrites. Specimens in the museum of Barnaul, on the Ob, are a cubic foot in size.

ALTAITE, *Haid.* Tellurid of Lead. Tellurblei.

Monometric. Usually massive; rarely in cubes. Cleavage: cubic.

H.=3—3·5 G.=8·159. Lustre metallic. Color tin-white, resembling that of native antimony, with a yellow tarnish. Sectile.

Composition.—$PbTe$=Tellurium 38·3, lead 61·7. Analysis by G. Rose, (Pogg. xviii, 68):

Tellurium 38·37, Silver 1·28, Lead 60·35.

BB. volatilizes in the reducing flame, excepting a minute bead of silver. Colors the flame blue. Soluble in nitric acid.

Occurs at Savodinsky, near Barnaoul, in the Altai, with telluric silver.

GRUNAUITE, *Nicol.* Saynite, *Kobell.* Bismuth Nickel. Nickelwismuthglanz.

Monometric. Figs. 11, 15, 16. Cleavage octahedral.

H.=4·5. G.=5·13. Lustre metallic. Color light steel-gray to silver-white, often yellowish or grayish through tarnish. Brittle.

Composition.—Analyses: 1, Kobell, (J. f. pr. Chem. vi, 332): 2, 3, Schnabel, (Ramm. 4th Suppl. 164):

	S	Bi	Ni	Fe	Co	Cu	Pb
1.	38·46	14·11	40·65	3·48	0·28	1·68	1·58=100·24.
2.	31·99	10·49	22·03	5·55	11·24	11·59	7·11=100, Schnabel.
3.	33·10	10·41	22·78	6·06	11·73	11·56	4·36=100, Schnabel.

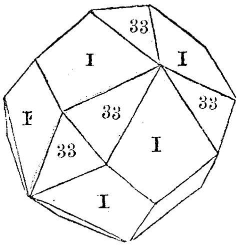
B.B. fuses to a gray brittle magnetic globule, coloring the charcoal greenish yellow. Dissolves in nitric acid, excepting the sulphur.

Found at Grünau, in Sayn Altenkirchen, with quartz and copper pyrites.

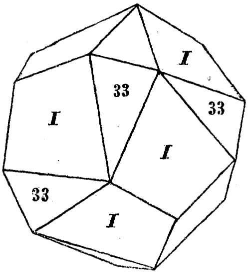
BLENDE. Sulphuret of Zinc. Black Jack. Zinc Sulfuré, *H.* Sphalerite, *Gl.* Cleiophane, *Nuttal.* Marasmolite, *Shepard.* Przibramite, *Huot.*

Monometric: tetrahedral. Observed planes, *O*, *I*, 1, 2, 33, $i\frac{3}{2}$. Figs. 14, 53 to 58. Cleavage: dodecahedral, highly perfect. Twins: face of composition 1, as in f. 273A, of which f. 273 is the simple form. Also botryoidal, and other imitative shapes; structure columnar impalpable; also massive, compact.

273



273A



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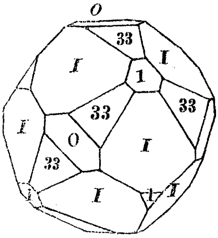


H.=3·5—4. G.=3·9—4·2. 4·063, white, New Jersey. Lustre resinous to adamantine. Color brown, yellow, black, red, green; white or yellow when pure. Streak white—reddish-brown. Transparent—translucent. Fracture conchoidal. Brittle.

Composition.—Zn S=Sulphur 33, zinc 67. Analyses: 1, Arfvedson, (K. V. Ac. H. 1822, 438, and Pogg. i, 62); 2, Löwe, (Pogg. xxxviii, 161); 3, Kersten, (Pogg. lxiii, 132); 4, Scheerer, (Pogg. lxv,300); 5, 6, 7, Jackson, (Geol. Rep. N. Hampshire, 208); 10, T. H. Henry, (Phil. Mag. [4], i, 23); 11, 12, C. Bechi, (Am. J. Sci. [2], xiv, 61); 13, Lecanu, (J. de Pharm. ix, 457); 14, Berthier; 15, 16, Boussingault, (Pogg. xvii, 399):

		S	Zn	Fe	Cd
1.		33·66	66·34	——	——=100, Arfvedson.
2.	Przibram, *fibrous*,	33·15	61·40	22·9	1·50=98·34, Löwe. [99·16, K.
3.	Carinthia, Raibel, *rh. yw.*	32·10	64·22	1·32	*trace*, Sb and $\dot{P}b$ 0·72, $\dot{H}$ 0·80=
4.	Christiania, *fibrous*,	33·73	53·17	11·79	——, Mn 0·74, Cu *trace* 99·43, Sch.
5.	Eaton, N. H. *ywh. bn.*,	33·22	63·62	3·10	0·6 including loss=100, Jackson.
6.	Shelburne, N. H.	32·6	52·0	10·0	3·2, Mn 1·3=99·1, Jackson.
7.	Lyman, N. H.	33·4	55·6	8·4	2·3=99·7, Jackson.
10.	*White*, N. Jersey,	32·22	67·46	——	*trace*, 99·68, Henry.
11.	*Marmatite*, Tuscany,	32·12	50·90	11·44	1·23, Fe S^2 0·75=96·44, Bechi.
12.	" "	33·65	48·11	16·23	*tr.*, Cu *tr.*=97·99, Bechi.

		ZnS	FeS	
13.	Charente,	82·76	13·71	=96·47, Lecanu.
14.	England,	91·8	6·4	=98·2, Berthier.
15.	*Marmatite*, Marmato,	77·5	22·5	=100, Boussingault.
16.	" "	76·8	23·2	=100, "

Part of the zinc, as shown by the analyses, is often replaced by iron and cadmium. The *Marmatite* (anal. 15, 16) affords the formula $3ZnS+FeS=77\ ZnS$ and $23\ FeS$; (anal. 11, 12), $4\,ZnS+FeS$. *Marasmolite* of Shepard (Am. J. Sci. [2], xiv, 210) is a marmatite from Middletown, Ct., partially decomposed and containing some free sulphur. *Przibramite* is cadmiferous blende.

B.B. infusible both alone and with borax, or only the thinnest edges rounded. By a strong heat in the outer flame on charcoal vapors of zinc are evolved, which coat the charcoal. Dissolves in nitric acid, during which sulphuretted hydrogen is disengaged. Some specimens phosphoresce when struck with a steel or by friction.

Blende occurs in both crystalline and sedimentary rocks, and is usually associated with galena; also with heavy spar, copper pyrites, fluor, spathic iron, and frequently in silver mines.

Derbyshire, Cumberland, and Cornwall, afford the black varieties; also Transylvania, Hungary, and the Hartz. Sahla in Sweden, Ratieborzitz in Bohemia, and many Saxon localities, afford splendid black and brown crystals. A variety having a divergent fibrous structure and presenting botryoidal forms, is met with in Cornwall; at Raibel; and at Geroldseck in Baden.

Blende abounds with the lead ore of Missouri, Wisconsin, Iowa, and Illinois. In New York, Sullivan Co., near Wurtzboro', it constitutes a large part of a lead vein in millstone grit, and is occasionally in octahedrons; in St. Lawrence Co., brown blende occurs at Cooper's falls, in a vein of carbonate of lime; at Mineral Point with galena, and in Fowler, on the farm of Mr. Belmont, in a vein with iron and copper pyrites traversing serpentine; at the Ancram lead mine in Columbia Co., of yellow and brown colors; in limestone at Lockport, in honey and wax-yellow crystals often transparent; with galena on Flat Creek, two miles southwest of Spraker's Basin. In Massachusetts, at Sterling of a cherry-red color, with galena; also yellowish brown at the Southampton lead mines; at Hatfield with galena. In New Hampshire at the Eaton lead mine; at Warren, a large vein of black blende. In Maine it occurs at the Lubec lead mines; also at Bingham, Dexter, and Parsonsfield. In Connecticut, yellowish-green, at Brookfield; at Berlin of a yellow color; brownish-black at Roxbury, and yellowish-brown at Lane's mine, Monroe; a *white* blende (Cleiophane of Nuttall) occurs at Franklin, N. Jersey. In Pennsylvania at the Perkiomen lead mine. In Virginia at Walton's gold mine, Louisa Co., and more abundantly at Austin's lead mines, Wythe Co., where it occurs crystallized, or in radiated crystallizations; at Prince vein, Lake Superior, abundant; near Rosiclare, Illinois, with galena and calcite; in Tennessee, at Haysboro', near Nashville.

The *Leber-blende* (hepatic-blende) of Breithaupt, (J. f. pr. Ch. xv, 321), contains carbon, and is considered by Berzelius common zinc-blende, impure with a mineral resin, or some other mineral with carbon in its composition.

ALTERED FORMS.—Blende by oxydation changes to zinc vitriol. Calamine ($\dot{Z}n^3\,\dddot{Si}+1\frac{1}{2}\,\dot{H}$), Smithsonite, ($\dot{Z}n\,\ddot{C}$), and Limonite occur as pseudomorphs. The sulphate is decomposed by bicarbonate of lime, producing Smithsonite; and the alkaline silicates in solution, acting on the sulphate or carbonate, afford Silicate of zinc.

COPPER-GLANCE. Chalkosine, *Beud.* Vitreous Copper. Sulphuret of Copper. Redruthite, *Nicol.* Glance Copper. Kupferglas, *W.* Kupferglanz, *Haus.* and *L.* Cuivre Sulfuré, *H.*

Trimetric. $I : I=119°\ 35'$, $O : 1\bar{i}=120°\ 57'$; $a : b : c=1{\cdot}6676 : 1 : 1{\cdot}7176$.

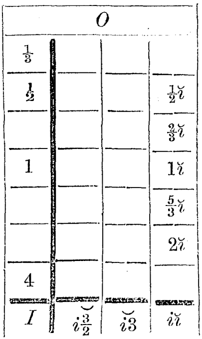
$O : \frac{1}{3}=147°\ 16'$. $O : \frac{2}{3}\breve{i}=147°\ 6'$. $\breve{i}3 : \breve{i}3=120°\ 25'$.

$O : \frac{1}{2}=136°\ 2\frac{1}{2}'$. $O : 2\breve{i}=117°\ 16'$. $1 : 1$ (mac.)$=126°\ 56\frac{1}{2}'$.

$O : 1=117°\ 24'$. $2\breve{i} : 2\breve{i}=125°\ 28'$. $1 : 1$ (brach.)$=79°\ 48\frac{1}{2}'$.

Cleavage: *I*, indistinct. Twins: (1,) composition-face *I*, producing hexagonal, or stellate forms, (f. 276B); (2,) composition-face $\frac{1}{2}$, a cruciform twin, (f. 276A), crossing at angles of 92° 5′ and 87° 55′; (3,) composition-face 2ĭ (f. 276B) a cruciform twin, angle of intersection 125° 28′. Also massive, structure granular or compact and impalpable.

H.=2·5—3. G.=5·5—5·8; 5·7022, Thomson. Lustre metallic. Color and streak blackish lead-gray; often tarnished blue or green; streak sometimes shining. Fracture conchoidal. Sectile.



Observed planes.

Composition.—Ꞓu S=Sulphur 20·2, copper 79·8. Analyses: 1, Ullmann, (Syst. tab. Uebers. 243); 2, 3, Scheerer, (Pogg. lxv, 290); 4, Schnabel, (Ramm. 4th Supp. 121); 5, C. Bechi, (Am. J. Sci. [2], xvi, 61); 6, Wilczynsky, (Rammelsberg's 5th Suppl., 151):

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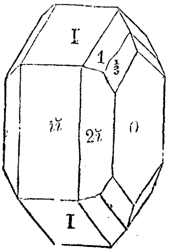

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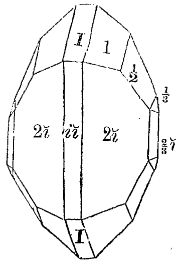
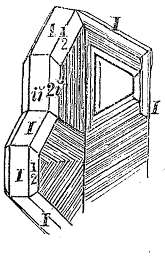


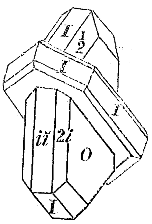
Bristol, Ct.

276B



Bristol, Ct.

276A



Bristol, Ct.

1.	Siegen,	19·00	79·50	0·75, S̈i 1·00=100·25,	Ullmann.
2.	Tellemark, Norway, G.=5·795,	20·43	77·76	0·91=99·10,	Scheerer.
3.	" ", G.=5.521,	20·36	79·12	0·28=99·76,	Scheerer.
4.	Siegen, *massive*,	21·50	74·73	1·26, S̈i 2·00=99·49,	Schnabel.
5.	Mt. Catini,	20·50	76·54	1·75=98·79,	Bechi.
6.	Chili,	21·81	74·71	3·33=99·85,	Wilczynsky.

Scheerer infers from the structure of the specimens employed for his second analysis above, that the crystallization was monometric, and therefore that this sulphuret of copper is dimorphous. Haüy erroneously made the crystallization hexagonal.

B.B. in the outer flame melts, gives out fumes of sulphur, and emits glowing drops with a noise, coloring the flame at the same time blue. In the inner flame becomes covered with a coating and does not melt. On charcoal the sulphur is driven off, and a globule of copper remains. In heated nitric acid forms a green solution, and the sulphur is precipitated.

Cornwall affords splendid crystals where it occurs in veins and beds with other ores of copper. It occurs also at Fassnetburn in Haddingtonshire, in Ayrshire, and in Fair Island, Scotland. The compact and massive varieties occur in Siberia, Hesse, Saxony, the Bannat, &c.

In the United States, compact varieties occur in the red sandstone formation at Simsbury and Cheshire, Conn.; also at Schuyler's mines, N. J. Bristol, Conn., affords large and brilliant crystals, f. 276, 276A, 276B; fig. 276B a crystal with its striæ and irregularities, compounded by two different methods. Another crystal has a small octahedral plane situated obliquely upon the intersection of 1, $\frac{1}{2}$, and adjoining the brachydiagonal section, which is probably the plane $\frac{2}{3}\breve{2}$. $2\breve{\imath}:2\breve{\imath}$ in the Bristol crystals=125° 43′.

In Virginia, in the United States copper mine district, Blue Ridge, Orange Co. Between Newmarket and Taneytown, Maryland, east of the Monocacey, with copper pyrites.

The *argent en epis* or *cuivre spiciforme* of Haüy, which is merely vegetable matter impregnated with this ore, occurs at Frankenberg in Hessia, and also Mahoopeny, Penn.

This species, if $\frac{2}{3}\bar{\imath}$ be taken as $1\bar{\imath}$, is closely homœomorphous with discrasite and aragonite.

Altered Forms.—Copper pyrites, Erubescite, Black copper, constitute pseudomorphs after copper glance.

Digenite, *Breithaupt.*—A copper glance or allied mineral from Chili and Sangerhausen in Thuringia. G.=4·568—4·68. By a blowpipe examination, Plattner obtained 70·2 of copper, and 0·24 of silver; the formula proposed is €u S+3Cu S(=$\text{Cu}^5\,\text{S}^4$), making it a compound of 1 of copper glance and 3 of covelline.

STROMEYERITE, *Haid.* Argentiferous Sulphuret of Copper. Cupreous Sulphuret of Silver. Sulphuret of Silver and Copper. Silberkupferglanz *of the Germans.* Cuivre Sulfuré Argentifère.

Trimetric: isomorphous with Copper glance. $I:I$=119° 35′. Observed planes O, $\breve{\imath}\breve{\imath}$, $\frac{1}{2}\breve{\imath}$, $\frac{1}{4}$; $O:\frac{1}{4}$=154° 16′, $O:\frac{1}{2}\breve{\imath}$=155° 7′. Also massive, compact.

H.=2·5—3. G.=6·2—6·3. Lustre metallic. Color dark steel-gray. Streak shining. Fracture subconchoidal. Sectile.

Composition.—(€u, Ag) S, or €u S+Ag S=Sulphur 15·8, silver 53·1, copper 31·1. Analyses: 1, Stromeyer, (Schw. J. xix, 325); 2, Sander, (Pogg. xl, 313); 3–7, Domeyko, (Ann. d. Mines [4], iii, 9):

	S	Ag	Cu	Fe
1. Schlangenberg, Siberia,	15·782	52·272	30·478	0·333=98·875, Stromeyer.
2. Rudelstadt, Silesia,	15·92	52·71	30·95	0·24=99·82, Sander.
3. S. Pedro, Chili,	20·79	2·96	75·51	0·74=100, Domeyko.
4. Catemo, "	21·41	12·08	63·98	2·53=100, Domeyko.
5. " "	20·53	16·58	60·58	2·31=100, Domeyko.
6. " "	19·93	24·04	53·94	2·09=100, Domeyko.
7. S. Pedro, "	17·83	28·79	53·38	——=100, Domeyko.

B.B. fuses easily to a gray metallic globule, which is a little malleable; with the fluxes gives the reaction of copper, and on a cupel with lead affords silver. Dissolves in nitric acid, affording sulphur. The blue solution, obtained with nitric acid, affords indications of copper when a plate of iron is dipped into it, and also precipitates silver upon an immersed copper plate.

Found associated with copper pyrites at Schlangenberg, near Kolyvan in Siberia; at Rudelstadt, Silesia; also in Chili. A variety has been observed at Combavalla, in Peru, which contains some iron. It was first described and recognized as a distinct species by Stromeyer.

CINNABAR. Sulphuret of Mercury. Zinnober, Mercurblende *of the Germans.* Quecksilber Lebererz, *W.* Stinkzinnober Lebererz, *Haus.* Corallinerz. Mercure Sulfuré, *H.* Κιννaβaρις, *Theoph.* c. 103. Αμμιον, *Dioscor.* V. c. 109, 110. Minium, *Vitruv.*, *Plin.*

Rhombohedral. $R:R$=92° 36′, $R:O$=127° 6′; a=1·1448. Observed planes: rhombohedrons, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{2}{5}$, $\frac{1}{2}$, $\frac{2}{3}$, $\frac{4}{5}$, R, $\frac{5}{4}$, $\frac{4}{3}$, $\frac{16}{9}$, 2, $\frac{32}{9}$, 4, $\frac{9}{2}$, $\frac{16}{3}$, 8, $-\frac{9}{2}$, -4, -2, $-\frac{16}{9}$, $-R$, $-\frac{2}{3}$, $-\frac{1}{2}$, $-\frac{2}{5}$, $-\frac{1}{3}$, $-\frac{1}{4}$; pyramids, 22, 62; scalenohedron $\frac{1}{3}^{3}$; and also O, I. Also granular, massive; sometimes forming superficial coatings.

$O : \frac{1}{2} = 146° 32'$. $O : 2 = 110° 43'$. $\frac{2}{3} : \frac{2}{3} = 110° 6'$.
$O : \frac{2}{3} = 138° 36'$. $2 : 2 = 71° 48'$. $O : I = 90°$.
$O : \frac{4}{5} = 133° 24'$. $\frac{4}{5} : \frac{4}{5} = 101° 58'$. $I : I = 120°$.

Cleavage: *I*, very perfect. Twins: composition face *O*. H.=2—2·5. G.=8·998, a cleavable variety from Neumarktel. Lustre adamantine, inclining to metallic when dark colored, and to dull in friable varieties. Color cochineal-red, often inclining to brownish-red and lead-gray. Streak scarlet, subtransparent, opaque. Fracture subconchoidal, uneven. Sectile.

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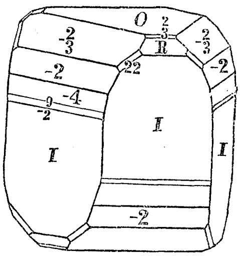

Composition.—Hg S=Sulphur 13·8, quicksilver 86·2. Sometimes impure from clay, oxyd of iron, bitumen. Analyses: 1, 2, 3, Klaproth, (Beit. iv, 14); 4, John, (John's Chem. Untersuch. i, 252); 5, 6, Schnabel, (Rammelsberg, 4th Supp. 269); 7, A. Bealey, (Quart. J. Chem. Soc. iv):

	S	Hg
1. Neumarktel,	14·25	85·00=99·25, Klaproth.
2. Japan,	14·75	84·50=99·25, Klaproth.
3. Idria, *hepatic*,	13·75	81·80, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·2, $\ddot{\bar{\mathrm{A}}}\mathrm{l}$ 0·55, Cu 0·02, $\dddot{\mathrm{S}}\mathrm{i}$ 0·65, C 3·3=99·27, [Klaproth.
4. Japan,	17·5	78·4, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 1·7, $\ddot{\bar{\mathrm{A}}}\mathrm{l}$ 0·7, $\dot{\mathrm{C}}\mathrm{a}$ 1·3, $\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·2=100, John.
5. Westphalia,	13·67	86·79=100·46, Schnabel.
6. Wetzlar,	18·78	84·55, gangue 1·02=99·35, Schnabel.
7. California,	11·38	69·36, Fe 1·23, $\dot{\mathrm{C}}\mathrm{a}$ 1·40, $\ddot{\bar{\mathrm{A}}}\mathrm{l}$ 0·61, $\dot{\mathrm{M}}\mathrm{g}$ 0·49, $\dddot{\mathrm{S}}\mathrm{i}$ 14·30, Bealey.

B.B. in a matrass wholly sublimes; and with soda yields mercury, sulphurous fumes escaping.

The *hepatic cinnabar* or *liver ore* is an impure variety, sometimes affording a brownish streak; it is occasionally slaty, though commonly granular or impalpable in structure.

Cinnabar occurs in beds in slate rocks, and rarely in granite or porphyry. It has been observed in veins, with ores of iron.

Good crystals occur in the coal formations of Moschellandsberg and Wolfstein in the Palatinate; also in Japan, Mexico, and Brazil. The most important European beds of this ore are at Almaden in Spain, and at Idria in Carniola, where it is usually massive. It occurs at Richenau in Upper Carinthia; in beds traversing gneiss at Dunbrawa in Transylvania; in graywacke at Windisch Kappel in Carinthia; at Neumarktel in Carniola; at Ripa in Tuscany; at Schemnitz in Hungary; in the Urals and Altai; in China abundantly, and in Japan; at San Onofre in Mexico; at Huanca Velica in Southern Peru, abundant; in the Province of Coquimbo at Guallilinga and Punitaqui; and forming extensive mines in California. The California beds occur at New Almaden, in a mountain to the south of San José, between the Bay of Francisco and Monterey. This ore is very abundant, and of easy access. The variety *corallinerz*, from Idria, has a curved lamellar structure.

This ore is the source of the mercury of commerce, from which it is obtained by sublimation. When pure it is identical with the manufactured vermillion of commerce.

The above figure is from an elaborate paper by Schabus, Wien. Akad. vi, 63.

MILLERITE, *Haid.* Capillary Pyrites. Sulphuret of Nickel. Haarkies, Schwefelnickel. Nickel Sulfuré, *Levy.* Nickel Natif, *H.*

Rhombohedral. $R : R = 144° 8'$, Miller; $a = 0·32955$. Observed planes: rhombohedral, R, -1, $\frac{1}{2}$, $-\frac{1}{2}$, -3; prismatic, I, $i2$, $i\frac{3}{2}$; $R : I=$

110° 50′, *I* : -3=138° 47′, $-\frac{1}{2}$: $-\frac{1}{2}$=161° 22′, *O* : *R*=159° 10′. Cleavage: rhombohedral, perfect. Usually in delicate capillary crystallizations.

H.=3—3·5. G.=5·25—5·65. 4·601, Kengott, Joachimstahl. Lustre metallic. Color brass-yellow, inclining to bronze-yellow, with a gray irridescent tarnish. Streak bright. Brittle.

Composition.—Ni S=Sulphur 35·1, nickel 64·9. Analyses: 1, Arfvedson, (K. V. Ac. H. 1822, 427); 2, Rammelsberg, (1st Supp. 67):

1. S 34·26 Ni 64·35=98·61, Arfvedson.
2. Saalfeld, S 35·79 Ni 61·34, Cu 1·14, Fe 1·73=100, Rammelsberg. G. 5·65.

B.B. fuses to a brittle metallic magnetic globule. With warm nitric acid partly dissolved, forming a gray or pale-green solution. Wholly soluble in aqua regia. In an open tube gives sulphurous acid.

Occurs in capillary crystals in the cavities, and among crystals of other minerals, at Joachimstahl in Bohemia, Johanngeorgenstadt, Przibram, Riechelsdorf, Andreasberg, Cornwall, and other places. Near Merthyr Tydvil, at Dowlais, it is found in regular crystals, occupying cavities in nodules of spathic iron. In capillary crystals with spathic iron at the Sterling Mine, Antwerp, N. Y.; the largest crystal yet observed was about a fifth of a line in diameter. In some cases crystals of spathic iron are transfixed by the needles of millerite. (Am. J. Sci. [2], ix, 287). Also in Lancaster Co., Pa., with chromiciron, emerald nickel, and kæmmererite.

PYRRHOTINE, *Breit.* Magnetic Pyrites. Magnetkies, *W.* Fer Sulfuré ferrifère. Fer Sulfuré magnetique, *H.*

Hexagonal. *O*: 1=135° 8′; *a*=0·862. Observed planes *O*, *I*, $\frac{1}{2}$, 1, 12, *i*2.

O : *I*=90°. *O* : 22=119° 53′. 1 : 1=138° 48′.
O : 2=116° 28′. 2 : 2=126° 52′. *I* : *I*=120°.

Cleavage: *O*, perfect; *I*, less so. Commonly massive and amorphous; structure granular.

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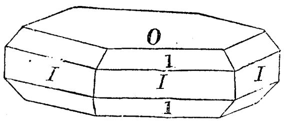

H.=3·5—4·5. G.=4·4—4·7; 4·631, a crystalline variety. Lustre metallic. Color between bronze-yellow and copper-red. Streak dark-grayish black. Fracture small subconchoidal. Brittle. Slightly attracted by the magnet, and subject to speedy tarnish.

Composition.—$FeS[+\frac{1}{5}Fe^2S^3]=Fe^7S^8$=Sulphur 39·5, iron 60·5, G. Rose. Schaffgotsch makes also the compounds $FeS+Fe^2S^3$, and $9FeS+Fe^2S^3$, but they are rejected by Rose. Analyses: 1, Stromeyer, (Gilb. Ann. xviii, 183, 209); 2, 3, Plattner, (Pogg. xlvii, 369); 4, 5, Berthier, (Ann. d. Mines, [3], xi, 499); 6, H. Rose, (Pogg. xlvii); 7, Schaffgotsch, (Pogg. l, 533); 8, Stromeyer, (loc. cit.):

	1. Hartz	2. Brazil	3. Fahlun	4. Sitten	5. Sitten	6. Bodenmais	7. Bavaria	8. Barèges
Sulphur,	40·15	40·43	40·22	40·2	39·0	38·78	39·41	43·63
Iron,	59·85	59·63	59·72	59·8	61·0	60·52	60·59	56·37
	100·00, S.	100·06 P.	99·94, P.	100·0, B.	100·0, B.	100·00, R.	100, Sch.	100, St.

Frankenheim considers the mineral essentially Fe S=Sulphur 36·4, iron 63·6, considering the species isomorphous with greenockite (Cd S).

A nickeliferous variety analyzed by Berzelius, (Jahresb. xxi, 182), and another by M. Boye, (Am. J. Sci. [2], xiii, 219), afforded,

	S	Fe	Ni	Co	Mn	Cu	Gangue
1. Klefva,	38·089,	57·643,	3·044,	0·094,	0·223,	0·447,	0·460.
2. Lancaster Co. Pa.	24·84,	41·34,	4·55,	Pb 0·27,	——	1·30,	27·16.

Deducting the impurities in Boye's analysis there are 21·01 sulphur to 40·19 iron. In another specimen from Modum, Norway, Scheerer detected 2·8 per cent. of nickel.

B.B. affords fumes of sulphurous acid and the odor of sulphur. On charcoal in the exterior flame, converted into a globule of red oxyd of iron; in the interior flame it fuses and continues to glow, after the blowpipe is removed. The mass on cooling, is magnetic and has a metallic crystalline structure, and a yellowish color on a surface of fracture. Dissolves in muriatic acid, excepting the sulphur.

Crystalline plates of this species have been observed at Kongsberg in Norway, and at Andreasberg in the Hartz; but they are of rare occurrence. It generally occurs massive, in fissures of crystalline rocks; also found at Kupferberg in Siberia, Bodenmais, Breitenbrunn, Fahlun; at Joachimstahl on crystals of pyrargyrite. Cleavable varieties accompany iolite at Bodenmais in Bohemia. The compact specimens are abundant in Cornwall, at Appin in Argyleshire, Saxony, Siberia, and the Hartz. It has also been observed in the lavas of Vesuvius, and in some meteoric stones.

Trumbull, Conn., and the adjoining town of Monroe, afford the cleavable variety of this species; at the former place it occurs in the topaz and fluor vein, at the latter in a quartz vein, in gneiss. Compact varieties occur with iron pyrites, at Stafford, Corinth and Shrewsbury, Vt., and in many parts of Massachusetts; also a mile and a half north of Port Henry, Essex Co., N. Y., near Natural Bridge in Diana, Lewis Co., and with magnetic iron ore at O'Neil mine, and elsewhere, in Orange Co., N. Y. In Canada in large veins at St. Jerome, &c.

Its inferior hardness is sufficient to distinguish it from common pyrites.

GREENOCKITE, *Brooke* and *Connel*, Jameson's Jour. xxviii, 390; *Breithaupt*, Pogg. li, 274. Sulphuret of Cadmium.

Hexagonal; hemihedral, with the opposite extremities dissimilar. $O:1=136^\circ\ 24'$; $a:0{\cdot}8247$. Observed planes as in the annexed figure, with also 4 and *i*2.

$O:\frac{1}{2}=154^\circ\ 32'$. $I:1=133^\circ\ 36'$ $1:1$ (pyr.) $139^\circ\ 39'$.
$O:2=117^\circ\ 42'$. $I:2=152^\circ\ 18'$ $2:2$ " $=127^\circ\ 26'$.

Cleavage: *I*, distinct; *O*, imperfect. H.=3—3·5. G.=4·8, Brooke; 4·9—4·999, Breithaupt; 4·5, the artificial, Söchting. Lustre adamantine. Color honey-yellow; orange-yellow—veined parallel with the axis. Streak powder between orange-yellow and brick-red. Nearly transparent. Strong double refraction. Not thermo-electric, (Breithaupt).

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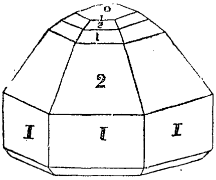


Composition.—Cd S=Sulphur 22·3, cadmium 77·7. Analysis by Connel, (loc. cit.), Sulphur 22·56, and cadmium 77·30=99·86.

B.B. on charcoal decomposed, and a yellowish-red ring of oxyd of cadmium is deposited. Soluble in muriatic acid, affording sulphuretted hydrogen.

Greenockite occurs in short hexagonal crystals at Bishoptown in Renfrewshire, Scotland, in a porphyritic trap and amygdaloid, associated with prehnite. It was named in honor of Lord Greenock, its discoverer. This species is related in form to copper nickel and breithauptite. It has been found as a furnace product, (Ann. Ch. Pharm. lxxxvii, 34, and Halle Zeitschr., i, 346, 1853).

ONOFRITE, *Haid.* Selenid of Mercury. Merkurglanz, *Br.* Selenquecksilber. Selenschwefelquecksilber.

Massive; texture compact granular; no cleavage.

H.=2·5. G.=7·1—7·37, Clausthal ore. Lustre metallic. Streak shining. Color steel to blackish lead-gray.

Composition.—Analyses: 1, H. Rose, (Pogg. xlvi, 315); 2, 3, Kerl, (B. u. H. Ztg., 1852, No. 47):

1. Mexico,	6·49	10·30	81·33=98·12, Rose.
2. Clausthal,	21·27	0·36	65·52, quartz 10·28=99·57, Kerl.
3. "	24·05	0·12	72·26, " 2·86=99·74, Kerl.

Analysis: 1, Hg (S, Se), with S to Se as 4 : 1; 2, 3, Hg Se=Selenium 28·3, quicksilver 71·7=100·0; or more nearly $Hg^6 Se^5$=Selenium 24·7, quicksilver 75·2=100.

B.B. on charcoal gives off the odor of selenium, and a white incrustation covers the coal.

Occurs with other ores of mercury in Mexico, near San Onofre; also with copper pyrites near Clausthal in the Hartz. It has nearly the color and lustre of gray copper.

COPPER NICKEL. Arseniet of Nickel, *Thom.* Kupfernickel, *W.* Arseniknickel, *L.* Nickel Arsenical, *H.* Nickelkies. Rothnickelkies.

Hexagonal, and isomorphous with Breithauptite. *O* : 1=136° 35′; *a* : 0·81944. Observed planes, *O* and 1; 1 : 1 (pyr.)=138° 48′. Usually massive—structure nearly impalpable; also reniform with a columnar structure; also reticulated and arborescent.

H.=5—5·5. G.=7·33—7·671. Lustre metallic. Color copper-red, with a gray to blackish tarnish. Streak pale brownish-black. Opaque. Fracture uneven. Brittle.

Composition.—Ni As=Arsenic 55·9, nickel 44·1. Analyses: 1, Stromeyer, (Gött. gel. Anz. 1817, 204); 2, Pfaff, (Schw. J. xxii, 256); 3, Suckow, (Verwitt. im Min., 58, Ramm. 4th suppl. 122); 4, Berthier, (Ann. Ch. Phys. xiii, 52); 5, Scheerer, (Pogg. lxv, 292); 6, Ebelmen, (Ann. d. M. [4], xi, 55); 7, Schnabel, (Ramm. 4th Suppl. 122):

	As	Ni	Fe	Pb	Co	Sb	S
1. Riechelsdorf,	54·73	44·21	0·34	0·32	—	—	0·40= 99·99, Strom.
2. "	46·42	48·90	0·34	0·56	—	—	0·80= 97·02, Rfaff.
3. "	53·69	45·76	2·70	—	—	—	0·15=102·30, Suckow.
4. Allemont,	48·80	39·94	—	—	0·16	8·00	2·00= 99·90, Berth.
5. Krageroe, G. 7·662,	54·35	44·98	0·21	—	Cu 0·16		0·14= 99·79, Scheer.
6. Ayer, G=7·39,	54·05	43·50	0·45	—	0·32	0·05	2·18, gangue 0·20= 100·75, E.
7. Westphalia,	52·71	45·37	—	—	—	—	0·48, Cu 1·44=100, S.

An ore from Balen in the Pyrenees, afforded Berthier,

As 33·0, Sb 27·8 Ni 33·0, Fe 1·4, S 2·8, quartz 2·0=100,

in which, as in his Allemont ore, part of the arsenic appears to be replaced by antimony.

B.B. on charcoal emits arsenical fumes and fuses to a white globule, which darkens by exposure to the air. In nitric acid soon assumes a green coating, and in nitromuriatic acid is dissolved.

Copper nickel accompanies cobalt, silver, and copper, in the Saxon mines of Annaberg, Schneeberg, &c.; also in Thuringia, Hesse, and Styria, and at Allemont in Dauphiny. It is occasionally observed in Cornwall, as at Pengelly and Huel Chance, and at the Leadhills, Scotland.

It is found at Chatham, Conn., in gneiss, associated with smaltine. This is the most important of the ores of nickel.

BREITHAUPTITE, *Haid.* Antimonial Nickel. Antimoniet of Nickel. Antimonnickel.

Hexagonal. $O : 1 = 135° 15'$; $a = 0·8585$. Observed planes: O, $\frac{1}{2}$, $\frac{3}{2}$, I. $O : \frac{1}{2} = 153° 38'$, $O : \frac{3}{2} = 123°55'$. In thin hexagonal plates. Also arborescent and disseminated.

H.=5·5. G.=7·541, Breithaupt. Lustre metallic, splendent. Color in the fresh fracture light copper-red, inclining strongly to violet. Streak reddish-brown. Opaque. Fracture uneven—small subconchoidal. Brittle. Not acted on by the magnet.

Composition.—Ni Sb=Antimony 68·6; Nickel 31·4. Analyses: 1, 2, Stromeyer, (Pogg. xxxi, 134):

1.	Sb 63·734	Ni 28·946	Fe 0·866	Galena 6·437=99·983.
2.	59·706	27·054	0·842	12·357=99·959.

B.B. on charcoal antimony sublimes.

Formerly found in the Andreasberg mountains, with calcite, galena, and smaltine, but long since exhausted. Has been observed as a furnace product, crystallized.

KANEITE, *Haid.* Arsenical Manganese. Arseniuret of Manganese. Arsenikmangan.

In botryoidal masses, also amorphous; structure foliated or granular.

H. above 5? stated as hard. G.=5·55. Lustre metallic. Color grayish-white, with a black tarnish. Opaque. Fracture uneven. Brittle.

Composition.—Mn As=Manganese 42·4, arsenic 57·6. Analysis by Mr. Kane, (Quarterly J. of Sci., New Ser., vi, 382):

Manganese 45·5, Arsenic 51·8, and a trace of Iron=97·3.

B.B. burns with a blue flame, and falls to powder; at a higher temperature the arsenic evaporates, and covers the charcoal with a white powder. Dissolves in aqua regia, without leaving any residue.

It is supposed to be from Saxony, and was first observed by Mr. R. J. Kane of Dublin, attached to a mass of galena.

SCHREIBERSITE, *Haidinger.*

In steel-gray folia and grains. Folia flexible.

H.=6·5. G.=7·01—7·22. Magnetic.

Composition.—Analysis by M. Patera, (Mitth. v. Freund. d. Nat. in Wien, 1847; and Am. J. Sci. [2], viii, 439): Phosphorus 7·26, iron 87·20, nickel 4·24=98·70, carbon *undetermined.*

Found in the meteoric iron of Arva. A similar substance was distinguished by Berzelius in the meteoric iron of Bohumilitz, consisting of iron, nickel, and sulphur.

The *Dyslytite* of Prof. Shepard, (Am. J. Sci. [2], ii, 380), is supposed to be a phosphuret of iron, nickel, and magnesium. It occurs as a blackish-brown powder in many meteoric irons, constituting usually 0·25 to 2·25 per cent.

The Schreibersite of Shepard, (Am. J. Sci. [2], ii), from a meteorite, is supposed to be a "Sesquisulphuret of chromium." The name has been changed to *Shepardite* by Haidinger.

3. PYRITES DIVISION.

1. PYRITES GROUP.—Monometric.

Pyrites,	Fe S^2.	Cobaltine,	Co (S, As)^2.
Hauerite,	Mn S^2.	Gersdorffite,	Ni (S, As)^2.
Smaltine,	(Co, Ni) As^2.	Ullmannite,	Ni (S, Sb, As)^2.
Chloanthite,	(Ni, Fe, Co) As^2.		

5. MARCASITE GROUP.—Trimetric.

Marcasite,	Fe S^2.	Mispickel,	Fe (S, As)^2.
Rammelsbergite,	Ni As^2.	Glaucodot,	(Co, Fe) (S, As)^2.
Leucopyrite,	Fe As^2.	Sylvanite,	(Ag, Au) Te^2.

3. NAGYAGITE GROUP.—Dimetric.

Nagyagite.	? (Pb, Au) (Te, S)^2.

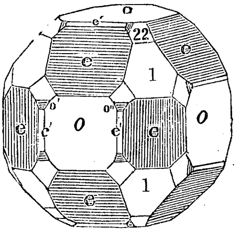
4. COVELLINE GROUP.—Hexagonal.

Covelline,	Ȼu S^2.	Molybdenite,	Mo S^2.

PYRITES. Cubic Pyrites. Mundic. Marcasite. Bisulphuret of Iron, *Thomson.* Schwefelkies, *W.* Eisenkies, *L.* Fer Sulfuré, *H.* πυρίτης.

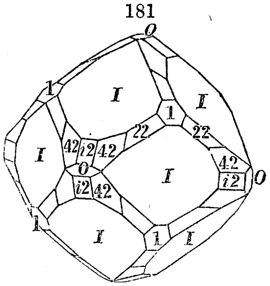
Monometric; pyritohedral. Common form, the cube. Observed planes O, I, 1, $i2$, $i\frac{3}{2}$, $i3$, 2, 22, 33, 42, $3\frac{3}{2}$, $5\frac{5}{3}$, $\frac{5}{3}\frac{5}{4}$. Fig. 1, (common), 11, 14, 67—75, and the annexed.

180



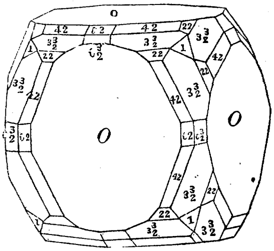
Rossie.

181



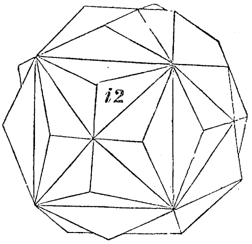
Rossie.

182



Peru.

182A



Cleavage: cubic and octahedral, more or less distinct. Planes *O* and *I* often striated, as in f. 167. Twins: composition parallel to *I;* this composition sometimes parallel to each of the edges, when the form in f. 182A is produced. Also radiated subfibrous, and massive. Often reniform or globular with a crystalline surface.

H.=6—6·5. G.=4·83—5·031. Lustre metallic, splendent—glistening. Color a characteristic bronze-yellow, nearly uniform. Streak brownish-black. Opaque. Fracture conchoidal, uneven. Brittle. Strikes fire with steel.

Composition—Fe S^2=Iron 46·7, sulphur 63·5. B.B. becomes red in the oxydating flame, and gives off sulphur; ultimately yields a globule of oxyd of iron, attractable by the magnet. Soluble in nitric acid, except a white residue. Some varieties are very liable to decomposition on exposure to the atmosphere.

A variety from Cornwall, Lebanon Co., Pennsylvania, gave J. C. Booth (as communicated to the author) 2·39 per cent. of copper, affording the formula (Fe, Cu) S^2. The analysis afforded,

S 53·37, Fe 44·47, Cu 2·39.

This variety tarnishes, readily, assuming the bluish tarnish of steel.

The *ballesterosite* is a variety in cubes from Galicia, containing traces of zinc and tin, (Bull. Geol. de F. vii, 21). A variety occurring with millerite at the Kearney Ore bed, Gouverneur, N. Y., is *nickeliferous*; it is pale bronze and radiated botryoidal in structure; H.=5·5; G.=4·863, (Am. J. Sci., [2], xv, 444.)

It sometimes contains mechanically mingled, a minute quantity (perhaps one five thousandth part) of gold, and is then termed *auriferous pyrites.* Auriferous pyrites occurs in most gold regions.

Iron pyrites occurs abundantly in rocks of all ages, from the oldest crystalline to the most recent alluvial deposits. It usually occurs in small cubes, but often modified as above described; also in irregular spheroidal nodules and in veins, in clay slate, argillaceous sandstones, the coal formation, &c. Cubes of gigantic dimensions have been found in some of the Cornish mines; pentagonal dodecahedrons and other forms occur on the island of Elba, sometimes three or four inches in diameter. Large octahedral crystals are found at Persberg in Sweden. Magnificent crystals have been brought from Peru; but still more brilliant and well-finished crystals occur at Traversella in Piedmont. Alston Moor, Derbyshire, Cornwall, Fahlun in Sweden, Kongsberg in Norway, are well-known localities. The clay at Münden in Hannover, and the chalk at Lewes in Surry, have afforded some remarkable compound crystals. It has also been met with in the Vesuvian lavas in small irregular crystals.

At Rossie, N. Y., fine crystals (f. 180, 181) occur at the lead mine in green shale; at Scoharie, a mile west of the court house in single and compound crystals, often highly polished and abundant; in interesting crystals at Johnsburgh and Chester, Warren Co., N. Y.; in gneiss near Yonkers; in Orange Co. at Warwick and Deerpark; in Jefferson Co., in Champion, and near Oxbow on the banks of Vrooman's lake, in modified octahedrons, (f. 16); in limestone at Shoreham, Vt., crystals abundant; at Hartford, Vt., in cubes of 2 to 4 inches; at Lane's mine, Monroe, Conn., in small octahedrons; in cubes in chlorite slate, at Orange and Milford, Conn., and in mica slate at Stafford; in Massachusetts at Heath in handsome crystals; in Maine at Corinna, Peru, Waterville and Farmington; in Connecticut at Middletown lead mine, (f. 15), sometimes acicular; in Pennsylvania, in crystals, at Little Brittain, Lancaster Co.; at Chester, Delaware Co.; in Carbon and York Cos.; at Knauertown, Chester Co.; in Cornwall, Lebanon Co., in lustrous cubo-octahedrons, and with an elegant steel tarnish, sometimes an inch through; at Pottstown, near French Creek, in large yellow octahedrons; with magnetic and copper pyrites. Massive varieties are abundant in Connecticut in gneiss at Colchester, Ashford, Tolland, Stafford, and Union; in Massachusetts at Hawley and Hubbardston; in Maine at Bingham, (saw-mills), Brooksville, and Jewell's Island; in New Hampshire at Unity; in New York in Franklin, Putnam, and Orange Cos., and elsewhere.

This species affords the greatest part of the sulphate of iron and sulphuric acid of commerce, and also a considerable portion of the sulphur and alum.

The name *pyrites* is derived from the Greek, πυρὶτης; a term applied to this mineral, because, as Pliny states, "there was much fire in it," as was made apparent by friction. This term was applied to flint and some siliceous millstones for a similar reason.

Altered Forms.—Pyrites readily changes to sulphate of iron by oxydation, some sulphur being set free; also to limonite on its surface, by the action of bicarbonate of lime carrying off the sulphuric acid, as change proceeds; and from limonite to red oxyd of iron. Green vitriol, Limonite, Göthite, Red iron ore, also Quartz, Graphite, occur as pseudomorphs after pyrites.

HAUERITE, *Haid.* Naturwiss. Abhandl. of Vienna, 4to. 1847, i, pp. 101 and 107.

Monometric; hemihedral, like pyrites. Figures 11, 16, 15, 19, 73 (O, $3\frac{3}{2}$), 67 (O, $i3$); octahedral form most common. Crystals sometimes clustered in spheroidal forms. Cleavage: cubic, imperfect.

H.=4. G.=3·463, v. Hauer. Lustre metallic adamantine. Color reddish-brown, brownish-black. Streak brownish-red.

Composition.—$Mn\,S^2$=Sulphur 53·7, manganese 46·3. Analysis by Patera, (loc. cit. and Pogg. lxx, 148):

S 53·64, Manganese 42·97, Iron 1·30, Silica 1·20=99·11.

B.B. gives off much sulphur and is reduced to a simple sulphuret $Mn\,S$; with soda a manganese reaction.

From Kalinka in Hungary, in clay with gypsum and sulphur, in a region something like a solfatara, trachytic and dioritic rocks decomposing and adding to the clay, and at the same time the sulphur which is given off producing some deposited sulphur, besides gypsum and sulphurets.

SMALTINE. Gray Cobalt. Tin-white Cobalt, *J.* Binarseniet of Cobalt, *Thom.* Tesseralkies, *Breit.* Weisser-Speiskobold, *W.* Speisskobalt, *Haus.* and *L.* Cobalt Arsenical, *H.*—Chloanthite, *Breit.* Rammelsbergite, *Haid.* White Nickel. Chathamite, *Shepard.* Weissnickelkies. Arseniknickel.

Monometric. Observed planes: O, 1, 22, I. Figures 9, 11, 15, 17, 19, 37. Cleavage: octahedral, distinct. Cubic, in traces. Also massive and in reticulated and other imitative shapes.

H.=5·5—6. G.=6·466—7·2. Lustre metallic. Color tin-white, inclining, when massive, to steel-gray, sometimes iridescent, or grayish from tarnish. Streak grayish-black. Opaque. Fracture granular and uneven. Brittle.

Composition.—(Co, Fe, Ni), As^2=, with cobalt alone, Arsenic 71·8, cobalt 28·2; with nickel alone, Arsenic 91·7, nickel 28·3; with equal parts of cobalt, iron and nickel, Arsenic 72·1, cobalt 9·4, nickel 9·5, iron 9·0. Anal. 6, $R^7\,As^6$; 5, 7, 8, $R^4\,As^3$. The species varies between an ore of cobalt and nickel, (or perhaps cobalt alone), with arsenic, and one of nickel alone; G. Rose doubts if it ever occurs without nickel, and states that in the earlier analyses of Stromeyer and Varrentrapp, the nickel was probably overlooked.

Smaltine has included the cobaltic variety, and *Chloanthite* the nickel variety, between which there are gradual transitions.

Analyses: 1, Stromeyer, (Gött. gel. Anz. 1817, 72); 2, Varrentrapp, (Pogg. xlviii, 505); 3, Hofmann, (xxv, 485); 4, Kobell; 5, Jäckel, (Rose's Kryst.-Chem., 53); 6, Klauer, (Ramm. 5th Suppl. 225); 7, Weber, (ib.); 8, Rammelsberg, (ib.); 9, Sartorius, (Ann. Ch. Pharm. lxvi, 278); 10, 11, B. W. Bull, (Rose's Kryst. Ch. Min. 52); 12, Karstedt, (Ramm. 5th Suppl. 225); 13, Booth, (Am. J. Sci., xxix, 241); 14, Rammelsberg, (J. f. pr. Chem. lv, 486); 15, 16, ib. (1st. Suppl. 15); 17, C. U. Shepard, (Am. J. Sci., xlvii, 351):

		As	Co	Fe	Cu	Ni	
1.	Riechelsdorf,	74·21	20·31	3·42	0·16	——	S 0·88=98·98, Stromeyer.
2.	Tunaberg,	69·46	23·44	4·95	——	——	S 0·90=98·75, Varrentrapp.
3.	Schneeberg,	70·37	13·95	11·71	1·39	1·79	S 0·66, Bi 0·01=99·88, Hofm.
4.	"	71·08	9·44	18·48	*trace*	——	S *trace*, Bi 1·00=99·92, Kob.
5.	Riechelsdorf,	66·02	21·21	11·60	1·90	——	S 0·49, Bi 0·04=101·26, Jäckel,
6.	" *cryst.*	68·73	16·37	2·30	0·45	12·15	=100, Klauer. [G=6·84.
7.	" *cubes*,	59·38	18·30	0·72	——	19·38	S 2·22=100, Weber, G=4·374.
8.	"	60·42	10·80	0·80	——	25·87	S 2·11=100, Ramm. G=4·374.
9.	"	73·53	9·17	2·24	——	14·06	S 0·94=99·94, Sartorius.
10.	" *cryst.*	76·09	4·56	6·82	——	12·25	=99·72, Bull.
11.	Schneeberg,	75·85	3·32	6·52	0·94	12·04	=98·67, Bull, G=6·537.
12.	"	74·80	3·79	7·33	——	12·86	S 0·85=99·63, Karstedt.
13.	Riechelsdorf,	72·64	3·37	3·25	——	20·74	=100, Booth.
14.	"	71·11	——	6·82	——	18·71	S 2·29=98·93, Ramm. G=6·411.
15.	Kamsdorf,	70·34	——	*trace*	——	28·40	=100·43, Ramm. G=6·735.
16.	"	70·93	——	*trace*	——	29·50	=100·43, "
17.	*Chathamite*,	70·00	1·35	17·70	——	12·16	=101·21, Shepard.

B.B. on charcoal emits copious arsenical fumes, and melts to a white brittle metallic globule. It colors borax and other fluxes blue, and produces with nitric acid, a pink solution, depositing arsenous acid; or gives the reactions of nickel.

Usually occurs in veins, accompanying ores of cobalt or nickel, and ores of silver and copper; also, in some instances, with copper nickel and mispickel; often having a coating of nickel green.

With silver and copper it occurs at Freiberg, Annaberg, and particularly Schneeberg in Saxony; at Joachimstahl in Bohemia, the reticulated varieties are frequently found imbedded in calc spar; also at Huel Sparnon in Cornwall; at Riechelsdorf in Hesse, in veins in the copper schist; at Tunaberg in Sweden; Allemont in Dauphiné. See analyses above, for the varieties at these localities.

At Chatham, Conn., the Chloanthite (Chathamite) occurs in mica slate, associated generally with mispickel and sometimes with copper nickel; affords but 1 or 2 per cent. of cobalt.

Altered Forms.—Smaltine occurs altered to Cobalt Bloom, (arsenate of cobalt), a change due to the oxydation of the arsenic and cobalt on exposure to moisture.

COBALTINE, *Beud.* Silver White Cobalt. Bright White Cobalt. Glance Cobalt. Glanzkobalt, *W.* Kobalt Glanz, *Haus.* and *L.* Cobalt Gris, *H.*

Monometric; pyritohedral. Observed planes, as in the annexed figure. Cleavage: cubic, perfect. Planes *O* striated. Also massive, granular or compact.

H.=5·5. G.=6—6·3. Lustre metallic. Color silver-white, inclined to red; also steel-gray with a violet tinge, or grayish black when containing much iron. Streak grayish black. Fracture uneven and lamellar. Brittle.

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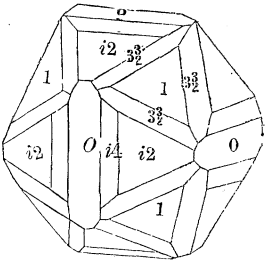


Composition.—$Co\,S^2+Co\,As^2$ or $Co\,(S, As)^2$=Sulphur 19·3, arsenic 45·2, cobalt 35·5. Analyses: 1, Stromeyer, (Schw. J. xix, 336); 2, Schnabel, (Ramm. 3d Supp. 65); 3, Huberdt, (Ramm. 4th Supp. 116); 4, Patera, (ib.); 5, Ebbinghaus, (ib.); 6, 7, Schnabel, (ib.); 8, Schnabel, (ib. 5th Suppl. 149); 9, Heidingsfeld, (ib.)

	S	As	Co	Fe
1. Skutterud,	20·084	43·46	33·101	3·232=99·882, Stromeyer.
2. Siegen,	19·10	44·75	29·77	6·38=100, Schnabel.
3. Oratwitza,	19·75	44·13	30·37	5·75=100, Huberdt.
4. " *columnar,*	19·78	43·63	32·03	4·56=100, Patera.
5. Skutterud,	20·25	42·97	32·07	3·42, quartz 1·63=100·34, Ebbinghaus.
6. Siegen, *massive,*	19·35	45·31	33·71	1·62=99·99, Schnabel.
7. " *plumose,*	19·98	42·53	8·67	25·98, Sb 2·84=100, Schnabel.
8. " "	20·86	42·94	8·92	28·03=100·75, Schnabel. [·75, Heid.
9. " "	19·08	43·14	9·62	24·99, Sb 1·04, Cu 3·26, gangue 0·52=100

The last 3 analyses have three-fourths of the cobalt replaced by iron; they are of the *Stahlkobalt* or *Ferrocobaltine,* from the Hamberg mine, Siegen.

B.B. gives off fumes of arsenic, and affords, after roasting, a dull black metallic globule, which attracts the magnet. Colors borax blue, and effervesces in heated nitric acid. Soluble in warm nitric acid, depositing arsenous acid.

Occurs at Tunaberg, Riddarhyttan, and Hokansbö, in Sweden, in large, splendid, well defined crystals; also at Skutterud in Norway. Other localities are at Querbach in Silesia, Siegen in Westphalia, and at Botallack near St. Just, and in other places in Cornwall. The most productive mines are those of Vena in Sweden, where it occurs in mica slate. These mines were first opened in 1809.

This, and the preceding species, afford the greatest part of the smalt of commerce. It is also employed in porcelain painting.

GERSDORFFITE, *Haid.* Nickel-Glance. Nickelglanz. Nickelarsenikglanz. Nickelarsenikkies. Amoibite, *Kob.* Tombazite. Disomose, *Beud.*

Monometric; pyritohedral. Observed planes *O*, 1, *i*2. Figs. 11, 15, 16, 68. Cleavage: cubic, rather perfect. Also lamellar and granular massive.

H.=5·5. G.=5·6—6·9. Lustre metallic. Color silver-white—steel-gray, often tarnished gray or grayish-black. Streak grayish-black. Fracture uneven.

Composition.—Ni S^2+Ni As^2 or Ni, (S, As)^2=Sulphur 19·3, arsenic 45·3, nickel 35·6. Analyses: 1, Berzelius, (K. V. Ac. H. 1820); 2, Rammelsberg, (Pogg. lxviii, 511); 3, Kobell, (J. f. pr. Ch. xxxiii, 402); 4, Löwe, (Berichte Fr. Nat. in Wien, 1847); 5, Döbereiner, (Schw. J. xxvi, 270); 6, Rammelsberg, (Handw. ii, 14); 7, Heidingsfeld, (Ramm. 5th Suppl., 174); 8, 9, Löwe, (Ramm. 2d Suppl. 102, Pogg. lv, 503); 10—12, Pless, (Ann. d. Ch. u. Pharm. li, 250); 13, Ludwig, (Archiv d. Pharm. 1847, 288):

	As	S	Ni	Fe	Co
1. Loos, Sweden,	45·37	19·34	29·94	4·11	0·92^a, $\dddot{\mathrm{S}}$i 0·9=100·58, Berzelius.
2. Harzgerode, G. 5·65,	44·01	18·83	30·30	6·00	—— Sb 0·86=100, Ramm.
3. *Amoibite,* G. 6·08,	45·34^b	14·00	37·34	2·50	*trace,* Pb 0·82=100, Kobell.
4. Prakendorf,	46·10	16·25	28·75	8·90	——=100, Löwe.
5. Kamsdorf,	48·	14·	27·^{c}	11·	——=100, Döbereiner.
6. Lobenstein,	48·02	20·16	31·82	——	——=100, Rammelsberg.
7. "	46·12	18·96	33·04	1·81	0·60 Cu 0·11, Sb 0·33=100·97,
8. *Gersdorffite,*	49·83	14·13	26·14	9·55	——=99·65, Löwe. [Heid.
9. Schlad., G. 6·7–6·9,	42·52	14·22	38·42	2·09	——, quartz 1·87=99·12, Löwe.
10. " *cryst.,* G. 6·64,	39·04	16·35	19·59	11·13	14·12=100·23, Pless.
11. " "	39·88	16·11	27·90	14·97	0·83=99·69, Pless.
12. " "	39·40	16·91	28·62	12·19	2·88=100, Pless
13. Oelsnitz,	35·26	8·90	20·94	——	——Pb 0·29, $\dot{\mathrm{C}}$a 12·58, $\dot{\mathrm{F}}$e 8·26, $\dot{\mathrm{M}}$n 1·02=87·25, Ludwig.

^{a}, with some Cu. ^{b}, by loss. ^{c}, with some Co.

Analyses 1, 2 and 7 give the formula Ni S^2+Ni As^2=Ni (S, As)^2, iron replacing some of the nickel.

Analysis 3 (*Amoibite*) afforded Kobell, $Ni^2 S^3 + 2Ni\ As^2 (= As^4\ S^3\ Ni^4)$=Arsenic 47·4, sulphur 15·2, nickel 37·4. The ratio for the arsenic, sulphur, and nickel, is more nearly 4 : 3 : 4½.

Analysis 4 corresponds nearly to Kobell's formula for the Amoibite—$(Ni, Fe)^2 S^3 + 2\ Ni\ As^2$; equivalent to 1 of $[Ni\ S^2 + Ni\ As^2]$ and ⅓ of copper nickel.

Analysis 8, *Gersdorffite*, according to Löwe, has the formula just mentioned for No. 4. The ratio 3 : 2 : 3 is nearer the analysis than 4 : 3 : 4, and affords the formula $Ni\ As^3 + 2(Fe, Ni)S$. This is equivalent to 1 of $[Ni\ S^2 + Ni\ As^2]$ and ½ of copper nickel. Analysis 5 may belong here or under the formula for No. 4.

Analyses 10 to 12 by Pless, give the formula $2NiS + Ni\ As^2$. The Oelsnitz ore, No. 13, was mixed with spathic iron and calc spar. It corresponds to $Ni\ S^2 + 2Ni\ As^2$, and comes under the general formula $Ni(S, As)^2$.

These discordant results do not seem to admit of being harmonized entirely.

When heated it decrepitates with great violence. Ignited in a glass tube, sulphuret of arsenic sublimes as a transparent yellowish-brown mass, which remains clear on cooling. Partly soluble in nitric acid, depositing sulphur and arsenous acid.

Occurs at Loos in Helsingland, Sweden; in the Albertine mine, near Harzgerode in the Hartz, with copper pyrites, galena, calcite, fluor spar, and quartz; at Schladming in Styria, and Kamsdorf near Lobenstein in Thuringia.

The *Amoibite* occurs in small octahedrons at Lichtenberg near Steben, in Fichtelgebirge. H.=4. Color light steel-gray.

ULLMANNITE, *Fröbel.* Nickel Stibine. Nickeliferous Gray Antimony. Nickel spiesglanzerz. Antimonnickelglanz. Nickelantimonglanz. Antimoine Sulfuré Nickelifère, *H.*

Monometric. Observed planes *O*, 1, *I*; f. 15–17. Cleavage: cubic, perfect. Occurs also massive; structure granular.

H.=5—5·5. G.=6·2—6·51. Lustre metallic. Color steel-gray, inclining to silver-white. Brittle.

Composition.—$Ni\ S^2 + Ni(Sb, As)^2$, Ramm. or $Ni\ (S, Sb, As)^2$=(arsenic excluded) Nickel 26·9, antimony 58·6, sulphur 14·5. Analyses: 1, Klaproth, (Beit. vi, 329); 2, Ullmann, (Syst. tab. Uebers. 379); 3, 4, H. Rose, (Pogg. xv, 588); 5, Rammelsberg, (Pogg. lxiv, 189):

		As	Sb	S	Ni
1.	Freusberg,	11·75	47·75	15·25	25·25=100, Klaproth.
2.	Siegen,	9·94	47·56	16·40	26·10=100, Ullman.
3.	"	——	55·76	15·98	27·36=99·10, H. Rose.
4.	"	——	54·47	15·55	28·04=98·06, H. Rose.
5.	G. 6·506,	2·65	50·84	17·38	29·43, Fe 1·83=102·13, Rammelsberg.

B.B. partly volatilizes, and the charcoal is covered with a white coating, with fumes of sulphurous acid and antimony; ultimately yields a metallic globule, which often gives a blue color with borax. In a tube decrepitates and gives a dark brownish sublimate without odor.

Occurs in the Duchy of Nassau, in the mines of Freusberg, with galena and copper pyrites; in Siegen, Prussia; at Harzgerode and Lobenstein.

Rammelsberg calls an ore from the Hartz *Bournonit-Nickelglanz.* It occurs in cubes; H.=4·5. G.—5·635—5·706. Analysis, (Pogg. lxxvii, 254):

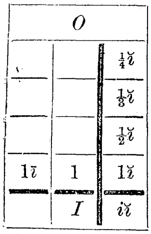
As 28·00, Sb 19·53, S 16·86, Ni 27·04, Co 1·60, Pb 5·13, Cu 1·33, Fe 0·51=100.

It comes from Wolfsberg in the Hartz. Rammelsberg considers this and a *nickel-bournonite*, (see under Bournonite), compounds of ullmannite and bournonite, and shows by calculation that the atomic volume of nickel glance and bournonite are the same.

MARCASITE, *Haid.* White Iron Pyrites. White Bisulphuret of Iron. Radiated Pyrites. Spear Pyrites. Hepatic Pyrites. Cellular Pyrites. Speerkies, Strahlkies, Kammkies, Leberkies, Zellkies, Spärkies, Rhombischer Eisenkies. Fer Sulphuré Aciculaire Radié, Fer Sulfuré Blanc, *H.* Weisskupfererz and Kyrosite, *Breit.*

Trimetric. $I : I = 106° 5'$, $O : 1\bar{i} = 122° 26'$, $a : b : c = 1·5737 : 1 : 13287$.

$O : 1 = 116° 55'$. $1 : 1$ (mac.) $= 115° 10'$. $1\bar{i} : 1\bar{i} = 64° 52'$.
$O : \frac{1}{3}\breve{i} = 158° 27'$. $1 : 1$(brach.)$= 89° 6'$. $1\breve{i} : 1\breve{i} = 80° 20'$.
$O : 1\breve{i} = 130° 10'$. $1 : 1$ (bas.) $= 126° 10'$. $I : i\breve{i} = 126° 57'$.



Observed Planes.

Cleavage: I rather perfect; $1\breve{i}$ in traces. Twins: plane of composition I, sometimes consisting of five individuals, united by the acute lateral angle (f. 285): also others with composition parallel to $1\bar{i}$. Also globular, reniform, and other imitative shapes—structure straight columnar; often massive, columnar, or granular.

H.=6—6·5. G.=4·678—4·847. Lustre metallic. Color pale bronze-yellow, sometimes inclined to green or gray. Streak grayish or brownish-black. Fracture uneven. Brittle.

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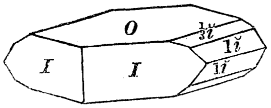

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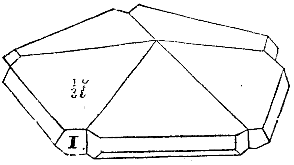

Composition.—FeS^2, or same as for Pyrites. Analyses: 1, Hatchett, (Phil. Trans. 1804, 325); 2, 3, Berzelius, (Schw. J. xxvii, 67); 4, Scheidhauer, (Pogg. lxiv, 282):

1.		Fe 46·4	S 53·6=100, Hatchett.
2.		45·66	54·34=100, Berzelius.
3.	*Speerkies,*	45·07	52·35, Mn 0·70, $\ddot{S}i$ 0·80=99·92, Berzelius.
4.	*Kyrosite,*	45·60	53·05, Cu 1·41, As 0·93=100·99, Scheidhauer.

B.B. like pyrites. Very liable to decomposition, more so than pyrites.

This species was formerly subdivided according to the different forms the mineral presents. *Radiated pyrites* included the radiated masses and more simple crystals; *spear pyrites,* the macled crystals; *hepatic pyrites,* or *leberkies,* (so called from ἧπαρ, *liver*), the decomposed liver-brown tessular crystals, which were originally iron pyrites, and also certain hexagonal pseudomorphs; *cockscomb pyrites,* or *kammkies,* the crest-like aggregations of this species of pyrites; *cellular pyrites,* the cellular varieties formed by the decomposition of crystals of galena, which contained films of pyrites between its layers, thus producing a honeycomb appearance.

The spear pyrites occurs abundantly in the plastic clay of the brown coal formation, at Littmitz and Altsattell, near Carlsbad in Bohemia, and is extensively mined for its sulphur and the manufacture of the sulphate of iron. The radiated variety occurs at the same place; also at Joachimstahl, and in several parts of Saxony. The cockscomb variety occurs with galena and fluor spar in Derbyshire. It occurs in stalactitic concretions in Cornwall.

The *kyrosite* (*Weisskupfererz,* or arsenid of copper, as it has been called) is from the mine Briccius, near Annaberg.

The Chilian *Weisskupfererz* contains, according to Plattner, 12·9 per cent. of copper, besides iron and sulphur, but no arsenic. (Breit. Pogg. lviii, 281).

At Warwick, N. Y., it occurs in simple and compound crystals, in granite, with zircon. Hustis's farm, in Phillipstown, N. Y., affords small crystals, referred by Beck to this species, occurring in magnesian limestone. Massive fibrous varieties abound throughout the mica slate of New England, particularly at Cummington, Mass., where it is associated with cummingtonite and garnet. Occurs at Lane's mine, in Monroe, Conn., and in the topaz and fluor vein in Trumbull; also in gneiss at East Haddam; at Haverhill, N. H., with common pyrites.

Cockscomb pyrites is employed in the manufacture of sulphur, sulphuric acid, and sulphate of iron, though less frequently than the common iron pyrites. Its color is considerably paler than the ordinary pyrites, and it is also more liable to decomposition.

Hydrous pyrites, or *Wasserkies* of the Germans. This mineral, hitherto considered a variety of white iron pyrites, contains water, according to Glocker, in chemical combination; (Pogg. lv, 489). H.=3—4. G.=3·33—3·5. From Moravia and Upper Silesia.

LONCHIDITE, *Breit.* and *Plattn.* Pogg. Ann. lxxvii, 135, (Kausimkies).—This mineral appears to be a variety of marcasite. Breithaupt gives for it the angles 104° 24′ for $I:I$ and 100° 36′ for the brachydome. H.=6·5. G.=4·925—5. Color tin-white, sometimes greenish or grayish; streak black. Analysis by Plattner (loc. cit.) S 49·61, As 4·40, Fe 44·23, Co 0·35, Cu 0·75, Pb 0·20=99·54, equivalent to 24 of marcasite (Fe S^2) and 1 of Fe As^2. From Freiberg, Schneeberg, and Cornwall.

ALTERED FORMS.—Limonite and pyrites occur as pseudomorphs after marcasite.

RAMMELSBERGITE. Weissnickelkies.

Trimetric; $I:I$=123°—124° (?)
H.=5·25—5·75. G.=7·099—7·188, Breit. Slightly ductile. Otherwise like the preceding.

Composition.—The same as for Chloanthite, Ni As^2=Arsenic 71·7, Nickel 28·3. Analysis: 1, Hoffmann, (Pogg. xv, 491, 494):

Schneeberg, As 71·30, Ni 28·14, Bi 2·19, Cu 1·50, S 0·14=102·27.

Occurs at Schneeberg and at Riechelsdorf. It was first separated from the tesseral white nickel by Breithaupt.

LEUCOPYRITE, *Shepard.* Glanzarsenikkies. Arseneisen. Arsenikeisen, Arsenikalkies. Arsenosiderit. Lölingite, *Haid.* Mohsine, *Chapman.*

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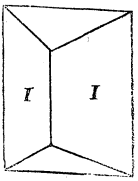

Trimetric. $I:I$=111° 30′, Greg; 122°, Rose. Cleavage: rather perfect, in one direction. Also massive.
H.=5—5·5. G.=7·0—7·4; 7·228, from Silesia; 7·337 from Bedford Co., Pa.; 8·67—8·71 from Schladming, Weidenbusch. Lustre metallic. Color between silver-white and steel-gray. Streak grayish-black. Fracture uneven. Brittle.

Composition.—Fe As^2=Arsenic 72·8, iron 27·2; or (Fe, Ni, Co) As^2. Sometimes Fe^2 As^3=Arsenic 66·8, iron 33·2. Analyses: 1, Hoffmann, (Pogg. xv, 485); 2, Meyer, (Pogg. l, 154); 3, Karsten, (Eisenhüttenkunde, ii, 19); 4, 5, Scheerer, (Pogg. xlix, 536, and l, 153); 6, Hoffmann; 7, 8, Weidenbusch, (Rose's Kryst.-Chem., 54):

	As	S	Fe	Ni	Co	
1. Reich'stein,	65·99	1·94	28·06	——	——,	serpentine 2·17=98·16, Hoffmann.
2. "	63·142	1·631	30·243	——	——	" 3·550=98·566, Meyer.
3. "	65·88	1·77	32·35	——	——	=100, Karsten. G.=7·09.
4. Fossum,	70·09	1·33	27·39	——	——	=98·81, Scheerer.
5. "	70·22	1·28	28·14	——	——	=99·64, Scheerer.
6. Schladming,	60·41	5·20	13·49	13·37	5·10	=97·57, Hoffmann.
7. Reich'stein,	65·61	1·09	31·51	——	——	gangue 1·04=99·25, Weid.
8. Schladming,	72·18	0·70	26·48	——	——	=99 36, Weid.

B.B. in a glass tube metallic arsenic sublimes; on charcoal yields arsenic fumes and a magnetic globule is left. In nitric acid dissolves with a separation of arsenous acid.

Occurs associated with copper nickel at Schladming, in Styria; with serpentine at Reichenstein in Silesia, and at Löling, near Hüttenberg in Carinthia, in a bed of sparry iron, associated with bismuth and scorodite; at Ehrenfriedersdorf, (G.= 7·219—7·290).

A crystal, weighing two or three ounces, was found in Bedford Co., Penn., but it is not known under what circumstances. In Randolph Co., N. C., a mass was found weighing nearly two pounds.

The name leucopyrite is derived from λευκος, *white*, and *pyrites;* it was given to the species by Shepard in 1835, thus antedating Haidinger's *Lölingite,* and Chapman's *Mohsine.*

The prism in this species is usually stated as having the angle 122° or 122° 26′. But according to observations by R. P. Greg, Jr., as he informs the author, the angle is 111° 30′. The angle 122° is near $1\bar{i} : 1\bar{i}$ in mispickel.

MISPICKEL. Prismatischer Arsenikkies. Fer Arsenical, *H.* Danaite. Plinian, *Breit.* Arsenopyrite, *Glocker.*

Trimetric. $I : I$=111° 53′, $O : 1\bar{i}$=119° 37′; $a : b : c$=1·7588 : 1 : 1·4793. Observed planes as in the annexed figures.

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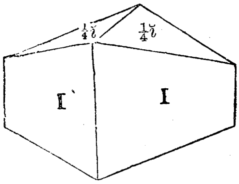

Franconia, N. H.

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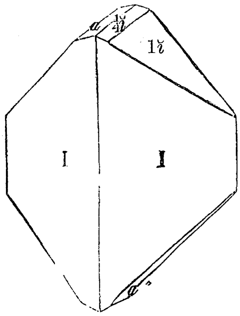

Franconia, N. H., and Kent, N. Y.

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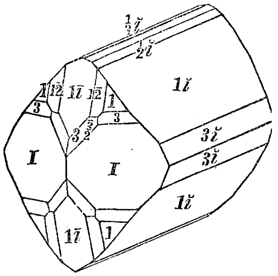

Danaite.

$O : 1\bar{2}$=118° 18′.
O : 1 =115° 12′.
O : 3 = 98° 55′.
$O : 3\frac{\bar{3}}{2}$=99° 37′.

$O : \frac{1}{3}\breve{i}$=158° 23′.
$O : \frac{1}{2}\breve{i}$=149° 16′.
$O : 1\breve{i}$=130° 4′.
$O : 3\breve{i}$=105° 40′.

$1\bar{i} : 1\bar{i}$ (bas.)=120° 46′.
$1\breve{i} : 1\breve{i}$ (bas.)=99° 52′.
$3\breve{i} : 3\breve{i}$ (ib.)=148° 40′.
$\frac{1}{2}\breve{i} : \frac{1}{2}\breve{i}$ (top)=118° 32′.

Cobaltic variety of Skutterud, according to Scheerer, $I : I$=111° 40′—112° 2′, $1\bar{i} : 1\bar{i}$ (basal) 121° 30′; that of Franconia (Danaite) according to Teschemacher, $I : I$=112°, $1\bar{i} : 1\bar{i}$ (bas.)=121° 30′, $1\breve{i} : 1\breve{i}$ (bas.)=100° 15′; according to Kengott, $I : I$=112° 33′, $1\bar{i} : 1\bar{i}$ =121° 20′, $1\breve{i} : 1\breve{i}$=99° 54′. Cleavage: I rather distinct; O, faint traces. Compound crystals: planes of composition I, and $1\bar{i}$. Also columnar, straight and divergent, or irregular; compact granular, or impalpable.

H.=5·5—6. G.=6—6·4; 6·269, Franconia, Kengott. Lustre metallic. Color silver-white, inclining to steel-gray. Streak dark grayish-black. Fracture uneven. Brittle.

Composition.—$Fe As^2 + Fe S^2 (= Fe (As, S)^2)$=Arsenic 46·0, sulphur 19·6, iron 34·4; or $(Fe, Co) (As, S)^2$ (Danaite and Skutterud variety). Analyses: 1, Stromeyer, (Schw. J. x, 404); 2, Chevreul, (Gilb. Ann. xvii, 84); 3, Thomson, (Ann. Lyc. Nat. H., N. Y., iii, 85); 4, Scheerer, (Pogg. xlii, 546); 5, Wöhler, (Pogg. xliii, 591); 6, Hayes, (Am. J. Sci. xxiv, 386); 7, Plattner, (Pogg. lxix, 430); 8, Weidenbusch, (Rose's Kryst.-Chem., 56):

	As	S	Fe	Co
1. Freiberg,	42·88	21·08	36·04	——=100, Stromeyer.
2. "	43·418	20·132	34·938	——=98·488, Chevreul.
3. "	45·74	19·60	33·98	——=99·32, Thomson.
4. Skutterud,	46·76	17·34	26·36	9·01=100·47, Scheerer.
5. "	47·45	17·48	30·91	4·75=100·59, Wöhler.
6. *Danaite*,	41·44	17·84	32·94	6·45=98·67, Hayes.
7. *Plinian*,	45·46	20·07	34·46	——=99·99, Plattner. [G.=5·896.
8. Reichenstein,	45·92	19·26	33·08	—— gangue, 1·97=100·25, Weid.

B.B. on charcoal, copious arsenical fumes, and a globule of nearly pure sulphuret of iron, which acts on the needle. Gives fire with steel, emitting an alliaceous odor. Dissolves in nitric acid, excepting a residue of sulphur.

Found principally in crystalline rocks, and its usual mineral associates are ores of silver, lead, and tin, iron and copper pyrites, and blende. Occurs also in serpentine.

Abundant at Freiberg and Munzig, where it occurs in veins; at Reichenstein in Silesia, in serpentine; and also in beds at Breitenbrunn and Raschau, Andreasberg, and Joachimstahl; at Tunaberg in Sweden. Huel Mawdlin, and Unanimity, in Cornwall, are other localities.

Met with in fine crystallizations in gneiss in New Hampshire at Franconia, associated with copper pyrites; also at Jackson, and at Haverhill. In Maine, at Blue Hill, Corinna; Newfield, (Bond's mountain), and Thomaston, (Owl's head). In Vermont at Brookfield, Waterbury, and Stockbridge. In Massachusetts, at Worcester and Sterling. In Connecticut at Chatham, with smaltine and copper nickel; at Monroe with wolfram and pyrites; at Derby in an old mine, associated with quartz. In New Jersey at Franklin. In New York, massive, in Lewis, ten miles south of Keeseville, Essex Co., with hornblende; in crystals and massive, near Edenville, on Hopkins's farm, and elsewhere in Orange Co., with scorodite, iron sinter, and thin scales of gypsum; also in fine crystals at two localities a few rods apart, four or five miles northwest of Carmel, near Brown's serpentine quarry in Kent, Putnam Co.

Plinian of Breithaupt, stated to be monoclinic, with the composition of mispickel, is shown by G. Rose to be nothing but mispickel. G.=6·3. Reported from St. Gothard, Ehrenfriedersdorf and Zinnwald. Jordan has analyzed a mispickel from near Andreasberg, (J. f. pr. Chem. x, 436), and obtained As 55·000, S 8·344, Fe 36·437, Ag 0·011=99·792, giving nearly the formula $2FeS + 3FeAs^2$=Arsenic 56·7, sulphur 8·0, iron 35·2. Jordan made out 3As, S, 3 Fe, which requires arsenic 52·9, sulphur 7·5, iron 39·6.

Altered Forms.—Pyrites pseudomorph.

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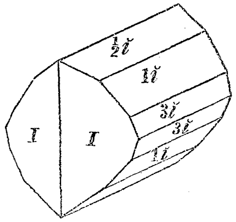


GLAUCODOT, (*Breithaupt and Plattner*, Pogg. Ann. 1849, lxxvii, 127). Trimetric, like Mispickel. In prisms; $I : I$=112° 36′. Cleavage: basal, very distinct, prismatic less so. Also massive.

H.=5. G.=5·975—6·003. Lustre metallic. Color grayish tin-white. Streak black.

Composition.—$(Co, Fe) S^2 + (Co, Fe) As^2$, with Co to Fe as 2 : 1, (or $Co, Fe) (S, As)^2$=Sulphur 19·4, arsenic 45·5, cobalt 23·8, iron 11·3=100. Analyses: 1, Plattner, (loc. cit.); 2, Patera, (Pogg. lxxxi, 578):

	S	As		Co	Fe
1. Chili,	20·210	43·200	(and trace of Ni)	24·774	11·900=100·84, Plattner.
2. Orawitza,	19·78	43·63		Cobalt 32·02	4·56=99·99, Patera.

B.B. gives the reaction of cobalt, iron, sulphur, and arsenic.

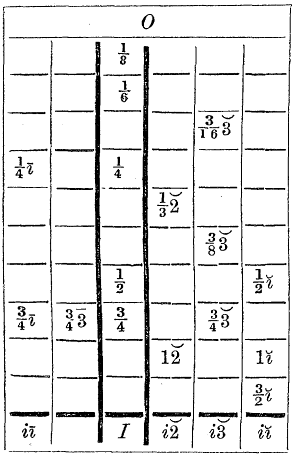
Occurs in chlorite slate with cobaltine, in the province of Huasco, Chili; also at Orawitza in the Bannat with a pale yellow calcite.

This species has the composition of Mispickel, excepting the replacement of one-third of the cobalt by iron. It is essentially a cobaltic mispickel, with which species it agrees nearly in crystallization.

SYLVANITE, *Haid.* Graphic Tellurium. Graphic Gold. Schrifterz. Schrift-tellur. Tellure Natif Auro-argentifére, *H.* Aurotellurite. Mullerite. Weisstellur.

Trimetric. $I : I = 110° \; 48'$, B and M., $O : 1\bar{i} = 119° \; 26\frac{1}{2}'$, $a : b : c = 1{\cdot}7721 : 1 : 1{\cdot}4496$.

$O : \frac{1}{2}\breve{i} = 148° \; 34'$. $O : \frac{3}{4} = 121° \; 47'$. $i\breve{2} : i\breve{2}$ (brach) $= 108° \; 8'$.
$O : 1\breve{i} = 129° \; 17'$. $O : \frac{1}{2}\bar{i} = 138° \; 28'$. $i\breve{3} : i\breve{3}$ " $= 128° \; 26'$.
$O : \frac{1}{2} = 132° \; 54'$. $O : \frac{3}{4}\bar{i} = 126° \; 58'$. $1\breve{i} : 1\breve{i}$ (bas.) $= 101° \; 26'$.



Observed Planes.

Cleavage: highly perfect in one direction. Twins: prisms intersecting at 60° nearly. Also massive, imperfectly columnar and granular.

H.=1·5—2. G.=5·732; 8·28, Petz. Lustre metallic. Streak and color pure steel-gray, to silver-white, and sometimes nearly brass-yellow. Fracture uneven. Very sectile.

Composition.—(Ag, Au) Te^2, G. Rose, =(Ag: Au being as 1 : 2) Tellurium 55·8, gold 28·6, silver 15·6. Analyses: 1, Klaproth, (Beit. iii, 16); 2, Berzelius, (Jahresb. xiii, 162, analysis imperfect); 3, 4, Petz, (Pogg. lvii, 472); 5, Klaproth, (Beit. iii, 20); 6–10, Petz. (Pogg. lvii, 473):

	Tellurium	Sb	Gold	Silver	Pb
1. Offenbanya,	60·	——	30·	10·	——=100, Klaproth.
2. "	52·	*tr.*	24·0	11·3	1·5, Cu, Fe, S, As, *traces*, B.
3. " *needles*,	59·97	0·58	26·97	11·47	0·25, Cu 0·76=100, P.
4. " *subcryst*,	58·81	0·66	26·47	11·31	2·75=100, Petz.
5. *Gelberz*,	44·75	——	26·75	8·50	19·50, S 0·5=100, K.
6. *White cryst.*, G.=8·27,	55·39	2·50	24·89	14·68	2·54=100, Petz.
7. " G.=7·99,	48·40	8·42	28·98	10·69	3·51=100, Petz.
8. *Yellow cryst.*, G.=8·33,	51·52	5·75	27·10	7·47	8·16=100, Petz.
9. " *massive*,	44·54	8·54	25·31	10·40	11·21=100, Petz.
10. " "	49·96	3·82	29·62	2·78	13·82=100, Petz.

B.B. fuses easily, tinging the flame greenish-blue, and covering the charcoal with a white oxyd; finally a ductile metallic globule is obtained. Dissolves in nitric acid.

Occurs with gold at Offenbanya in Transylvania, in narrow veins, which traverse porphyry; also at Nagyag in the same country. Probably also at Gold Hill, Rowan Co., N. C. (Genth) in minute crystals, with gold, pyrites, and chalcopyrite in chlorite slate.

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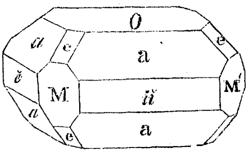

The name *graphic tellurium* alludes to the arrangement of the crystals, like writing characters.

The large amount of gold it contains renders it a highly valuable ore.

The above angles and observed planes are from Brooke and Miller. Haidinger makes the Aurotellurite (or Weisstellur of Werner) (Analyses 5 to 10) different in its dimensions, and gives the following angles: M : M=105° 30′, O : a=108° 30′, O : *a*=143° 5′. It is from Nagyag. G=7·99—8·33.

NAGYAGITE, *Haid.* Elasmose, *Beudant.* Foliated Tellurium. Bitelluret of Lead, *Thom.* Black Tellurium, *P.* Tellurium Glance. Nagyager-erz, *W.* Blättertellur, *Haus.* and *L.* Blättererz. Tellure Natif Auro-Plombifère, *H.*

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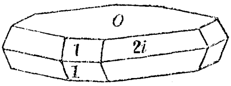

Dimetric. *O* : 1*i*=127° 37′; *a*=1·298. Observed planes as in the annexed figure. *O* : 1=118° 37′, 1 : 1=103° 14′, *O* : 2*i*= 111° 4′, 2*i* : 2*i* (bas.) 137° 52′. Cleavage: basal. Also granularly massive, particles of various sizes; generally foliated.

H.=1—1·5. G.=6·85—7·2. Lustre metallic, splendent. Streak and color blackish lead-gray. Opaque. Sectile. Flexible in thin laminæ.

Composition.—Analyses: 1, Klaproth (Beit. iii, 32); 2, Brandes, (Schw. J. xxxv, 409); 3, P. Schönlein, (J. f. pr. Ch. lx, 166):

	Te	S	Pb	Au	Ag	Cu
1.	32·2	3·0	54·0	9·0	0·5	1·3=100, Klaproth.
2.	31·96	3·07	55·49	8·44	*trace*	1·14=100, Brandes.
3.	30·52	8·07	50·78	9·11	0·53	0·99=100, Schönlein.

Schönlein found in other trials, Pb 51·01, 51·06, Te 26·67, S 9·62, 10·59; and Petz obtained (Pogg. lvii, 478), 8·54, 7·81, 6·48 per cent. of gold. Wöhler deduces from Schönlein's analysis, Pb^{11} Au, Te^{11} S^{13}=Tellurium 31·36, sulphur 9·24, lead 50·65, gold 8·74=100; and proposes the formula (5 Pb S, 6 Pb Te, Au^2 Te)+4 Te S^2, or perhaps 3 R(S, Te), +Te S^2, sulphuret and telluret of lead being considered isomorphous.

This formula further simplified becomes nearly (Pb, Au) $(Te, S)^2$.

B.B. on charcoal fuses readily to a malleable metallic button, tinging the flame at the same time blue, and covering the charcoal with a white coating. With borax it affords a bead of gold, with a little silver. It dissolves partially in nitric acid, and also in nitro-muriatic.

Occurs at Nagyag and Offenbanya in Transylvania, in foliated masses and crystalline plates, accompanying, at the former place, silicate of manganese, blende, and gold; and at the latter, associated with antimony ores.

Berthier has analyzed another ore very similar to the above in physical characters, consisting of Tellurium 13·0, sulphur 11·7, lead 63·1, gold 6·7, antimony 4·5, copper 1·0=100; corresponding to 21S, 6Te, 4Sb, 18Pb, 2Au, but probably impure with sulphuret of antimony.

COVELLINE, *Beud.* Indigo Copper. Kuferindig. Blue Copper.

Hexagonal; *O*, *I*. Cleavage: basal, very perfect. Commonly massive or spheroidal, surface crystalline.

H.=1·5—2. G.=3·8—3·85. Lustre resinous, faint. Color indigo-blue or darker. Streak lead-gray, shining. Opaque. Thin leaves, flexible. Sectile.

Composition.—$\overline{\text{C}}\text{u}\,\text{S}^2$=Sulphur 33·5, copper 66·5. Analyses: 1, Walchner, (Schw. J. xlix, 158); 2, Covelli, (Ann. Ch. Phys. xxxv, 105):

1. Badenweiler,	S 32·64	Cu 64·773	Fe 0·462,	Pb 1·046=98·921,	Walchner.
2. Vesuvius,	32·0	66·0=98·0,			Covelli.

A Dillenberg covelline afforded Grimm, (Lieb. Jahresb. 1850, 702), 66·82 bisulphuret of copper, 3·96 iron pyrites, 18·63 quartz, and 10·57 $\ddot{\overline{\text{F}}}\text{e}$ $\ddot{\overline{\text{M}}}\text{n}$ $\dot{\text{H}}$.

B.B. burns, before becoming red hot, with a blue flame, and fuses to a globule which is strongly agitated and emits sparks; finally yields a button of copper.

Occurs with other copper ores near Badenweiler at Leogang in Saltzburg; Keilce in Poland; Sangerhausen in Saxony; Mansfeld, Thuringia; at Vesuvius on lava.

MOLYBDENITE. Sulphuret of Molybdena, *P.* Molybdène Sulfuré, *H.* Molybdänglanz, *L.* Wasserblei, *W.*

Hexagonal. In short or tabular hexagonal prisms with replaced terminal edges. Cleavage: basal, eminent. Commonly foliated massive, or in scales.

H.=1—1·5, being easily impressed by the nail. G.=4·44—4·8. Lustre metallic. Color pure lead-gray. Streak similar to color, slightly inclined to green. Opaque. Laminæ highly flexible, not elastic. Sectile, and almost malleable. A gray trace on paper, a greenish on porcelain.

Composition.—Mo S^2=Sulphur 41·0, molybdenum 59·0. Analyses: 1, Brandes, (Schw. J. xxix, 325); 2, Seybert, (Am. J. Sci. iv, 1822, 320); 3, 4, Svanberg and Struve, (J. f. pr. Ch. xliv, 257); 5, Wetherill, (Am. J. Sci. [2], xv, 443):

1. Altenberg,		Mo 59·6	S 40·4=100, Brandes.
2. Chester, Pa.	G.=4·444,	59·42	39·68=99·10, Seybert.
3. Smaoland,		58·627	40·573, gangue 0·800, S & S.
4. Bohüslan,		57·154	39·710, " 3·136, S & S.
5. Reading, Pa.		55·727	38·198, $\ddot{\overline{\text{F}}}\text{e}$ 3·495, $\ddot{\text{S}}\text{i}$ 2·283, H. 0·297, Wetherill.

B.B. infusible, but sulphurous fumes emitted, which are deposited on the charcoal. In the forceps, flame greenish; a dull brown pearl with borax on adding nitre. Dissolves in nitric acid, excepting a white or grayish residue.

Molybdenite generally occurs imbedded in, or desseminated through, granite, gneiss, zircon-syenite, granular limestone, and other crystalline rocks. At Numedal in Sweden, Arendal in Norway, and Greenland, it has been observed in hexagonal prisms. Altenberg and Ehrenfriedersdorf in Saxony, Schlackenwald and Zinnwald in Bohemia, Rathausberg in Salzburg, Laurvig in Norway, Chessy in France, Peru, Brazil, are among its foreign localities. At Caldbeck Fell in Cumberland, it is associated with tungstate of lime and apatite; it also occurs at several of the Cornish mines; in Scotland at Peterhead, Glenelg, and at Corby on Loch Creran.

In Connecticut at Haddam, and the adjoining towns on the Connecticut river, it occurs in gneiss in crystals and large plates; also at Saybrook. In Vermont at Westmoreland, there is a large vein of molybdenite; at Newport, with crystals of white apatite. In Massachusetts at Shutesbury, east of Locke's pond; at Brimfield, with iolite. In New Hampshire, at Westmoreland, four miles south of the north village meeting-house, in a vein of mica slate, where it is abundant; at Llandaff, in regular tabular crystals; at Franconia. In Maine at Blue Hill Bay and Camdage farm, in large crystallizations; also at Brunswick, Bowdoinham, and Sanford, but less interesting. In New York, two miles southeast of Warwick, in irregular plates associated with rutile, zircon, and pyrites. In Pennsylvania, in Chester, on Chester Creek, near Reading; near Concord, Cabarras Co., N. C., with pyrites in quartz. In Canada at Balsam Lake, Terrace Cove, Lake Superior and St. Jerome, C. E.

Distinguished from plumbago by its lustre and streak, and also by its behavior before the blowpipe and with acids.

4. SKUTTERUDITE DIVISION.

SKUTTERUDITE, *Haidinger*. Tesseralkies, *Breit.* Hartkobaltkies. Hartkobalterz. Arsenikkobaltkies. Modumite, *Nicol.*

Monometric. Observed planes *O*, 1, 2, *I*. Figs. 1, 11, 14, 39. Cleavage: cubic, distinct; *I*, in traces. Also massive granular.

H.=6. G.=6·74—6·84. Lustre bright metallic. Color between tin-white and pale lead-gray, sometimes iridescent

Composition.—$Co\,As^3$=Arsenic 79·2, cobalt 20·8. Analyses: 1, Scheerer, (Pogg. xlii, 545); 2, 3, Wöhler, (ib. xliii, 591):

1. Skutterud,		As 77·84	Co 20·01	Fe 1·51	S 0·69	=100·05, S.
2. “	*cryst.*	79·2	18·5	1·3		=99·0, W.
3. “	*mass.*	79·0	19·5	1·4		=99·9, W.

B.B. nearly like smaltine. Yields a sublimate of metallic arsenic in a closed tube. From Skutterud near Modum, in Norway.

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2. DOUBLE BINARY COMPOUNDS.

I. THE PERSULPHURET A SULPHURET OF AN ELEMENT OF THE HYDROGEN GROUP, AS OF IRON, COBALT, OR NICKEL.

1. LINNÆITE GROUP.—Monometric.

LINNÆITE, $(\text{Ꞓu}, Co)\,S+Co^2\,S^3$. SIGENITE, $(Ni, Co, Fe)\,S+(Ni, Co, Fe)^2\,S^3$.

2. CHALCOPYRITE GROUP.—Dimetric, Tetrahedral.

CHALCOPYRITE, $\text{Ꞓu}\,S+Fe^2\,S^3$. ?TIN PYRITES, $\text{Ꞓu}\,S+(Fe^2\,S^3, Sn^2\,S^3)$.

3. STERNBERGITE GROUP.—Trimetric.

STERNBERGITE, $Ag\,S+2\,Fe^2\,S^3$.

LINNÆITE, *Haid.* Cobalt Pyrites. Sulphuret of Cobalt. Kobaltkies. Schwefelkobalt. Kobaldine, *Beud.* Carrollite, *Faber.* Siegenite.

Monometric. Figs. 11, 15, 16. Cleavage: cubic, imperfect. Twins; plane of composition octahedral. Also massive, granular to impalpable.

H.=5·5. G.=4·8—5; 4·85, Carrollite, S. and B. Lustre metallic. Color pale steel-gray, tarnishing copper red. Streak blackish-gray. Fracture uneven or subconchoidal.

Composition.—$Co\,S+Co^2\,S^3$, (Frankenheim)=Sulphur 42·0, cobalt 58·0. Cobalt sometimes replaced by copper or nickel. Analyses: 1, Hisinger, (Afhandl. iii, 319); 2, 3, Wernekink, (Schw. J. xxxix, 306, and Leonh. Zeit. f. Min. 1826); 4, 5, Smith and Brush, (Am. J. Sci. [2], xvi, 367); 6, Schnabel, (Ramm. 4th Suppl. 117); 7, Ebbinghaus, (ib.):

		S	Co	Cu	Fe
1.	Riddarhyttan,	38·50	43·20	14·40	3·53, gangue 0·33=99·96, Hisinger.
2.	Müsen,	41·00	43·86	4·10	5·31, gangue 0·67=94·94, Wernekink.
3.	"	42·52	53·35	0·97	2·30=98·87, Wernekink.
4.	*Carrollite,*	41·93	37·25	17·48	1·26, Ni 1·54, As *tr.*=99·46, S. & B. G.=4·85.
5.	"	40·94	38·21	17·79	1·55, " 1·54, " *tr.*=100·03, S. & B.
6.	*Siegenite,*	41·98	22·09	——	2·29, " 33·64,=100 Schnabel. G.=4·8.
7.	"	42·30	11·00	——	4·69, " 42·64=100·63, Ebb. G.=5·0.

Carrollite, according to the analyses of Smith and Brush, is a *Copper-Linnæite*=Ꞓu $\mathrm{S+Co^2\,S^3}$.

Siegenite (*Kobalt-Nickelkies*, Rammelsberg) is a *Nickel-Linnæite*=(Ni, Co, Fe) S+(Ni, Co, Fe)^2 S^3.

B.B. on charcoal gives a sulphurous odor, and after roasting colors glass of borax blue. Dissolves in nitric acid, excepting the sulphur.

Occurs in gneiss with copper pyrites at Bastnaes near Riddarhyttan, Sweden, and at Müsen near Siegen, in Prussia, with heavy spar and spathic iron. Also at Mine La Motte, Missouri, with galena and black cobalt. *Carrollite* is found at Finksburg, Carroll Co., Maryland, with copper pyrites, (W. L. Faber, Am. J. Sci., [2], xiii, 418). The *Siegenite* is from Siegen and occurs in octahedrons.

CUBAN, *Breit.*, Pogg., lix, 325, 1843.

Monometric. In cubes or massive. Color between bronze and brass-yellow. Streak dark-reddish bronze, black. H.=4. G.=4·026, Br.; 4·169, Booth.

Composition.—$\mathrm{Cu\,S+Fe^2\,S^3}$, Booth. Analyses: 1, Eastwick, (communicated by J. C. Booth); 2, Magee, (ib.); 3, Stevens, (ib.); 4, Scheidauer, (Pogg. lxiv, 280):

S	Cu	Fe	$\ddot{\mathrm{Si}}$
39·01	19·80	38·01	2·30= 99·12.
39·35	21·05	38·80	1·90=101·10.
39·05	20·12	38·29	2·85=100·31.
34·78	22·96	42·51	Pb. *tr.*=100·25.

Breithaupt obtained in repeated trials 19 per cent. of copper. B.B. fuses easily, giving off fumes of sulphur, but no arsenic. With 2 of copper instead of 1, the composition would be analogous to that of Linnæite.

From Barracanao, Cuba.

CHALCOPYRITE, *Beud.* Copper Pyrites. Yellow Copper Pyrites, Pyritous Copper. Kupferkies. Cuivre Pyriteux. Towanite, *B. & M.*

O			
$\frac{1}{4}$			
$\frac{1}{3}$			
$\frac{1}{2}$	$\frac{1}{2}3$		
			$\frac{2}{3}i$
1			$1i$
$\frac{3}{2}$			$\frac{3}{2}i$
2			$2i$
		55	
I	$i3$		ii

Observed planes.

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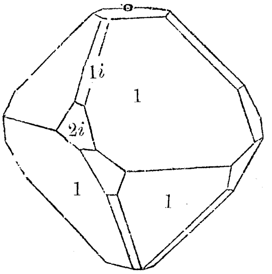

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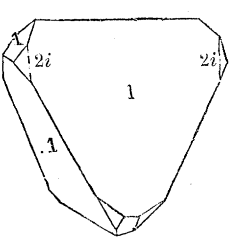

Dimetric; tetrahedral. *O* : 1*i*=135° 25′; *a*=·98556.
O : $\frac{1}{2}$=145° 8′. *O* : 2*i*=116° 54′. 2 : 2 (pyr.)=96° 33′.
O : 1=125° 40′. *O* : $\frac{3}{2}$*i*=124° 5′. $\frac{3}{2}$: $\frac{3}{2}$ (pyr.)=100° 44′.
O : 2=109° 44′. 1 : 1(pyr.)=109° 53′. 1 : 1 (f.294)=71° 20′ and [70° 7′.

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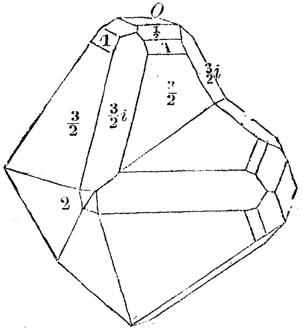
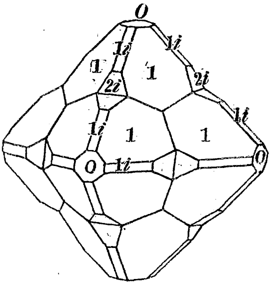


295A



Cleavage: 2*i* sometimes distinct; *O*, indistinct. Twins: plane of composition, (1) 1*i*, f. 295, 295A; in the last, composition parallel to 4 terminal edges of a pyramid: (2) 1, similar to f. 200; (3) *ii*, similar to f. 207. Often massive and impalpable.

H.=3·5—4. G.=4·1—4·3. Lustre metallic. Color brass-yellow; subject to tarnish, and often iridescent. Streak greenish-black—a little shining. Opaque. Fracture conchoidal, uneven. Rather sectile.

Composition.—€u S+Fe^2 S^3, Ramm.=Sulphur 34·9, copper 34·6, iron 30·5=100. But some analyses give other proportions, and probably from admixture with iron pyrites. Analyses: 1, H. Rose, (Gilb. lxxii, 185); 2, Hartwall, (Leonh. Handb. 646); 3, 4, C. Bechi, (Am. J. Sci. [2], xiv, 161); 5, S. D. Forbes, (Jameson's J. 1, 278):

		S	Cu	Fe		
1.	Sayn,	35·87	34·40	30·47	quartz 0·27	=101·01, Rose.
2.	Finnland,	36·33	32·20	30·03	2·23	=100·79, Hartwall.
3.	Val Castrucci,	35·62	34·09	30·29	——	=100·00, Bechi.
4.	Mt. Catini,	36·16	32·79	29·75	0·86	= 99·56, Bechi.
5.	Norway,	33·88	32·65	32·77	Mn *tr.* S̈i 0·32	=99·62, Forbes.

Other analyses: Malaguti and Durocher, (Ann. des M. [4], xvii, 299).*

This ore is often mixed with iron pyrites indefinitely, and the color becomes correspondingly paler.

B.B. on charcoal blackens, but becomes red on cooling. After a continued heat it fuses to a globule which is magnetic. With borax affords pure copper. Dissolves in nitric acid, excepting the sulphur, forming a green solution. A drop of liquid ammonia changes it to a deep blue.

Chalcopyrite is the principal ore of copper at the Cornish mines, and 10 to 12,000 tons of pure copper are smelted annually from 150 to 160,000 tons of ore. It is there associated with tin, erubescite, copper glance, galena, gray copper, and blende. The copper beds of Fahlun in Sweden, are composed principally of this ore, which

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* For analyses of different ores from New Hampshire, see Geol. Rep. of that State, by C. T. Jackson, p. 214.

occurs in large masses, surrounded by a coating of serpentine, and imbedded in gneiss. At Rammelsberg, near Goslar in the Hartz, it forms a bed in graywacke slate, and is associated with iron pyrites, galena, blende, and minute portions of silver and gold. The Kurprinz mine at Freiberg affords well defined crystals. It occurs also in the Bannat, Hungary, Thuringia; in Scotland in Kirkcudbright and Wigtonshires, in Perthshire and Invernessshire; in Tuscany, (analyses, 3, 4); in South Australia.

In the United States it occurs at the Southampton Lead Mines, Mass., at Turner's falls on the Connecticut, near Deerfield, and at Hatfield and Sterling, Mass.: in Vermont, at Stafford, and at Corinth, Waterbury, and Shrewsbury: in New Hampshire, at Franconia, in gneiss; at Unity, on the estate of James Neal; at Warren, on Davis's farm; at Eaton, two miles northeast of Atkins's tavern; at Lyme, east of East Village; at Haverhill and elsewhere: in Maine, at the Lubec lead mines, and at Dexter: in Connecticut, at Bristol and Middletown, sometimes in crystals: in New York, at the Ancram lead mine; five miles from Rossie, beyond DeLong's mills at the Rossie lead mines in crystals; in crystals and massive near Wurtzborough, Sullivan Co.; crystals and massive at Ellenville, Ulster Co.: in Pennsylvania, at Phenixville; at Pottstown, Chester Co., (Elizabeth Mine): in Virginia at the Phenix copper mines, Fauquier Co., and the Walton gold mine, Louisa Co.: in North Carolina near Greensboro', abundant massive, (Fenress or North Carolina, and Macculloch Mines), along with spathic iron in a quartz gangue: in Tennessee, 30 miles from Cleveland, in Polk Co., (Hiwassee Mines), with black copper and pyrites: in the Catoctin Mts., Maryland, and between Newmarket and Taneytown; also abundant near Finksburg, Carroll Co., Md., (Patapsco and other Mines), along with erubescite, carrollite, and malachite; in Canada, in Perth; extensively mined at Bruce mines, on Lake Huron.

The Cornwall copper pyrites is not a rich ore; what is picked for sale at Redruth rarely yielding 12, generally only 7 or 8, and occasionally but 3 or 4 per cent. of metal. Its richness may in general be judged of by the color; if of a fine yellow hue, and readily yielding to the hammer, it may be considered a good ore; but if hard, and pale-yellow, it is poor from admixture with iron pyrites.

Copper pyrites is readily distinguished from iron pyrites, which it somewhat resembles, by its inferior hardness; it may be cut by the knife, while iron pyrites will strike fire with steel. The effects of nitric acid are also different. It differs from gold in being brittle, on which account it cannot be cut off in slices, like the latter metal; and moreover gold is not attacked by nitric acid.

Occurs as a furnace product near Goslar. *Chalcopyrite* is from χαλκος, *brass* and *pyrites.*

ALTERED FORMS.—Changes on exposure with moisture, especially if heated, to a sulphate. Malachite, Covelline, Chrysocolla, Black Copper, Copper glance, and oxyd of iron, are other forms into which it is sometimes altered.

TIN PYRITES. Stannine, *Beud.* Sulphuret of Tin, *P.* Bell Metal Ore. Zinnkies, *W.* Etain Sulfuré, *H.*

Probably dimetric and hemihedral like chalcopyrite, Kengott. Commonly massive, granular, and disseminated.

H.=4. G.=4·3—4·522; 4·506, Zinnwald. Lustre metallic. Streak black. Color steel-gray to iron-black, sometimes a bluish tarnish; often yellowish from the presence of copper pyrites. Opaque. Fracture uneven. Brittle.

Composition.—Ꞓu S ($\mathrm{Sn}^2\,\mathrm{S}^3$, $\mathrm{Fe}^2\,\mathrm{S}^3$), Kengott, analogous to Chalcopyrite=(ratio of S, Sn, Ꞓu, Fe, being 4 : 1 : 1 : 1), Sulphur 30·0, tin 27·2, copper 29·7, iron 13·1=100. Analyses: 1, Klaproth, (Beit. v, 228); 2, Kudernatsch, (Pogg. xxxix, 146); 3, Johnston, (Rep. Geol. Cornwall, &c., 1839); 4, Rammelsberg, (Pogg. lxxxviii, 607); 5, Mallet, (Am. J. Sci., [2], xvi, 33):

	S	Sn	Cu	Fe	Zn
1. Huel Rock,	30·5	26·5	30.0	12·0	——=99·0, Klaproth.
2. "	29·64	25·55	29·39	12·44	1·77, gangue 1·02=99·81, Kud.
3. St. Michael's Mt.,	29·929	31·618	23·549	4·791	10·113=100, Johnston.
4. "	29·46	26·85	29·18	6·73	7·26, gangue 0·16=99·64, Mal.
5. Zinnwald,	29·05	25·65	29·38	6·24	9·66=99·98, Rammelsberg.

B.B. on charcoal sulphur is expelled, and afterwards a black scoriaceous globule is obtained; the charcoal is covered with the oxyd of tin. With soda and borax yields a globule of impure copper. Soluble in nitro-muriatic acid, with the exception of sulphur.

This species is found at Huel Rock, in the parish of St. Agnes, Cornwall, where it forms a considerable vein, and is accompanied by iron pyrites, blende, and other minerals; also in granite at St. Michael's Mount; also at Zinnwald in the Erzgebirge with blende and galena. It frequently has the appearance of bronze or bell metal, and hence the name *bell-metal ore.*

STERNBERGITE, *Haidinger*, Edinb. Phil. Trans. xl, 1, and Brewster's Journal, vii, 242.

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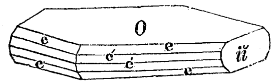

Trimetric. *I* : *I*=119° 30′, *O* : 1ī=124° 49′, B. & M.; *a* : *b* : *c*=1·4379 : 1 : 1·7145. *O* : 1 (e)=121°, *O* : 2 (é)=106° 43′, *O* : 2ĭ=120° 48′. Striæ of *O* macrodiagonal, of sides horizontal. Cleavage: basal highly eminent. Commonly in implanted crystals, forming rose-like or fan-like aggregations. Sometimes compound parallel to *I*.

H.=1—1·5. G.=4·215. Lustre of *O* brightly metallic. Color pinchbeck-brown, occasionally a violet-blue tarnish on e and e′. Streak black. Opaque. Thin laminæ flexible; may be smoothed down by the nail when bent, like tin foil. Very sectile. Leaves traces on paper like plumbago.

Composition. $Ag\,S+2\,Fe^2\,S^3$ (?)=Sulphur 33·7, silver 32·5, iron 33·7. Ratio of sulphur, iron and silver more exactly 6 : 4 : 1. Analysis by Zippe, (Pogg. xxvii, 690):

Sulphur 30·0, Silver 33·2, Iron 36·0=99·2.

Heated in a glass tube it gives off a sulphurous odor, loses lustre, and becomes dark-gray and friable. B.B. on charcoal burns with a blue flame, and melts to a globule which is generally hollow, has a crystalline surface, is covered with metallic silver, and acts on the magnetic needle, exhibiting the properties of sulphuret of iron. With borax, a globule of silver may be obtained.

Occurs with ores of silver, particularly Pyrargyrite and Stephanite, at Joachimstahl in Bohemia, and Johanngeorgenstadt in Saxony. Named after Count Casper Sternberg of Prague.

The *Flexible silver ore* (*Argent sulphuré flexible,* Bour., *Biegsamer Silberglanz*) from Himmelsfürst, near Freiberg, is referred here. According to Brooke & Miller the figure by Phillips is a distorted figure of silver glance. The angles of sternbergite, above given, are from very perfect crystals in Mr. Brooke's collection, which were formerly in the possession of Count Bournon, (B. & M., p. 180). The plane 2ĭ is on the edge *O* : *ĭĭ ;* and besides this, there is another 10ĭ, represented by these authors, with also the macrodome 6ī, and the pyramid 2$\breve{2}$.

II. THE PERSULPHURET A SULPHURET OF ELEMENTS OF THE ARSENIC GROUP.*

1. *Persulphuret of the form $R^2\ S^3$.*

1. WOLFSBERGITE GROUP, III.	Wolfsbergite,	$\text{Ꞓu S}+\text{Sb}^2\,\text{S}^3$
	? Tannenite,	$\text{Ꞓu S}+\text{Bi}^2\,\text{S}^3$
	Berthierite,	$\text{Fe S}+\text{Sb}^2\,\text{S}^3$
	Zinkenite,	$\text{Pb S}+\text{Sb}^2\,\text{S}^3$
2. MIARGYRITE GROUP, IV.	Miargyrite,	$\text{Ag S}+\text{Sb}^2\,\text{S}^3$
3. PLAGIONITE GROUP, IV.	Plagionite,	$\text{Pb S}+\tfrac{3}{4}\text{Sb}^2\,\text{S}^3$
4. JAMESONITE GROUP, III.	Jamesonite,	$\text{Pb S}+\tfrac{3}{4}\text{Sb}^2\,\text{S}^3$
5. HETEROMORPHITE GROUP, III.	Heteromorphite,	$\text{Pb S}+\tfrac{1}{2}\text{Sb}^2\,\text{S}^3$
	? Brongniardite,	$(\text{Pb, Ag})\ \text{S}+\tfrac{1}{3}\ \text{Sb}^2\,\text{S}^3$
	? Chiviatite,	$(\text{Ꞓu, Pb})\ \text{S}+\tfrac{1}{2}\ \text{Bi}^2\,\text{S}^3$
6. DUFRENOYSITE GROUP, I.	Dufrenoysite,	$\text{Pb S}+\tfrac{1}{2}\ \text{As}^2\,\text{S}^3$
7. FREISLEBENITE GROUP, IV.	Freislebenite,	? $(\text{Pb, Ag})\ \text{S}+\tfrac{4}{9}\text{Sb}^2\,\text{S}^3$
8. PYRARGYRITE GROUP, VI.	Pyrargyrite,	$\text{Ag S}+\tfrac{1}{3}\ \text{Sb}^2\,\text{Sb}^3$
	Proustite,	$\text{Ag S}+\tfrac{1}{3}\ \text{As}^2\,\text{S}^3$
9. BOURNONITE GROUP, III.	Bournonite,	$(\text{Ꞓu, Pb})\ \text{S}+\tfrac{1}{3}\ \text{Sb}^2\,\text{S}^3$
	Boulangerite,	$\text{Pb S}+\tfrac{1}{3}\ \text{Sb}^2\,\text{S}^3$
	? Aciculite,	$(\text{Ꞓu, Pb})\ \text{S}+\tfrac{1}{3}\ \text{Bi}^2\,\text{S}^3$
	Wolchite,	
10. KOBELLITE GROUP,	Kobellite,	$(\text{Pb, Fe})\ \text{S}+\tfrac{2}{5}\ (\text{Sb, Bi})^2\ \text{S}^3$
11. TETRAHEDRITE GROUP, I.	Tetrahedrite,	$\text{R S}+\tfrac{1}{4}\ (\text{Sb, As})^2\,\text{S}^3$
	Tennantite,	$\text{R S}+\tfrac{1}{4}\ \text{As}^2\,\text{S}^3$
12. GEOCRONITE GROUP, III.	Geocronite,	$\text{Pb S}+\tfrac{1}{5}\ (\text{Sb, As})^2\,\text{S}^3$
13. STEPHANITE GROUP, III.	Stephanite,	$\text{Ag S}+\tfrac{1}{6}\ \text{Sb}^2\,\text{S}^3$
14. POLYBASITE GROUP, VI.	Polybasite,	$(\text{Ag, Ꞓu})\ \text{S}+\tfrac{1}{9}\ (\text{Sb, As})^2\,\text{S}^3$

2. *Persulphuret of the form $R^2\ S^5$.*

Enargite, III.	$\text{R S}+\tfrac{1}{3}\ (\text{As, Sb})^2\ \text{S}^5.$
Xanthocone, VI.	$(3\text{Ag S}+\text{As}^2\,\text{S}^5)+2(3\text{Ag S}+\text{As}^2\,\text{S}^3).$
Fireblende.	

APPENDIX. Witticite, $\text{Ꞓu S}+\text{Bi}^2\ \text{S}$?

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* In this table, the system of Crystallization is indicated by Roman numerals, as follows:

I. Monometric System,	IV. Monoclinic System,
II. Dimetric System,	V. Triclinic System,
III. Trimetric System,	VI. Hexagonal System.

In the formulas, the ratios of the two Sulphurets—the Protosulphuret and Persulphuret—are given by making the former a unit, as this method is best adapted for a comparison of the composition of the several species. All hypothesis as to the arrangements of the constituents, beyond the simple expression of this ratio, is avoided. In this view, the objection to the use of fractions, that molecules are indivisible atoms, is of no importance, even if based on fact.

WOLFSBERGITE, *Nicol.* Antimonial Copper. Sulphuret of Copper and Antimony, *H. Rose.* Kupferantimonglanz, *Zincken.* Chalcostibites, *Glocker.*

Trimetric. $I : I = 101°$, $\overline{i2} : \overline{i2} = 138° 12'$, $\overline{i2} : i\breve{i} = 112° 24'$. In small aggregated tabular prisms presenting the planes O, I, $\overline{i2}$, $i\breve{i}$. Cleavage: $i\breve{i}$, very perfect; O, less so.

H.=3—4. G.=4·748. Lustre metallic. Streak black. Color between lead-gray and iron-gray. Opaque. Fracture conchoidal.

Composition.—$\text{Ꞓu S}+\text{Sb}^2\text{S}^3$=Sulphur 25·0, antimony 50·2, copper 24·8=100. Analysis by H. Rose, (Pogg. xxxv, 361);

S 26·34, Sb 46·81, Cu 24·46, Fe 1·39, Pb 0·56=99·56.

The iron is supposed to exist as pyrites, and the lead as feather ore.

B.B. decrepitates, fuses readily, and gives on charcoal fumes of antimony; also after a strong heat with soda a globule of copper.

From Wolfsberg in the Hartz, in nests imbedded in quartz. It is usually covered with a coating of pyrites. Glocker's name antedates Nicol's, but it was given as a Latin generic name, the species being called by him *Chalkostibites Hercynius.*

TANNENITE. Kupferwismuthglanz, *R. Schneider*, Pogg. xc, 166, 1853.

Trimetric? In thin striated prisms. Lustre bright metallic. Color grayish to tin-white.

Composition.—$\text{Ꞓu S}+\text{Bi}^2\text{S}^3$=Sulphur 19·1, bismuth 62·0, copper 18·9. Analysis by R. Schneider, (loc. cit.):

Sulphur 18·83, Bismuth 62·16, Copper 18·72=99·71.

In an open tube yields sulphur; B.B. on coal fuses easily with intumescence, and gives with soda a globule of copper. Nitric acid solution deep bluish green, becoming dark blue with ammonia.

From Tannenbaum in Johanngeorgenstadt.

BERTHIERITE, *Poggendorff.* Haidingerite of *Berthier.*

In elongated prisms or massive; a longitudinal cleavage rather indistinct. Also fibrous massive, plumose; also granular.

H.=2—3. G.=4—4·3. Lustre metallic, less splendent than gray antimony. Color dark steel-gray, inclining to pinchbeck-brown: surface often covered with iridescent spots.

Composition.—$\text{Fe S}+\text{Sb}^2\text{S}^3$=Sulphur 28·9, antimony 58·4, iron 12·7=100. Analyses: 1, 2, 3, Berthier, (Ann. Ch. Phys. xxxv, 51); 4, 5, Rammelsberg, (Pogg. xl, 153); 6, Pettko, (Haid. Ber. i, 62):

	S	Sb	Fe	*Zn*
1. Chazelles,	30·3	52·0	16·0	0·30=98·6, Berthier.
2. Martouret,	28·81	61·34	9·85	——=100, Berthier.
3. Anglar,	29·18	58·65	12·17	——=100, Berthier.
4. Bräunsdorf,	30·575	54·338	11·965	*trace*, Mn 0·456=97·834, Rammelsberg.
5. "	31·326	54·700	11·432	0·737, " 2·544=100·739, "
6. Arany Idka,	29·27	57·88	12·85	——=100, Pettko. G.= 4·043.

Anal. 3—6 correspond to the above formula.

No. 1=$3\text{Fe S}+2\text{Sb}^2\text{S}^3$=Sulphur 29·6, antimony 53·1, iron 17·3=100.
No. 2=$3\text{Fe S}+4\text{Sb}^2\text{S}^3$=Sulphur 28·6, antimony 61·4, iron 10·0=100.

B.B. on charcoal fuses readily, gives out fumes of antimony, and forms a black magnetic slag. Dissolves readily in muriatic acid, giving out sulphuretted hydrogen.

Occurs at Chazelles and Martouret in Auvergne, associated with quartz, calcareous spar, and iron pyrites; in the Vosges, Commune of Lalaye, containing about 32 of Sb to 18 of Fe; at Anglar in La Creuse; also at Bräunsdorf in Saxony, and at Tintagel and Padstow in Cornwall; at Arany Idka in Hungary. Yields antimony, but of inferior quality.

ZINKENITE, *G. Rose*, Pogg. vii. Brewster's Journal, vi, 17.

Trimetric. *I* : *I*=120° 39′, Rose; 120° 34, Kengott. Usual in twins, as hexagonal prisms, with a low hexagonal pyramid at summit; angle at pyramidal edge=165° 26′; *I* on face of pyramid=104° 42′. Lateral faces longitudinally striated. Sometimes columnar, fibrous or massive. Cleavage not distinct.

H.=3—3·5. G.=5·30—5·35. Lustre metallic. Color and streak steel-gray. Opaque. Fracture slightly uneven.

Composition.—$PbS+Sb^2S^3$=Sulphur 21·6, antimony 43·5, lead 34·9=100. Analyses: 1, 2, H. Rose, (Pogg. viii, 99); 3, Kerl, (B. u. H. Ztg., 1853, No. 2):

1.	Wolfsberg,	S 22·58	Sb 44·39	Pb 31·84	Cu 0·42=99·23.
2.	"	undet.	44·11	31·97	undet.
3.	"	21·22	43·98	30·84	Ag 0·12, Fe 1·45=97·61, K.

B.B. alone on charcoal, decrepitates briskly, and fuses as readily as gray antimony, affording small metallic globules, which are volatilized, and the charcoal is covered with a coating of oxyd of lead. With carbonate of soda, yields globules of metallic lead. With muriatic acid forms chlorid of lead.

Occurs in the antimony mine of Wolfsberg in the Hartz; the groups of columnar crystals occur on a massive variety in quartz; the crystals sometimes over half an inch long, and two or three lines broad, frequently extremely thin and forming fibrous masses. Named in honor of Mr. Zinken, the director of the Anhalt mines, by G. Rose. Has been reported from St. Trudpert in the Schwarzwald.

Resembles gray antimony and bournonite, but may be distinguished by its superior hardness and specific gravity.

Kengott makes the crystallization monoclinic, and the pyramidal planes oblique basal planes; but such twins with pyramids so formed are not known among monoclinic species. (See page 152, vol. I).

MIARGYRITE, *H. Rose.*

Monoclinic; *C*=81° 36′, *I* : *I* =39° 38′, *O* : 1ì=109° 9′; *a* : *b* : *c*=1·0377 : 1 : 0·3565.

O : 1*i*=138° 26′
O : 3*i*=116° 2′
O : $\frac{1}{4}$ =142° 6′
O : $\frac{1}{3}$ =134° 17′
O : $\frac{1}{2}$ =123° 38′
O : 1 =109° 36′
O : *I* = 92° 40′
O : -2=119° 47′
1 : 1 (front)= 53° 16′
–2 : –2 " = 38° 44′
22 : 22 " = 77° 13′
55 : 55 " =115° 54′
33 : 33 " = 95° 59′
–13 : –13 " =106° 21′
–16 : –16 " =141° 1′
*i*3 : *i*3 " = 90° 30′

Crystals thick tabular, pyramidal or short prismatic. Lateral planes deeply striated. Cleavage: *ii*, 1*i*, imperfect.

O							
						$\frac{1}{10}$	
						$\frac{1}{6}$	
						$\frac{1}{4}$	
						$\frac{1}{3}$	
						$\frac{1}{2}$	
1*i*					1̇2	1	1ì
					22		
3*i*			33				
					42		
		55					
				$7\frac{7}{3}$			
ii			*i*3			*I*	*i*ì
						–2	
–1*i*	–16		–13				1ì
						$-\frac{1}{2}$	

Observed Planes.

H.=2—2·5. G.=5·2—5·4. Lustre submetallic-adamantine. Color iron-black. Streak dark cherry-red. Opaque, except in thin splinters, which, by transmitted light, are deep blood-red. Fracture subconchoidal. Very sectile.

Composition.—$Ag\ S+Sb^2S^3$=Sulphur 21·2, antimony 42·9, silver 35·9. Analysis by H. Rose, (Pogg. xv, 469):

S 21·95, Sb 39·14, Ag 36·40 Cu 1·06, Fe 0·62=99·17.

In an open tube fuses easily and gives a sublimate of oxyd of antimony and sulphurous acid. On charcoal with soda reduced, and a globule of silver obtained.

Observed only at Braünsdorf, near Freiberg in Saxony, associated with argentiferous arsenical pyrites. Named from *μειων*, *less*, *ἀργυρος*, *silver*, because it contains less silver than some kindred ores.

The *Hypargyrite* of Breithaupt contains, according to Plattner, 35 per cent. silver, and is probably a variety of the above.

PLAGIONITE, *G. Rose*, Pogg. xxviii, 421, 1833.

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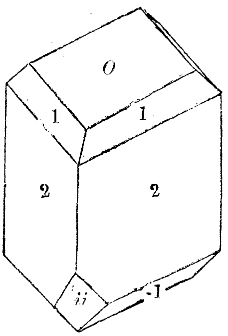

Monoclinic. *C*=72° 28′, *I* : *I*=85° 25′, *O* : 1*ì*=158° 9′, Rose; *a* : *b* : *c*=0·37015 : 1 : 0·8802. Observed planes as in the annexed figure.

O : 1=154° 20, *O* : *ii*=107° 32′.
O : 2=138° 52, 1 : 1 =142° 3′.
O : -1=149°, 2 : 2 =120° 49′.

Crystals thick tabular; the plane *O* shining and smooth; others striated. Cleavage: 2, perfect, but seldom affording smooth surfaces. Also massive, granular.

H.=2·5. G.=5·4. Lustre metallic. Color blackish lead-gray. Opaque. Brittle.

Composition.—$PbS+\frac{3}{4}Sb^2S^3$=Sulphur 20·6, antimony 38·3, lead 41·1. Analyses: 1, H. Rose, (Pogg. xxviii, 428); 2, Kudernatsch, (Pogg. xxxvii, 588):

1.	Wolfsberg,	S 21·53	Sb 37·94	Pb 40·52=99·99, Rose.
2.	“	21·49	37·53	40·98=100, Kudernatsch.

B.B. decrepitates and fuses easily, affording fumes of sulphur and oxyd of antimony, and coating the charcoal with oxyd of lead.

Occurs at Wolfsberg in geodes and druses of crystals in massive plagionite, or crystallized on quartz, and was discovered by Zincken. Named, in allusion to its unusually oblique crystallization, from *πλαγιος*, *oblique*.

Taking the planes 2, 2, as the lateral faces of the fundamental prism, the lateral angle is nearly the same as in Freislebenite.

JAMESONITE, *Haid.* Bleischimmer.

Trimetric. *I* : *I*=101° 20′ and 78° 40′. Observed planes, *I*, *ii*. Cleavage: basal, highly perfect; *I* and *ii* less perfect. Sometimes capillary. Also massive, structure columnar, particles delicate, straight, and parallel or divergent.

H.=2—2·5. G.=5·5—5·8; 5·564, Haidinger. Lustre metallic. Color and streak steel-gray. Opaque. Sectile.

Composition.—$PbS + \frac{2}{3} Sb^2 S^3$=Sulphur 20·2, antimony 36·2, lead 43·6. Analyses: 1, 2, H. Rose, (Pogg. viii, 101); 3, Schaffgotsch, (Pogg. xxxviii, 403); 4, C. Bechi, (Am. J. Sci. [2], xiv, 60):

	S	Sb	Pb	Fe	Cu
1. Cornwall,	22·15	34·40	40·75	2·30	0·13=99·73, Rose.
2. "	22·53	34·90	38·71	2·65	0·19, Fe, Pb, Zn 0·74=99·72, Rose.
3. Estremadura,	21·78	32·62	39·97	3·63	—— Bi 1·06, Zn 0·42=99·48, Sch.
4. Tuscany,	20·53	32·16	43·38	0·94	1·25, Zn 1·74=100, Bechi.

B.B. in an open tube affords dense white fumes of oxyd of antimony; on charcoal decrepitates, fuses readily, and almost wholly passes off in fumes.

Occurs principally in Cornwall, associated with quartz and minute crystals of Bournonite; occasionally also in Siberia, Hungary, Spain, and Brazil. Its perfect cleavage at right angles with the vertical axis, is sufficient to distinguish it from the species it resembles. Named after Prof. Jameson of Edinburgh.

HETEROMORPHITE, *Ramm.* Feather Ore. Plumosit, *Haid.* Federerz.

In capillary forms resembling a cobweb. Also massive.

H.=1—3. G.=5·67—5·9; 5·6788, massive, Poselger. Lustre dull metallic. Color dark lead-gray—steel-gray, sometimes irised.

Composition.—$PbS + \frac{1}{2} Sb^2 S^3$=Sulphur 19·2, antimony 31·0, lead 49·8. Analyses: 1, H. Rose, (Pogg. xv, 471); 2, Rammelsberg, (Pogg. Ann. lxxvii, 241); 3, Poselger, (Ramm. 3d Supp. 44); 4, 5, C. Bechi, (Am. J. Sci., [2], xiv, 60):

	S	Sb	Pb	Fe	Zn
1. Wolfsberg, *plumose*,	19·72	31·04	46·87	1·30	0·08=99·01, Rose.
2. " "	20·86	30·67	42·79	2·83	1·84, Cu 1·01=100, Rose.
3. " *massive*,	20·32	32·98	48·48	——	——=101·78, Poselger.
4. Tuscany, *capil.*	18·39	30·19	47·68	0·26	1·08, Cu 1·11=98·71, Bechi.
5. " *acic.*,	19·25	29·24	49·31	——	0·21, " 2·00=100·01, Bechi.

Fuses instantly in the flame of a candle, evolving white fumes.

Occurs at Wolfsberg in the Eastern Hartz; also at Andreasberg and Clausthal; at Freiberg and Schemnitz; in the Anhalt at Pfaffenberg and Meiseberg; in Tuscany, near Bottino.

The name Feather Ore or Plumosite being inapplicable, since a massive variety has been found, Rammelsberg substituted Heteromorphite.

ZUNDERERZ, (Tinder Ore), supposed formerly to be Red Antimony, proves to be an impure arsenical sulphuret of antimony and lead, supposed to be mixed with red silver ore and mispickel. Bornträger obtained in an analysis, (J. f. pr. Chem. xxxv, 49), S 19·57, As 12·60, Sb 16·88, Pb 43·06, Ag 2·56, Fe 4·52=96·19. It is soft like tinder, and has a dirty dark reddish color. From Andreasberg and Clausthal in the Hartz.

BROGNIARDITE, *Damour*, Ann. des M. [4], xvi, 227.

Massive without cleavage.

H. above 3. G.=5·950. Lustre like that of bournonite. Streak grayish-black.

Composition.—$Pb S + Ag S + Sb^2 S^3$, or $(Pb, Ag) S + \frac{1}{2} Sb^2 S^3$=Sulphur 19·0, antimony 30·7, silver 25·7, lead 24·6=100. Analyses by Damour, (loc. cit.):

	S	Sb	Ag	Pb	Cu	Fe	Zn
1.	19·38	29·95	25·03	24·74	0·54	0·30	0·40=100·34.
2.	19·21	29·60	24·46	25·05	0·61	0·26	0·32=99·51.
3.	19·14	29·75	24·81	24·94	0·70	0·22	0·37=99·93.

B.B. on charcoal decrepitates, fuses easily, giving off an odor of sulphur and white vapors; after roasting, yields a globule of silver, surrounded with a yellow areola of lead. In a closed tube a feeble orange sublimate with a white one above; in an open tube fuses, affords an odor of sulphur and a white sublimate of oxyd of antimony. Rapidly attacked by concentrated nitric acid.

From Mexico.

CHIVIATITE, *Rammelsberg*, Pogg. lxxxviii, 320.

Foliated massive; cleavable in three directions in one zone, one making an angle with the second of 153°, and with the third of 133°, Miller.

G.=6·920. Lustre metallic. Color lead-gray.

Composition.—$(\text{Ꞓu}, Pb)S+\frac{1}{2}Bi^2S^3$, R. Analysis by Rammelsberg, (loc. cit.):

S	Bi	Pb	Cu	Fe	Ag	insol.
18·00	60·95	16·73	2·42	1·02	*trace*	0·59=99·71.

B.B. like needle ore, which it is near in constitution.

From Chiviato, in Peru; along with Pyrites and Barytes. Resembles Bismuth glance.

DUFRENOYSITE, *Damour*. Gotthardite, *Rammelsberg*.

Monometric. Figure 43. Cleavage not distinct.

G.=5·549. Lustre metallic. Color steel-gray. Streak reddish-brown. Brittle.

Composition.—$PbS+\frac{1}{2}As^2S^3$=Sulphur 22·1, arsenic 20·7, lead 57·2, or analogous to Heteromorphite, arsenic replacing the antimony. Analyses by Damour, (Ann. Ch. Phys. [3], xiv, 379):

	S	As	Pb	Ag	Cu	Fe
1.	22·49	20·69	55·40	0·21	0·31	0·44=99·54
2.	22·30	20·87	56·61	0·17	0·22	0·32=100·49.

In a matrass affords a red sublimate of sulphuret of arsenic. B.B. fuses easily, yielding sulphurous acid and arsenical fumes, and a globule of lead. Dissolves in acids.

Occurs in dolomite at St. Gothard, with realgar, orpiment, blende, and pyrites.

PYRARGYRITE. Dark-red Silver Ore. Ruby Silver, *P.* Black Silver. Ærosite. Rothgültigerz, *W.* Argyrythrose, *Beud.* Dunkles Rothgültigerz, *G.* Argent Antimonié Sulfuré, *H.* Antimonsilberblende. Argentum rubrum, *Linn.*

Rhombohedral. Opposite extremities of crystals often unlike. $R:R$=108° 42′, B. and M., $O:R$=137° 42′; a=0·788. Observed planes: rhombohedral, $\frac{1}{4}$, $1(R)$, 4, –5, –2, –1, $-\frac{1}{2}$; scalenohedral 1^5_3, 1^3, 1^5, 1^7, $\frac{1}{4}^3$, $\frac{2}{5}^3$, $\frac{5}{8}^3$, -2^3 $-\frac{1}{2}^3$, $\frac{1}{4}^7$; pyramidal, $\frac{2}{3}2$; and also O, I, $i2$.

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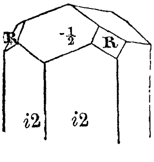
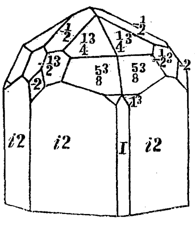


298A



$O:\frac{1}{2}$ =155° 32′. $\frac{1}{2}:\frac{1}{2}$ =137° 58′. $R:\frac{1}{2}$=144° 21′.

$O:1^3$=112° 33′. $i2:R$=125° 39′. $R:\frac{1}{4}^3$ =164° 5′.

$O:1^7$=100° 14′. $i2:1^3$=155° 4′. $i2:i2$ =120°.

Cleavage: *R* rather imperfect. Twins: plane of composition $-\frac{1}{2}$ as in f. 300, which consists of four individuals; *O* or basal plane, as in f. 300A; also *R* and *I*. Also massive, structure granular, sometimes impalpable.

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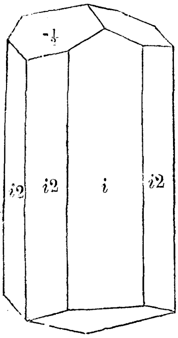

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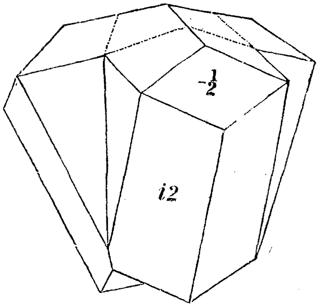

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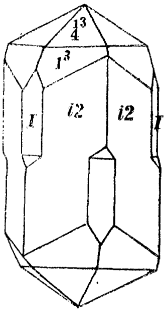

H.=2—2·5. G.=5·7—5·9. Lustre metallic-adamantine. Color black, sometimes approaching cochineal-red. Streak cochineal-red. Translucent—opaque. Fracture conchoidal. Sectile, yielding readily to the knife.

Composition.—$Ag S+\frac{1}{3} Sb^2 S^3$=Sulphur 17·5, antimony 23·5, silver 59·0. Analyses: 1, Bonsdorff, (K. V. Ac. H. 1821, 338); 2, Wöhler, (Ann. d. Pharm. xxvii, 157); 3, Böttger, (Ramm. Handw. ii, 106):

	S	Sb	Ag
1. Andreasberg,	16·61	22·85	58·95, gangue 0·30=98·70, Bonsdorff.
2. Mexico,	18·0	21·8	60·2 =100, Wöhler.
3. Zacatecas, Mex.,	17·76	24·59	57·45=99·80, Böttger.

B.B. fuses and gives out fumes of antimony; ultimately on charcoal a globule of silver is obtained. Dissolves in heated nitric acid, leaving sulphur and oxyd of antimony.

The *dark-red silver ore* occurs principally with calcareous spar, native arsenic, and galena, at Andreasberg in the Hartz; also in Saxony, Hungary, Norway, at Gaudalcanal in Spain, and Cornwall. In Mexico it is worked extensively as an ore of silver.

A *light-red* ore from Andreasberg, according to Zincken, contains no arsenic. A *gray* ore from the same locality contains both arsenic and antimony, and may be miargyite.

ALTERED FORMS.—Occurs like Proustite, changed to Silver glance, (Ag S); also to Pyrites.

PROUSTITE. Light red Silver Ore. Lichter Rothgültigerz. Arseniksilberblende.

Rhombohedral. $R : R=107° 48'$, $O : R=137° 9'$; $a=0·78506$. Observed planes: rhombohedral, $\frac{1}{4}$, $1(R)$, -2, $-\frac{3}{2}$, $-\frac{1}{2}$; scalenohedral, 1^3, 1^5, $\frac{1}{4}^3$; prismatic I, $i2$; basal, O. $\frac{1}{2} : \frac{1}{2}=137° 16'$. Simple forms and twins as in the preceding species. Also granular.

H.=2—2·5. G.=5·422—5·56. Lustre adamantine. Color cochineal-red. Streak cochineal-red, sometimes inclined to aurora-red. Subtransparent—subtranslucent. Fracture concheidal—uneven.

Composition.—$AgS+\frac{1}{3}As^2S^3$=Sulphur 19·4, arsenic 15·2, silver 65·4. Analysis by H. Rose, (Pogg. xv, 472):

Joachimstahl, S 19·51, As 15·09, Ag 64·67, Sb 0·69=99·96.

B.B. like the preceding, excepting it gives off arsenical fumes instead of oxyd of antimony.

Occurs in Saxony at Johanngeorgenstadt, Marienberg, and Annaberg; at Joachimstahl in Bohemia, Wolfach in Baden, Markirchen in Alsace, Chalanches in Dauphiné, Guadalcanal in Spain, in Mexico and Peru.

FREISLEBENITE, *Haid.* Antimonial Sulphuret of Silver. Sulphuret of Silver and Antimony, *P.* Schilfglaserz, *Freisleben.* Silber-und-Antimon. Argent Sulfuré Antimonifère et Cuprifère, *Levy.*

Monoclinic. C=87° 46′, $I:I$=119° 12′, O : 1ì=137° 10′, (B. & M.); $a:b:c$=1·5802 : 1 : 1·7032.

O : 1i=123° 55′ 1 : 1 (front)=128° 2′ $i\frac{4}{3}:i\frac{4}{3}$ (front)=132° 48′.
O : $\frac{1}{2}$ì=156° 8′ 14 : 14 " =166° 6′ i3 : i3 " =157° 54′.
O : 2ì=118° 21′ 12 : 12 " =152° 36′ 1ì : 1ì (top) = 94° 20′.

Prisms longitudinally striated. Cleavage : I perfect.

H.=2—2·5. G.=6—6·4; 6·194, Hausmann. Lustre metallic. Color and streak light steel-gray, inclining to silver-white, also blackish lead gray. Yields easily to the knife, and is rather brittle. Fracture conchoidal—uneven.

O									
					$\frac{1}{2}$				$\frac{1}{2}$ì
1i	14		12		1				1ì
		$\frac{3}{2}3$							$\frac{3}{2}$ì
									2ì
ii		i3		$i\frac{4}{3}$	I	$ì\frac{6}{5}$	$ì\frac{5}{3}$	ì2	iì

Observed Planes.

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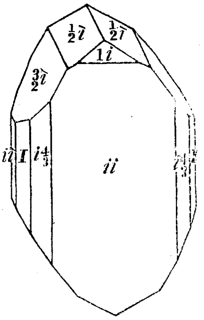

Composition.—$(PbS+Sb^2S^3)+2[3(Pb,Ag)S+Sb^2S^3$, or $(Pb,Ag)S+\frac{3}{7}Sb^2S^3$, Wöhler. $(Pb,Ag)S+\frac{4}{9}Sb^2S^3$, is nearer the analysis, which may correspond to $(Pb,Ag)S+\frac{1}{3}Sb^2S^3$, together with $\frac{1}{9}Sb^2S^3$ (or gray antimony) as impurity. Analyses by Wöhler, (Pogg. xlvi, 146):

1. S 18·77 Sb 27·72 Pb 30·00 Ag 22·18, Fe 0·11 Cu 1·62=100.
2. 18·72 27·05 30·08 23·78=99·60.

B.B. on charcoal emits copious white vapors and a slight sulphurous odor, deposits oxyd of antimony and lead around the assay, and finally a white metallic globule remains.

Occurs with silver glance, spathic iron, and galena, in the Himmelsfürst mine, at Freiberg in Saxony, and Kapnik in Transylvania; also at Ratieborzitz, the ore of this region containing bismuth, according to Zincken.

An antimonial sulphuret of silver is said to occur with native silver and native copper, at the copper mines of Michigan.

BOURNONITE. Endellionite, *Bournon.* Schwarz-spiessglaserz, *W.* Bleifahlerz, Spiessglanz-bleierz, *Haus.* Wheel Ore. Radelerz. Antimonié Sulfuré Plumbo-cuprifère, *H.*

Trimetric. $I : I = 93° 40'$, $O : 1\bar{i} = 136° 17'$, $a : b : c = 0{\cdot}95618 : : 1{\cdot}0662$.

$O : \frac{1}{2}\bar{i} = 154° 27'$. $O : \frac{1}{2} = 146° 45'$. $1 : 1$ (mac.) $= 114° 6'$.
$O : \frac{2}{3}\bar{i} = 147° 29'$. $O : 1 = 127° 20'$. $1 : 1$ (brach.) $= 109° 6'$.
$O : 1\bar{2} = 133° 26'$. $O : \frac{3}{4}\breve{3} = 144° 29'$. $i\bar{2} : i\bar{2}$ (ov. $i\bar{i}$) $= 129° 44'$.
$O : 2\bar{2} = 115° 20'$. $O : 1\breve{i} = 138° 6'$. $i\breve{2} : i\breve{2}$ (ov. $i\breve{i}$) $= 123° 52'$.

O							
$\frac{1}{4}\bar{i}$							
$\frac{1}{2}\bar{i}$			$\frac{1}{2}$				
$\frac{2}{3}\bar{i}$							
						$\frac{3}{4}\breve{3}$	
$1\bar{i}$	$1\bar{2}$		1				$1\breve{i}$
$2\bar{i}$	$2\bar{2}$						
$i\bar{i}$	$i\bar{2}$	$i\overline{\frac{3}{2}}$	I	$i\breve{\frac{4}{3}}$	$i\breve{2}$		$i\breve{i}$

Observed Planes.

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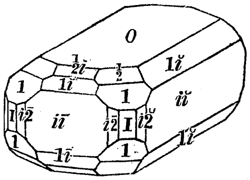

Cleavage: $i\breve{i}$ imperfect; $i\bar{i}$ and O less distinct. Twins: plane of composition I; crystals often cruciform, crossing at angles of 93° 40′ and 86° 20′. Also massive, granular, compact.

H.=2·5—3. G.=5·7—5·9. Lustre metallic. Color and streak steel-gray, inclining to blackish lead-gray or iron-black. Opaque. Fracture conchoidal or uneven. Brittle.

Composition.—$(\text{Ȼu}, \text{Pb})\text{S} + \frac{1}{3}\text{Sb}^2\text{S}^3$, or $(3\,\text{Ȼu}\,\text{S} + \text{Sb}^2\text{S}^3) + 2(3\,\text{Pb}\,\text{S} + \text{Sb}^2\text{S}^3)$, Rammelsberg=Sulphur 19·4, antimony 26·0, lead 41·8, copper 12·8. Analyses: 1, H. Rose, (Pogg. xv, 573); 2, Sinding, (Ramm. Handw. 123); 3, 4, Dufrénoy, (Ann. d. Min. [3], x, 371); 5, 6, 7, 8, Rammelsberg, (Pogg. Ann. lxxvii, 253):

		S	Sb	Pb	Cu
1.	Pfaffenberg,	20·31	26·28	40·84	12·65=100·08, Rose.
2.	"	19·63	25·68	41·38	12·68=99·37, Sinding.
3.	Alais,	19·4	29·4	38·9	12·3=100, Dufrénoy.
4.	Mexico,	17·8	28·3	40·2	13·3=99·6, Dufrénoy.
5.	Meiseberg,	19·49	24·60	40·42	13·06=97·57, Ramm.
6.	"	18·99	24·82	40·04	15·16=99·01, Ramm.
7.	Wolfsberg,	19·76	24·34	42·88	13·06=100·04, Ramm.
8.	"	19·87	24·28	35·52	9·05, Ni & Co 5·47, Fe 0·84, As 3·22=98·26, R.

The Meiseberg mineral (No. 6) is light gray, and occurs in tabular crystals with an uneven conchoidal fracture, and submetallic lustre. G.=5·703, Zincken; 5·726, and 5·792, Bromeis; 5·779, Rammelsberg.

Another variety (No. 5) is iron-black, with the faces of a rhombic octahedron largely developed. Fracture conchoidal. Lustre metallic. G.=5·822 and 5·847, Bromeis; 5·844, Zincken; 5·863, Rammelsberg.

The Wolfsberg ore, (No. 7), is iron black. The crystals are rectangular prismatic. Fracture conchoidal. Lustre metallic. G.=5·726, Rammelsberg; 5·796, Zincken; 5·801 and 5·855, Bromeis.

In the last analysis, part of the lead is replaced by nickel and cobalt. The specific gravity is 5·524—5·590. Rammelsberg calls the mineral *Nickel-bournonite.*

B.B. decrepitates, fuses easily and gives off sulphur and fumes of antimony. Ultimately, fuses to a black globule. In a strong heat, the charcoal is covered with oxyd of lead. Readily dissolves in nitric acid, forming a blue solution.

Good crystals of this species occur in the mines of Neudorf in the Hartz, where they occasionally exceed an inch in diameter; with quartz, gray copper, and phosphorescent blende, at Kapnik in Transylvania, in flattened crystals; at Servoz in Piedmont, it is associated with pearl spar and quartz. Other localities are at Braunsdorf and Gersdorf in Saxony, Clausthal, and Andreasberg in the Hartz, &c.; also Endellion, near Redruth in Cornwall, where it was first found, and hence called *Endellionite*, by Count Bournon, after whom it has since been named. Occurs also at Beeralston in Devonshire; and in Chili.

BOULANGERITE. Sulphuret of Antimony and Lead, *C. Boulanger,* Ann. des Mines, 3d ser. vii, 1835. Plumbostib, *Br.* Embrithite, *Br.* Schwefelantimonblei.

In plumose masses, exhibiting in the fracture a crystalline structure, generally massive; also granular and compact.

H.=2·5—3. G.=5·75—6·0. Lustre metallic. Color bluish lead-gray; often covered with yellow spots from oxydation.

Composition.—$\text{Pb S}+\frac{1}{3}\text{Sb}^2\ \text{S}^3$=Sulphur 17·9, antimony 24·1, lead 58·0. Analyses: 1, Boulanger, (Ann. d. Mines, [2], viii, 575); 2, Thaulow, (Pogg. xli, 216); 3, Bromeis, (Pogg. xlvi, 281); 4, Brüel, (ib.); 5, Abendroth, (Pogg. xlvii, 493); 6, Rammelsberg, (3d Supp. 28); 7, 8, C. Bechi, (Am. J. Sci., [2], xiv, 60).

	S	Sb	Pb
1. Molières,	18·5	25·5	53·9, Fe 1·2, Cu 0·9=100, Boulanger.
2. Nasafjeld,	18·86	24·60	55·57=99·03, Thaulow.
3. Nertschinsk,	18·21	25·04	56·29=99·54, Bromeis.
4. "	19·11	23·66	53·87, Fe 1·78, Ag 0·05=98·47, Brüel.
5. Ober-Lahr,	19·05	25·40	55·60=100·05, Abendroth.
6. Wolfsberg,	18·91	25·94	55·15=100, Rammelsberg.
7. Tuscany, *mas.*	17·99	26·08	53·15 Cu 1·24 Zn 1·41 Fe 0·35=100·23, Bechi.
8. " *acic.*	17·82	27·74	55·39 " 1·25 " 0·09 " 0·23=101·52, Bechi.

B.B. fuses readily, with exhalations of sulphurous acid and fumes of oxyd of antimony. On charcoal, a yellow circle indicates the presence of lead. Easily attacked by nitric acid. Boiling strong muriatic acid decomposes it with the extrication of sulphuretted hydrogen.

Occurs quite abundantly at Molières, department of Gard, in France; also at Nasafjeld in Lapland; at Nertschinsk, and Ober-Lahr; Wolfsberg; near Bottino in Tuscany, both massive, acicular, and fibrous. Specimens from Wolfsberg gave Rammelsberg G.=5·75, and pulverized 5·96.

AIKINITE, *Chapman.* Aciculite, *Nicol.* Acicular Bismuth. Needle Ore, *J.* Plumbo-cupriferous Sulphuret of Bismuth. Nadelerz. Bismuth Sulfuré Plombo-Cuprifère, *H.* Belonit, *Glocker.*

Trimetric. $I:I$=110° nearly, Hörnes. In imbedded long acicular crystals, longitudinally striated. Also massive.

H.=2—2·5. G.=6·1—6·8. Lustre metallic. Color blackish lead-gray, with a pale copper-red tarnish. Opaque. Fracture uneven.

Composition.—$(3\,\text{Ꞓu}S+\text{Bi}^2\,S^3)+2(3\text{Pb}\,S+\text{Bi}^2\,S^3)=(\text{Ꞓu, Pb})\,S+\frac{1}{3}\,\text{Bi}^2\,S^3$=Sulphur 16·7, bismuth 36·2, lead 36·1, copper 11·0=100: supposed to be isomorphous with Bournonite.

Analyses: 1, 2, Frick, (Pogg. xxxi, 529); 3, Chapman, (Phil. Mag. [3], xxxi, 541):

	S	Bi	Pb	Cu
1. Beresof,	16·05	34·62	35·69	11·79=98·15, Frick.
2. "	16·61	36·45	36·05	10·59=99·70, "
3. "	18·78	27·93	40·10	12·53=99·64, Chapman. G.=6·1.

B.B. gives off fumes of sulphur, fuses, and emits numerous burning globules, and yields a bead of lead, containing copper, which colors glass of borax greenish-blue. Partly dissolved in nitric acid.

Acicular bismuth occurs imbedded in white quartz, and accompanies gold, malachite, and galena, at Beresof, near Ekatherinenberg in Siberia.

An ore of bismuth, according to Jackson, occurs at the Lubec lead mines, in Maine.

Chapman's name, after Mr. Aikin, the chemist, given in 1843, claims priority.

ALTERED FORMS.—Occurs altered to bismuth ochre.

WOLCHITE, *Haid.* Antimonial Copper Glance. Antimonkupferglanz, *Breit.*

Prismatic. In short rhombic prisms; observed planes O, $\bar{ii}$, $\breve{ii}$, I, $1\bar{i}$. Angles not ascertained. Cleavage: brachydiagonal, imperfect. Also massive.

H.=3. G.=5·7—5·8. Color blackish lead-gray. Fracture conchoidal to uneven. Brittle.

Composition.—Analysis by Schrötter, (Baumgart. Zeit. viii, 284):

S 28·602, Sb 16·647, As 6·036, Pb 29·902 Cu 17·352, Fe 1·404=99·943.

Occurs in the iron mines at St. Gertraud, in Carinthia.

KOBELLITE, *Sätterberg*, K. V. Ac. H. 1839, p. 188,—Berz. Jahresb. xx, 215.

Resembles gray antimony, but brighter in lustre; structure radiated.

G.=6·29—6·32. Soft. Color blackish lead-gray to steel-gray. Streak black.

Composition. —$(3\text{Fe}\,S+2\,\text{Sb}^2\,S^3)+4(3\,\text{Pb}\,S+\text{Bi}^2\,S^3)=(\text{Fe, Pb})S+\frac{2}{5}(\text{Sb, Bi})^2\,S^3$= Sulphur 17·9, antimony 8·7, bismuth 28·3, lead 42·2, iron 2·8. Analysis by Sätterberg, (loc. cit.):

S 17·86, Sb 9·24, Bi 27·05, Pb 40·12, Fe 2·96, Cu 0·80, gangue 1·45=99·48.

B.B. fuses, colors the charcoal yellow, passes off mostly in fumes, and yields a white metallic globule. Dissolves in concentrated muriatic acid, affording sulphuretted hydrogen.

From the cobalt mine of Hvena in Sweden. Named after von Kobell.

TETRAHEDRITE, *Haid.* Gray Copper. Fahlerz, *P.* Panabase, *Beud.* Schwarzerz, *W.* Kupferfahlerz. Weissgiltigerz. Schwarzgiltigerz and Graugiltigerz, in part, or Polytelite, *Glocker.* Cuivre Gris, *H.* Aphthonite, *Svanberg.* Aftonite. Quecksilberfahlerz, or Spaniolite, *Kobell.*

Monometric: tetrahedral. Observed planes as in the annexed figures, with also 33. Figs. 54–59, 61–64. Cleavage: octahedral, in traces. Twins: plane of composition a face of the octahedron. Also granular, coarse or fine, to impalpable, compact.

H.=3—4·5. G.=4·5—5·11. Lustre metallic. Color between steel-gray and iron-black. Streak sometimes inclined to brown, but generally the same as the color. Opaque or subtranslucent in very thin splinters, with a cherry-red transmitted color. Fracture subconchoidal, uneven. Rather brittle.

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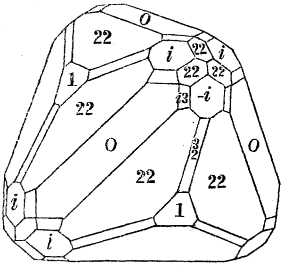

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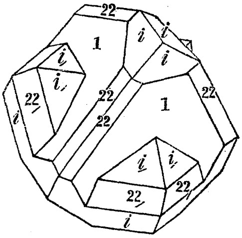

Some varieties contain silver and quicksilver: the former are called *Polytelite* by Glocker, the latter *Spaniolite* by Kobell. But the limits between these varieties are indefinite.

Composition.—(Ꞓu, Ag, Fe, Zn) S+$\frac{1}{4}$(Sb, As)^2 S^3, in which Ag+Ꞓu is to Zn+Fe as 2 to 1. Analyses: 1, Klaproth, (Beit. iv); 2—6, H. Rose, (Pogg. xv, 576); 7, 8, Kersten, (Pogg. lviii, 161, lxvii, 428); 8½, C. Bechi, (Am. J. Sci. [2], xiv, 60); 9, Bromeis, (Pogg. lv, 117); 10, Amelung, (Ramm. 3d Supp. 51); 10½, Ebelmen, (Ann. des. M. [4], xi, 47); 11, Klaproth, (Beit. iv); 12, 13, H. Rose, (loc. cit.); 14, Sander, (Ramm. 1st Supp. 52); 15, Svanberg, (Oefv. K. V. Ac. Förh. iv, 85); 16, 17, 18, Rammelsberg, (Pogg. Ann. lxxvii, 251); 18½, F. A. Genth, (Am. J. Sci. [2], xvi, 83); 19, Scheidhauer, (Pogg. lviii, 161); 20, H. Weidenbusch, (Pogg. 1849, lxxvi, 86); 21, 22, v. Hauer, (Jahrb. d. Geol. Reichs. 1852, 98, J. f. pr. Ch. lx, 55):

I. *Containing little or no Silver.*

		S	Sb	As	Cu	Fe	Zn	Ag
1.	Kapnik,	28·00	22·00	——	37·75	3·25	5·00	0·25=96·25, Klap.
2.	"	25·77	23·94	2·88	37·98	0·86	7·29	0·62=99·34, Rose.
3.	Gersdorf,	26·33	16·52	7·21	38·63	4·89	2·76	2·37=98·71, Rose.
4.	Elsace,	26·83	12·46	10·19	40·60	4·66	3·69	0·60 quartz 0·41, R.
5.	Dillenburg,	25·03	25·27	2·26	38·42	1·52	6·85	0·83=100·18, Rose.
6.	Clausthal,	24·73	28·24	——	34·48	2·27	5·55	4·97=100·24, Rose.
7.	V. di Castello,	24·17	27·47	——	35·80	1·89	6·05	0·33=Hg 2·70, K.
8.	Angina, Tusc.	23·40	27·47	——	35·90	1·93	6·24	0·33=Hg 2·70, Au *trace* gangue and loss 2·03, Kersten.
8½.	Angina,	24·14	26·52	——	37·72	1·64	6·23	0·45, Hg 3·03=99·73, B.
9.	Durango, Mex.	23·76	25·97	——	37·11	4·42	5·02	1·09, Pb 0·54, undec. 0·47=98·38, Bromeis.
10.	Camsdorf,	23·73	28·87	*trace*	38·78	5·03	3·59	——=100, Amel'g.
10½.	Algeria,	27·25	14·77	9·12	41·57	4·66	2·24	——=99·61, Ebelm.

II. *Containing Silver.* (Weissgiltigerz or Silberfahlerz, *Polytelite*). G. of 15, 4·87; of 16, 4·852; of 17, 4·892—4·946; of 18, 4·526.

		S	Sb	As	Cu	Fe	Zn	Ag
11.	Wolfach,	25·50	27·00	——	25·50	7·00	——	13·25=98·25, Klap.
12.	"	23·52	26·63	——	25·23	3·72	3·10	17·71=99·91, Rose.
13.	Freiberg,	21·17	24·63	——	14·81	5·98	0·99	31·29=98·87, Rose.
14.	Clausthal,	24·1	26·8	——	35·7	4·5	——	8·9, Pb 0·9=100·9, S.
15.	*Aphthonite*,	30·05	24·77	*trace*	32·91	1·31	6·40	3·09, Pb 0·04, Co 0·49, gangue 1·29=100·37, S.
16.	Meiseberg, *cry.*	24·80	26·56	——	30·47	3·52	3·39	10·48, Pb 0·78, Ramm.
17.	Neudorf, *mass.*	24·22	26·44	——	31·53	4·36	3·25	7·27=97·07, Ramm.
18.	" "	24·69	25·74	——	32·46	4·19	3·00	7·55=97·63, Ramm.
18½.	Cabarras N.C.	25·48	17·76	11·55	30·73	1·42	2·53	10·53=100, Genth.

III. *Containing Quicksilver, Spaniolite,* (see also, Nos. 7, 8, 8½, above). G. of No. 20= 5·107, of No. 21, 4·605, of No. 22, 5·107.

	S	Sb	As	Cu	Fe	Zn	Ag	Hg	
19. Iglo, Hungary,	23·34	18·48	3·98	35·90	4·90	1·01	*trace*,	7·52,	quartz 2·73=97·86, S.
20. Schwatz, Tyrol,	22·96	21·35	—	34·57	2·24	1·34	—	15·27,	insol, 0·80 W.
21. Poratsch, Hung.	25·90	26·70	*tr.*	36·59	7·11	—	0·11	3·07=99·37, H.	
22. " "	24·37	25·48	*tr.*	30·58	1·46	—	0·09	16·69=98·58, H.	

The ore of Moschellandsberg also, according to Zincken, contains mercury.

A variety from Guadalcanal in Spain, according to Vauquelin, contains from one to ten per cent. of platinum.

B.B gives off fumes of antimony and arsenic, finally melts, and after roasting, affords a globule of copper. When pulverized, dissolves with a little residue in nitric acid; the solution has a brownish-green color.

The Cornish mines, near St. Austle, afford large tetrahedral crystals; their surfaces are commonly rough and dull. More brilliant and highly modified crystallizations occur at Andreasberg in the Hartz, Kremnitz in Hungary, Freiberg in Saxony, Kapnik in Transylvania, and Dillenberg in Nassau. Those belonging to the *Fahlerz* (gray ore) of Werner, have a steel-gray color. The *Schwarzerz* is nearly iron-black; this variety occurs principally at the old mine of Schwatz in the Tyrol, and at Kapnik in Transylvania; also at Clausthal in the Hartz, where it is imbeded in red manganese. The *Silberfahlerz* has a light steel-gray color, G.=4·8—5·1. A variety from McMakin's mine, Cabarras Co., N. C. (Anal. 18½) afforded Genth the ratio 4 : 5 between the sulphur of the sulphobases and sulphacids, instead of 4 : 3, as in the above formula; but the amount analyzed he observes was too small to authorize a separation of the mineral as a distinct species. It occurs with pyrites, galena, blende, talc, etc.

It is associated usually with copper pyrites, and is worked as an ore of copper.

An ore from mine Altar, 30 leagues from Coquimbo, afforded F. Field (Quart. J. Chem. Soc. iv, 332), S 30·35, As 3·91, Sb 20·28, Cu 36·72, Zn 7·26, Fe 1·23, Ag 0·075, Au 0·003. It is soft, of greasy appearance, greenish gray, slightly reddish, with powder bright red. Domeyko considers it impure with blende, pyrites, and galena. Prof. Ettling observes (ib. vi, 140) that the constitution is analogous rather to enargite than tetrahedrite, corresponding to the formula $4\ (\text{Ꞓu}, Zn, Fe, Ag)\ S+(Sb, As^2)\ S^5$.

The *Aphthonite* of Svanberg, (or *Aftonite*), from Wermland, (analysis 15), occurs massive of a steel-gray color and black streak; G.=4·87. H.=3. It gives the formula $7\ R\ S+(Sb, As)\ S^3$. It resembles an argentiferous tetrahedrite.

A *Weissgultigerz* from the mine "Hoffnung Gottes" near Freiberg, contains 36 to 38 per cent. of lead. It afforded S 22·53, antimony (loss) 22·39, lead 36·51—38·26, Ag 5·92–5·78, Fe 3·72–3·83, Zn 3·15–6·79, Cu 0·19–0·32=100. It occurs massive, fine granular, mixed with a little blende and pyrites. G.=5·438 and 5·465. The sulphur ratio for the bases and acid is 3 : 2; but it becomes the tetrahedrite ratio 4 : 3, if part of the bases exist as impurities.

Altered Forms.—Chalcopyrite malachite, azurite, occur as pseudomorphs after tetrahedrite.

TENNANTITE. Graukupfererz. Kupferblende, *Breit.*

Monometric; tetrahedral. Observed planes, O, I, 1, 22, $\frac{3}{2}\frac{3}{2}$. Figs. 55, 57, 58, and 18 with planes of 55. Cleavage: dodecahedral, imperfect. Twins, as in tetrahedrite. Not observed massive.

H.=3·5—4. G.=4·375—4·491. Lustre metallic. Color blackish lead-gray to iron black. Streak dark reddish-gray. Fracture uneven.

Composition.—$(\text{Ꞓu}, Fe)\ S+\frac{1}{4}\ As^2\ S^3$, isomorphous with tetrahedrite. Analyses: 1, Phillips, (Quart. Jour. vii, 95); 2, Kudernatsch, (Pogg. xxxviii, 397); 3, Fearnley, (Scheerer, in Pogg. lxv, 298); 4, Plattner, Pogg. lxvii, 422):

	S	As	Cu	Fe
1. Trevisane, Cornwall,	30·25	12·46	47·70	9·75=100·16, Phillips.
2. " "	27·76	19·10	48·94	3·57, Ag *tr.*, quartz 0·08=99·45, K.
3. Skutterud, G. 4·53,	29·18	19·01[a]	42·60	9·21=100, Fearnley.
4. Freiberg, *Kupferblende*,	28·111	18·875	41·07	2·219, Zn 8·894, Ag and Sb *trace*, Pb 0·341=99·51, Plattner.

[a] Determined by the loss.

B.B. decrepitates slightly, burns with a blue flame, emits copious fumes having an alliaceous odor, and finally fuses to a black scoria which acts upon the magnet.

Occurs in the Cornish mines, particularly near Redruth and St. Day, commonly in very splendent crystals investing other ores of copper. Also found at Skutterud in Norway, and in Algeria.

The *Kupferblende* of Breithaupt or Zincfahlerz, from near Freiberg, has part of the iron replaced by zinc, (anal. 4): it has a brownish-red or dirty cherry-red streak. G.=4·2—4·4.

GEOCRONITE, *Svanberg*. Kilbrickenite, *Apjohn*. Schulzite.

Trimetric; *I* : *I*=119° 44′, Kerndt. Observed planes, *I*, $i\breve{i}$, $1\bar{2}$. : $1\bar{2}$: $1\bar{2}$ (pyram.) about 153° and 64° 45′ (bas.) 122°. Cleavage: *I*. Usually massive. Also granular or earthy.

H.=2—3. G.=6·4—6·6. Lustre metallic. Color and streak light lead-gray—grayish blue. Fracture uneven.

Composition.—Pb S$+\frac{1}{5}$ (Sb, As)^2 S^3=Sulphur 16·5, antimony 16·7, lead 66·8. Analyses: 1, Svanberg, (Jahresb. xx, 203); 2, Sauvage, (Ann. d. Mines, [3], xvii, 525); 3, Kerndt, (Pogg. lxv, 302); 4, Apjohn, (Trans. Roy. Irish Acad. for 1840); 5, Svanberg, (Ofv. K. V. Ak. Förh. 1848, 64):

	S	Sb	As	Pb	Cu	Fe
1. Sala, Sweden, G.=6·54,	16·26	9·58	4·69	65·45	1·51	0·42, Zn 0·11=99·03, Sv.
2. Merido, G.=6·43,	16·90	16·00	——	64·89	1·60	——=99·39, Sauvage.
3. Tuscany, G.=6·45=6·47,	17·32	9·69	4·72	66·55	1·15	1·73=100·95, Kerndt.
4. *Kilbrickenite*, G.=6·407,	16·36	14·39	——	68·87	——	0·38=100, Apjohn.
5. Fahlun, G.=6·434,	15·16	5·66	4·62	64·17	4·17	0·08, Ag 0·24, Zn 0·59, Cu 4·17, Äl 1·9=98·35, Svanberg.

Svanberg deduces for the last the formula Pb S$+\frac{1}{6}$ (Sb, As)^2 S^3.

B.B. fuses readily, gives off fumes of antimony and sulphur, and colors the charcoal around, yellow.

Geocronite comes from the silver mines of Sala in Sweden; also in Gallicia, at Meredo in Spain, in nodules in galena; it crumbles easily and soils the fingers; in the valley di Castello near Pietro Santo, in Tuscany. The Kilbrickenite is from Kilbricken, Clare Co., Ireland. The name geocronite is derived from γη, *earth*, and Κρονος, *Saturn*, the alchemistic name for lead.

POLYBASITE, *H. Rose*. Eugenglanz.

Hexagonal. *O* : 1=121° 30′; *a*=1·4132. Observed planes *O*, *I*, 1. 1 : 1 (pyr.)=129° 32′, (bas.)=117°. Usually in short tabular hexagonal prisms; terminal planes triangularly striated, parallel to the alternate terminal edges. Cleavage: basal, imperfect. Also massive and disseminated.

H.=2—3. G.=6·214. Lustre metallic. Color iron-black; in thin tabular crystals, cherry-red by transmitted light. Streak iron-black. Opaque. Fracture uneven.

Composition.—(Ag, Ȼu)S$+\frac{1}{9}$ (Sb, As)^2 S^3=with silver alone, Sulphur 14·9, antimony 9·9, silver 75·2=100. Analyses: 1—3, H. Rose, (Pogg. xv, 573); 4, C. A. Joy, (Inaug. Dissert., 24):

	S	Sb	As	Ag	Cu	Fe	Zn
1. Durango, Mexico,	17·04	5·09	3·74	64·29	9·93	0·06	——=100·15, R.
2. Schemnitz,	16·83	0·25	6·23	72·43	3·04	0·33	0·59=99·70, R.
3. Freiberg,	16·35	8·39	1·17	69·99	4·11	0·29	——=100·30, R.
4. Cornwall,	15·87	5·46	3·41	72·01	3·36	0·34	——=100·45, Joy.

B.B. decrepitates somewhat, and fuses easily. In an open tube gives a white sublimate and a sulphurous odor; on charcoal an area colored with oxyd of antimony; with the fluxes a copper reaction; with soda, arsenical fumes. With acids like bournonite.

Occurs in the mines of Guanaxuato and Gaudalupe y Calvo in Mexico; also at Guarisamez in Durango, with copper pyrites and calcareous spar.

Named from πολυς, *much*, and *βασις*, *base*, in allusion to the large amount of the base sulphuret of silver, as compared with the sulphurets of arsenic and antimony.

ALTERED FORMS.—Stephanite and Pyrites, occur as pseudomorphs after polybasite.

STEPHANITE, *Haid.* Brittle Silver Ore. Brittle Silver Glance. Black Silver. Brittle Sulphuret of Silver. Sprödglaserz, *W.* Sprödglanzerz, *Haus.* Melanglanz. Argent Noir, Argent Antimonié Sulphuré Noir, *H.* Argent Sulphuré Fragile.

Trimetric. $I : I = 115° 39'$, $O : 1\bar{i} = 132° 32\frac{1}{2}'$; $a : b : c = 1·0897 : 1 : 1·5844$. Observed planes O, I, $\bar{i}\bar{i}$, $\breve{i}\breve{i}$, $\frac{1}{2}$, 1, 2, $1\breve{i}$ $2\breve{i}$.

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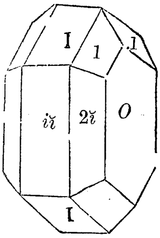

$O : \frac{1}{2} = 147° 14'$.
$O : 1 = 127° 50'$.
$O : 2 = 111° 14'$.
$O : 1\breve{i} = 145° 34'$.
$O : 2\breve{i} = 126° 6'$.

$1\breve{i} : 1\breve{i}$ (ov. $\breve{i}\breve{i}$) $= 68° 52'$.
$2\breve{i} : 2\breve{i}$ (ov. $\bar{i}\bar{i}$) $= 107° 48'$.
$1 : 1$ (mac.) $= 131° 16'$.
$1 : 1$ (brach) $= 96° 8'$.

Cleavage: $2\breve{i}$ and $\breve{i}\breve{i}$ imperfect. Twins: plane of composition I; forms like those of Aragonite frequent. Also massive, compact, and disseminated.

H.=2—2·5 G.=6·269, Przibram. Lustre metallic. Color and streak iron-black. Fracture uneven. Sectile.

Composition.—$Ag\,S + \frac{1}{6}Sb^2S^3$=Sulphur 15·6, antimony 14·0, silver 70·4. Analyses: 1, H. Rose, (Pogg. xv, 474); Kerl, (B. u. H. Ztg. 1853, No. 2).

	S	Sb	Ag	Fe	Cu	As
1. Schemnitz,	16·42	14·68	68·54	——	0·64	——=100·28, Rose.
2. Andreasberg,	16·51	15·79	68·38	0·14	——	——=100·82, Kerl.

In an open tube gives a sublimate of arsenic acid, or of oxyd of antimony. B.B. fuses and gives out on charcoal fumes of sulphur and antimony, and is reduced to a dark colored metallic globule, which may be further reduced by the addition of soda. Soluble in dilute heated nitric acid, sulphur and oxyd of antimony being deposited.

It occurs in veins with other silver ores at Freiberg, Schneeberg, and Johanngeorgenstadt in Saxony, at Przibram and Ratieborzitz in Bohemia, at Schemnitz and Kremnitz in Hungary, at Andreasberg in the Hartz, at Zacatecas in Mexico, and in Peru. A valuable ore of silver. Homœomorphous with aragonite.

ENARGITE, *Breithaupt*, Pogg. lxxx, 383.

Trimetric. $I : I = 98^\circ\ 11'$. Observed planes O, I, $i\bar{i}$, $i\breve{i}$. Cleavage: I, perfect, $i\bar{i}$, $i\breve{i}$ distinct, O indistinct. Also massive, granular or columnar.

H.=3. G.=4·43—4·45; 4·362, Kengott. Lustre metallic. Color iron-black; streak black. Brittle. Fracture uneven.

Composition.—(Ȼu, Fe, Zn) S+$\frac{1}{3}$(As, Sb)^2 S^5(?)=Sulphur 32·5, Arsenic 19·1, Copper 48·4. Analysis by Plattner, (loc. cit.):

S	As	Sb	Cu	Fe	Zn	Ag
32·222	17·599	1·613	47·205	0·565	0·228	0·017=99·449.

In a glass tube decrepitates and affords easily a sublimate of sulphur; and with more heat reddish-yellow sulphuret of arsenic. B.B. on charcoal gives out fumes of arsenous acid, oxyd of antimony and oxyd of zinc, and in the reduction flame with borax yields a globule of copper.

From Morococha, Cordilleras of Peru, at a height of 15,000 feet, in large masses, occasionally with small druses of crystals, along with Tennantite, imbedded in crystalline limestone.

XANTHOCONE, *Breithaupt*, J. f. prakt. Chem. xx, 67, and Pogg. lxiv, 272.

Rhombohedral; $R : R = 71^\circ\ 34'$; $O : R = 110^\circ\ 30'$, $a = 2·3163$. Observed planes R, -2, O. $O : 2 = 100^\circ\ 35'$. Cleavage: R, and O. Usually in reniform masses, with the interior consisting of minute crystals.

H.=2. G.=5·0—5·2. Color dull-red to clove-brown; crystals orange-yellow on the edges by transmitted light. Streak-powder yellow. Brittle.

Composition.—(3 AgS+As^{2}S^5)+2(3AgS+As^{2}S^3)=Sulphur 18·5, arsenic 15·3, silver 66·2=100. Analyses by Plattner, (Pogg. lxiv, 275):

	S	As (loss)	Ag	
1.	21·358	13·491	64·181	Fe 0·97=100.
2.	21·798	14·322	63·880=100.	

B.B. in a matrass fuses easily and affords a sublimate of sulphuret of arsenic; on charcoal fumes of sulphur and arsenic, and a grain of silver remains.

Occurs with Stephanite at the Himmelsfürst mine, near Freiberg. Named by Breithaupt, in allusion to its yellow powder, from ξανθος, *yellow*, and κονις, *powder*.

Rittingerite, *Zippe*. (Ber. Wien. Akad, ix, 2, 345).

Monoclinic; $C = 88^\circ\ 26'$. In small rhombic tables with replaced basal edges. Observed planes: O, $\frac{1}{2}$, I, ± 6, ± 1. Observed angles: $O : I = 91^\circ\ 24'$, $I : I = 126^\circ\ 18'$, $O : 1 = 132^\circ\ 24'$, $O : -1 = 130^\circ\ 50'$, $1 : -1 = 96^\circ\ 20'$, $O : -6 = 98^\circ\ 30$, $O : \frac{1}{2} = 150^\circ$, $-1 : -1 = 140^\circ\ 1'$. H.=1·5—3. Lustre submetallic adamantine. Color: O blackish brown in the larger crystals, less dark in the more minute; other parts iron-black. Translucent and dull honey-yellow to hyacinth-red in the direction of the axis. Streak orange yellow. Brittle.

Composition.—Probably a compound of sulphuret of silver and antimony. B.B. fuses very easily, gives an arsenical odor, and finally a globule of pure silver. From Joachimsthal, in small crystals.

This mineral is considered identical with Xanthocone by Breithaupt, (B. u. H. *Z*tg. 1853, 16).

FIREBLENDE. Feuerblende, *Breithaupt.*

Monoclinic. In delicate crystals grouped like stilbite. Observed planes, according to Brooke and Miller, *I*, *ii*, $1\bar{2}$, 1*i*, 2*i*.
I : *I*=139° 12′. 2*i* : 2*i* (top)=74°. *ii* : 1*i*=123° 34′.
1*i* : 1*i* (top)=112° 52′. *ii* : 2*i*=148° 42′. $1\bar{2} : 1\bar{2}$=62° 36′.

Cleavage: *ii*, and crystals flattened in this direction. Faces *ii* striated parallel to the clinodiagonal. Twins: plane of composition *ii*, (orthodiagonal).

H.=2. G.=4·2—4·3. Lustre pearly adamantine. Color hyacinth-red. Translucent. Sectile and somewhat flexible.

Composition.—Contains 62·3 per cent. of silver, along with sulphur and antimony, (Plattner). B.B. like pyrargyrite. Rammelsberg has referred the species to Xanthocone.

From the Kurprinz mine near Freiberg, and from Andreasberg.

Appendix.

WITTICHITE, *Kobell.* Cupreous Bismuth. Kupferwismutherz, *Klap.* Kupferwismuthglanz.

Trimetric? Massive and disseminated, also coarse columnar or an aggregate of imperfect prisms. Cleavage in one vertical direction.

H.=3·5. G.=5. Color steel-gray, tin-white, tarnishing pale lead-gray. Streak black.

Composition.—$\mathrm{\bar{C}uS+Bi^2S}$? According to Klaproth, (Beit. iv, 91):
S 12·58, Bi 47·24, Cu 34·66=94·48.

B.B. fuses easily in an open tube, and gives sulphur and a white sublimate. On charcoal decrepitates, fuses, and yields a bismuth slag; and after roasting with soda, a globule of copper. Klaproth supposes the loss in his analysis to be oxygen.

From cobalt mines near Wittichen in Baden.

III. FLUORIDS, CHLORIDS, BROMIDS, IODIDS.

I. BINARY COMPOUNDS.

1. *Calomel Division.* Composition R^2 (Cl, I, Br).

1. CALOMEL GROUP.—Dimetric.

Calomel,	$Hg^2\,Cl$.

2. *Rock Salt Division.* Composition R(Cl, I, Br) or R F.

1. ROCK SALT GROUP.—Monometric.

Sylvine,	K Cl.	Embolite,	Ag (Cl, Br).
Rock Salt,	Na Cl.	Bromyrite,	Ag Br.
Sal Ammoniac,	NH^4Cl.	Fluor Spar,	Ca F.
Kerargyrite,	Ag Cl.	Yttrocerite,	(Ca, Ce, Y) F.

2. IODYRITE GROUP.—Hexagonal.

Iodyrite,	Ag I.	Fluocerite,	Ce F?

3. COTUNNITE GROUP.—Trimetric.

Cotunnite,	Pb Cl.

II. DOUBLE BINARY COMPOUNDS.

Cryolite,	$Na\,F+\frac{1}{3}\,Al^2F^3$.	Chiolite,	$Na\,F+\frac{2}{3}Al^2F^3$.

CALOMEL. Horn Quicksilver. Dichlorid of Mercury, *Thom.* Chlorquecksilber. Chlormercur. Quecksilberhornerz. Mercure Chloruré.

Dimetric. $O:1i=129^\circ\ 4'$; $a=1{\cdot}232$. Observed planes $\frac{1}{3}$, 1, I, $\frac{2}{3}i$, $2i$, ii.

$O:1i=112^\circ\ 5'$. $O:1=119^\circ\ 51'$. $2i:2i$ (pyr.)$=\ 98^\circ\ 8'$.
$O:\frac{2}{3}i=140^\circ\ 36'$. $O:\frac{1}{3}=149^\circ\ 51'$. $1\ :1$ (pyr.)$=104^\circ\ 20'$.

Pyramid $2i$ when alone gives a very acute termination to the prism. Cleavage: I, indistinct. Also in crystalline coats, and granular.

H.=1—2. G.=6·482, Haid. Lustre adamantine. Color yellowish-gray, or ash-gray, also grayish, and yellowish-white, brown. Streak white. Translucent—subtranslucent. Fracture conchoidal. Sectile.

Composition.—$Hg^2\,Cl$=Chlorine 15·1, mercury 84·9.

When pure it is entirely volatilized before the blowpipe, on charcoal. It is insoluble in water.

Found at Moschellandsberg in the Palatinate, coating the cavities of a ferruginous gangue, associated with cinnabar; crystals often large and well defined; also at the quicksilver mines of Idria in Carniola, at Almaden in Spain, and Horzowitz in Bohemia.

SYLVINE, *Beud.* Chlorid of Potassium. Muriate of Potash. Kali Salzsäures.

Monometric. Figs. 1, 15, 11. Cleavage cubic. Also compact.
H.=2. G.=1·9—2. White, or colorless. Vitreous. Soluble, taste like common salt.

Composition.—KCl=Potassium 52·5, chlorine 47·5.

Occurs, according to Smithson, at Vesuvius about the fumaroles of the volcano.

Kremersite.—Kremers has analyzed ruby-red octahedrons from Vesuvius, (Pogg. lxxxiv, 79), which gave, Cl 55·15, Fe 16·89, K 12·07, Na 0·16, Am 6·17, $\dot{H}$ 9·56=100. Formula 2, (K, Am, Na), $Cl+Fe\,Cl^3+2\dot{H}$.

COMMON SALT. Rock Salt. Muriate of Soda. Chlorid of Sodium. Kochsalz, *W.* Steinsalz, *L.* Soude muriatée, *H.* Sal gemme.

Monometric. Observed planes, *O*, 1, *I*, *i*2. Figs. 1, 11, 15, 32, and 15+32, 196. Cleavage: cubic, perfect. Massive and granular rarely columnar.
H.=2·5. G.=2·1—2·257. Lustre vitreous. Streak white. Color white, also sometimes yellowish, reddish, bluish, purplish; often colorless. Transparent—translucent. Fracture conchoidal. Rather brittle. Taste purely saline.

Composition.—$NaCl$=Chlorine 60·7, sodium 39·3. Commonly mixed with some sulphate of lime, chlorid of calcium, and chlorid of magnesium, which render it liable to deliquescence. Analyses: 1–8, Berthier, (Ann. d. Mines, [1], x, 259); 9, Fournel, (ib. [4], ix, 551):

		$NaCl$	$MgCl$	$\dot{Ca}\dddot{S}$	$\dot{Na}\dddot{S}$	$\dot{Mg}\dddot{S}$	
1.	Vic, *white,*	99·3	—	0·5	—	—	Clay 0·2=100, B.
2.	" *grayish,*	97·8	—	0·3	—	—	1·9=100, B.
3.	" *gray,*	90·3	—	5·0	2·0	—	2·0 $\dot{H}$ 0·7=100, B.
4.	" *red,*	99·8	—	—	—	—	— $\dot{H}$ 0·2=100, B.
5.	Marennes, *whitish,*	97·2	0·4	1·2	—	0·5	0·7=100, B.
6.	" *yellow,*	96·70	0·23	1·21	—	0·66	1·20=100, B.
7.	" *red,*	96·78	0·68	1·09	—	0·60	0·85=100, B.
8.	" *green,*	96·27	0·27	1·09	—	0·80	1·57=100, B.
9.	Algiers,	97·8	1·1	—	Silica 1·5		$\dot{H}$ 0·6=100, F.

Dissolves in three parts of water; attracts moisture, but is unchanged in a dry atmosphere. When heated, it usually decrepitates, owing to water between the laminæ; the native rock salt, containing no water, fuses at a red heat without decrepitation.

The *martinsite* of Karsten (J. f. pr. Ch. xxxvi, 127) contains 9·02 per cent. of sulphate of magnesia, which is equivalent to 10 parts of common salt to 1 of sulphate of magnesia. It is from Stassfurth.

Common salt usually occurs in extensive but irregular beds in rocks of various ages, associated with gypsum, polyhalite, clay, sandstone, and calcareous spar; also dissolved, and forming salt springs.

In Europe it usually occurs in the new red sandstone, or associated with red marl, but it is not confined to these rocks. At Durham, Northumberland, and Leicestershire, England, salt springs arise from the carboniferous series; in the Alps, some salt works are supplied from oolitic rocks; the famous mines of Cardona and Wieliczka are referred the former to the green sand formation, and the latter to tertiary rocks. Salt springs also occur in volcanic regions. In the United states the brines mostly come from Silurian sandstones. Salt also occurs as efflorescences over the dry prairies of the Rocky Mountains, and California; and in most desert or semi-desert regions there are numerous salt lakes.

The principal mines of Europe are at Wieliczka, in Poland; at Hall, in the Tyrol; and along the range through Reichenthal in Bavaria, Hallein in Saltzburg, Halstadt, Ischl, and Ebensee, in Upper Austria, and Aussee in Styria; in Hungary, at Marmoros and elsewhere; in Transylvania; Wallachia, Gallicia, and Upper Silesia; Vic and Dieuze in France; Valley of Cardona and elsewhere, in Spain, forming hills 300 to 400 feet high; Bex, in Switzerland; and Northwich in Cheshire, England. At Cheshire it occurs in a basin-shaped deposit, and is arranged in spheroidal masses, from 5 to 8 feet in diameter, which are composed of concentric coats, and present polygonal figures. It is but little contaminated with impurities, and is prepared for use by merely crushing it between iron rollers. At the Austrian mines, where it contains much clay, the salt is dissolved in large chambers, and the clay thus precipitated. After a time, the water fully saturated with the salt, is conveyed by aqueducts to evaporating houses, and the chambers, after being cleared out, are again filled; at Berchtesgaden, the water is saturated in a month, at Hall it takes nearly a year.

It also occurs forming hills and extended plains near Lake Oroomiah, the Caspian, &c. In Algeria, abundant; in Abyssinia; in India in the province of Lahore, and in the valley of Cashmere; in China and Asiatic Russia; in South America, in Peru, and at Zipaquera and Nemocon, the former a large mine long explored in the Cordilleras of Granada.

In the United States, salt has been found forming beds with gypsum, in Virginia, Washington Co., 18 miles from Abingdon, and in the Salmon River Mts. of Oregon. Brine springs are very numerous in the Middle and Western States. The most famous of these springs are at Salina, in N. Y., in the Kenawha Valley, Va., and Muskingum, Ohio, and in Kentucky. The salt water is obtained by boring, and raised by means of machinery, and thence conveyed by troughs to the boilers, where it is evaporated usually by the direct application of artificial heat; sometimes by the heat of steam, and occasionally by exposure to the heat of the sun.

The following table by Prof. Beck, (*Mineralogy of New York*, p. 112), gives the amount of brine required for a bushel of salt at the principal salt springs in the United States:

	Galls.		Galls.
Boon's Lick, Missouri,	450	Kenawha, Virg.	75
Conemaugh, Penn.	300	Grand River, Ark.	80
Shawneetown, Ill.	280	Illinois River, Ark.	80
Jackson, Ohio,	213	Montezuma, N. Y.	70
Lockhart's, Miss.	180	Grand Rapids, Mich.	50–60
St. Catherines, Upper Canada,	120	Muskingum, Ohio,	50
Zanesville, Ohio,	95	Salina—Old wells,	40–45
		New wells,	30–35

Sea water at Nantucket gives a bushel of salt for every 350 gallons.

Composition of New York brines, according to Beck:

	Syracuse.	Salina, old well.	Liverpool.
Carbonic acid,	0·007	0·009	0·007
Oxyd of iron, silica, and trace of carb. lime,	0·002	0·004	0·003
Sulphate of lime,	0·569	0·472	0·404
Carbonate of lime,	0·014	0·017	0·013
Chlorid of magnesium,	0·046	0·051	0·077
Chlorid of calcium,	0·083	0·104	0·172
Chlorid of sodium, (pure salt),	13·239	14·002	14·285
Water, with a trace of organic matter, etc.	86·040	85·341	85·039

Vast lakes of salt water exist in many parts of the world. Lake Timpanogos in the Rocky mountains 4,200 feet above the level of the sea, is 2,000 square miles in area. L. D. Gale found in this water 20·196 per cent. of chlorid of sodium, (Stansb. Exped. cited in Amer. Jour. Sci. [2], xvii, 129). The Dead and Caspian Seas are salt, and the waters of the former contain 20 to 26 parts of solid matter in 100 parts. Prof. Gmelin, who analyzed a portion of these waters of specific gravity 1·212, found them to contain chlorid of calcium 3·336, chlorid of magnesium, 12·167, chlorid of sodium 7·039, sulphate of lime 0·052, bromid of magnesium, 0·443, chlorid of potassium 1·086, chlorid of aluminium 0·144, chlorid of ammonium 0·007, chlorid of manganese 0·161=24·435, with 75·565 water=100·000. This result is given as corrected by Marchand.

Altered Forms.—Anhydrite, Gypsum, Polyhalite, occur as pseudomorphs after this species; also Celestine, Dolomite, Quartz, Hematite, Pyrites; the removal of the salt cubes by their solution, leaves a cavity which any mineral may then occupy. The hopper-shaped crystals often leave an impression of their form on clays.

SAL-AMMONIAC. Muriate of Ammonia. Chlorid of Ammonium. Salmiak, *L.* Naturlicher Salmiac, *W.* Ammoniaque muriatée, *H.*

Monometric. Observed planes, *O*, 1, *I*, 22. Figs. 1, 11, 14, 15, 43, 39. Cleavage octahedral. Also stalactitic and in globular masses; in crusts, or as an efflorescence.

H.=1·5—2. G.=1·528. Lustre vitreous. Color white; often yellowish or grayish. Streak white. Translucent—opaque. Fracture conchoidal. Taste saline and pungent.

Composition.—NH^4Cl=Ammonium 33·7, chlorine 66·3. Klaproth obtained:

	Vesuvius.	Bucharia.
Muriate of ammonia,	99·5	97·50
Sulphate of ammonia,	0·5	2·50

B. Silliman, Jr. obtained (Dana's Geol. Rep. Exp. Exp., p. 202) for a specimen from Kilauea, Hawaii, Chlorid of ammonium 65·53, chlorid of iron 12·14, peroxyd of iron 8·10, chlorid of aluminium 13·00, insoluble matter and loss 1·23=100.

Dissolves in three times its weight of water, but does not deliquesce. B.B. sublimes in a matrass without fusing. Pulverized with quicklime, or soda, it gives out the pungent odor of ammonia.

Occurs about volcanos, as at Etna, the island of Vulcano, Vesuvius, and the Sandwich Islands, and near Hecla after the eruption of 1845, as observed by Bunsen. It has been observed in small quantities in the vicinity of ignited coal seams, as at St.Etienne, in France, and also at Newcastle, and in Scotland; crystallized near Duttweiler in Palatia, Germany, where a coal seam has been burning for more than a hundred years. It occurs also in Bucharia; at Kilauea in Hawaii, a variety which contains largely of iron, and becomes rusty yellow on exposure; in Guano from the Chincha Islands.

The ἅλς ἀμμωνιακὸς, sal-ammoniac of Dioscorides, Celsius, and Pliny, is proved by Beckmann (Hist. of Inventions, iv, 360) to be common rock salt, dug in Egypt, near the oracle of Ammon. The name was afterwards transferred to the muriate of ammonia, when, subsequently manufactured in Egypt. Sal-ammoniac is supposed to have been included by the ancients, with one or two other species, under the name of *nitrum*, which, according to Pliny, gave the test of ammonia when mingled with quicklime.

KERARGYRITE, *Beud.* Horn Silver. Kerate, *Haid.* Chlorid of Silver. Hornerz, *Wern.* Silberhornerz. Hornsilber, *Haus.* Buttermilcherz. Argent Muriaté, *H.*

Monometric. Observed forms, *O*, 1, *I*; f. 1, 11, 14, 15, 16, 17. Cleavage none. Usually massive and looking like wax; sometimes columnar, or bent columnar; often in crusts.

H.=1—1·5. G.=5·552; 5·31—5·43, Domeyko. Lustre resinous, passing into adamantine. Color pearl-gray, greenish, whitish, rarely violet-blue; brown on exposure. Streak shining. Translucent—feebly subtranslucent. Fracture somewhat conchoidal. Sectile.

Composition.—Ag Cl=Chlorine 24·7, silver 75·3. This constitution corresponds with Klaproth's analyses, (Beit. i, 132, and iv, 10).

Fuses in the flame of a candle, with an emission of acrid fumes. On charcoal easily reduced; and if rubbed with a plate of moistened iron, the iron becomes covered with a thin film of metallic silver. Not soluble in nitric acid or water.

Horn silver occurs in veins of clay slate, accompanying other ores of silver, and usually only in the higher parts of these veins. It has also been observed with ochreous varieties of brown iron ore; also with several copper ores, calc spar, heavy spar, &c.

The largest masses, and particularly those of a green color, are brought from Peru, Chili, and Mexico, where it occurs with native silver. In Chili it is a common ore of silver. It was formerly obtained in the Saxon mining districts of Johangeorgenstadt at Freiberg, but is now rare. A mass weighing six and three-quarter pounds, from this region, is now in the Zwinger collection, at Dresden. It also occurs in Siberia; at Kongsberg in Norway; in Alsace; in Cornwall, and at Huelgoet in Britanny.

At Andreasberg in the Hartz, an earthy variety is met with, called by the Germans *Buttermilcherz,* which, according to Klaproth, contains silver 24·64, muriatic acid 8·28, alumina 67·08.

Horn silver is valuable as an ore of silver.

EMBOLITE, *Breith.* Chlorobromid of Silver, *Domeyko.*

Monometric. In cubes and cubo-octahedrons, f. 1, 15, 16. Also massive.

H.=1—1·5. G.=5·31—5·43, Domeyko; 5·53, Yorke; 5·79—5·81, Breith. Lustre resinous and somewhat adamantine. Color asparagus-green to pistachio, olive, and grayish-green.

Composition.—3 Ag Cl+2 Ag Br (or Ag (Cl, Br))=Chlorine 13·2, bromine 19·8. silver 67·0. Analyses: 1, 2, 3, Domeyko, (Elementos de Mineralogia, 1845, 203); 4, Yorke, (Quart. J. Chem. Soc. iv, 2):

Chlorid of Silver,	51·0	52·8	51·0	53·2
Bromid of Silver,	49·0, D.	47·2, D.	49·0, D.	46·8, Y.

Plattner obtained Silver 66·862, bromine 20·088, chlorine 13·050, (Pogg. lxxvii, 134). Impure varieties from Quillota, Chili, of a grayish green color, afforded Domeyko, 81·4, 72·9, 66·4 and 65·6, of the chlorid of silver. His other specimens were from Chañarcillo. Abundant in Chili; found also at Eulalia in Chihuahua, Mexico, and at Colula in Honduras.

BROMYRITE. Bromic silver. Bromite, *Haid.* Bromsilber. Bromure d'Argent. Plata Verde.

Monometric: in cubo-octahedrons. Figs. 1, 15, 18. Occurs in small concretions, rarely in crystals.

H.=1—2. G.=5·8—6. Lustre splendent. Color when pure bright-yellow, slightly greenish; often grass-green or olive-green externally. Sectile.

Composition.—Ag Br=Bromine 42·6, silver 57·4. Analysis by Berthier, (Ann. d. Mines, [4], ii, 526):

Bromine 42·44, Silver 57·56.

B.B. fuses easily. Imperfectly dissolved by acids; soluble in heated concentrated ammonia.

Occurs with other silver ores in the district of Plateros, Mexico, and at the mine of San Onofre, seventeen leagues from Zacatecas, associated with chlorid of silver and carbonate of lead; also at Chañarcillo, Chili, with chlorid of silver; also at Huelgoet in Brittany, with horn silver.

As the word *Bromite* has the form used for a class of salts in chemistry, a syllable has been added, giving it a termination like that of Argyrite.

FLUOR. Fluor Spar. Fluorid of Calcium. Fluate of Lime. Ratoffkit, *John.* Chlorophane. Blue John. Chaux Fluatée, *H.* Flussspath. Muria Phosphorans, *Linn.* Liparite, *Gl.*

Monometric. Observed planes: *O*, *I*, 1, 2, 3, 22, 42, $\frac{11}{3}\frac{11}{5}$, $7\frac{7}{3}$, 33, *i*2, $i\frac{5}{3}$, *i*3. Figs. 1 (common), 11, 14, 15 to 18, 34, 38, 39, 41, similar to 48, (planes 1, and 33), 50. Cleavage: octahedral, perfect. Twins: plane of composition, 1, f. 200; also f. 306, in which the composition is parallel to each octahedral face. Rarely columnar; often granular, coarse or fine.

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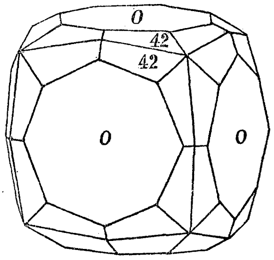
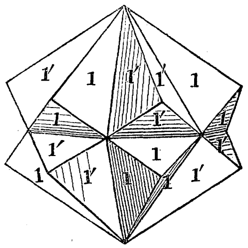


306



H.=4. G.=3·14—3·19; 3·1800—3·1889, Kengott, from 43 specimens, mean 3·183. Lustre vitreous; sometimes splendent; usually glimmering in the massive varieties. Color white, yellow, green, rose and crimson-red, violet-blue, sky-blue, and brown: wine-yellow, greenish and violet-blue, most common; red, rare. Streak white. Transparent—subtranslucent. Brittle. Fracture of fine massive varieties flat conchoidal and splintery.

Composition.—CaF=Fluorine 48·7, and calcium 51·3.

Berzelius found 0·5 of phosphate of lime in the fluor spar of Derbyshire. Kersten, in a fluor from Marienberg and Freiberg, detected a little muriatic acid. Schaffhäutl (Ann. d. Ch. u. Ph. lxvi, 344) states that a violet-blue fluor of Welsendorf contained 0·02073 nitrogen, 0·00584 hydrogen, 0·0365 carbon, and 0·08692 chloric (or chlorous) acid. Ratoffkite is a granular or earthy-blue variety impure with clay, from Ratoffka, Russia.

Below a red heat, the coarsely pulverized spar is vividly phosphorescent; the light is of various colors, and independent of the external color. The variety *chlorophane* emits a bright emerald-green light. At a high temperature, phosphorescence ceases, but it is partially restored by an electric discharge. B.B. decrepitates, and ultimately fuses to an enamel. If the flame be continued, the fluorine is in part expelled, and the specimen assumes a cauliflower appearance. Gives the reaction of fluorine.

Seldom in beds, but generally in veins, intersecting gneiss, mica slate, clay slate, and also several secondary rocks. In the North of England, it is the gangue of the lead veins, which intersect the coal formations of Northumberland, Cumberland, Durham, and Yorkshire; the Cumberland fluor often contains drops of fluid within, especially the green variety, (Greg and Lettsom). In Derbyshire, it is abundant; and also in Cornwall, where the veins intersect much older rocks. Common in the mining district of Saxony. In the dolomites of St. Gothard it occurs in pink octahedrons; at Münsterthal in Baden in flesh-red hexakisoctahedrons. It has been detected in cannel coal by Prof. Rogers.

A remarkable locality of fluor spar in the United States, now exhausted, was discovered on the borders of Muscalonge lake, in Jefferson Co., N. Y., where cubical crystals, some of them more than a foot through, and having a greenish tinge, were found in granular limestone, (occasionally f. 305). Rossie and Johnsburgh, St. Lawrence Co., have afforded some fine crystals of fluor. In Gallatin county, Illinois, for thirty miles along the Ohio, in the region southwest of Cone's Rock, 10 to 15 miles below Shawneetown, and other places, a dark purple fluor, often in large crystals, occurs through the soil, or in carboniferous limestone with galena. At the north village of Westmoreland, N. H., two miles south of the meetinghouse, of white, green, and purple shades, constituting a vein with quartz; also, sparingly, at the Notch in the White Mountains, green octahedrons in a crystalline quartz. Some fine veins have been discovered on Long Island, Blue Hill Bay, Maine. It also occurs sparingly of a green color at Putney, Vt.; in Shenandoah county, Virginia, near Woodstock, in the fissures of a limestone; on the Potomac, at Shepardstown, in white limestone; in Smith county, Tennessee, in white and purple cubes; at Lockport, N. Y., in white cubes with celestine in limestone; in cubes near Rochester and Manlius in limestone; at Amity, N. Y., in thin seams with spinel and tourmaline; at the Southampton lead mines in Massachussetts; the lead mine, Middletown, Ct.; and near the Franklin Furnace, New Jersey.

The variety *chlorophane* forms two veins in gneiss, each about 18 inches wide, in the town of Trumbull, Conn., along with topaz and magnetic pyrites.

ALTERED FORMS.—Fluor spar is slightly soluble in waters containing bicarbonate of lime in solution. The alkaline carbonates decompose it, producing carbonate of lime or *Calcite*, and a subsequent change of the calcite may produce other forms of pseudomorphs. Fluor spar occurs changed to quartz, by substitution, and also to Limonite, Hematite, Lithomarge, Psilomelane, Calamine, Smithsonite, and Cerusite.

YTTROCERITE, *Berz.*

Massive; crystalline-granular and earthy. Cleavage: in two directions inclined to one another 108° 30′.

H.=4—5. G.=3·447, Berz. Lustre glistening; vitreous—pearly. Color violet-blue, inclining to gray and white, often white; sometimes reddish-brown. Fracture uneven.

Composition.—Contains CaF, CeF and YF, in different proportions. Analyses by Gahn and Berzelius, (Afhand. iv, 151 and Schw. J. xvi, 241):

$\dot{C}a$ 47·63,	$\ddot{\bar{C}}e$ 18·21,	Y 9·11,	FH 25·05.
" 50·00,	" 16·45,	" 8·10,	" 25·45.

B.B. on charcoal alone infusible; with gypsum the yttrocerite of Finbo fuses to a bead, not transparent, and that of Broddbo is infusible. With the three fluxes, the Finbo mineral behaves like fluor spar; the glass is however yellow in the oxydating flame as long as hot, and becomes opaque sooner than the glass given by fluor spar. In a pulverized state, it dissolves completely in heated muriatic acid, forming a yellow solution.

Occurs sparingly at Finbo and Broddbo, near Fahlun in Sweden, imbedded in quartz, and associated with albite and topaz. Also at Amity, Orange Co., N. Y.; and in Mass., probably Worcester Co. The Amity mineral has been examined by J. E. Teschemacher. The Massachusetts mineral afforded Dr. C. T. Jackson, (Proc. Bost. Soc. N. Hist. 1844, p. 166), lime, yttria, oxyd of cerium, with some $\dddot{\bar{A}}l$, $\dddot{\bar{F}}e$ and $\dddot{S}i$, and a loss of 19·4. The mineral is mixed with fluor spar in the vein, and probably the specimen analyzed was not pure from it.

Yttrocerite has been considered a fluor spar in which part of the lime is replaced by oxyds of cerium and yttrium. The angle of cleavage reported, 108° 30′, differs but a degree from the angle between faces of an octahedron.

IODYRITE. Iodic Silver. Iodite, *Haid.* Argent iodure, *Duf.* Iodsilber, *M.*

Hexagonal. $O : 1 = 136° 46'$; $a = 0·81438$. Observed planes, (Descloizeaux), O, I, 4, 2, ½. Angles, (Descl.):

O : 2=118°.   *O* : $\frac{1}{2}$=154° 49′.   2 : 2 (pyr.) 127° 36′.
O : 4=104° 53′. $\frac{1}{2}$: $\frac{1}{2}$ (pyr.)=155° 26′.   4 : 4 " =122° 12′.

Cleavage: basal highly perfect. Also in thin plates with a lamellar structure.

Soft. G.=5·504. Lustre resinous to adamantine. Color citron and sulphur-yellow, to yellowish-green. Streak yellow. Translucent. Plates flexible, sectile.

Composition.—Ag I=Iodine 54, Silver 46, Domeyko, (Elementos de Min. p. 206, 1845.

B.B. on charcoal, fuses immediately, producing a vapor which tinges the flame of a fine violet color, affording a globule of silver.

Iodic silver occurs in thin veins in steatite at Abarradon, near Mazapil, in Zacatecas, Mexico, and at Delirio, mines of Chañarcillo, Chili. It has also been found at Guadalajara in Spain. Descloizeaux has pointed out its homœomorphism with Greenockite. (Ann. Ch. Phys. [3], xl).

COCCINITE, *Haid.* Iodic Mercury, *Del Rio.* Mercury iodurè, *Duf.* Iodquecksilber, *H.*

In particles of a reddish-brown color on selenid of mercury. Lustre adamantine.

Composition.—Probably Hg I=Mercury 44·1, iodine 55·9. Fuses and easily sublimes. From Casas Viejas, Mexico.

Artificial crystals of Hg I are dimetric, and have *I* : 1=160° 30′; 1 : 1 (pyram.)=96° 24′.

FLUOCERITE, *Haid.* Fluorcerium neutrales. Fluate of Cerium. Flucerine, *Beud.*

Hexagonal. In hexagonal prisms and plates. Cleavage: basal most distinct. Also massive.

H.=4—5. G.=4·7. Lustre weak. Color dark tile-red or almost yellow; deeper when the mineral is wet. Streak white or slightly yellowish. Subtranslucent—opaque.

Composition.—Berzelius obtained in an analysis, (Afhandlingar, v, 56), $\ddot{\bar{C}}e$ 82·64 $\dot{Y}$ 1·12, HF 16·24.

B.B. infusible alone, but darkens. In borax and salt of phosphorus, fuses slowly but completely. The globule is blood-red in the exterior flame, but becomes colorless on cooling. In the interior flame, colorless at all temperatures. In carbonate of soda does not fuse, but swells out and is decomposed. In a glass tube at a strong heat, yields fluorine.

Occurs at Finbo and Broddbo near Fahlun, in Sweden, imbedded in quartz and albite, accompanying pyrophysalite and orthite.

FLUOCERINE, *Hausm.* Basic flucerine. Basicerine, *Beud.* Fluorcerium basisches.

Monometric? Supposed to show traces of the rhombic dodecahedron; usually massive. H.=4·5—5. Lustre vitreous or resinous. Color a fine yellow, with some red, and when impure, brownish-yellow. Streak yellow, brownish. Subtranslucent to opaque.

Composition.—$Ce^2F^3+3\ddot{\bar{C}}e\,\dot{H}$=Cerium 17·56, fluorine 10·88, peroxyd of cerium 66·41, water 5·15. Berzelius obtained (Afhand. v, 64) $\ddot{\bar{C}}e$ 84·20, HF 10·85, $\dot{H}$ 4·95. From Finbo. A mineral from Bastnäs afforded Hisinger, (K. V. Ac. H. 1838, 189), Peroxyd of Ce (and La) 36·43, fluorid, ibid. 50·150, water 13·413, which corresponds to the formula $Ce^2F^3+\ddot{\bar{C}}e\,\dot{H}^4$.

COTUNNITE. Cotunnia, *Monticelli*. Cotunnite, *von Kobell*. Chlorid of Lead, *Thom.*

Trimetric. $I:I$=99° 46′, $O:1\bar{i}$=149° 14′; $a:b:c$=0·5953 : 1 : 1·1868. Observed planes, I, $i\bar{i}$, $i\breve{i}$, $i\breve{2}$, $1\breve{i}$. $O:1$=142° 6′, $O:1\breve{i}$=153° 22′, 1 : 1 (mac.)=133° 22′, (brach.) 123° 58′, $i\breve{2}:i\breve{2}$ (ov $i\breve{i}$) =118° 38′. In acicular crystals.

May be scratched by the nail. G.=5·238. Lustre adamantine; inclining to silky or pearly. Color white. Streak white.

Composition.—Pb Cl=Chlorine 25·5, lead 74·5.

B.B. fuses readily and colors the flame blue, giving off white vapors, which condense on the charcoal. With soda, yields a globule of lead. Dissolves in about twenty-seven times its weight of cold water.

Observed by Monticelli and Covelli, in the crater of Vesuvius, after the eruption of 1822, accompanied by chlorid of sodium, and chlorid and sulphate of copper. Named after a distinguished medical man at Naples. Angles very near those of Haidingerite.

IODID AND BROMID OF ZINC.

Iodine and bromine are stated by Mentzel to occur along with a cadmiferous zinc in Silesia, and hence it is inferred that iodid and bromid of zinc exist in nature, though not yet distinguished.

MURIATIC ACID. Hydrochloric Acid. Chlorhydric Acid.

Gaseous. G.=1·2847. Colorless. Odor pungent. Taste acid.

Composition.—HCl=Hydrogen 2·74, chlorine 97·26.

Muriatic acid is one of the constituents of the vapors that issue from active volcanoes. It is sometimes found in solution in crevices about their slopes.

CRYOLITE, *Andrada*. Alumine Fluatée Alcaline, *H.* Kryolite. Eisstein. Chodneffite.

Trimetric or dimetric. Cleavage: rectangular or nearly so; basal, perfect; lateral, less so. Occurs in cleavable masses, sometimes showing a compound structure like albite, (Genth).

H.=2·5. G.=2·9—3·077. Lustre vitreous; slightly pearly on O. Color snow-white; sometimes reddish or brownish. Subtransparent—translucent. Immersion in water increases its transparency. Brittle.

Composition.—$\mathrm{Na\,F}+\frac{1}{3}\mathrm{Al^2F^3}$=Aluminium 13·0, sodium 32·8, fluorine 54·2. Berzelius obtained, (K. V. Ac. H. 1823, 315): Aluminium 13·00, sodium 32·93, fluorine 54·07. Chodnev obtained, (Verh. d. K. Russ. min. Ges. 1845—46, p. 208), excluding the fluorine, Alumina 24·83, soda 43·89, $\dot{\mathrm{M}}\mathrm{g}$ and $\dot{\mathrm{M}}\mathrm{n}$ 0·83. Durnev obtained from the Miask Cryolite, (Pogg. lxxxiii, 588), Aluminium 13·41, sodium 32·31, fluorine 53·48, calcium 0·25, $\ddot{\mathrm{F}}\mathrm{e}$ and $\ddot{\mathrm{M}}\mathrm{n}$ 0·55=100. G.=2·95. Durnev; 2·962, Kokscharov.

Fusible in the flame of a candle, and hence its name, from *κρυος, ice.* Heated in an open tube, yields water, and by directing the flame in the tube the glass is corroded. B.B. fuses, then becomes hard, white, and opaque; ultimately a crust of alumina remains; soluble in sulphuric acid and hydrofluoric acid evolved.

Found at Arksutfiord, in West Greenland, where it was discovered by Giesècke, in two veins in gneiss, associated with galena, pyrites, and spathic iron. Specimens may be obtained there from six inches to a foot in diameter; also with chiolite, lithia mica, and fluor, at Miask in the Urals.

CHIOLITE, *Hermann* and *Auerbach*, J. f. pr. Chem. xxxvii, 188.

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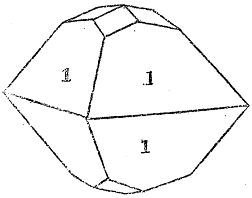

Dimetric; a=1·077. Observed form f. 307 (Kokscharov). Pyramidal edges 107° 32′, basal 113° 25′. Cleavage indistinct. Occurs massive granular, resembling cryolite; structure crystalline.

H.=4. G.=2·72, Hermann; of powder, 2·842—2·898, Rammelsberg. Color snow-white. Lustre somewhat resinous. Translucent.

Composition.—$NaF+\frac{2}{3}Al^2F^3$=Aluminium 18·6, sodium 23·4, fluorine 58·0=100. Analyses: 1, Hermann, (loc. cit.); 2, 3, Rammelsberg, (Pogg. lxxiv, 1848, p. 315); 4, Pearce, in Rammelsberg's laboratory, (ib.):

	1. *H.*	2. *R.*	3. *R.*	4. *P.*
Sodium,	23·78	24·69	24·56	22·91
Aluminium,	18·69	18·02	17·72	19·59
Fluorine,	57·53=100, H.			

Rammelsberg's analyses, supposing the undetermined part to be fluorine, give respectively, 57·29, 57·72, 57·50 per cent. B.B. fuses easily like cryolite, and gives the reaction of fluorine.

From Miask, where it occurs in granite, with fluor, topaz, phenacite, and cryolite.

FLUELLITE, *Levy*, Edinb. Jour. Sci. 1825, p. 168. Fluate of Alumine. Fluorid of Aluminium.

Trimetric; in acute rhombic octahedrons with truncated apex. 1 : 1 (pyram.)=109° 6′, 82° 12′, and (basal) 144°; $I:I$=105° nearly.

H.=3. Color white. Transparent.

Composition.—Fluorine and aluminium, according to Wollaston.

Fluellite is a rare mineral found at Stenna-gwyn, in Cornwall, with wavellite and uranite, in minute crystals, on quartz.

IV. OXYGEN COMPOUNDS.

I. OYYDS.

1. OXYDS OF ELEMENTS OF THE HYDROGEN GROUP.
   - *a.* Anhydrous.
   - *b.* Hydrous.
2. OXYDS OF ELEMENTS OF THE ARSENIC GROUP.
3. OXYDS OF CARBON, BORON OR SILICON.

I. OXYDS OF ELEMENTS OF THE HYDROGEN GROUP.

a. *Anhydrous Oxyds.*

I. MONOMETRIC.

1. PERICLASE GROUP.—Composition R O.

PERICLASE,	$\dot{\mathrm{Mg}}$.	RED COPPER,	$\dot{\bar{\mathrm{Cu}}}$.

2. MARTITE GROUP.—Composition $R^2\ O^3$.

MARTITE, $\dddot{\bar{\mathrm{Fe}}}$.

3. SPINEL GROUP.—Composition $R\,O + R^2\,O^3$.

ISERINE,	$\dot{\mathrm{Fe}}\,(\dddot{\bar{\mathrm{Ti}}}, \dddot{\bar{\mathrm{Fe}}}.)$	KREITTONITE,	$(\dot{\mathrm{Zn}}\,\dot{\mathrm{Fe}})\,(\dddot{\bar{\mathrm{Al}}}, \dddot{\bar{\mathrm{Fe}}})$.
IRITE,	$\dot{\mathrm{R}}\,(\dddot{\bar{\mathrm{Ir}}}, \dddot{\bar{\mathrm{Fe}}})$.	MAGNETITE,	$\dot{\mathrm{Fe}}\,\dddot{\bar{\mathrm{Fe}}}$.
SPINEL,	$\dot{\mathrm{Mg}}\,(\dddot{\bar{\mathrm{Al}}}, \dddot{\bar{\mathrm{Fe}}})$.	FRANKLINITE,	$(\dot{\mathrm{Zn}}, \dot{\mathrm{R}})\,(\dddot{\bar{\mathrm{Fe}}}, \dddot{\bar{\mathrm{Mn}}})$.
AUTOMOLITE,	$\dot{\mathrm{Zn}}\,\dddot{\bar{\mathrm{Al}}}$.	CHROMIRON,	$(\dot{\mathrm{Fe}}, \dot{\mathrm{Mg}})\,(\dddot{\bar{\mathrm{Al}}}\,\dddot{\bar{\mathrm{Cr}}})$.
HERCINITE,	$\dot{\mathrm{Fe}}\,\dddot{\bar{\mathrm{Al}}}$.	PITCHBLENDE,	$\dot{\mathrm{U}}\,\dddot{\bar{\mathrm{U}}}$.

? 4. MELACONITE GROUP.—Composition $R\,O^2$. MELACONITE, $\bar{\mathrm{Cu}}\,\mathrm{O}^2$.

II. HEXAGONAL.

1. ZINCITE GROUP.—Composition, R O.

Water,	$\dot{\mathrm{H}}$.	Chalcotrichite,	$\dot{\bar{\mathrm{C}}}\mathrm{u}$.
Zincite,	$\dot{\mathrm{Z}}\mathrm{n}$.		

2. CORUNDUM GROUP.—Composition $R^2 O^3$.

Corundum,	$\ddot{\bar{\mathrm{A}}}\mathrm{l}$.	Ilmenite,	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$, $\ddot{\bar{\mathrm{T}}}\mathrm{i}$.
Specular Iron,	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$.		

? 3. TENORITE GROUP.—Composition $R O^2$.

Tenorite,	$\bar{\mathrm{C}}\mathrm{u}\ O^2$.

III. DIMETRIC.

RUTILE GROUP.—Composition $R O^2$.

Cassiterite,	$\ddot{\mathrm{S}}\mathrm{n}$.	Anatase,	$\ddot{\mathrm{T}}\mathrm{i}$.
Rutile,	$\ddot{\mathrm{T}}\mathrm{i}$.		
Appendix—	? Braunite,	? Hausmannite.	

IV. TRIMETRIC.

CHALCOTRICHITE GROUP.—Composition, R O.

Chalcotrichite,	$\bar{\mathrm{C}}\mathrm{u}\ O$.

CHRYSOBERYL GROUP.—Composition $R^2 O^3$ (or $RO + R^2 O^3$).

Chrysoberyl,	$\dddot{\bar{\mathrm{B}}}\mathrm{e} + \ddot{\bar{\mathrm{A}}}\mathrm{l}^3$ or $\dot{\mathrm{B}}\mathrm{e}\ \ddot{\bar{\mathrm{A}}}\mathrm{l}$.

BROOKITE GROUP.—Composition $R O^2$.

Brookite,	$\ddot{\mathrm{T}}\mathrm{i}$.
? Pyrolusite,	$\ddot{\mathrm{M}}\mathrm{n}$.
Heteroclin.	

Appendix to Anhydrous Oxyds.

Minium, $Pb^3 O^4$. Crednerite, $(\dot{\mathrm{B}}\mathrm{a}, \dot{\mathrm{C}}\mathrm{u})^3\ \dddot{\bar{\mathrm{M}}}\mathrm{n}^2$.

V. COMBINATIONS OF OXYDS, AND CHLORIDS OR SULPHURETS.

Matlockite, II.	$Pb\ Cl + Pb\ O$.
Mendipite, III.	$Pb\ Cl + 2\ Pb\ O$.
Voltzite,	$Zn\ S + \frac{1}{4}\ Zn\ O$.

I. OXYDS OF ELEMENTS OF THE HYDROGEN GROUP.

A. *Anhydrous Oxyds.*

I. MONOMETRIC OXYDS.

PERICLASE. Periclasia, *Scacchi,* Mem. Min. Naples. Periklase.

Monometric. Figs. 1 and 11. Cleavage: cubic, perfect. Also in grains.

H.=nearly 6. G.=3·674, Damour. Color grayish to dark-green. Transparent to translucent.

Composition.—$\dot{\mathrm{M}}\mathrm{g}$, or magnesia, with 1 part in 25 of protoxyd of iron. Analyses: 1, Scacchi, (loc. cit.); 2, 3, Damour, (Ann. d. M. [4], iii, 360, and Bull. Soc. Geol. de France, 1849, p. 313):

1.	$\dot{\mathrm{M}}\mathrm{g}$ 89·04	$\dot{\mathrm{F}}\mathrm{e}$ 8·56=97·60,	Scacchi.
2.	93·86	5·97=99·83,	Damour.
3.	93·38	6·01=99·39,	Damour.

B.B. infusible. When pulverized dissolves slowly in nitric acid, but rapidly when heated. Moistened on test paper shows an alkaline reaction.

Occurs disseminated through ejected masses of a white limestone, and in spots of clustered crystals, on Mt. Somma, sometimes with white olivine and earthy magnesite.

RED COPPER. Cuprite, *Haid.* Red Oxyd of Copper. Oxydulated Copper, *P.* Tile Ore. Rothkupfererz, Ziegelerz, *W.* Cuivre Oxidé Rouge, Cuivre Oxidulé, *H.* Zigueline.

Monometric. Observed planes 1, *O*, *i*2, *i*5, 2, 3, 22, $3\frac{3}{2}$. Figs. 1, 14, 15 to 19, 32, and also 144, p. 92; forms commonly octahedral. Cleavage: octahedral. Also massive, granular; sometimes earthy.

H.=3·5—4. G.=5·85—6·15; 5·992, Haidinger. Lustre adamantine or submetallic—earthy. Color red, of various shades, particularly cochineal-red; occasionally crimson-red by transmitted light. Streak several shades of brownish-red, shining. Subtransparent—subtranslucent. Fracture conchoidal, uneven. Brittle.

Composition.—$\dot{\cancel{\mathrm{C}}}\mathrm{u}$=Copper 88·8, oxygen 11·2. B.B. in the reducing flame on charcoal, affords a globule of copper. Dissolves with effervescence in nitric acid.

Tile ore formerly included the earthy variety, usually of a brick-red or reddish-brown color, and frequently mixed with oxyd of iron. Occurs in the Bannat, at Camsdorf and Saalfield, in Thuringia, at Les Capanne Vecchie, in Tuscany; on Elba in cubes; and in Cornwall; fine translucent crystals of red copper ore occur with native copper and quartz at Huel Gorland and other Cornish mines. Isolated crystals, sometimes an inch in diameter, are found imbedded in lithomarge at Chessy, near Lyons; they are generally coated with malachite. Splendid specimens are brought from the Bannat and Ekatherinenberg in Siberia. It is abundant also in South Australia.

The zigueline (or ziegelerz of the Germans) is the earthy red oxyd of copper, or tile ore.

It has been observed crystallized and massive at Schuyler's, Somerville, and Flemington copper mines, N. J., associated with chrysocolla and native copper; also in red shale near New Brunswick, N. J.; with green malachite in trap, two miles from Ladenton, Rockland Co., N.Y.; at Cornwall, Lebanon Co., Pa.; in the Lake Superior Region.

When found in large quantities, this species is valuable as an ore of copper.

Altered Forms.—A deoxydation of the Red Copper Ore sometimes takes place, producing *native copper*. It also becomes carbonated and green, by means of carbonated waters, changing to *Malachite* or *Azurite;* or through a silicate in solution it is changed to *Chrysocolla*. Limonite occurs as a pseudomorph by substitution after Red Copper.

MARTITE, *Breit.*

Monometric. In octahedrons like magnetite; f. 11, 16, 19; often flattened, and octahedral faces striated parallel to the edges. Cleavage indistinct.

H.=6. G.=4·82, Brazil; 4·65, Puy de Dome; 3·80, Peru, Breit.; 5·33, Monroe, N. Y., Hunt. Lustre submetallic. Color iron-black, sometimes with a bronzed tarnish. Streak brown or purplish-brown. Fracture conchoidal. Not magnetic.

Composition.—$\dddot{\bar{\mathrm{F}}}\mathrm{e}$=Oxygen 30, iron 70, same as for specular iron.

Found in the localities above mentioned, and at Framont. The Monroe crystals, occur in a rock containing quartz, flesh-colored feldspar and dark-green hornblende, and are imbedded in each of these minerals; they are sometimes half an inch through. The association with hornblende which contains protoxyd of iron is urged by Mr. T. S. Hunt, (Am. J. Sci. [2], xiii, 370), as evidence that the crystals are not pseudomorphous, as some have supposed. The change from magnetic iron to the peroxyd is one that may and does take place in nature, as is believed, and some of the so-called martite may be altered specular iron, although probably not all.

Scacchi has observed regular octahedrons of specular iron at Vesuvius, which he considers compound crystals after the rhombohedral primary. But it is more probable that they are actually simple crystals of martite.

G. H. O. Volger endeavors to show that the crystals are dimetric (Entwick. Min., 1854, 368) and pseudomorphous, probably, after the oxyd $\mathrm{Fe\,O^2}$, supposed by him to be isomorphous with anatase, whence he derives the name for the mineral *Eisenanatas*.

ISERINE.

Monometric. Figs. 15 to 17; faces usually rounded and rough. Cleavage indistinct.

H.=6—6·5. G.=4·85—5·1. Lustre metallic or submetallic. Color iron-black; streak black. Brittle. Magnetic.

Composition.—$\dot{\mathrm{F}}\mathrm{e}$ ($\dddot{\bar{\mathrm{F}}}\mathrm{e}$, $\ddot{\mathrm{T}}\mathrm{i}$). Analyses: 1, Rammelsberg, (Pogg. liii, 129); 2, Rhodius, (Ann. d. Ch. u. Pharm., lxiii, 218); 3, Waltershausen, (Vulk. Gest. 121):

	$\ddot{\mathrm{T}}\mathrm{i}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{F}}\mathrm{e}$	
1. Unkel, Rhine,	11·51	48·07	39·16=98·74, Ramm.	
2. Rheinbreitenbach,	8·69	61·27	31·80=101·76, Rhod.	G.=5·1.
3. Etna,	11·14	58·86	30·00=100, Waltersh.	G.=4·43.

No. 1 has been called Slag-like magnetic iron. Waltershausen deduces the above from his analysis, which afforded $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 92·19, $\ddot{\mathrm{T}}\mathrm{i}$ 12·37=104·56. No. 2 is strongly magnetic. B.B. infusible.

From basalt at the localities mentioned, and also in Bohemia, Saxony, Calabria, and near Puy-de-dome in France.

Iserine has been regarded as having the formula ($\dddot{\bar{\mathrm{F}}}\mathrm{e}$, $\ddot{\mathrm{T}}\mathrm{i}$), and related to Martite.

IRITE, *Hermann*.

Monometric. In octahedrons, Kengott. Structure thin foliated. Color black. Lustre shining. G.=6·506. Magnetic.

Composition.—Probably $\dot{\mathrm{R}}\ddot{\bar{\mathrm{R}}}$ or ($\dot{\mathrm{I}}\mathrm{r}$, $\dot{\mathrm{O}}\mathrm{s}$, $\dot{\mathrm{F}}\mathrm{e}$) (Ir, Os, Cr)^{2}O^3, and isomorphous with spinel, magnetic iron, etc. Analysis by Hermann, (J. f. pr. Ch. xxiii, 276): Peroxyd of iridium 62·86, protoxyd of osmium 10·30, protoxyd of iron 12·50, peroxyd of chromium 13·70=99·36, with traces of manganese.

Occurs in the Ural with native platinum, titanic iron, iridosmine, and hyacinth.

SPINEL, *W.* Ceylanite. Pleonaste. Spinelle Ruby. Balas Ruby. Almandine Ruby. Rubicelle. Candite, *Bournon.* Zeilanit, *W.* Automolite. Gahnite. Dysluite. Hercinite. Kreittonite. Chlorospinel.

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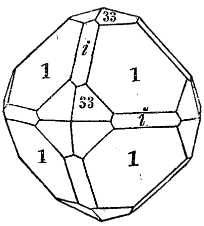

Monometric. Observed planes: 1, *I*, *O*, 2, 33. Figs. 308, 11, (common), 16, 19, 41. Cleavage: octahedral. Twins: f. 200; face of composition 1.

H.=8. G.=3·5—4·9; 3·523, Haid.; 3·575, red spinel. Lustre vitreous; splendent—nearly dull. Color red of various shades, passing into blue, green, yellow, brown, and black; occasionally almost white. Streak white. Transparent—nearly opaque. Fracture conchoidal.

Composition.—($\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{F}}\mathrm{e}$, $\dot{\mathrm{C}}\mathrm{a}$, $\dot{\mathrm{Z}}\mathrm{n}$, $\dot{\mathrm{M}}\mathrm{n}$) $\ddot{\bar{\mathrm{A}}}\mathrm{l}$. Pure spinel, sometimes $\dot{\mathrm{M}}\mathrm{g}$ $\ddot{\bar{\mathrm{A}}}\mathrm{l}$=Magnesia 28·0, alumina 72·0; but the magnesia is often partly replaced by protoxyds of iron, zinc, or manganese, or by lime; and the alumina sometimes by peroxyd of iron.

Analyses: 1, 2, Abich, (Pogg. xxiii, 305); 3, Berzelius, (Gehl. N. J. d. Chem. vi, 304); 4, 5, Thomson, (Min. i. 214); 6, C. Gmelin, (Jahresb. iv, 156); 7—10 Abich, (loc. cit.); 11, Abich, (K. V. Ac. H. 1842, 6); 12, Scheerer, (Pogg. lxv, 294); 13, 14, H. Rose, (Pogg. 1, 652); 15, Erdmann, (K. V. Ac. H. 1848); 16, Zippe, (Ann. d. Ch. u. Pharm. lv, 357); 17, Ekeberg (Gehlen's N. J. v, 418); 18, 19, Abich, (loc. cit.); 20, Thomson, (Min. i, 221); 21, Kobell, (J. f. pr. Ch. xliv, 99).

I. *Containing Magnesia, Lime, or Iron.*

		$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{F}}\mathrm{e}$	
1.	Ceylon, *red*,	69·01	26·21	——	0·71	$\ddot{\bar{\mathrm{C}}}\mathrm{r}$ 1·10, $\dddot{\mathrm{S}}\mathrm{i}$ 2·02=99·05, Ab.
2.	Aker; *blue*,	68·94	25·72	——	3·49	$\dddot{\mathrm{S}}\mathrm{i}$ 2·25=100·47, Abich.
3.	" "	72·25	14·63	——	4·26	" 5·48=96·62, B. and H.
4.	Franklin, N. J., *green*,	73·31	13·63	7·42	——	" 5·62=99·98, Thomson.
5.	Amity, N. Y.	61·79	17·87	10·56	——	$\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$ 2·80, $\dot{\mathrm{H}}$ 0·98=99·60, T.
6.	Ceylon, *Ceylanite*,	57·20	18·24	——	20·51	$\dddot{\mathrm{S}}\mathrm{i}$ 3·15=99·11, Gmelin.
7.	Ural, *Pleonaste*,	65·27	17·58	——	13·97	" 2·50=99·32, Abich.
8.	Monzoni, "	66·89	23·61	——	8·07	" 1·23=99·80, Abich.
9.	Vesuvius, "	67·46	25·94	——	5·06	" 2·38=100·85, Abich.
10.	Iserwiese, "	59·66	17·70	——	19·29	" 1·79=99·17, Abich.
11.	Vesuvius, "	62·84	24·87	——	3·87	$\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 6·15, $\dddot{\mathrm{S}}\mathrm{i}$ 1·83=99·56, A.
12.	Arendal,	55·17	17·65	——	18·33	$\dddot{\mathrm{S}}\mathrm{i}$ 5·09, $\dot{\mathrm{M}}\mathrm{n}$ 2·71=98·95, S.
13.	Ural, *Chlorospinel*,	64·13	26·77	0·27	——	$\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 8·70, $\dot{\mathrm{C}}\mathrm{u}$ 0·27=100·14, R.
14.	" "	57·34	27·49	——	——	" 14·77, " 0·62=100·22, R.
15.	Tunaberg,	62·95	13·03	——	23·46=99·44, Erdmann.	
16.	*Hercinite*,	61·17	2·92	——	35·67=99·76, Zippe.	

II. *Containing Oxyd of Zinc.*

	$\ddot{\bar{\rm A}}{\rm l}$	$\dot{\rm Mg}$	$\dot{\rm Mn}$	$\dot{\rm Zn}$	$\dddot{\rm Si}$	
17. Fahlun, *Automolite,*	60·00	——	*trace,*	24·25	4·75,	$\ddot{\bar{\rm F}}{\rm e}$ 9·25=98·25, E.
18. " "	55·14	5·25	*trace,*	30·02	3·84,	" 5·85=100·10, A.
19. North America,	57·09	2·22	*trace,*	34·80	1·22,	$\dot{\rm Fe}$ 4·55=99·38, A.
20. Sterling, N. J. *Dysl.*	30·49	——	7·60	16·80	2·97,	$\dot{\rm H}$ 0·40, $\ddot{\bar{\rm F}}{\rm e}$ 41·93, T.
21. Bodenmais, *Kreitt.*	44·66	3·05	$\dot{\rm Ca}$ 1·30	24·00,	$\ddot{\bar{\rm F}}{\rm e}$ 16·63, insol. 10=99·64, K.	

Automolite (or gahnite): a zinc-spinel=$\dot{\rm Zn}\ddot{\bar{\rm A}}{\rm l}$; color dark-green or black; G.=4·1—4·6.

Hercinite: an iron spinel=$\dot{\rm Fe}\ddot{\bar{\rm A}}{\rm l}$; G.=3·91—3·95.

Ceylanite, (or *pleonaste*): an iron and magnesia spinel=($\dot{\rm Mg}$, $\dot{\rm Fe}$)$\ddot{\bar{\rm A}}{\rm l}$; G.=3·575.

Dysluite: a zinc, manganese, and iron spinel; color yellowish-brown or grayish-brown; ($\dot{\rm Zn}$ $\dot{\rm Mn}$) ($\ddot{\bar{\rm A}}{\rm l}$, $\ddot{\bar{\rm F}}{\rm e}$); G.=4·55.

Chlorospinel, (G. Rose): a grass-green spinel from Slatoust; $\dot{\rm Mg}$($\ddot{\bar{\rm A}}{\rm l}$,$\ddot{\bar{\rm F}}{\rm e}$); G.=3·591—3·594.

Kreittonite: a black spinel, (G.=4·49); Kobell writes for the formula, $\dot{\rm Zn}\ddot{\bar{\rm A}}{\rm l}+\dot{\rm Fe}$ $\ddot{\bar{\rm F}}{\rm e}$, or ($\dot{\rm Zn}$, $\dot{\rm Fe}$) ($\ddot{\bar{\rm A}}{\rm l}$, $\ddot{\bar{\rm F}}{\rm e}$), and corrects the analysis as regards the iron as follows: $\ddot{\bar{\rm A}}{\rm l}$ 49·73, $\ddot{\bar{\rm F}}{\rm e}$ 8·70, $\dot{\rm Zn}$ 26·72, $\dot{\rm Fe}$ 8·04, $\dot{\rm Mg}$ 3·41, $\dot{\rm Mn}$ 1·45=98·05.

B.B. alone infusible; red variety changes to brown, and even black and opaque, as the temperature increases, and on cooling becomes first green, and then nearly colorless, and at last resumes the red color. Fuses with difficulty with borax, but somewhat more readily with salt of phosphorus. Black varieties yield a deep green globule, owing to the iron they contain. The zinc varieties afford with soda oxyd of zinc.

The varieties of this species have been denominated, according to their colors, as follows; the black varieties *pleonaste:* the scarlet *spinelle ruby;* the rose red *balas ruby;* the yellow or orange-red *rubicelle:* the violet colored *almandine ruby.* The *oriental ruby* is sapphire.

Spinel occurs imbedded in granular limestone, and with calcareous spar in serpentine and gneiss. It also occupies the cavities of volcanic rocks.

In Ceylon, in Siam, and other eastern countries, it occurs of beautiful colors, as rolled pebbles in the channels of rivers. Pleonaste is found at Candy, in Ceylon, and hence was called *Candite,* by Bournon. At Aker, in Sweden, is found a pale-blue and pearl-gray variety in limestone. Small black splendent crystals occur in the ancient scoria of Mount Somma, with mica and idocrase; also in compact gehlenite, at Monzoni, in the Fassa valley.

From Amity, N. Y., to Andover, N. J., a distance of about thirty miles, is a region of granular limestone and serpentine, in which localities of spinel abound. At Amity, crystals are occasionally 16 inches in diameter; and one collected by Dr. Heron, weighs forty-nine pounds; it is in three pieces, and contains cavities studded with crystals of corundum; colors, green, black, brown, and less commonly red, along with chondrodite, and other minerals. A mile southwest of Amity, on J. Layton's farm, is a remarkable locality; also on W. Raynor's farm, a mile to the north; another half a mile north, affording grayish-red octahedrons; and others to the south. Localities are numerous about Warwick, and also at Monroe and Cornwall, though less favorable for exploration than those at Amity, (form 1, also 1, *i,* 33, f. 308). Franklin, N. J. affords crystals of various shades of black, blue, green, and red, which are sometimes transparent, and a bluish-green ceylanite variety here, has the lustre of polished steel; Newton, N. J. pearl-gray crystals along with blue corundum, tourmaline, and rutile; at Bryan, red, brown, green, and black colors, along with chondrodite. At Sterling, Sparta, Hamburgh, and Vernon, N. J., are other localities. Light blue spinels occur sparingly in limestone in Antwerp, Jefferson Co., N. Y., two and a half miles south of Oxbow, and rose and reddish brown in Gouverneur, two miles north and three-fourths of a mile west of Somerville, St. Lawrence Co.; green, blue, and occasionally red varieties occur in granular limestone at Bolton, Boxborough, Chelmsford, and Littleton, Mass. Soft octahedral crystals occur in Warwick, which, according to Beck, are spinels permeated with steatite or serpentine, (Min. N. Y., p. 318). They have been considered pseudomorphs. Good black spinel in Burgess, Canada West; blue with clintonite at Daillebout, C. E.

The *automolite* occurs in talcose slate near Fahlun and elsewhere in Sweden. The *dysluite* is from Sterling, N. J., along with franklinite and willemite. *Kreittonite* is from Bodenmais; and *chlorospinel* from Slatoust.

The fine colored spinels, when of large size, are esteemed as gems.

Altered Forms.—Acted on by silicate of magnesia in solution, and changed to *Steatite* or *Serpentine*, also when the alumina is not wholly removed by the process of change it becomes *Völknerite*, ($\ddot{\mathrm{Mg}}^6\ddot{\overline{\mathrm{Al}}}+15\dot{\mathrm{H}}$).

MAGNETITE, *Haid.* Magnetic Iron Ore. Oxydulated Iron. Magneteisenstein, Magneteisenerz. Fer Oxydulé, *H.*

Monometric. Observed planes O, 1, I, $i2$, 2, 22, 33, 10-10, 16-16, $3\frac{3}{2}$. Figs 11 and 14 (common), 15 to 19, 168. Cleavage: octahedral, perfect to imperfect. Dodecahedral faces commonly striated parallel to the longer diagonal. Twins like f. 200. Massive, structure granular—particles of various sizes, sometimes impalpable.

H.=5·5—6·5. G.=4·9—5·2; 5·168—5·180, crystals, Kengott, and 5·27 after long heating. Lustre metallic—submetallic. Color iron-black; streak black. Opaque. Fracture subconchoidal, shining. Brittle. Strongly magnetic, and sometimes possessing polarity.

Composition.—$\dot{\mathrm{Fe}}\ddot{\overline{\mathrm{Fe}}}$=Iron 72·4, oxygen 27·6, or $\ddot{\overline{\mathrm{Fe}}}$ 68·97, $\dot{\mathrm{Fe}}$ 31·03=100. Breithaupt describes a magnetite from Sparta, N. J., containing magnesia; G.=4·41—4·42. A variety from the Mourne Mts. gave Prof. Andrews, (Chem. Gaz., 1852, 379), $\ddot{\overline{\mathrm{Fe}}}$ 71·41, $\dot{\mathrm{Fe}}$ 21·59, $\dot{\mathrm{Mg}}$ 6·45=$\ddot{\overline{\mathrm{Fe}}}$ ($\dot{\mathrm{Fe}}$, $\dot{\mathrm{Mg}}$).

An earthy magnetite (*Eisenmulm*) from near Siegen afforded Genth, (Ann. Ch. u. Pharm. lxvi, 277), $\ddot{\overline{\mathrm{Fe}}}$ 66·20, $\dot{\mathrm{Fe}}$ 13·87, $\dot{\mathrm{Mn}}$ 17·00, $\dot{\mathrm{Cu}}$ 0·09, sand, &c. 1·75=98·91=$\ddot{\overline{\mathrm{Fe}}}$ ($\dot{\mathrm{Fe}}$, $\dot{\mathrm{Mn}}$). G.=3·76.

B.B. becomes brown, and loses its influence on the magnet, but fuses with great difficulty. With borax, in the oxydizing flame, fuses to a dull-red glass, which becomes clear on cooling, and often assumes a yellow tint; in the reducing flame becomes bottle-green. Dissolves in heated muriatic acid, but not in nitric acid.

Magnetite occurs in beds in gneiss or syenite, also in beds or isolated crystals in clay slate, hornblende slate, chlorite slate, greenstone, basalt, and occasionally in limestone. Often associated with emery.

The beds of ore at Arendal and nearly all the celebrated iron mines of Sweden, consist of massive magnetite. Dannemora, and the Täberg in Smaoland, are entirely formed of it. Still larger mountains of it exist at Kurunavara and Gelivara, in Lapland. Fahlun in Sweden, and Corsica, afford octahedral crystals, (f. 11), imbedded in chlorite slate. Splendid dodecahedral crystals occur at Normark in Wermland. The most powerful native magnets are found in Siberia, and in the Hartz; they are also obtained on the island of Elba.

Extensive beds of magnetite occur in the counties of Warren, Essex, and Clinton, New York, in granite, syenitic granite, or allied rocks; and in Orange, Putnam, Saratoga, Herkimer counties, &c., in gneissoid granite, either in isolated masses or layers alternating with the layers of gneiss, (Beck); also in the mountainous districts of New Jersey and Pennsylvania, and on the eastern side of Willis mountain in Buckingham Co., Virginia; at Franconia, N. H., in epidote and quartz, (f. 14); at Warwick, N. Y.; near Morgantown, Berks Co., Penn., (f. 11, 14); at Marlboro', Rochester, Bethel and Bridgewater, Vt., in chlorite or chlorite slate, (f. 11); at Swanzey, near Keene, and Unity, New Hampshire; at Deer Creek, Md.; at O'Neil mine, Orange Co., N. Y., (f. 1, 11, 14, 15, 17); at Webb's mine, Columbia Co., Penn.; at Haddam, Conn., (f. 18, 19, 169); at Hamburg, near Franklin furnace, N. J.; at Raymond, Davis's Hill, Maine, in an epidotic rock. Masses strongly magnetic occur at Marshall's Island, Me.; also at Magnet Cove, Arkansas; at Goshen, Chester Co., Pa. Large beds at Hull, South Crosby, Marmora and Madre, Canada West, and Bromet, Sutton, Canada East, at Sutton in crystals.

No ore of iron is more generally diffused than the magnetic, and none superior for the manufacture of iron. It is easily distinguished by its being attracted readily by the magnet, and also by means of the black color of its streak or powder, which is some shade of red or brown in specular iron and brown iron ore. The ore when pulverized may be separated from earthy impurities by means of a magnet, and machines are in use in many parts of Northern New York for cleaning the ore on a large scale.

Dimagnetite of Shepard (Am. J. Sci. [2], xiii, 392) appears to be a magnetite pseudomorph. The slender rhombic prisms occur upon a surface which is covered with small cubo-octahedrons, dodecahedrons and cubo-dodecahedrons of magnetite, and some small irregular cavities in the dimagnetite crystals contain similar crystals; moreover no difference of lustre is perceived in a fractured surface of the magnetite and dimagnetite. The species imitated in the pseudomorph is probably Lievrite. The angle of the prism varies between 110° and 115°, according to the author's measurements; (Shepard gives the angle 130°). One crystal gave approximately 110° and 70°; another 114° 20′ and 65° 40′; another 112° and 68°, and the obtuse edge was beveled in this last crystal by planes ($i\bar{2}$) inclined to the larger ones at an angle of about 160½°. The faces are even but not very bright. From Monroe, Orange Co., N. Y.

ALTERED FORMS.—By deoxydation through organic matter changed to protoxyd, which may become a carbonate or spathic iron. By oxydation becomes sesquioxyd of iron or *Specular iron.* Pseudomorphs of chlorite after magnetite have been reported.

FRANKLINITE, *Berth.*

Monometric. Observed planes 1, *I*, *O*, 2, 22. Figs. 11, 16, 19, common. Cleavage: octahedral, indistinct. Also massive, coarse or fine granular to compact.

H.=5·5—6·5. G.=5·069, Thomson; 5·091, Haidinger. Lustre metallic. Color iron-black. Streak dark reddish-brown. Opaque. Fracture conchoidal. Brittle. Acts slightly on the magnet.

Composition.—($\dot{\mathrm{F}}\mathrm{e}$, $\dot{\mathrm{Z}}\mathrm{n}$, $\dot{\mathrm{M}}\mathrm{n}$), ($\ddot{\bar{\mathrm{F}}}\mathrm{e}$, $\ddot{\bar{\mathrm{M}}}\mathrm{n}$). Analyses: 1, Berthier, (Ann. des Mines, iv, 189); 2, Thomson, (Min. i, 438); 3, Abich, (Pogg. xxiii, 342); 4, 5, G. J. Dickerson, (C. T. Jackson's Rep. on N. J. zinc mines):

	$\ddot{\bar{\mathrm{F}}}\mathrm{e}$	$\ddot{\bar{\mathrm{M}}}\mathrm{n}$	$\dot{\mathrm{Z}}\mathrm{n}$	
1.	66·	16·	17·	=99, Berthier.
2.	66·10	14·96	17·43,	$\ddot{\mathrm{S}}\mathrm{i}$ 0·20, $\dot{\mathrm{H}}$ 0·56=99·25, Thomson.
3.	68·88	18·17	10·81	" 0·40, $\ddot{\mathrm{A}}\mathrm{l}$ 0·73=98·99, Abich.
4.	66·07	12·24	21·39	" 0·29=100, Dickerson.
5.	66·12	11·99	21·77	" 0·13=100, Dickerson.

B.B. infusible. On charcoal affords oxyd of zinc at a high heat. Manganese reaction with borax.

Stated to occur in amorphous masses at Altenberg, near Aix la Chapelle.

Abundant at Hamburgh, N. J. near the Franklin furnace, with red oxyd of zinc and garnet, in granular limestone; also at Stirling Hill, in the same region, where it is associated with willemite, in a large vein, in which cavities occasionally contain crystals from one to four inches in diameter.

The attempts to work this ore for zinc have proved unsuccessful; but it is ground up for a dark paint, and is used also as an ore of iron. The zinc is said to give increased tenacity to the iron.

CHROMIC IRON. Chromite, *Haid.* Chromate of Iron. Chromeisenstein. Eisenchrom. Fer Chromaté, *H.*

Monometric. In octahedrons, (f. 11). Commonly massive, structure fine granular, or compact.

H.=5·5. G.=4·321, crystals, Thomson; 4·498, a variety from Styria; 4·568, Texas, Pa. Lustre submetallic. Streak brown. Color between iron-black and brownish-black. Opaque. Fracture uneven. Brittle. Sometimes magnetic.

Composition.—$\dot{\mathrm{Fe}}\,\dddot{\bar{\mathrm{Cr}}}$, or $(\mathrm{Fe}, \dot{\mathrm{Mg}})\,(\dddot{\bar{\mathrm{Al}}}, \dddot{\bar{\mathrm{Cr}}})$. Analysis: 1, 2, Seybert, (Am. J. Sci. iv, 321); 3, 4, Abich, (Pogg. xxiii, 335); 5, 6, Laugier, (Ann. d. Mus. d'Hist. N. vi); 7, 8, T. S. Hunt, (Logan's Rep. Geol. Canada, 1849); 9, Moberg, (J. f. pr. Ch. xliii, 119); 10, A. Rivot, (Ann. Ch. Phys. [3], xxx, 202); 11, C. Bechi, (Am. J. Sci. [2], xiv, 62); 12, 13, Starr and Garrett, (Am. J. Sci. [2], xiv, 45):

		$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dddot{\bar{\mathrm{Cr}}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\mathrm{Si}}$
1.	Chester Co. Pa.,	35·14	——	51·56	9·72	2·90=99·32, Seybert.
2.	Baltimore,	36·00	——	39·51	13·00	10·60=99·11, Seybert.
3.	Baltimore, *massive*,	18·97	9·96	44·91	13·85	0·83=98·25, Abich,
4.	" *cryst.*	20·13	7·45	60·04	11·85	——=99·45, Abich.
5.	Siberia,	24·	——	53·	11·	1· $\dot{\mathrm{Mn}}$ 1=100, Laugier.
6.	Röraas,	25·66	5·36	54·08	9·02	4·83=98·95, Laugier.
7.	Bolton, Canada,	35·68	15·03	45·90	3·20	——=99·81, Hunt.
8.	L. Memphramagog,	21·28	18·13	49·75	11·30	——=100·46, Hunt.
9.	Beresof,	18·42	6·68	64·17	10·83	0·91=101·01, Moberg.
10.	Baltimore,	30·04	——	63·37	1·95	2·21 [a] $\dot{\mathrm{Ca}}$ 2·02=99·60, Rivot.
11.	Volterra, Tuscany,	33·93	——	42·13	19·84	4·75=100·65, Bechi.
12.	Chester, Pa.,	$\dddot{\bar{\mathrm{Fe}}}$ 38·95	——	60·84	0·93	0·62, $\dot{\mathrm{Ni}}$ 0·10, Starr.
13.	Texas, Pa.	38·66	——	63·38	——	—— " 2·28, Garrett.

[a] With some Titanic Acid ?

In Moberg's analysis, the chromium is supposed to be partly protoxyd, giving the formula $(\dot{\mathrm{Fe}}, \dot{\mathrm{Mg}}, \dot{\mathrm{Cr}})\,(\dddot{\bar{\mathrm{Cr}}}, \dddot{\bar{\mathrm{Al}}})$. Garrett's analysis of the Texas ore corresponds to $\dot{\mathrm{Fe}}\,\dddot{\bar{\mathrm{Cr}}}$ 93·16+$\dot{\mathrm{Fe}}\,\dddot{\bar{\mathrm{Fe}}}$ 0·59+$\dot{\mathrm{Ni}}\,\dddot{\bar{\mathrm{Fe}}}$ 7·15. In grains that were magnetic, Garrett found $\dddot{\bar{\mathrm{Cr}}}$ 41·55, $\dddot{\bar{\mathrm{Fe}}}$ 62·02, $\dddot{\mathrm{Si}}$ 1·25, corresponding to $\dot{\mathrm{Fe}}\,\dddot{\bar{\mathrm{Cr}}}$ 61·07+$\dot{\mathrm{Fe}}\,\dddot{\bar{\mathrm{Fe}}}$ 38·64+$\dddot{\mathrm{Si}}$ 1·25=100·96, (loc. cit.)

B.B. alone, infusible. With borax fuses with difficulty, but completely, to a beautiful green globule.

Chromic iron occurs in serpentine, forming veins, or in imbedded masses. It assists in giving the variegated color to verde-antique marble.

Occurs in the Gulsen mountains, near Kraubat in Syria; in crystals in the islands of Unst and Fetlar, in Shetland; in the Department du Var in France; in Silesia and Bohemia; abundant in Asia Minor, (Am. J. Sci. [2], vii, 285); in the Eastern Urals.

At Baltimore, Md., in the Bare Hills, it occurs in large quantities in veins or masses in serpentine; also in Montgomery Co., six miles north of the Potomac; at Cooptown, Harford Co. and in the north part of Cecil Co., Md. In Pennsylvania, in W. Goshen, (crystals), Nottingham, Mineral Hill, and elsewhere; Chester Co., near Unionville, abundant; near Texas, Lancaster Co., very abundant. Massive and in crystals at Hoboken, N. J., in Serpentine and dolomite; sparingly at Milford and West Haven, Conn.; in the southwestern part of the town of New Fane, and in Jay, Troy, and Westfield, Vt.; Chester and Blanford, Mass.; on I. à Vache, near San Domingo; in the gold sands of California; at Bolton and Ham, Canada East.

This ore affords the oxyd of chrome, used in painting, etc. The ore employed in England is obtained mostly from Baltimore, Drontheim, and the Shetland Isles; it amounts to about 2000 tons annually.

PITCHBLENDE. Protoxyd of Uranium. Pecherz, *W.* Pechuran, *Haus.* Nasturan, *Kob.* Gummierz, Pittinerz, *Breit.* Uranpecherz. Urane Oxydulé, *H.*

Monometric. Observed forms, f. 11, 16, 19. Usually massive and botryoidal; also in grains; structure sometimes columnar or curved lamellar.

H.=5·5. G.=6·468—8. Lustre submetallic or greasy to dull. Color grayish, greenish, brownish, red, or velvet-black. Streak, brownish-black, or olive green, a little shining. Opaque. Fracture conchoidal, uneven.

Composition.—$\dot{\mathrm{U}}\dddot{\bar{\mathrm{U}}}$? Ramm. Analyses: 1, Klaproth, (Beit. ii, 197); 2, Pfaff, (Schw. J. xxxv, 326); 3, Rammelsberg, (Pogg. lix, 35); 4, Ebelmen, (Ann. Ch. Phys. 1843, 498); 5, Scheerer, (Pogg. lxxii, 561); 6, Kersten, (Schw. J. lxvi, 18); 7, von Hauer, (Jahrb. geol. Reichs. 1853, 107):

1. $\dot{\mathrm{U}}$ 86·5 $\dot{\mathrm{Fe}}\dddot{\bar{\mathrm{Fe}}}$ 2·5 PbS 6·0 $\dddot{\mathrm{Si}}$ 5·0=100, Klaproth.
2. 84·52 $\dot{\mathrm{Fe}}$ 8·24 4·20 2·02, $\dot{\mathrm{Co}}$ 1·42=100·46, Pfaff.
3. $\dddot{\bar{\mathrm{U}}}\dot{\mathrm{U}}$ 79·15 $\dot{\mathrm{Fe}}$ 3·03 Pb 6·20 As 1·13, $\dot{\mathrm{Ca}}$ 2·81, $\dot{\mathrm{Mg}}$ 0·46, $\dddot{\mathrm{Si}}$ 5·30, Bi (with Pb and Cu) 0·65, $\dot{\mathrm{H}}$ 0·36=99·09, Rammelsberg.
4. " 75·94 $\dot{\mathrm{Fe}}$ 3·10 4·22 $\dot{\mathrm{Mn}}$ 0·82, $\dot{\mathrm{Ca}}$ 5·24, $\dot{\mathrm{Mg}}$ 2·07, $\dot{\mathrm{Na}}$ 0·25, $\ddot{\mathrm{C}}$ 3·32, $\dddot{\mathrm{Si}}$ 3·48, S 0·60, $\dot{\mathrm{H}}$ 1·85=100·89, Ebelmen.
5. 76·6, $\dot{\mathrm{Pb}}$, met. acids, and $\dddot{\mathrm{Si}}$ 15·6 $\dddot{\bar{\mathrm{Mn}}}$ 1·0 $\dot{\mathrm{H}}$ 4·1, loss and rock 2·7, Scheerer.
6. $\dddot{\bar{\mathrm{U}}}$ 72·00, $\dddot{\bar{\mathrm{Mn}}}$ 0·05, $\dot{\mathrm{Ca}}$ 6·00, $\dddot{\mathrm{Si}}$ 4·26 $\dot{\mathrm{H}}$ 14·75, As *trace*, $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 2·30, HF *trace*=99·36, K.
7. $\dddot{\bar{\mathrm{U}}}\dot{\mathrm{U}}$ 80·52, $\dot{\mathrm{Fe}}$ 2·86, Pb 6·07, Sb 2·09, S 1·18, $\dddot{\mathrm{Si}}$ 1·79, $\dot{\mathrm{Ca}}$. 2·97, $\dot{\mathrm{Mg}}$ 0·64, $\dot{\mathrm{H}}$ 0·48, $\ddot{\mathrm{C}}$ 0·89, v. Hauer.

The specimens for these analyses were from Joachimsthal, excepting Nos. 2, 6, and 7; and 6 is the so-called *Gummierz;* No. 5 is the crystallized variety; No. 7 was from Przibram. Vanadium and also selenium occur in the ore from Johanngeorgenstadt.

B.B. alone infusible, but in the forceps colors exterior flame green. With borax, melts to a dark yellow glass, which is dirty green in the reducing flame. With soda not dissolved, but yields the smell of arsenic. In the state of powder dissolves slowly in nitric acid, evolving red fumes of nitrous acid. Not acted on by muriatic acid, but affords easily a yellow solution with nitric acid. Not attractable by the magnet.

Pitchblende accompanies various ores of silver and lead at Johanngeorgenstadt, Marienberg, and Schneeberg in Saxony, at Joachimsthal and Przibram in Bohemia, and Retzbanya in Hungary. It is associated with uranite at Tincroft and Tolcarn mines near Redruth, in Cornwall; also near Adrianople, Turkey; at the Middletown feldspar quarry in octahedrons with truncated edges, according to Shepard.

It is very valuable in porcelain painting, affording an orange color in the enamelling fire, and a black color in that in which the porcelain is baked. A laboratory has been opened at Joachimstahl, where the ore is converted into uranate of soda for use.

The *Pittinerz* of Breithaupt has an olive-green streak. H.=3—3·5. G.=4·8—5. The *Gummierz* of the same author has H.=2·5—3. G.=3·9—4·18. Color: hyacinth-red, yellowish and reddish-brown, and looking like gum; contains nearly 15 per cent. of water.

Coracite, Leconte, (Am. J. Sci. [2], iii, 173).

Resembles pitchblende. Amorphous, with a pitch-black color and gray powder. H.=3. Afforded J. D. Whitney, (Jour. Bost. Soc. N. H. 1849, vi, 36, and Am. J. Sci. [2], vii, 434):

$\dddot{\bar{\mathrm{U}}}$	$\dot{\mathrm{Pb}}$	$\dot{\mathrm{Ca}}$	$\ddot{\mathrm{C}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{H}}$	$\dddot{\mathrm{Si}}$
59·30	5·36	14·44	7·47	2·24	0·90	4·64	4·35, $\dot{\mathrm{Mg}}$, $\dot{\mathrm{Mn}}$ *trace*=98·70.

Excluding the carbonate of lime as impurity, the percentage becomes:

$\dddot{\bar{\mathrm{U}}}$ 72·60, $\dot{\mathrm{Pb}}$ 6·56, $\dot{\mathrm{Ca}}$ 5·99, $\dddot{\bar{\mathrm{Fe}}}$ 2·74, $\dddot{\bar{\mathrm{Al}}}$ 1·10, $\dot{\mathrm{H}}$ 5·68, $\dddot{\mathrm{Si}}$ 5·33=100.

B.B. does not change nor tinge the flame. Gives the reaction of uranium with the fluxes. Dissolves readily without heat in dilute muriatic acid, effervescing strongly and yielding a green solution. On account of the ready solubility in acids, Mr. Whitney supposes the uranium to be in the state of peroxyd ($\dddot{\bar{\mathrm{U}}}$), and not $\dot{\mathrm{U}}\dddot{\bar{\mathrm{U}}}$, as in common pitchblende.

Eliasite, *Haidinger*, (Pogg. 1853, iv, Erganz. 348). Resembles pitchblende and coracite and may be an impure mineral. Occurs in flattened pieces, occasionally half an inch thick. H.=3·5. G.=4·086—4·237, v. Zepharovich. Lustre greasy—subvitreous. Color dull reddish-brown, inclined to hyacinth-red on thinnest edges; streak dull, wax-yellow to orange. Subtranslucent.

Composition.—According to F. Ragsky, (loc. cit.):

$\dddot{\bar{\text{U}}}$	$\dddot{\bar{\text{Al}}}$	$\dddot{\bar{\text{Fe}}}$	$\dot{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Pb}}$	$\dddot{\text{Si}}$	$\ddot{\text{C}}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\text{P}}}$	$\dot{\text{H}}$	As
61·33	1·17	6·63	1·09	3·09	2·20	4·62	5·13	2·52	0·84	10·68,	*tr.*=99·30

B.B. like pitchblende. Decomposed by muriatic acid. At 100°C loses 5·81 per cent., and at 300° C, 4·77, making 10·58 per cent. of water. From the Elias mine, Joachimstahl, with fluor, dolomite, quartz, etc.

The carbonic acid may be combined with the lime and part of the magnesia as carbonate, making 5·7 per cent.

MELACONITE, *D.* Black Oxyd of Copper. Kupferschwärze.

Monometric? Occurs in cubes (pseudomorphs?) with truncated angles. Cleavage: none distinct. Mostly massive.

H.=3. G.=6·25, J. D. Whitney; 5·952, Ramm. Lustre submetallic to earthy. Color dark steel-gray in crystals, to black or grayish-black when massive. Opaque. Streak shining.

Composition.—$\bar{\text{Cu}}\text{O}^2$=Oxygen 20·15, copper 79·85. Often with one to two per cent. of impurities, consisting mostly of silica, lime, and iron, J. D. Whitney. B.B. in the inner flame yields easily a globule of copper.

Occurs at Copper Harbor, Kewenaw Point, Lake Superior, forming a vein in conglomerate, from which about 40,000 lbs. of the ore were removed; it is now exhausted. The crystals are imbedded in the masses, and Teschemacher and Hayes have considered them pseudomorphs after red oxyd of copper. J. D. Whitney objects to this view on the ground that the red copper of the vein is in octahedrons and not cubes, and that no evidence exists to prove that such a change has taken place. (See J. D. Whitney in Foster and Whitney's Report on Lake Superior Region, Part 2, p. 99).

The *Kupferschwärze* or *Black Copper* of Werner is an impure, earthy black oxyd of copper, resulting from the decomposition of other ores, being mixed with more or less sulphuret of copper, pyrites, and other impurities.

PLUMBIC OCHRE. Lead-ochre. Bleiglätte. Glätte.

Massive. Structure sometimes scaly crystalline.

G.=8·0. Lustre dull. Color between sulphur and orpiment-yellow. Streak lighter than the color. Opaque. Does not soil.

Composition.—$\dot{\text{Pb}}$=Oxygen 7·17, lead 92·83; more or less impure. Analysis by John, (Schw. J. iv, 219 and xxxii, 106):

$\dot{\text{Pb}}$ 89·10, $\ddot{\text{C}}$ 3·84, $\dddot{\bar{\text{Fe}}}$ and $\dot{\text{Ca}}$ 0·48, $\dddot{\text{Si}}$ 2·40=95·82.

Melts readily before the blowpipe, and is easily reduced on charcoal to the metallic state.

It is said to occur at Badenweiler in Baden, in quartz. Gerolt states that it has been ejected from the volcanoes of Popocatapetl and Jztaccituall, in Mexico. It is found in many places in the provinces of Chihuahua and Cohahuila in considerable quantities, having been collected along the streams between Ceralvo and Monterey, being supposed to come from the range of mountains running nearly north of Monterey. The specimens (often 2 or more cubic inches in size) are between orpiment and sulphur yellow in color, and glisten like a granular mica of a nearly golden color. The natural surface is slightly crystalline and shining; and when broken it shows a scaly texture, (Bailey in Am. J. Sci. [2], viii, 420).

Occurs also at Austin's mines, Wythe Co., Va.

This species may belong with the *Trimetric Oxyds.*

2. HEXAGONAL OXYDS.

WATER.

Rhombohedral. Usual in compound stellate forms, f. 210. Liquid above 32° F., and boils at 212° F. A cubic inch of pure water at 60° F., and 30 inches of the barometer weighs 252·458 grains. Colorless. Inodorous. Tasteless.

Composition.—HO=Oxygen 88·89, hydrogen 11·11.

The density of water is greatest at 39° 1 F., according to Joule and Playfair, (Phil. Mag., xxx, 41, 1847), the most recent investigators of this subject. Despretz obtained 39° 176; Hallström 39° 38; Blagden and Gilpin 39°; Hope 39° 5; Muncke 38·804. Below this temperature it expands as it approaches 32°, owing to incipient crystallization.

Water as it occurs in nature is seldom pure. It ordinarily contains some atmospheric air, often pure oxygen and carbonic acid, besides various saline ingredients. For analyses of the waters used in Boston, New York, and Philadelphia, by B. Silliman, Jr., see Am. Jour. Sci. [2], ii, 218; and for another of that last mentioned, by M. H. Boyé, see same Journal, ix, 123. In different mineral waters are found salts of magnesia, lime, iron, soda, potash, and sometimes traces of zinc, arsenic, lead, copper, antimony, and even tin, these ingredients being derived from the rocks or soil of the region. For citation of numerous recent analyses of Waters, see Kengott's Min. Forsch., 1844–1849, and 1850–51. 2 vols. 4to. Vienna.

See on the Crystallization of Ice, Leydolt, Wien. Akad. vii, 477. It also occurs under Trimetric forms, and is regarded as dimorphous.

ZINCITE, *Haid.* Red Zinc Ore. Red Oxyd of Zinc. Zinkoxyd, *L.* Zinc Oxydé. Rothzinkerz. Spartalite, *B.* and *M.*

Hexagonal; $O:1=118°\ 7'$; $a=1·6208$. In quartzoids with truncated summits, and prismatic faces I. $1:1=127°\ 40'$, (to 43′), Rose, $I:1=151°\ 53'$; 152° 20′, Levy. Cleavage basal, eminent. Usual in grains or coarse particles and disseminated masses, structure foliated; also granular.

H.=4—4·5. G.=5·432—5·524. Lustre subadamantine. Streak orange-yellow. Color deep red, also inclining to yellow. Translucent—subtranslucent. Fracture subconchoidal. Brittle.

Composition.—$\dot{\mathrm{Z}}\mathrm{n}$=Oxygen 19·74, zinc 80·26; containing oxyd of manganese as an unessential ingredient. Analyses: 1, Berthier, (Ann. d Mines, iv, 483); 2, 3, Whitney, (Pogg. lxxi, 169); 4, A. A. Hayes, (Am. J. Sci. xlviii, 261):

1. $\dot{\mathrm{Z}}\mathrm{n}$	88·	$\dot{\mathrm{M}}\mathrm{n}\dddot{\overline{\mathrm{M}}}\mathrm{n}$ 12=100, Berthier.
2.	94·45	$\dddot{\overline{\mathrm{M}}}\mathrm{n}$ *trace*, gangue (franklinite) 4·49, ign 1·09=100·03, Whitney.
3.	96·19	. 3·70, undecomp. 0·10=99·99, Whitney.
4·	93·48	$\dot{\mathrm{M}}\mathrm{n}$ 5·50, $\dddot{\overline{\mathrm{F}}}\mathrm{e}$ 0·36, scales of specular iron 0·44=89·78, Hayes.

Thin scales magnified and viewed by transmitted light are deep yellow. The author finds by means of a high magnifying power that this ore is free from foreign scales of red oxyd of iron or other substances; and consequently the color is probably due as held by G. Rose and J. D. Whitney, to the presence of $\dddot{\overline{\mathrm{M}}}\mathrm{n}$.

B.B. alone infusible; with borax yields a yellow transparent glass. Dissolves without effervescence in nitric acid. On exposure to the air, it suffers a partial decomposition at the surface, and becomes invested with a white coating, which is carbonate of zinc.

Occurs with Franklinite and also with calcareous spar at Stirling Hill, Sussex Co., sometimes in lamellar masses in pink calcite. It was first noticed, described, and analyzed, by Dr. Bruce, (Bruce's American Mineralog. Journ., vol. i. p. 96).

Mitscherlich has observed minute six-sided prisms in the iron furnaces of Königshütte, in Silesia, which he believes to be identical with this species. Similar crystals have been met with in the zinc furnaces near Siegen. It has been observed in considerable quantities in the furnaces and roast-heaps at the New Jersey zinc mines; surface drusy, color white to amber-yellow, (Am. J. Sci. [2], xiii, 417); also by M. Stadtmuller at the iron furnace of Van Deusenville, Mass. An oxyd of zinc mixed with hydrate of iron occurs on marmatite at Bottino in Tuscany, which afforded C. Bechi (Am. J. Sci. [2] xiv, 62) $\dot{Z}n$ 31·725, $\ddot{\bar{F}}e$ 47·450, $\dot{H}$ 20·825.

CORUNDUM. Sapphire. Emery. Oriental Amethyst, Topaz, Ruby, Emerald. Adamantine Spar. Rubin. Salamstein. Smirgel. Korund. Demanthspath. Telésie. Corindon. Asteria *of Pliny.*

Rhombohedral; $R:R=86°\ 4'$, $O:1(R)=122°\ 26$; $a=1·363$. Observed planes: rhombohedrons, $\frac{1}{3}$, $\frac{1}{2}$, $1(R)$, -2, -1; pyramids, $\frac{4}{3}2$, $\frac{14}{9}2$, 22, $\frac{7}{3}2$, $\frac{8}{3}2$, 42, $\frac{16}{3}2$, 82; scalenohedrons $\frac{2}{3}\frac{5}{3}$, $\frac{2}{5}3$, $\frac{1}{4}5$, (=$\frac{10}{9}\frac{5}{4}$, $\frac{3}{5}\frac{3}{2}$, $\frac{5}{4}\frac{5}{3}$); also I, $i2$, $i\frac{8}{7}$, O.

$O:\ \frac{1}{3}=152°\ 19'$. $O:\frac{4}{3}2\ =118°\ 49'$. $\frac{4}{3}2:\frac{4}{3}2$ (pyr.)$=128°\ 2'$.
$O:\ \frac{1}{2}=141°\ 48'$. $O:42\ =100°\ 24'$. $22:22$ " $=124°$.
$O:\ 2=107°\ 38'$. $O:\frac{6}{5}\frac{3}{2}\ =120°\ 59'$. $i2:R=136°\ 58'$.
$O:22=110°\ 9'$. $O:\frac{10}{9}\frac{5}{4}=121°\ 58'$. $2:\ 2=78°\ 45'$.

Cleavage: basal, sometimes perfect, but interrupted, commonly imperfect in the blue variety; also rhombohedral. Large crystals usually rough. Twins: face of composition R. Also massive granular or impalpable; often in layers from composition parallel to R.

H.=9. G.=3·909—4·16. Lustre vitreous; sometimes pearly on the basal planes, and occasionally exhibiting a bright opalescent star of six rays in the direction of the axis. Color blue, red, yellow, brown, gray, and nearly white; streak uncolored. Transparent—translucent. Fracture conchoidal, uneven. Exceedingly tough when compact.

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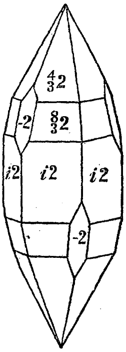

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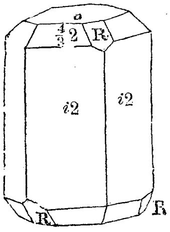

Sapphire is pure alumina crystallized.

The species Corundum includes sapphire, emery, corundum, and other varieties. Corundum embraces the opaque specimens, usually of dingy colors and often dark; emery the massive granular or compact variety, more or less impure, and sapphire, the brightly colored varieties. The following are analyses by J. Lawrence Smith, taken from an elaborate paper in the Amer. J. Sci. [2], x, 354, xi, 53. The column of hardness, gives the effective abrasive power of the powdered mineral, that of sapphire being 100; Mag. stands for *Magnetite:*

	H.	G.	Äl	Mag.	Ċa	S̈i	Ḣ	
1. Sapphire of India,	100	4·06	97·51	1·89	——	0·80	——	=100·20.
2. Ruby of India,	90	——	97·32	1·09	——	1·21	——	= 99·62.
3. Corundum of Asia Minor,	77	3·88	92·39	1·67	1·12	2·05	1·60	= 98·83.
4. " of Nicaria,	65	3·92	87·52	7·50	0·82	2·01	0·68	= 99·53.
5. " of Asia,	60	3·60	86·62	8·21	0·70	3·85	1·16	=101·04.
6. " of India,	58	3·89	93·12	0·91	1·02	0·96	2·86	= 98·87.
7. " of India,	55	3·91	84·56	7·06	1·20	4·00	3·10	= 99·92.
Emery,				F̈e				
8. Kulah,	57	4·28	63·50	33·25	0·92	1·61	1·90	=101·18.
9. Samos,	56	3·98	70·10	22·21	0·62	4·00	2·10	= 99·03.
10. Nicaria,	50	3·75	71·06	20·32	1·40	4·12	2·53	= 99·43.
11. Kulah,	53	4·02	63·00	30·12	0·50	2·36	3·36	= 98·34.
12. Gumuch,	47	3·82	77·82	8·62	1·80	8·13	3·11	= 99·48.
13. Naxos,	46	3·75	68·53	24·10	0·86	3·10	4·72	=101·31.
14. Nicaria,	46	3·74	75·12	13·06	0·72	6·88	3·10	= 98·88.
15. Gumuch,	42	4·31	60·10	33·20	0·48	1·80	5·62	=101·20.
16. Kulah,	40	3·89	61·05	27·15	1·30	9·63	2·00	—101·13.

B.B. unaltered, both alone and with soda; fuses entirely with borax, though with great difficulty; and also, if pulverized, with salt of phosphorus. Not attacked by acids. Friction excites electricity, and in polished specimens the electrical attraction continues for a considerable length of time.

The *red* sapphire is sometimes called *Oriental ruby;* the yellow, *topaz;* the green, *emerald;* violet, *amethyst;* and hair-brown, *adamantine spar;* the asteriated crystals, *asteria,* a name used by Pliny.

This species is associated with crystalline rocks, as granular limestone or dolomite, gneiss, granite, mica slate, chlorite slate. The fine sapphires are usually obtained from the beds of rivers, either in modified hexagonal prisms, or in rolled masses, accompanied by grains of magnetic iron ore, and several species of gems. The emery of Asia Minor, according to Dr. Smith, occurs in granular limestone.

The best ruby sapphires occur in the Capelan mountains, near Syrian, a city of Pegu, and in the kingdom of Ava; smaller individuals occur near Bilin and Merowitz in Bohemia, and in the sand of the Expailly river in Auvergne. Blue sapphires are brought from Ceylon; this variety was called *Salamstein* by Werner. Corundum occurs in the Carnatic on the Malabar coast, in the territories of Ava, and elsewhere in the East Indies; also near Canton, China. At St. Gothard it occurs of a red or blue tinge in dolomite, and near Mozzo in Piedmont, in white compact feldspar. Adamantine spar is met with in large coarse hexagonal pyramids on the Malabar coast, in Gellivara, Sweden. Emery is found in large boulders at Naxos, Nicaria and Samos of the Grecian islands; also in Asia Minor, 12 miles east of Ephesus, near Gumuch-dagh, where it was discovered in situ by Dr. J. Lawrence Smith, associated with margarite, chloritoid, pyrites, calc spar, etc.; and also at Kulah, Adula, and Manser, the last, 24 miles north of Smyrna; also with the nacrite (?) of Cumberland, England. Other localities are in Bohemia, near Petschau, in the Ural, near Katherinenburg, and in the Ilmen mountains, not far from Miask; Frederick Valley, Australia.

Blue sapphire occurs at Newton, N. J., (now rare), with hornblende, mica, feldspar, and tourmaline, in granular limestone; red variety at Vernon, N. J., near State line, crystals often several inches long; crystals of bluish and pink colors occur at Warwick, N. Y., in the cavities of large crystals of spinel. At Amity, N. Y., white, blue and reddish crystals accompany spinel and rutile in granular limestone. In Pennsylvania, grayish corundum occurs in large crystals in Delaware Co.; near Village Green in Aston; at Mineral Hill in loose crystals; also in crystals at Unionville, Chester Co., abundant, with tourmaline in margarite, and in albite some masses weighing 4000 pounds, and crystals being occasionally 4 inches long. Pale blue crystals are found with kyanite at West Farms, Conn. near Litchfield. A boulder of blue massive corundum, affording broad cleavage surfaces, has been found in Buncombe Co., North Carolina; and crystals and massive corundum in place in Gaston Co.; and a fine red sapphire has been obtained in Cherokee Co., Georgia. In Canada at Burgess, red and blue.

Red sapphire is the most highly esteemed. A crystal weighing four carats, perfect in transparency and color, has been valued at half the price of a diamond of the same size.

They seldom exceed half an inch in length. Two splendid red crystals, however, having the form of the pyramidal dodecahedron, and "de la longueur du petit doigt," with a diameter of about an inch, are said to be in the possession of the king of Arracan. Transparent blue sapphires are sometimes over three inches long.

The sapphire is cut by means of diamond dust, and polished on copper or lead wheels with the powder of emery.

The word *sapphire* is from the Greek *σαπφειρος*, the name of a *blue* stone, and probably the lapis lazuli, which agrees with the character given it by Theophrastus, Pliny, Isidorus, and others. The latter remarks, "Sapphirus cœruleus est cum purpura, habens pulveres aureos sparsos," particles of iron pyrites, which are frequently disseminated through lapis lazuli, looking like gold. Corundum is a word of Asiatic origin.

Altered Forms.—Corundum under some circumstances absorbs water and changes to diaspore; and perhaps also to the mica-like mineral margarite. It is also replaced by silica, forming *quartz* pseudomorphs.

HEMATITE. Specular Iron. Iron Glance. Peroxyd of Iron. Red Iron Ore. Oligiste Iron. Micaceous Iron Ore. Red Hematite. Red Clay Ironstone. Red Ochre. Iron Foam. Eisenglanz. Rotheisenstein, *W.* Blutstein, *Haus.* Rotheisenerz. Eisenoxyd, *L.* Rother Glaskopf. Fer Oligiste, *H.*

Rhombohedral. $R : R = 86° 10'$, $O : R = 122° 30'$; $a : 1{\cdot}3591$. Observed planes: rhombohedrons, $\frac{1}{16}$, $\frac{1}{4}$, $\frac{4}{7}$, $\frac{5}{8}$, 1 (R), $\frac{5}{2}$, 4, -5, -2, $-\frac{3}{2}$, -1, $-\frac{1}{2}$, $-\frac{2}{7}$, $-\frac{1}{4}$, $-\frac{1}{6}$, $-\frac{1}{8}$; scalenohedrons, 1^3, $\frac{2}{5}^3$, $-\frac{1}{2}^3$, $\frac{1}{5}^3$, 2^3; $\frac{1}{4}$ $-\frac{1}{2}^5$; pyramids, $\frac{1}{3}2$, $\frac{2}{3}2$, $\frac{4}{3}2$, $\frac{10}{3}2$, 42; prisms, I, $i2$, $i\frac{5}{4}$; and the basal plane O.

$O : 2 = 107° 40'$. $2 : 2 = 68° 47'$. $R : \frac{4}{3}2 = 154° 2'$.
$O : \frac{2}{3}2 = 137° 49'$. $5 : 5 = 61° 34'$. $R : \frac{1}{4} = 143° 55'$.
$O : \frac{4}{3}2 = 118° 53'$. $\frac{1}{4} : \frac{1}{4} = 143° 7'$. $R : i2 = 136° 55'$.
$O : 1^3 = 103° 32'$. $\frac{1}{2} : \frac{1}{2} = 115° 22'$. $1^3 : i2 = 162° 41'$.

Cleavage: parallel to O and R; often indistinct. Twins: face of composition R; also O. Also columnar—granular, botryoidal, and stalactitic shapes; also lamellar—laminæ joined parallel to O, and variously bent—thick or thin; also granular—friable or compact.

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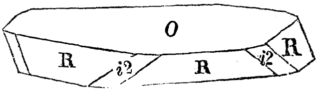
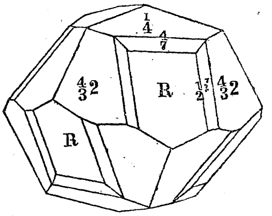


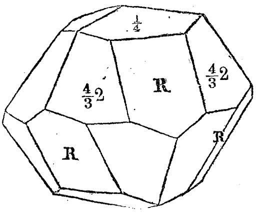
Vesuvius.

312



Elba.

313



Elba.

H.=5·5—6·5. G.=4·5—5·3; of some compact varieties, as low as 4·2. Lustre metallic and occasionally splendent; sometimes earthy. Color dark steel-gray or iron-black; when earthy, red. Streak cherry-red or reddish-brown. Opaque, except when in very thin laminæ, which are faintly translucent, and blood-red. Fracture subconchoidal, uneven. Sometimes slightly attractable by the magnet.

Composition.—$\dddot{\bar{\mathrm{F}}}\mathrm{e}$=Iron 70, oxygen 30.

B.B. infusible alone; with borax forms a green or yellow glass. Dissolves readily in heated muriatic acid, when pulverized.

This species includes the old species specular iron and red iron ore, the latter uncrystallized, and presenting the color of the former when in powder. *Specular iron* includes specimens of a perfect metallic lustre; if the structure is micaceous, it is called *micaceous iron.* The varieties of a sub-metallic or non-metallic lustre, were included under the name of *red hematite, fibrous red iron;* or if soft and earthy, *red ochre,* and when consisting of slightly coherent scales, *scaly red iron,* or *red iron froth.* Under this species must also be included different clay or argillaceous iron ores, many of which contain but small portions of iron; *reddle* or *red chalk,* the common drawing material, which has an earthy appearance and a flat conchoidal fracture; *jaspery clay iron,* more firm in its structure than the preceding, and having a large and flat conchoidal fracture; *columnar* and *lenticular argillaceous iron,* distinguished by a columnar or flat granular structure. *Itabirite* is a granular slaty rock consisting of specular or magnetic iron and quartz.

Specular iron occurs in crystalline rocks; also among the ejected lavas of Vesuvius, etc. Argillaceous ores form beds in secondary rocks. It is usually an associate of emery.

Fine specimens of this species are brought from the island of Elba, which has afforded it from a very remote period, and is described by Ovid as "Insula inexhaustis chalybdum generosa metallis." The surfaces of the crystals often present an irised tarnish, and brilliant lustre. The faces *O* and $\frac{1}{4}$ are usually destitute of this tarnish and lustre, and may therefore assist, when present, in determining the situation of other planes when the crystal is quite complex. St. Gothard affords beautiful specimens, composed of crystallized plates grouped in the form of rosettes, and accompanying crystals of feldspar. Near Limoges, France, it occurs in large crystals. Fine crystals are the result of volcanic action at Etna and Vesuvius, and particularly in Fossa Kankarone, on Monte Somma, where it incrusts the ejected lavas. Arendal in Norway, Langbanshyttan in Sweden, Framont in Lorraine, Dauphiny, and Switzerland, also afford splendid specimens. Red hematite occurs in reniform masses of a fibrous concentric structure, near Ulverstone in Lancashire, in Saxony, Bohemia, and the Hartz. In Westphalia it occurs as pseudomorphs of calcareous spar. In Brazil it is associated with quartz.

Hematite, both compact, micaceous, and jaspery, is abundant in St. Lawrence and Jefferson Cos., N. Y., at Gouverneur, Hermon, Edwards, Fowler, Canton, &c. Handsome irised crystallizations of specular iron are found at Fowler, in cavities in granular micaceous iron ore, associated often with splendid groups of quartz crystals. Other localities are Woodstock and Aroostook, Me., and Liberty, Md. Occurs also in the Blue Ridge, in the western part of Orange Co., Va. Micaceous iron in large masses, composed of irregular curved laminæ, occurs at Hawley, Mass., and Piermont, N. H.; also eight miles above Falmouth, Stafford Co., Va., on the Rappahannock river; St. Armand, Canada East. Red hematite is found at Ticonderoga, upon Lake George. The iron mountain and Pilot Knob of Missouri are situated about fourteen miles from the La Motte lead mines, and ninety miles south of St. Louis. The Iron Mountain is 300 feet in height, and consists wholly of massive peroxyd of iron lying in loose blocks, which are largest about the summit, many 10 to 20 tons in weight. The Pilot Knob is estimated by J. D. Whitney at 650 feet in height; it is made up of a quartzose rock of the azoic period and is capped with specular iron which has an appearance of stratification and is micaceous in structure. Lenticular argillaceous ore is abundant in upper Silurian rocks, in Oneida, Herkimer, Madison, and Wayne Cos., N. Y., constituting one or two beds, ten to twenty inches thick, in a compact sandstone; and the same exists in similar strata in Pennsylvania and as far south as Alabama. Large beds exist at Wallace Mine, Lake Huron and McNab, and Marmora, Canada West.

This ore affords a considerable portion of the iron manufactured in different countries. The varieties, especially the specular, require a greater degree of heat to smelt than other ores, but the iron obtained is of good quality. Pulverized red hematite is employed in polishing metals, and also as a coloring material. This species is readily distinguished from magnetite by its reddish streak.

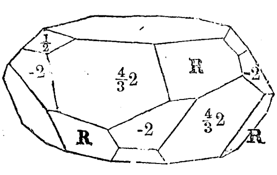
Hematite, a word in use among the ancients, was applied to this species on account of the red color of the powder, from *αἷμα, blood.* The term *specular* alludes to the brilliant lustre it often presents.

Altered Forms.—By deoxydation through organic matter forms *magnetite* or protoxyds; and from the latter comes *spathic iron* by combination with carbonic acid; or by further deoxydation through sulphuretted hydrogen, forms *pyrites.* By combination with water, forms *Limonite.* Limonite, magnetite, and pyrites, constitute occurring pseudomorphs after Hematite.

ILMENITE, *Kupffer.* Titanate of Iron. Crichtonite, *Bournon.* Titaniferous Iron. Menaken, Menaccanite, Kibdelophan, Basanomelan, *Kobell.* Titaneisen. Hystatite. Washingtonite, *Shepard.* Mohsite, *Levy.*

Rhombohedral; tetartohedral to the hexagonal type. $R : R = 85° 40'—86° 10'$, 86° 5, Rose and Descloizeaux, 85° 59′, Mohs. Observed planes: rhombohedrons $\frac{2}{5}$, 1(R), -5, $-\frac{2}{5}$, -2, $-\frac{1}{2}$; pyramids, $\frac{2}{3}2$, $\frac{4}{3}2$, $\frac{10}{3}2$, which are hemihedral; also I, $i2$, O. Angles nearly as in Hematite. Often a cleavage parallel with the terminal plane,—but properly due to planes of composition. Crystals usually tabular. Twins: face of composition O; sometimes producing when repeated a form resembling f. 313. Often in thin plates or laminæ, angular masses or grains.

314



H.=5—6. G.=4·5—5. Lustre submetallic. Color iron-black. Streak metallic, black to brownish-red. Opaque. Fracture conchoidal. Influences slightly the magnetic needle.

Varieties.—This species includes several varieties which have been considered distinct species. They are however identical in crystallization, and the differences arise, as shown by Rose, from the isomorphous nature of titanic oxyd and peroxyd of iron. The following are the most important of these varieties:

Axotomous Iron, Kibdelophan of Kobell.—Physical characters as above. H.=5—5·5. G.=4·661, Mohs; 4·723—4·735, Breit. Occurs in crystals; usually massive, or in thin plates or laminæ; $R : R$=85° 59′.

Ilmenite.—Occurs crystallized and massive at Lake Ilmen, near Miask, whence the name *Ilmenite.* In general the physical characters the same as above. H.=6. G.=4·895, Breit.; $R : R$=85° 43′.

Mennaccanite.—Occurs massive with traces of cleavage and in grains. Fracture uneven to flat conchoidal. H.=5·5. G.=4·7—4·8. Streak black. Color light iron-black to steel-gray. Magnetic. First observed at Mennaccan, Cornwall.

Crichtonite.—In acute rhombohedrons; $R : R$=86° 6½′; $-5 : -5$=61° 27′. H.=6. G.=4·79. Cleavage imperfect. From Oisans.

Hystatite. Hystatisches Eisenerz, Breit.—Titaniferous iron from Arendal. $R : R$=86° 10′. Cleavage, and color as in Ilmenite. H.=6. G.=5.

The *Washingtonite* of Shepard, (Am. J. Sci. xliii, 364), is near Hystatite. It occurs in large tabular crystals, sometimes two inches in diameter. They are hexagonal tables with the faces of the rhombohedron; $R : R$=86°, (obtained by varnishing the faces). Rhombohedral cleavage often distinct; O the brightest face, R the least so. H.=5·75. G.=4·963, from Westerly; 5·016, from Litchfield. Anal. 13, 14.

Eisenrose, Basanomelan of Kobell, is placed by Breithaupt along with hystatite.

Titaniferous iron sand or *trappisches eisenerz* of Breithaupt, is described as occurring in octahedrons and cubes in roundish grains. It is iserine, (p. 102).

The *titaniferous iron* of Aschaffenburg.—Occurs massive and in plates, with imperfect cleavage in one direction. H.=6. G.=4·78. Color iron-black.

Composition.—Ŧi and Ꞙe in various and probably indefinite proportions. *H. Rose.* Rose holds that the T̈i (titanic acid) and Ḟe (protoxyd of iron) found in analyses, arise from an oxydation of the titanic oxyd (Ŧi) of the mineral, at the expense of the Ꞙe, which takes place during the investigation. Berzelius sustained the view of Rose both on atomic grounds, and on that of the magnetism of the mineral. Rose shows that the specific gravity increases with the proportion of iron.

Analyses: 1, Kobell, (Schw. J. lxiv, 59, 245); 2, Marignac, (Ann. Ch. Phys. [3], xiv, 50); 3, 4, Mosander, (K. V. Ac. H. 1829, 220, and Pogg. xix, 211); 5, Delesse, (Thèse sur l'empl. de l'anal. etc. p. 46); 6, H. Rose, (Pogg. iii, 163); 7, Kobell, (loc. cit.); 8–12, Mosander, (loc. cit.); 13, Kendall, (This work, 2d edit. p. 527); 14, Marignac, (loc. cit.); 19, Plantamour, (J. f pr. Chem. xxiv, 302); 16–18, Kobell, (loc. cit.); 19, Rammelsberg, (3d Supp. 122); 20, T. S. Hunt, (Logan's G. Rep. 1849, 1850, 105, and Amer. Jour. Sci. [2], xi, 231):

		T̈i	Ꞙe	Ḟe
1.	*Kibdel.* Gastein,	59·00	4·25	36·00, Ṁn 1·65=100, Kobell.
2.	*Uricht.* St. Cristophe,	52·27	1·20	46·53=100, Marignac.
3.	*Ilmenite,* Ilmen, Mts.,	46·92	10·74	37·86, Ṁn 2·73, Ṁg 1·14=99·39, Mos.
4.	" "	46·67	11·71	35·37, Ṁn 2·39, Ṁg 0·60, Ċa 0·25, C̶r 0·38, S̈i 2·80=100·17, Mosander.
5.	" "	45·4	40·7	14·1, Ċa 0·5, S̈n 0·5, Ṗb 0·2=101·4, D.
6.	" Egersund,	43·73	42·70	13·57=100, Rose.
7.	*Menacc.* "	43·24	28·66	27·91=99·81, Kobell.
8.	" "	42·57	23·21	29·27, Ċa 0·50, Ṁg 1·22, C̶r 0·33, S̈i 1·65=98·75, M.
9.	" "	41·08	25·93	29·04, Ċa 0·49, Ṁg 1·94, Ẏt and C̶e 0·58, S̈i 0·07=99·13, M.
10.	" "	39·04	29·16	27·23, Ċa 0·96, Ṁg 2·30, Ṁn 0·21, C̶r 0·12. S̈i 0·31=99·13, M.
11.	*Hystatite,* Arendal,	24·19	53·01	19·91, Ċa 0·33, Ṁg 0·68, S̈i 1·17=99·29, M.
12.	" "	28·59	58·51	13·90, Ċa 0·86, Ṁg 1·10, C̶r 0·44, S̈i 1·88, =100·28, M.
13.	" Conn.	25·28	51·84	22·86=99·98, Kendall.
14.	" "	22·21	59·07	18·72=100, Marignac.
15.	*Titan. I.* Uddewalla,	15·56	71·25	11·32 F, S̈i and loss 1·87=100, Plant.
16.	" Aschaffenberg,	14·16	75·00	10·04, Ṁn 0·80,=100, Kobell.
17.	*Basanom.* Schweiz,	12·67	82·49	4·84=100, Kobell.
18.	*Titanic I.* "	10·0	88·5	1·5 with Ṁn=100, Kobell.
19.	" Binnen,	Ŧi 8·58	Ꞙe 91·42=100, Rammelsberg.	
20.	St. Paul, Canada,	Ŧi 48·60	Ḟe 46·44, including some peroxyd, Ṁg 3·60=98·64, [Hunt. G.=4·66.	

A large crystal from Miask gave E. E. Schmid (Pogg. lxxxiv, 498), Ŧi 28·05, Ꞙe 70·7, Ṁn 0·7=99·9. Specific gravity of Miask mineral, 4·579—4·780, and after long heating 4·950—4·963, Kengott, (Min. Unters. ii, 124).

The proportion of peroxyd of titanium to peroxyd of iron in analyses 1 to 20, according to the view of Rose, is as follows:—

	Ŧi : Ꞙe						
Anal. 1,	5 : 4	(G. 4·66)=53·6	peroxyd of	Ti,	to 46·4	peroxyd	of Fe.
2,	1 : 1	(G. 4·727)=48·1	"	"	51·9	"	"
3–5,	4 : 5	(G. 4·77)=42·5	"	"	57·5	"	"
6–9,	2 : 3	(G. 4·74)=38·2	"	"	61·8	"	"
11,	1 : 3	(G. 4·93)=23·6	"	"	76·4	"	"
14,	1 : 4	(G. 4·96)=18·8	"	"	81·2	"	"
15,	1 : 6	(G. 4·78)=13·4	"	"	86·6	"	"
17,	1 : 8	=10·4	"	"	89·6	"	"
20,	1 : 10	(G. 5·127)= 8·5	"	"	91·5	"	"

B. B. alone unchanged. With salt of phosphorus in the reduction flame, a dull red glass. Dissolves very slowly in muriatic acid.

Fine crystals of ilmenite, sometimes an inch in diameter, occur in Warwick, Amity, and Monroe, Orange County, N. Y., imbedded in serpentine and white limestone, and associated with spinel, chondrodite, rutile, &c.; also four miles west of Edenville, and near Greenwood furnace with spinel and chondrodite; also at South Royalston, Mass. Vast deposits or beds of titanic iron occur at St. Paul's Bay and Canada, with rutile in syenite; one bed 200 feet long and 90 broad; also at Vandreuil Beauce, mixed with magnetite as a vein in serpentine; G.=4·56–4·66. Also with labradorite at Chateau Richer. Grains are found in the gold sand of California.

PLATTNERITE, *Haid.* Superoxyd of Lead. Schwerbleierz, *Breit.*

In hexagonal prisms with replaced basal edges, planes O, I, 1, but pseudomorphous after pyromorphite, (Greg); cleavage indistinct. G.=9·39—9·45. Lustre metallic adamantine. Color iron-black. Streak brown. Opaque.

Composition.—$\mathrm{Pb\,O^2}$=Lead 86·6, oxygen 13·4. Probably from Leadhills, Scotland. A doubtful species.

TENORITE, *Semmola.* Opere Minori di Giovanni Semmola, Napoli, 1841, p. 45. Bull. Soc. Geol. de la France, xiii, 1841–42, p. 206.

Hexagonal? Crystals small tabular or like scales. Lustre metallic. Color dark steel-gray. Streak black. Thin folia translucent and brown.

Composition.—Ȼu O^2=Oxygen 20·15, copper 79·85.

Found on lava at Vesuvius, in minute scales from $\frac{1}{20}$ to $\frac{1}{8}$ of an inch in diameter, often hexagonal, and sometimes triangular. Usually associated with common salt.

The Melaconite (p. 109) may belong here, if the observed cubes of the mineral were pseudomorphs, which is hardly probable.

III, DIMETRIC OXYDS.

BRAUNITE. Hartbraunstein, *Haus.*

Dimetric; $O : 1i = 135° 26'$; $a = 0·98525$. Observed planes O, 1, 2, 22:

$O : 1 = 125° 40'$.
$O : 2 = 109° 45'$.
$1 : 1$ (pyr.)$= 109° 53'$.
$2 : 2$ (pyr.)$= 96° 33'$.
$22 : 22$ (pyr. axial)$= 128° 17'$.
$22 : 22$ (pyr. diag.)$= 144° 4'$.

$1 : 1 = 109° 46'$ and $108° 53'$, according to Descloizeaux. Occurs also massive.

H.=6—6·5. G.=4·75—4·818. Lustre submetallic. Streak and color dark brownish-black. Fracture uneven. Brittle.

Composition.—$\dddot{\bar{\mathrm{M}}}\mathrm{n}$(=$\dot{\mathrm{M}}\mathrm{n}\dddot{\bar{\mathrm{M}}}\mathrm{n}$)=Manganese 69·68, oxygen 30·32. Analyses: 1, Turner, (Edinb. Trans. xi); 2, Tronsager, (Pogg. lxv, 276); 3, C. Bechi, (Am. J. Sci., [2], xiv, 62); 4, A. J. Scott, (Jameson's J., 1852, liii, 277); 5, Damour, (Ann. d. Mines, [4], i, 400):

1. Eglersburg,	$\dot{\mathrm{M}}\mathrm{n}$ 86·94	O 9·85	$\dot{\mathrm{B}}\mathrm{a}$ 2·26	$\dot{\mathrm{H}}$ 0·95	$\dddot{\mathrm{S}}\mathrm{i}$ *trace*=100, Tur.; G. 4·818.
2. Tellemark,	$\dddot{\bar{\mathrm{M}}}\mathrm{n}$ 86·40	—	—	1·98	6·22, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 1·57, *gangue* 3·62. =99·79, Tr.
3. Elba,	$\acute{\mathrm{M}}\mathrm{n}$ 88·31	3·08	1·03	2·08	0·75, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 4·75=100, Bechi.
4. Vizianagram,	$\ddot{\mathrm{M}}\mathrm{n}$ 73·79	1·86	$\dot{\mathrm{M}}\mathrm{g}$ 2·34	0·54	8·30, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 12·91=99·74, S. G.=4·50.
5. *Marceline,*	" 67·37	$\dot{\mathrm{M}}\mathrm{n}$ 19·17	$\dot{\mathrm{C}}\mathrm{a}$ 1·22	—	7·71, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 1·45, *gangue*, 2·72.

B.B. alone infusible. With concentrated muriatic acid evolves chlorine, and Marceline gelatinizes.

Occurs both crystallized and massive, in veins traversing porphyry, at Oehrenstock, near Ilmenau, at Eglersberg in Thuringia; also near Ihlefeld in the Hartz, at St. Marcel in Piedmont; at Elba; at Vizianagram in India. Found also at Brandon and Chittenden, Vt. The species was named in honor of Mr. Braun of Gotha.

Marceline is an impure Braunite, as shown by Damour and Descloizeaux. Descloizeaux's measurements were from St. Marcel crystals. G.=4·75, Damour.

Braunite is supposed by Volger (on the ground of an approximation in form to rutile) to be an altered mineral, changed by deoxydation from $\ddot{\mathrm{M}}\mathrm{n}$; but the angles differ rather widely.

HAUSMANNITE. Black Manganese. Red Oxyd of Manganese. Braunstein, *Haus.* Manganèse Oxydé Hydraté, *H.*

Dimetric; $O : 1i$=130° 25′; a=1·1743. Observed planes 1, $\frac{1}{3}$, $1i$; forms octahedral.

$O : 1$=121° 3′. $\frac{1}{3} : \frac{1}{3}$ (pyr.)=139° 57′.
1 : 1 (pyr.)=105° 25′. $1i : 1i$ " =114° 52′.
$O : \frac{1}{3}$=151° 2′. 1 : $1i$ 142° 42′.

Cleavage: basal, nearly perfect. Twins, parallel to $1i$; nearly like f. 200; the same kind of composition sometimes between four individuals. Also granular, particles strongly coherent.

H.=5—5·5. G.=4·722. Lustre submetallic. Color brownish-black. Streak chestnut-brown. Opaque. Fracture uneven.

Composition.—$\dot{\mathrm{M}}\mathrm{n}\dddot{\bar{\mathrm{M}}}\mathrm{n}$=Manganese 72·1, oxygen 27·9=$\dddot{\bar{\mathrm{M}}}\mathrm{n}$ 69, $\acute{\mathrm{M}}\mathrm{n}$ 31. Analyses: 1, Turner, (Trans. Roy. Soc. Edinb. xi); 2, Rammelsberg, (Pogg. xiv, 222):

	$\dot{\mathrm{M}}\mathrm{n}$	$\dddot{\bar{\mathrm{M}}}\mathrm{n}$	O	$\dot{\mathrm{B}}\mathrm{a}$	$\dddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{H}}$
1. Ihlefeld,	98·902		0·215	0·111	0·337	0·435=100, Turner.
2. Ilmenau,	92·487	——	7·004	0·150	——	——=99·641, Ramm.

B.B. acts like manganite. Dissolves in heated muriatic acid, affording chlorine.

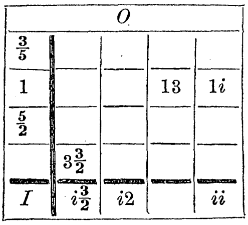
Occurs with porphyry, along with other manganese ores, in fine crystals, near Ilmenau in Thuringia, and Ihlefeld in the Hartz. Reported also from Framont in Alsace. Observed at Lebanon, Penn.

CASSITERITE, *Beud.* Tin Ore. Oxyd of Tin. Peroxyd of Tin, *Thom.* Tin Stone. Wood Tin. Stream Tin. Zinnerz, Zinnstein, *W.* Etain Oxydé, *H.*

Dimetric; $O : 1i$=146° 5′; a=0·6724.

$O : 1$ =136° 26′. $O : 3\frac{3}{2}$=112° 25′. $I : 1$ =133° 34′.
$O : \frac{5}{2}$ =112° 49′. 1 : 1 (pyr.)=121° 40′. $1i : 1i$(pyr.)=133° 31′.
$O : 13$=144° 40′. 1 : 1 (bas.)= 87° 7′. $I : i\frac{3}{2}$=168° 42′.

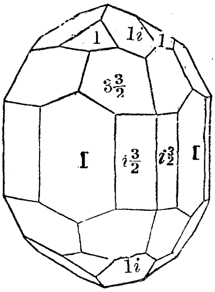
Cleavage: *I* and *ii* hardly distinct. Twins: f. 205 plane of composition 1*i*; also f. 316. Often in reniform shapes, structure fibrous divergent; also massive, granular or impalpable.



O				
$\frac{3}{5}$				
1			13	1i
$\frac{5}{2}$				
	$3\frac{3}{2}$			
I	$i\frac{3}{2}$	$i2$		ii

Observed Planes.

315



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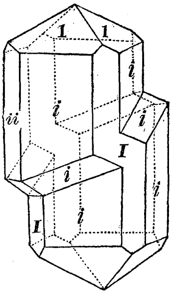

H.=6—7. G.=6·3—7·1; 6·96, crystallized variety; 6·514, thin columnar variety. Lustre adamantine, and crystals usually splendent. Color brown or black; sometimes red, gray, white, or yellow. Streak white, grayish, brownish. Nearly transparent—opaque. Fracture subconchoidal, uneven. Brittle.

Composition.—$\ddot{\mathrm{Sn}}$=Tin 78·38, oxygen 21·62. Berzelius, (Afhand.iv, 164), found in a Finbo specimen:

$\ddot{\mathrm{Sn}}$ 93·6 $\ddot{\mathrm{Ta}}$ 2·4, $\dddot{\mathrm{Fe}}$ 1·4, $\dddot{\mathrm{Mn}}$ 0·8=98·2.

In another specimen from the vicinity of Fahlun, Berzelius found 7 per cent. of columbic acid. Vauquelin obtained 9 per cent. of peroxyd of iron from *wood tin.*

B.B. on charcoal, reducible, but with difficulty; reduction takes place more rapidly if mixed with borax and carbonate of soda. Alone in the forceps infusible. Insoluble in acids. Fused with caustic potash it yields a mass which is mostly soluble in water; hydriodic acid throws down from the solution a yellow precipitate.

Tin ore is met with in veins traversing granite, gneiss, mica or clay slate, and porphyry.

Cornwall affords remarkable simple crystals, associated with fluor, apatite, topaz, blende, wolfram, &c. The singular compound crystals come mostly from Bohemia and Saxony. The twin forms from Zinnwald and Schlackenwald often weigh several pounds. At Limoges splendid crystals occur. Also found in Galicia, Greenland, Sweden, and the peninsula of Malacca and the island of Banca in the East Indies.

The *fibrous* or *wood tin* occurs in botryoidal and reniform shapes of a radiated structure, and composed of concentric coats, and is found in Cornwall and Brazil. *Toad's eye tin* is the same, on a small scale. *Stream tin* is the alluvial debris of tin veins which is separated from the gravel by washing. It occurs in the low grounds of Cornwall.

The United States have afforded a few small crystals of tin at Chesterfield and Goshen, Mass., associated with albite and tourmaline; also at Lyme, N. H., and somewhat more abundantly on the estate of Mr. Eastman, in the town of Jackson, N. H., where it was discovered by Dr. C. T. Jackson; also observed sparingly in some of the gold mines of Virginia, by Prof. Rogers, imbedded in a talco-micaceous slate.

RUTILE. Nigrine. Gallicinite. Sagenite, *Saussure.* Crispite. Titane Oxydé, *H.* Titanic Acid, *Thom.* Eisentitan, *Hausm.*

Dimetric. $O : 1i = 147^\circ\ 12\frac{1}{2}'$, $a = 0{\cdot}6442$.

$O : 1 = 137^\circ\ 40'$. $1 : 1$ (pyr.) $= 123^\circ\ 8'$. $I : i2 = 161^\circ\ 34'$.
$O : 3\frac{3}{2} = 113^\circ\ 18'$. $1 : 1$ (bas.) $= 84^\circ\ 40'$. $I : i3 = 153^\circ\ 26'$.
$O : 13 = 145^\circ\ 49'$. $I : i\frac{3}{2} = 168^\circ\ 42'$. $ii : i2 = 153^\circ\ 26'$.

$1 : 1 = 123^\circ\ 7\frac{1}{2}'$, Kokscharov, Pogg. xci, 154, 1854. Cleavage I and ii, distinct. Vertical planes usually striated. Crystals often acicular. Often in singly and doubly geniculated crystals, (f. 206); composition parallel to $1i$; also rarely parallel to $3i$. Massive, compact.

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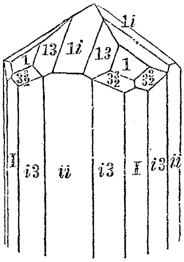

O						
$\frac{3}{4}$						
1			13			$1i$
	$3\frac{3}{2}$					$3i$
I	$i\frac{3}{2}$	$i2$	$i3$	$i4$	$i7$	ii

Observed Planes.

H. = 6—6·5. G. = 4·18—4·25; 4·249, Ohlapian, Nigrine; 4·244, Snarum. Lustre metallic-adamantine. Color reddish-brown, passing into red; sometimes yellowish, also black. Streak pale brown. Subtransparent—opaque. Fracture subconchoidal, uneven. Brittle.

Composition.—Titanic Acid, $\ddot{\text{Ti}}$ = Titanium 60·98, oxygen 39·02. The black variety *nigrine,* contains 1·5 to 2·5 per cent. of oxyd of iron. Analyses: 1, Damour, (Ann. Ch. Phys. [3], x, 417); 2, Kersten, (J. f. pr. Chem. xxxvii, 170); 3, 4, Demoly, (Lieb. u. K. Jahresb. 1849, 728); 5, H. Müller, (J. f. pr. Ch. lvii, 184):

$\ddot{\text{Ti}}$ $\ddot{\bar{\text{F}}}\text{e}$
1. St. Yrieix, *rdh. subtrp.* G. = 1·209, 97·60 1·55 = 99·15, Damour.
2. Freiberg, *nigrine.* G. = 4·242, 96·75 1·40 with magnetite = 99·15, Kersten.
3. $\ddot{\text{Ti}}$ 96·41 $\ddot{\bar{\text{F}}}\text{e}$ 1·63 $\ddot{\bar{\text{M}}}\text{n}$ 0·13, $\ddot{\text{Si}}$ 1·83 = 100, Demoly.
4. 96·45 1·62 " 0·14, " 1·79 = 100, "
5. Terschenreuth, 86·2 $\dot{\text{F}}\text{e}$ 14·2 = 100·4, H. Müller. G. = 4·56.

The magnetite in No. 2 was easily separated by a magnet after pulverizing.

B.B. unaltered. With borax forms a hyacinth-red bead in the outer flame, less pure than the color with anatase.

Rutile occurs in granite, gneiss, mica slate, and syenitic rocks, and sometimes in granular limestone. It is generally found in imbedded crystals, often in masses of quartz or feldspar, and frequently occurs in acicular crystals penetrating quartz. It has also been met with in specular iron.

Brazil affords acicular crystals in limpid quartz; also occurs in Arendal in Norway; Saualpe, Carinthia; in the Urals; in the Tyrol; at St. Gothard; at Yrieix, in France; Krummhennersdorf, near Freiberg; in Castile, in geniculated crystals, often large. At Ohlapian in Transylvania, *Nigrine* in pebbles; in large crystals in Perthshire; at Cairngorm, Scotland; at Craig Cailleach near Killin, and in Bengloe, in isle of Burray, Shetland. A variety from Karingsbricka in Sweden contains a small percentage of chrome, and is the *titane oxydé chromifère* of Haüy. Rough octahedrons, reticulated within, from Brazil, are supposed to be pseudomorphs after anatase.

Fine rutiles occur in Massachusetts, in gneiss at Barre, crystals occasionally an inch and a half in diameter; at Windsor, in feldspar veins intersecting chlorite slate; at Shelburne, in fine crystals in mica slate; at Leyden, with scapolite; at Conway, with gray epidote. In Vermont, at Waterbury, Bristol, Dummerston, and Putney; also in capillary forms in transparent quartz, exceedingly beautiful, but exhausted. In New Hampshire, sparingly at Lyme, with tourmaline; near Hanover, rarely in magnificent specimens of acicular crystals in quartz, only in loose masses. In Maine, at Warren, along with tremolite and copper pyrites. In Connecticut, at Lane's Mine, Monroe, and in the adjoining town of Huntington. In New York, in Orange Co., a mile north of Edenville, with pargasite in linestone boulders; two miles east of Warwick, in granite with zircon; a mile east of Amity, in quartz with brown tourmaline, and two miles west, with spinel and corundum, and also two miles southwest, in dark-blue eight-sided prisms with red spinel and chondrodite; near Warwick, in slender prisms penetrating quartz; in New York Co., in veins of quartz, feldspar, and mica traversing granular limestone, at Kingsbridge; and in the limestone of Essex Co. In Pennsylvania, in fine long crystals, at Sadsbury, Chester Co., and the adjoining district in Lancaster Co.; at Parksburg, Concord, West Bradford, and Newlin, Chester Co.; at the Poor House quarry, Chester Co., in delicate crystals, sometimes iridescent, on dolomite. In New Jersey, at Newton, with spinel. In North Carolina, at Crowder's Mountain. In Georgia, in Habersham Co. In the district of Columbia, sparingly, at Georgetown. In Canada, small crystals with specular iron at Sutton, C. E.; in the ilmenite of Bay St. Paul, C. E., orange translucent grains, pure $\ddot{T}i$, and probably rutile or brookite.

The oxyd of titanium is employed for a yellow color, in painting porcelain, and also for giving the requisite tint to artificial teeth.

Rutile is so named from the Latin *rutilus*, which signifies *a shining red.* Saussure named a reticulated variety *sagenite*, from *σαγηνη, a net.*

ANATASE. Octahedrite, *J.* Oisanite. Titane Anatase, *H.*

Dimetric; commonly octahedral, or tabular: $O : 1i = 119° 26'$; $a = 1·7723$.

$O : \frac{1}{5} = 153° 22'$. $O : 2i = 105° 45'$. $2i : 2i$ (bas.) $= 148° 30'$.
$O : \frac{1}{7} = 160° 47'$. $1 : 1$ (pyr.) $= 97° 55'$. $1i : 1i$ (bas.) $= 121° 8'$.
$O : 1 = 111° 45'$. $1 : 1$ (bas.) $= 136° 30'$. $O : I = 90°$.

Cleavage: 1 and O, perfect.

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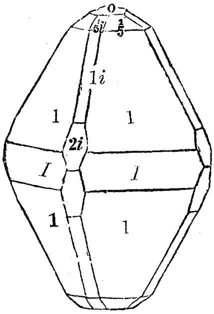

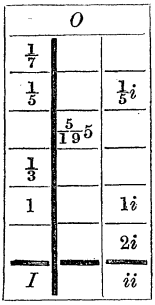

O		
$\frac{1}{7}$		
$\frac{1}{5}$		$\frac{1}{5}i$
	$\frac{5}{19}5$	
$\frac{1}{3}$		
1		$1i$
		$2i$
I		ii

Obs. Planes. Add $3i$.

H.=5·5—6. G.=3·83—3·95; sometimes 4·11—4·16 after heating. Lustre metallic-adamantine. Color various shades of brown, passing into indigo-blue; greenish-yellow by transmitted light. Streak uncolored. Fracture subconchoidal. Brittle.

Composition.—Anatase, like rutile and brookite, is pure titanic acid. When heated it gives out a reddish-yellow phosphorescent light, which appears suddenly like a flame and is soon over. Rose found in crystals from Brazil 1·25 per cent. peroxyd of iron, and Damour obtained in an analysis, (Ann. Ch. Phys, [3], 10, 417), $\ddot{\mathrm{Ti}}$ 98·36, $\dddot{\mathrm{F}}\mathrm{e}$ 1·11, $\ddot{\mathrm{Sn}}$ 0·20=99·67.

Anatase occurs most abundantly at Bourg d'Oisans in Dauphiny, with feldspar, axinite, and ilmenite. Found in mica slate in the Grisons, in Bavaria, near Hof in the Fichtelgebirge, Norway, and the Urals; in chlorite in Devonshire; with Brookite at Tremadoc, in North Wales; in Brazil in quartz, and in detached crystals so splendent as to be sometimes mistaken for diamonds.

According to Beck, anatase accompanies native titanium in slags from the iron furnaces of Orange County, N. Y.

IV. TRIMETRIC OXYDS.

CHALCOTRICHITE, *Glocker.* Capillary Red Oxyd of Copper. Haarformiges Rothkupfererz. Kupferblüthe, *Haus.*

Trimetric. *I* : *I*=140°—150°, the prisms with the acute and obtuse edges truncate, Kengott. Observed planes, *I*, $i\bar{\imath}$, $i\breve{\imath}$. Usually in fine capillary crystallizations grouped or reticulated. Cleavage: rhombohedral, perfect.

G.=5·8. Color cochineal and crimson-red.

Composition.—Identical with Red Copper. Kersten detected Selenium.

Occurs at Rheinbreitenbach, Moldawa, and at N. Tagilsk. Kengott's specimens were from each of these localities. A capillary red copper occurs also at the Perkiomen copper mine, according to C. M. Wheatley.

Mr. Brooke has shown that the fibrous red copper of Cornwall and Siberia is monometric, the fibres being enlongated cubes. Kengott has recently confirmed his own measurements.

CHRYSOBERYL. Cymophane, *H.* Krisoberil, *W.* Alexandrite.

Trimetric. *I* : *I*=119° 46′; *O* : $1\bar{\imath}$=140° 59′; *a* : *b* : *c*=0·81 : 1 : 1·72.

O : $\frac{3}{2}\bar{\imath}$=129° 27′. *O* : $1\breve{\imath}$=154° 49′. 1 : 1 (brach.)=93° 44′.
O : 1 =136° 52′. *O* : $2\breve{\imath}$=136° 46′. $1\bar{\imath}$: $1\bar{\imath}$ (top)=101° 58′.
O : 2 =118° 05′. *O* : $3\breve{\imath}$=125° 20′. $1\breve{\imath}$: $1\breve{\imath}$ (top)=129° 38′.
O : $2\breve{2}$=128° 52′. 1 : 1 (mac.)=139° 53′. $3\breve{\imath}$: $3\breve{\imath}$ (top)=70° 41′.

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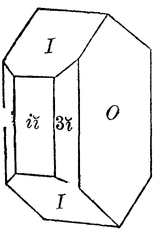

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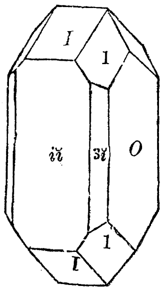

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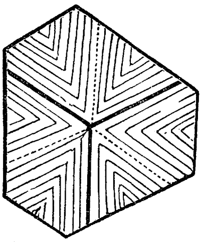


O			
	½		
$1\bar{\imath}$	1		$1\breve{\imath}$
$\frac{3}{2}\bar{\imath}$			
	2	$2\breve{2}$	$2\breve{\imath}$
			$3\breve{\imath}$
			$\frac{7}{2}\breve{\imath}$
$i\bar{\imath}$	*I*		$i\breve{\imath}$

Observed Planes.

Cleavage parallel to $i\breve{i}$; O less distinct. Twins: face of composition, I, f. 209, 322.

H.=8·5. G.=3·5—3·8; 3·597, Haddam; 3·733, Brazil; 3·689, Ural, Rose. Lustre vitreous. Color asparagus-green, grass-green, emerald-green, greenish-white, and yellowish-green: sometimes raspberry or columbine-red by transmitted light. Streak uncolored. Transparent—translucent. Sometimes a bluish opalescence internally. Fracture conchoidal, uneven.

Composition.—($\dddot{\mathrm{B}}\mathrm{e}+\dddot{\mathrm{A}}\mathrm{l}^3$)=Alumina 80·2, glucina 19·8=100. Analyses: 1, 2, 3, Avdejev, (Pogg. lvi, 118); 4, 5, Damour, (Ann. Ch. Phys. [3], vii, 173):

	$\dddot{\mathrm{A}}\mathrm{l}$	$\dddot{\mathrm{B}}\mathrm{e}$	$\dot{\mathrm{F}}\mathrm{e}$	
1. Brazil,	78·10	17·94	4·47=100·15,	Avdejev; G.=3·7337.
2. "	78·71	18·06	3·47=100·24,	"
3. Ural,	78·92	18·02	3·12,	$\ddot{\mathrm{C}}\mathrm{r}$ 0·36, $\dot{\mathrm{C}}\mathrm{u}$ and $\dot{\mathrm{P}}\mathrm{b}$ 0·29=100·71, Avdejev.
4. Haddam, Ct.,	76·02	18·41	—,	$\dddot{\mathrm{F}}\mathrm{e}$ 4·51, quartz 0·49=99·43, Damour.
5. "	75·43	17·93	—,	" 4·06, " 0·96=98·38, "

B.B. alone unaltered; with soda, the surface is merely rendered dull. With borax, or salt of phosphorus, fuses with great difficulty. No action with acids.

Chrysoberyl occurs in Brazil and also Ceylon, in rolled pebbles, in the alluvial deposits of rivers; at Marchendorf, in Moravia; also in the Ural 85 wersts from Ekatherinenberg in mica slate, with beryl and phenacite; this variety, which is of an emerald-green color, and columbine-red by transmitted light, has been called *Alexandrite.* It is supposed to be colored by chrome like the emerald. At Haddam, Ct., it occurs in granite traversing gneiss, with tourmaline, garnet, beryl, automolite, and columbite. Found also in the same rock at Greenfield, near Saratoga, N. Y., with tourmaline, garnet, and apatite; in the granite of Orange Summit, Vt., at the deep cut of the northern railroad.

When transparent, and of sufficient size, chrysoberyl is cut with facets, and forms a beautiful yellowish-green gem. If opalescent, it is usually cut *en cabochon.*

The name *Chrysoberyl,* from *χρυσος, golden, βηρυλλος, beryl,* was employed by the ancients for a different mineral, which possibly was chrysoprase. The name *Cymophane,* from *κυμα, wave, φαινω, to appear,* alludes to a peculiar opalescence it sometimes exhibits.

BROOKITE, *Levy.* Jurinite, *Soret.* Arkansite, *Shepard.* Eumanite, *Shepard.*

Trimetric. $I : I$=99° 50′ (–100° 50′) : O : $1\bar{i}$=131° 42′; $a : b : c$=1·1260 : 1 : 1·1883.

$O : \frac{1}{2}\bar{i}$ =150° 42′.
$O : \frac{1}{2}\bar{\frac{3}{2}}$=147° 14′.
$O : 1$ =124° 17′.
$O : \frac{1}{2}$ =143° 45′.
$O : 2\frac{4}{3}$=111° 34′.
$O : 1\breve{2}$=132° 19′.
$O : 5\breve{5}$=101° 38′.
$O : 2\breve{i}$=117° 54′.
$I : i\bar{i}$ =139° 55′.

$i\bar{i} : i\bar{2}$=157° 11′.
$i\bar{i} : i\bar{\frac{9}{4}}$=159° 30′.
$i\bar{2} : i\bar{2}$ (mac.)=134° 22′.
$\frac{1}{2} : \frac{1}{2}$ " =135° 14′.
$1 : 1$ " =115° 43′.
$1\breve{2} : 1\breve{2}$ (mac.)=101° 3′.
$1\breve{2} : 1\breve{2}$ (brach.=135° 37′.
$2\breve{i} : 2\breve{i}$ (top)=55° 48′.
$i\breve{i} : \frac{4}{3}\breve{i}$=141° 33′.

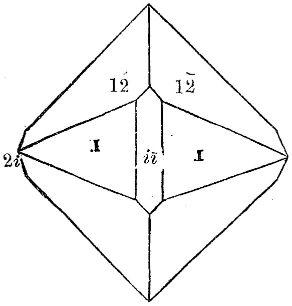
Cleavage: I, indistinct; O, still more so.

H.=5·5—6. G.=4·12—4·17, Brookite; 4·03—4·085, Arkansite, Whitney and Damour, 3·86—3·95, Rammelsberg; 3·81, Ural, Hermann. Hair-brown, yellowish or reddish, with metallic adamantine lustre and translucent, (brookite); also iron-black, opaque, and submetallic, (arkansite). Streak uncolored—grayish, yellowish. Brittle.

O														
$\frac{1}{4}\bar{i}$														
$\frac{1}{2}\bar{i}$			$\frac{1}{2}\overline{\tfrac{9}{4}}$*		$\frac{1}{2}\overline{\tfrac{3}{2}}$	$\frac{1}{2}$	$\frac{1}{2}\breve{\tfrac{9}{8}}$*							
														$\frac{8}{9}\breve{i}$*
			$1\overline{\tfrac{9}{4}}$			1				$1\breve{2}$				
									$\frac{4}{3}\breve{\tfrac{4}{3}}$					$\frac{4}{3}\breve{i}$
					$\frac{3}{2}\overline{\tfrac{3}{2}}$									
						2		$2\breve{\tfrac{8}{7}}$	$2\breve{\tfrac{4}{3}}$	$2\breve{2}$				$2\breve{i}$
												$\frac{7}{2}\breve{\tfrac{7}{2}}$		
											$5\breve{\tfrac{10}{3}}$		$5\breve{5}$	
$i\bar{i}$	$i\overline{\tfrac{11}{2}}$	$i\bar{4}$	$i\overline{\tfrac{9}{4}}$*	$i\bar{2}$	$i\overline{\tfrac{3}{2}}$	I								$i\breve{i}$

Observed Planes. Add? $i\overline{\tfrac{23}{4}}$, $\frac{7}{9}\breve{\tfrac{14}{5}}$, Kokscharov; $\frac{4}{9}\breve{\tfrac{4}{3}}$? D.

323



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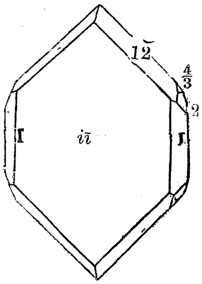

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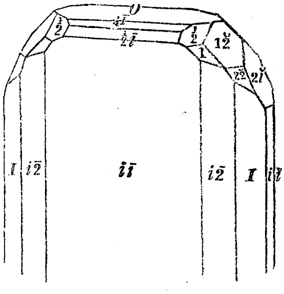

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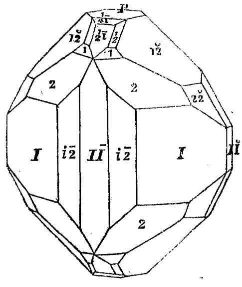

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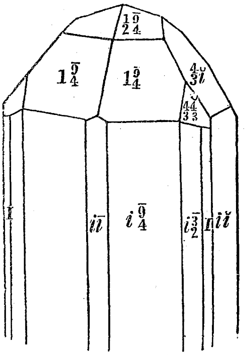

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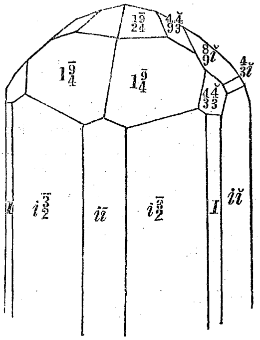


Composition.—Pure titanic acid, ($\ddot{\mathrm{Ti}}$), like anatase. Analyses: 1, Hermann, (J. f. pr. Chem. xlvi, 404); 2, Damour, (Ann. d. M. [4], xv, 447):

1. Urals,	$\ddot{\mathrm{Ti}}$ 94·09,	$\dddot{\mathrm{Fe}}$ 4·50,	$\dddot{\mathrm{Al}}$ *trace*,	ign. 1·40=100·00,	Hermann.
2. Arkansas,	99·36,	1·36,	0·73	——=101·45,	Damour.

Rammelsberg obtained 94·23 per cent. of titanic acid from the arkansite, and a corresponding low specific gravity, while Whitney and Damour found little impurity and a higher specific gravity.

Brookite occurs at Bourg d'Oisans in Dauphiny; at St. Gothard, with albite and quartz; in the Urals, district of Slatoust, and near Miask; rarely at Val del Bove, Etna, with rutile; on Snowdon and near Tremaddoc, Wales; in thick black crystals (arkansite, f. 323) at Magnet Cove, Ozark Mts., Arkansas, along with elæolite and schorlamite; in small crystals from the gold washings of North Carolina; rare at Chesterfield albite vein, (Eumanite). Also lead mine at Ellenville, Ulster Co., N. Y., on quartz, (f. 325), with copper pyrites and galena.

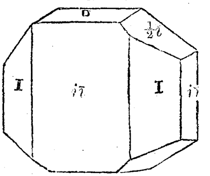
$I:I$ in Arkansite=100°—100° 30′, $\underset{\smile}{12} : \underset{\smile}{12}$=101° 30′, and 135° 15′ to 135° 50′.

In Eumanite, (f. 327, 328), some of the observed angles are $I:I$=100° to 101°, $\frac{4}{3}\breve{i} : \frac{4}{3}\breve{i}$=77° 49′, $i\frac{\bar{9}}{4} : i\frac{\bar{9}}{4}$=140°—140° 15′, $\breve{i}\breve{i} : \frac{4\breve{4}}{3\,3}$=128° 20′—128° 30′, $\breve{i}\breve{i} : i\frac{\bar{9}}{4}$= 108°. Am. J. Sci. [2], xii, 211, 397, xiii, 117. The chemical identity of eumanite and brookite has not yet been ascertained.

In Brookite from the Urals, $I:I$=99° 50′, Kokscharov.

PYROLUSITE. Gray Ore of Manganese. Wad. Anhydrous Binoxide of Manganese, *Turner*. Graubraunsteinerz. Weichmangan. Weichbraunstein.

328 A



Trimetric. $I:I$=93° 40′, $O : 1\bar{i}$=142° 11′; $a:b:c$=0·776 : 1 : 1·066. Observed planes as in the figure. $O : \frac{1}{2}\breve{i}$=160°, $I : \bar{i}\bar{i}$=136° 50′, $I : \breve{i}\breve{i}$=133° 10′, $\frac{1}{2}\breve{i} : \frac{1}{2}\breve{i}$ (top)=140°. Cleavage : I and $\breve{i}\breve{i}$. Also columnar, often divergent; also granular massive, and frequently in reniform coats. Often soils.

H.=2—2·5. G.=4·819, Turner; 4·97 when pure. Lustre metallic. Color iron-black, dark steel-gray, sometimes bluish. Streak black. Opaque. Rather brittle.

Composition.—$\ddot{\mathrm{Mn}}$=Manganese 63·3, oxygen 36·7. Analyses: 1, Arfvedson, (Schw. J., xlii, 210); 2, 3, Turner, (Edinb. Trans. 1828); 4, Scheffler, (Arch. d. Pharm. xxxv, 260):

	$\dot{\mathrm{Mn}}\ddot{\overline{\mathrm{Mn}}}$	O	$\dot{\mathrm{Ba}}$	$\ddot{\mathrm{Si}}$	$\dot{\mathrm{H}}$
1. Undenaes,	83·56	14·58	——	——	1·86=100, Arfvedson.
2. Eglersburg,	84·05	11·78	0·53	0·51	1·12=100, Turner.
3. Ihlefeld,	85·62	11·60	0·66	0·55	1·57=100, Turner.
4. Ilmenau,	87·0	11·6	1·2	0·8	5·8, $\ddot{\overline{\mathrm{Fe}}}$ 1·3, $\dot{\mathrm{Ca}}$ 0·3, $\ddot{\overline{\mathrm{Al}}}$ 0·3, Scheffler.

In another specimen Scheffler found 9·7 per cent. of baryta. Specimens from near Battenberg, Hesse, afforded Schwarzenberg and Engelhardt, 96·45 to 100 per cent. of pure superoxyd of manganese, (Ann. d. Ch. u. Pharm. lxi, 262).

B.B. alone infusible; on charcoal loses oxygen. A manganese reaction with borax. Affords chlorine with muriatic acid.

This ore is extensively worked at Eglersberg, Ilmenau, and other places in Turingia; also at Vorderehrensdorf near Mährish-Trübau, in Moravia, which place annually affords many hundred tons of the ore. Fine crystals occur near Johanngeorgenstadt, and at Hirschberg in Westphalia,, and crystalline plates at Matzka, Transylvania; also found in Timor.

Occurs in the United States with psilomelane, abundantly in Vermont, at Brandon, Irasburg, Bennington, Monkton, Chittenden, &c., both crystallized (f. 328 A) and massive; at Conway, Mass., in a vein of quartz; at Plainfield and West Stockbridge, Mass.; at Winchester, N. H.; at Salisbury and Kent, Conn., forming velvet-like coatings on limonite.

Pyrolusite parts with its oxygen at a red heat, and is extensively employed for discharging the brown and green tints of glass. It hence receives its name from *πυρ*, *five*, and *λυω*, *to wash;* and for the same reason it is whimsically entitled by the French, *le savon de verriers.* It is easily distinguished from psilomelane by its inferior hardness.

Appendix to Anhydrous Oxyds.

MINIUM. Mennige, *Haus.* Plomb Oxidé Rouge, *H.*

Pulverulent, occasionally exhibiting, under the miscroscope, crystalline scales.

G.=4·6. Color vivid red, mixed with yellow.

Composition.—$\dot{\mathrm{P}}\mathrm{b}^3\mathrm{O}^4$ [$=\ddot{\mathrm{P}}\mathrm{b}+2\dot{\mathrm{P}}\mathrm{b}$?]=Oxygen 9·34, lead 90·66=100.

In the reduction flame of the blowpipe, globules of lead are obtained.

Occurs at Bleialf in the Eifel; in Badenweller, in Baden; in Brillon in Westphalia; island of Anglesey; and Grassington Moore and Weirdale, in Yorkshire. Usually associated with galena, and also with calamine.

Found at Austin's mine, Wythe Co., Va., along with cerusite.

CREDNERITE, *Rammelsberg.* Mangankupferoxyd, *Haus.* Mangankupfererz, *Credner.*

Monoclinic. Foliated crystalline. Cleavage: basal very perfect; less distinct in two other directions obliquely inclined to one another.

H.=4·5 G.=4·9—5·1. Lustre metallic. Color iron-black to steel-gray. Streak black, brownish.

Composition.—$\dot{\mathrm{C}}\mathrm{u}^3\ddot{\overline{\mathrm{M}}}\mathrm{n}^2$=Oxyd of copper 42·9, oxyd of manganese 57·1; but often mixed with oxyd of manganase. Analysis: 1, Credner, (Pogg. lxxiv, 555); 2–4, Rammelsberg, (Pogg. lxxxiv, 559):

	$\dot{\mathrm{Mn}}$	$\ddot{\overline{\mathrm{Mn}}}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{Ba}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{H}}$	O
1. Friederichsrode,	22·96	31·25	42·13	0·52	0·63	0·25	——gangue 0·63=88·35, Cred.
2. “	52·55	——	40·65	1·48	——	——	5·78=100·46, Ramm.
3. “	54·72	——	34·65	2·71	——	——	6·51=98·49, Ramm.
4. “	64·24	——	23·73	2·01	——	——	8·83=98·81, Ramm.

B.B. fuses only on thin edges when strongly heated. With borax gives a dull violet color, and with salt of phosphorus a green glass.

From Frederichsrode, with volborthite, malachite, and manganese ores. Rammelsberg observes that this ore is the source undoubtedly of the cupreous manganese, a secondary product.

HETEROCLIN, *Breithaupt; Evreinoff*, Pogg. xlix, 204.

Monoclinic. An oblique rhombic prism of 128° 16′: acute lateral edges of prism usually truncated, and two of the terminal edges replaced, (*I*: e=151° 37), and one of the front solid angles. Cleavage in one direction not very distinct. Also massive. H.=5. G.=4·652. Lustre submetallic. Color iron-black, inclining a little to steel-gray. Streak black, brownish. Fracture uneven to small conchoidal.

Composition.—Analyses by Evreinoff, (Pogg. xlix, 204):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Mn}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$
1.	10·30	85·86	3·72	0·62	0·44=100·94
2.	10·02	85·88	3·05	0·60	0·44=99·99.

B.B. acts like the peroxyd of manganese. This species occurs at St. Marcel in Piedmont, mixed with manganesian epidote and quartz. Named from ἑτεροκλῖνής, in allusion to its oblique form of crystallization.

Berzelius obtained for a manganese ore from Piedmont, $\dddot{\mathrm{Si}}$ 15·17, $\dddot{\bar{\mathrm{Mn}}}$ 75·80, $\dddot{\bar{\mathrm{Fe}}}$ 4·14, $\dddot{\bar{\mathrm{Al}}}$ 2·80=97·91.

V. COMBINATIONS OF OXYDS WITH SULPHURETS OR CHLORIDS.

VOLTZITE. Voltzine, *Fournet.*

In implanted spherical globules; structure thin curved lamellar. H.=4·5. G.=3·66. Lustre vitreous to greasy; or pearly on a cleavage surface. Color dirty rose-red, yellowish, brownish. Opaque or subtranslucent.

Composition.—4Zn S+Zn O=Sulphuret of zinc 82·73, oxyd of zinc 17·27. Analysis: 1, Fournet, (Ann. Ch. Phys. xli, 426):

Zn S 82·92, Zn O 15·34, $\dddot{\bar{\mathrm{Fe}}}$ 1·84, resinous matter *trace*=100·10.

J. F. Vogl finds the same composition for a specimen from Joachimstahl, (Jahrb. k. k. R. 220).

B.B. like blende. In muriatic acid affords fumes of sulphuretted hydrogen.

Occurs at Rosières in Puy de Dome; and Elias mine near Joachimstahl, with galena, blende, native bismuth, etc. Observed by Kersten in the slags of the iron works of Freiberg and Altenberg.

MATLOCKITE, *R. P. Greg*, Phil. Mag., [4], ii, 120, 1851.

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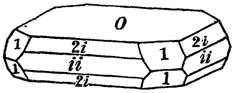


Dimetric. *O* : 1*i*=128° 42′; *a*=1·2482. Observed planes, *O*, *I*, 1, 2*i*. *O* : *I*=90°, *O* : 2*i*=111° 50½′ *O* : 1=119° 34′, 2*i* : 2*i* (pyram.) =97° 58′, (basal)=136° 19′, 1 : 1 (pyram.)= 104° 6′, (basal) 120° 52′. Cleavage: basal not perfect. Crystals tabular.

H.=2·5—3. G.=7·21; 5·3947, in powder, Rammelsberg. Lustre adamantine, occasionally pearly. Color clear yellowish, sometimes a little greenish. Transparent to translucent.

Composition.—Pb Cl+Pb O=Chlorid of lead 55·5, oxyd of lead 44·5. Analysis by Dr. R. A. Smith, (loc. cit):

Pb Cl 55·177, Pb O 44·300, Moisture 0·072=99·549.

Rammelsberg found, (Pogg. lxxxv, 141), Pb Cl 52·45, Pb O 46·42. Decrepitates when heated. B.B. fuses to a grayish-yellow globule.

From the old mine of Cromford near Matlock, with cerasine. Largest crystals an inch square and one-eighth thick.

MENDIPITE, *Breit.* Chlorid of Lead. Berzelite, *Levy.* Kerasine, *Beud.* Cerasite.

Trimetric; $I : I$=102° 36′. Observed planes, O, I, $i\bar{i}$, $i\breve{i}$. Occurs in fibrous or columnar masses, often radiated. Cleavage I, highly perfect, diagonal less perfect.

H.=2·5—3. G.=7—7·1. Lustre pearly and somewhat adamantine upon cleavage faces. Color white, with a tinge of yellow, red or blue. Streak white. Feebly translucent—opaque.

Composition.—$\mathrm{Pb\,Cl}+2\mathrm{PbO}$=Chlorid of lead 38·4, oxyd of lead 61·6 Analyses: 1, Berzelius, (K. V. Ac. H. 1823, Pogg. i, 272, and Ramm. 1st Supp. 24); 2, Schnabel, (ib. 3d Supp. 78):

1. Pb Cl 39·82 PbO 60·18=100, Berzelius by Rammelsberg.
2. " 38·74 61·26=100, Schnabel.

B.B. decrepitates slightly, and readily fuses, producing a globule of a deeper yellow color than the original specimen. On charcoal, lead may be obtained. Treated with peroxyd of copper and salt of phosphorus, the flame assumes an intensely blue color. Easily soluble in nitric acid.

This rare mineral occurs at the Mendip Hills, in Somersetshire, on earthy black manganese. Also at Tarnowitz, Silesia, in clay in opaque prismatic crystals; and near Brillon in Westphalia.

B. Hydrous Oxyds.

DIASPORE GROUP.—Ratio of oxygen of oxyd and water 3 : 1. Trimetric.

DIASPORE, $\ddot{\mathrm{Al}}\,\dot{\mathrm{H}}$. MAGANITE, $\ddot{\mathrm{Mn}}\,\dot{\mathrm{H}}$. (? $\ddot{\mathrm{Mn}}\,\dot{\mathrm{H}}^2$).
GÖTHITE, $\ddot{\mathrm{Fe}}\,\dot{\mathrm{H}}$. ? POLIANITE, ? $\ddot{\mathrm{Mn}}\,\dot{\mathrm{H}}$.

LIMONITE GROUP.—Ratio of oxygen of oxyd and water 2 : 1.

LIMONITE, $\ddot{\mathrm{Fe}}^2\,\dot{\mathrm{H}}^3$.

BRUCITE GROUP.—Ratio of oxygen of oxyd and water, 1 : 1. Hexagonal.

BRUCITE, $\dot{\mathrm{Mg}}\,\dot{\mathrm{H}}$. GIBBSITE, $\ddot{\mathrm{Al}}\,\dot{\mathrm{H}}^3$.

Appendix.—VÖLKNERITE, $\dot{\mathrm{Mg}}^6\,\ddot{\mathrm{Al}}+16\dot{\mathrm{H}}$.—PSILOMELANE, $\dot{\mathrm{R}}\,\ddot{\mathrm{Mn}}^2\,\dot{\mathrm{H}}$.—WAD.
Combination of Oxyds and Chlorids.—ATACAMITE, $\mathrm{Cu\,Cl}+3\dot{\mathrm{Cu}}\,\dot{\mathrm{H}}$.

DIASPORE. *Haüy.* Dihydrate of Alumina, *Thom.* Stephanite.

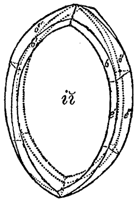
Trimetric. $I : I$=93° 52′, $O : 1\bar{i}$=147° 38′, $a : b : c$=0·634 : 1 : 1·07. Observed planes as in the figures.

O : 1=139° 3′. 1 : 1 (mac.)=126° 50′. $i\breve{\tfrac{3}{2}} : i\breve{\tfrac{3}{2}}$=109° 6′.
O : $1\bar{2}$=145° 1′. 1 : 1(brach.)=122° 46′. $i\breve{2} : i\breve{2}$ (ov $i\breve{i}$) 123° 48′.
O : $1\breve{i}$=149° 21′. $1\bar{2} : 1\bar{2}$ (mac.) =151° 54′. $i\bar{2} : i\bar{2}$ (ov $i\bar{i}$) 129° 54′.

Crystals usually thin flattened prisms, sometimes acicular; commonly implanted. Cleavage $i\breve{i}$, eminent; also $i\bar{2}$ less perfect. Occurs foliated massive.

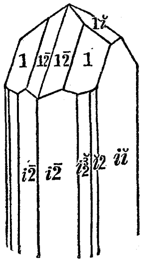
H.=6·5–7. G.=3·3–3·5; 3·4324, Haüy; 3·452, Duf.; 3·30—3·34, Schemnitz diaspore. Lustre brilliant and pearly on cleavage faces; elsewhere vitreous. Color greenish-gray or hair-brown, yellowish to colorless, sometimes violet-blue in one direction, reddish plumb-blue in another, and pale asparagus-green in a third. When thin, translucent—subtranslucent. Very brittle.

330



Schemnitz.

331



Composition.—$\ddot{\text{A}}\text{l}\dot{\text{H}}$=85·1 alumina, 14·9 water. Analyses: 1, 2, Dufrénoy, (Ann. des Mines [3], x, 577, 1837); 3, Hess, (Pogg. xviii, 255); 4, Damour, (Comptes Rend. xxi, 322); 5, Löwe, (Pogg. lxi, 307); 6, 7, J. L. Smith, (Am. J. Sci. [2], xi, 58); 8, Damour, (L'Institut, 1853, 78):

		$\ddot{\text{A}}$l	$\dot{\text{H}}$	$\dot{\text{F}}$e	$\dddot{\text{S}}$i
1.	Siberia,	74·66	14·58	$\dddot{\text{F}}$e 4·51	2·90, $\dot{\text{C}}$a and $\dot{\text{M}}$g 1·64=98·29, Duf.
2.		78·93	15·13	" 0·52	1·39, $\dot{\text{C}}$a 1·98=97·95, Duf.
3.	Miask,	85·44	14·56	——	——=100, Hess.
4.	Siberia,	79·91	14·90	——	——unattacked 5·80=100·61, Dam.
5.	Schemnitz,	85·131	15·00	——	——=100·131, Löwe. G.=3·303.
6.	Gumuch-dagh,	83·12	14·28	0·66	0·82 $\dot{\text{C}}$a, $\dot{\text{M}}$g, *trace*=98·88, S. G.3·45.
7.	Naxos,	82·94	14·81	1·06	0·26 $\dot{\text{C}}$a 0·35=99·42, S.
8.	Bahia, S. A.,	84·02	14·59	$\dddot{\text{F}}$e 0·68	$\dddot{\text{S}}$i 0·43=99·72, Damour. G.=3·464.

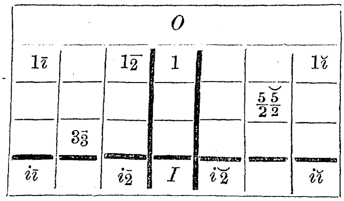
In a matrass decrepitates strongly and separates into small white scales; finally yields water. B.B. infusible. With borax and salt of phosphorus dissolves slowly to a clear colorless glass. Not acted on by soda. A fine blue with cobalt solution. Not at all altered by concentrated and boiling sulphuric acid, except after calcination.

Occurs in chlorite slate, near Koroibrod, district of Katharinenburg in the Ural, and at Schemnitz in veins between dolomite and limestone; also at Broddbo near Fahlun; with corundum in dolomite at St. Gothard; at Gumuch-dagh and Manser, Asia Minor, and the Grecian Islands Naxos, Samos, and Nicaria, with emery, as detected by J. L. Smith.

GÖTHITE, *Beud.* Pecheisenerz, (in part). Nadeleisenerz, *Naum.* Pyrrhosiderite, *Haus.* Onegite. Lepidokrokite. Sammetblende. Stilpnosiderite. Rubinglimmer. Eisenrutil. Chileit, *Breith.*

Trimetric. $I : I$=94° 52′, B. and M. (95° 14′, Levy, 96° Yorke), $O : 1\bar{i}$=146° 33′, $a : b : c$=0·66 : 1 : 1·089.

$O : 3_{\bar{3}}$=115° 44′. $O : 1\breve{i}$=148° 48′. $1_{\bar{2}} : 1_{\bar{2}}$(mac.)=151° 35 .
$O : 1_{\bar{2}}$=143° 55′. $O : \tfrac{5}{2}\breve{\tfrac{5}{2}}$=121° 8′. $i\bar{2} : i\bar{2}$=130° 40′.
$O : 1$=138° 6′. 1:1(brach.)=121° 4′. $i\breve{2} : i^{\smile}$(ov.$i\breve{i}$)=122° 52′.



Observed Planes.

In prisms longitudinally striated, and often flattened parallel to the shorter diagonal. Cleavage: brachydiagonal, very perfect. Also fibrous; reniform; foliated or in scales; massive.

H.=5—5·5. G.=4·0—4·4. Lustre imperfect adamantine. Color yellowish, reddish, and blackish-brown. Often blood-red by transmitted light. Streak brownish-yellow—ochre-yellow.

Composition.—$\dddot{\bar{F}}e\,\dot{H}$=Peroxyd of iron 89·89, water 10·11. Analyses: 1–5, Kobell, (J. f. pr. Chem. i, 181, 319); 6, Brandes, (Nög. Geb. in Rheinl. Westph. i, 358); 7, Breithaupt, (J. f. pr. Chem. xix, 103); 8, Yorke, (Phil. Mag. [3], xxvii, 264):

		$\dddot{\bar{F}}e$	$\dot{H}$
1.	*Lepidokrokite*, Oberkirchen,	90·53	9·47=100, Kobell.
2.	" H. Zug,	85·65	11·50, $\dddot{\bar{M}}n$ 2·50, $\dddot{Si}$ 0·35=100, Kobell.
3.	*Göthite*, Eiserfeld,	86·35	11·38, $\dddot{\bar{M}}n$ 0·51, $\dddot{Si}$ 0·85, $\dot{C}u$ 0·90=99·99, K.
4.	*Stilpnosiderite*, Amberg,	86·24	10·68, $\dddot{\bar{P}}$ 1·08, $\dddot{Si}$ 2·00=100, Kobell.
5.	*Massive*, Maryland,	86·32	10·80, $\dddot{Si}$ 2·88=100, Kobell.
6.	*Lepidokrokite*, H. Zug,	88·00	10·75, $\dddot{\bar{M}}n$ 0·50, $\dddot{Si}$ 0·5=99·75, Breithaupt.
7.	*Chileite*, Chili,	83·5	10·3, $\dot{C}u$ 1·9, $\dddot{Si}$ 4·3=100, Breithaupt.
8.	*Crystals*, Lostwithiel, G.4·37,	89·55	10·07, $\dddot{\bar{M}}n$ 0·16, $\dddot{Si}$ 0·28=100·06, Yorke.

Before the blowpipe the varieties act like limonite.

The *Lepidokrokite* occurs in minute radiating crystals, or granular scales and feathery aggregations, imbedded in fibrous red oxyd of iron, in quartz, and in nodules of chalcedony. It has been found at Spring Mills, Montgomery County, Pa. The *Göthite* of Eiserfeld, in the County of Nassau, occurs in foliated crystallizations, (*Rubinglimmer*), of a hyacinth red color, with brown hematite. Other localities of Göthite are at Clifton, near Bristol, near Lostwithiel, and Botallack, in Cornwall, and at Lake Onega (*Onegite*) in Siberia, at Oberkirchen in Westerwald, Zwickau in Saxony, Eiserfeld in Siegen, Przibram, &c. A capillary variety (*Sammetblende*) occurs at Przibram and elsewhere. *Stilpnosiderite* occurs amorphous and stalactitic or massive. H.=4·5—5. G.=3·6—3·8; pitch-black and blackish-brown. Some specimens, according to Vauquelin's and Ullmann's analyses, are Limonite. The *Sammetblende* has been called *Przibramite*, from Przibram, where it occurs.

MANGANITE. Gray Manganese Ore. Gray Oxyd of Manganese. Acerdèse, *Beud.* Grauer Bräunstein. Manganese Oxydè, *H.* Newkirkite, *Thomson.*

Trimetric. $I : I$=99° 40′, $O : 1\bar{\imath}$=147° 9½′; $a : b : c$=0·6455 : 1 : 1·185. Hemihedral in plane $\frac{6}{5}\bar{2}$.

$O : 2\bar{\imath}$=127° 46′. $O : 2\bar{2}$=128° 18′. $1\bar{3} : 1\bar{3}$(mac.)=162° 39′.
$O : 1\bar{3}$=146° 9′. $O : 1\breve{\imath}$=151° 25′. $i\bar{2} : i\bar{2}$(mac.)=134° 14′.
$O : 1\bar{2}$=144° 59′. 1 : 1(mac.)=130° 49′. $i\breve{2} : i\breve{2}$ (br.)=118° 48′.
O : 1 =139° 49′. 1:1(brach)=120° 54′. $i\breve{3} : i\breve{3}$ (br.)=136° 54′.

Twins: plane of composition $1\breve{\imath}$. Cleavage: $i\breve{\imath}$ very perfect, I perfect. Crystals longitudinally striated and often grouped. Also columnar and granular.

H.=4. G.=4·2—4·4. Lustre submetallic. Color dark steel gray—iron-black. Streak reddish-brown, sometimes nearly black. Opaque; minute splinters, sometimes brown by transmitted light. Fracture uneven.

O									
$1\bar{i}$	$1\bar{3}$	$1\bar{2}$		1					$1\breve{i}$
						$\frac{6}{5}\breve{2}$			
$2\bar{i}$				2		$2\breve{2}$			
$i\bar{i}$		$i\bar{2}$	$i\bar{\frac{4}{3}}$	I	$i\breve{\frac{3}{2}}$	$i\breve{2}$	$i\breve{\frac{5}{2}}$	$i\breve{3}$	$i\breve{i}$

Observed Planes.

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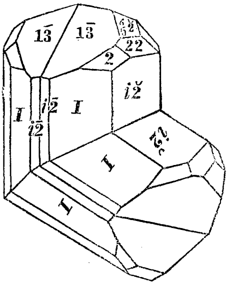

Composition.—$\ddot{\bar{M}}n\dot{H}=\ddot{\bar{M}}n$ 89·79, (=Mn 62·78, O 27·22), $\dot{H}$ 10·21. Analyses: 1, Arfvedson, (Schw. J. xxvi, 262); 2, Gmelin, (ib. xlii, 208); 3, 4, Turner, (Edinb. Trans. 1828):

		Mn	O	$\dot{H}$	
1.	West Gothland,	89·92		10·08,	Arfvedson.
2.	Ihlefeld,	62·86	27·64	9·50,	Gmelin.
3.	"	62·68	27·22	10·10, (by loss),	Turner.
4.	"	62·77	27·13	10·10, "	Turner.

B.B. alone fusible; with borax yields a violet-blue globule. Insoluble in nitric acid; in muriatic acid gives off chlorine, and dissolves without a residue.

Occurs in veins traversing porphyry, associated with calcareous spar and heavy spar, at Ihlefeld in the Hartz; also at Ilmenau and Oehrenstock in Thuringia; in Aberdeenshire; at Undenaes in Sweden, and Christiansand in Norway.

Newkirkite, according to Lettsom, is nothing but manganite. Volger endeavors to show that the analyses of manganite are doubtful with regard to the water, and probably correspond to $\ddot{\bar{M}}n\,\dot{H}^2$, like Xanthosiderite, (Stud. z. Entw. 391).

ALTERED FORMS.—By loss of water changes to pyrolusite, hausmannite, or braunite. *Varvacite* of R. Phillips, from Warwickshire, is considered an altered manganite, consisting largely of pyrolusite. Analysis by Phillips afforded, Mn 63·3, *O* 31·7, $\dot{H}$ 5·0. Breithaupt observed a crystal with nearly the angles of manganite, giving *I*: *I*=80° 24′ and 99° 36′. H.=2·5—3. G.=4·283—4·623.

POLIANITE, *Breit.*

Trimetric. *I* : *I*=92° 52′, *O* : $1\bar{i}$=147° 43′; *a* : *b* : *c*=0·6317 : 1 : 1·0513. Observed planes *O*, *I*, $i\bar{i}$, $i\breve{i}$, $i\bar{2}$, $i\breve{2}$, $1\breve{i}$, $2\breve{i}$. $1\breve{i}$: $1\breve{i}$=118°, *O* : $1\breve{i}$=149°. Cleavage: brachydiagonal, perfect. H.=6·5—7. G.=4·84—4·88. Resembles pyrolusite.

Composition.—Plattner obtained, (Pogg. lxi, 192),

$\dot{M}n\ddot{\bar{M}}n$ 87·274, O 12·111, $\bar{F}e$ and $\ddot{\bar{A}}l$ 0·165, quartz 0·132, $\dot{H}$ 0·318=100,

and this is the composition of pyrolusite, or $\dot{M}n$. But according to Volger (Stud. z. Entw. Min.) it is an altered $\ddot{\bar{M}}n\dot{H}$, it being isomorphous with Göthite.

Occurs near Platten in Bohemia, also at Schneeberg, Geyer, and Johanngeorgenstadt in Saxony, and in Siegen; near Schwarzenberg, and near Ilmenau in Thuringia.

LIMONITE, *Beud.* Brown Hematite. Brown Iron Ore. Hydrous Peroxyd of Iron. Brown Ochre. Iron Stone. Yellow Clay Iron Stone. Brauneisenstein, Thoneisenstein, *W.* Gelberde. Eisenoxydhydrat. Brauner Glaskopf. Bog Iron Ore. Raseneisentein (bog ore), Morasterz, Sumpferz. Bohnerz.

Usually in stalactitic and botryoidal or mammillary forms, having a fibrous or subfibrous structure; also massive and occasionally earthy.

H.=5—5·5. G.=3·6—4. Lustre silky, often submetallic; sometimes dull and earthy. Color various shades of brown, commonly dark, and none bright. Streak yellowish-brown.

Composition.—$\dddot{\overline{\mathrm{F}}}\mathrm{e}^2\dot{\mathrm{H}}^3$=Peroxyd of iron 85·6, water 14·4=100. The bog iron ore is often mixed with phosphates, (sometimes 10 or 11 per cent.), and also with some salts of organic acids formed in marshy ground. Analyses: 1, 2, Kobell; 3, 4, Karsten, (Arch. xv, 1); 5, Hermann, (J. f. pr. Ch. xxvii, 53):

		$\dddot{\overline{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{H}}$	$\dddot{\mathrm{Si}}$
1.	Perm, *fibrous*,	83·38	15·01	1·61=100, Kobell.
2.	Siegen, *Pitchy Ore*,	82·87	13·46	0·67, $\dddot{\overline{\mathrm{P}}}$ 3·00, Mn, Cu, $\dot{\mathrm{C}}\mathrm{a}$ *trace*=100, Kobell.
3.	*Bog ore*, New York,	66·33	26·40[a]	2·80, " 0·12, $\dot{\mathrm{F}}\mathrm{e}$ 3·6, $\dddot{\overline{\mathrm{M}}}\mathrm{n}$ 0·75=100, Karsten.
4.	" Neumark,	57·50	29·50[a]	8·60, " 3·90, "10·8, " 1·75, Sand 22·75, Kar.
5.	" Novgorod,	32·75	13·00	$\dddot{\overline{\mathrm{M}}}\mathrm{n}$ 100, $\dddot{\overline{\mathrm{P}}}$ 3·50, humic acid 2·5, Sand 47·5, Her.

[a] With organic substances.

Hermann writes for the last (his *Quellerz*) the formula $\dddot{\overline{\mathrm{F}}}\mathrm{e}\,\dot{\mathrm{H}}^3=\dddot{\overline{\mathrm{F}}}\mathrm{e}$ 74·8, $\dot{\mathrm{H}}$ 25·2.

A very pure stalactitic limonite from Amenia, N. Y., gave Beck, (Min. N. Y. p. 33), Peroxyd of iron 82·90, silica and alumina 3·60, water 13·50, with a trace of oxyd of manganese. In a limonite (bohnerz) from Staatswald Hardt, Württemberg, A. Müller found (J. f. pr. Chem. lvii, 124) 0·05 per cent. of chromic acid, and 0·03 per cent. of vanadic acid.

In a matrass yields water. B.B. blackens and becomes magnetic and thin splinters fuse; with borax gives an iron reaction. Dissolves in warm nitro-muriatic acid.

The following are the principal varieties of this species. *Brown hematite* includes compact mammillary and stalactitic varieties. *Scaly* and *ochrey brown iron ore* are decomposed earthy varieties, often soft like chalk; yellow ochre is here included. *Bog iron ore* is a brittle or loosely aggregated submetallic ore, occurring in low marshy grounds. It proceeds from the decomposition of other species, and often takes the form of the leaves, nuts or stems, found in the marshy soil. *Brown and yellow clay iron stone* are hard and impure from admixture with clay or iron.

Limonite occurs in secondary or more recent deposits, in beds associated at times with spathic iron, heavy spar, calcareous spar, aragonite, and quartz; and often with ores of manganese.

Found in Cornwall, Clifton, Sandloge in Shetland, in Carinthia and Bohemia, at Siegen near Bonn, and at Villa Rica in Brazil. The bog ore forms large beds in Germany, Poland, and Russia.

This ore is abundant in the United States. We mention a few only of its localities, and would refer to the various geological reports for more complete lists. Extensive beds exist at Salisbury and Kent, Conn., also in the neighboring towns of Beekman, Fishkill, Dover, and Amenia, N. Y., and in a similar situation north at Richmond and Lenox, Mass. At Hinsdale it is the cement in a conglomerate quartz rock. It is very abundant at Bennington, Vt., also at Monkton, Pittsford, Putney, and Ripton, of the same State. Nantucket and Martha's Vineyard are other localities; also near Tinder's Gold Mine, Louisa Co., Va, there is an abundant deposit; at Birmingham and elsewhere, Mo. The argillaceous varieties are abundant in Pennsylvania, near Easton, and through the Lehigh range in Fayette Co., at Armstrong, Upper Dublin, and in Washington Co. In nodules from one inch to a foot in diameter, it is met with at Bladensburg, Md.; also in gravel hills, near Marietta in Ohio. An argillaceous ore is also found on Mount Alto, in the Blue Ridge, in Shenandoah Co., Va., and in Chatham and Nash Co., N. C.: also near the Iron Mountains, Missouri.

Limonite is one of the most important ores of iron. The pig iron, from the purer varieties, obtained by smelting with charcoal, is readily convertible into steel. That yielded by bog ore is what is termed *cold short*, owing to the phosphorus present, and cannot therefore be employed in the manufacture of wire, or even of sheet iron, but is valuable for casting. The hard and compact nodular varieties are employed in polishing metallic buttons, &c.

Turgite, Hermann, a reddish-brown mineral from the Turginsk Copper Mines in the Urals, and the Altai afforded $\dddot{\overline{\mathrm{F}}}\mathrm{e}$ 94·15, $\dot{\mathrm{H}}$ 5·85, whence the formula $\dddot{\overline{\mathrm{F}}}\mathrm{e}^2\dot{\mathrm{H}}$

=sesquoxyd of iron 94·7, water 15·3. G.=3·54—3·74. It may be only a red hematite.

Kaliphite, Ivanoff. A mixture of brown iron ore, oxyd of manganese, and silicate of zinc with lime, from Hungary.

Altered Forms.—By deoxydation through organic matter, if carbonic acid is present, may form *spathic iron*, ($\dot{\mathrm{C}}\mathrm{a}\,\ddot{\mathrm{C}}$). By losing water becomes *hematite*, ($\dddot{\bar{\mathrm{F}}}\mathrm{e}$). Hematite occurs as pseudomorphs after limonite. This species forms numerous pseudomorphs of other species, (see under Chemical Mineralogy).

Xanthosiderite, E. E. Schmid, (Pogg. lxxxiv, 495).—In fine needles or fibres stellate and concentric. Golden yellowish-brown to brownish-red, silky or greasy in lustre. H.=2·5.

Composition.—$\dddot{\bar{\mathrm{F}}}\mathrm{e}\,\dot{\mathrm{H}}^2$. Analyses by E. E. Schmid, (loc. cit.):

	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\bar{\mathrm{M}}}\mathrm{n}$	$\dddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{H}}$
1. *Yellow*,	74·96	1·32	1·82	2·51	15·67=96·28,
2. *Brown*,	75·00	1·51	1·33	5·02	14·10=96·96,

leaving a loss due to undetermined carbonate of lime, magnesia, alkalies, antimony, and lead or bismuth, present as impurities.

Occurs associated with manganese ores at Ilmenau.

BRUCITE. Native Hydrate of Magnesia, Bruce's Min. Jour. i, 26. Native Magnesia, *Cleav.* Talk-Hydrat. Magnesia-hydrat. Magnésie Hydratée, *H.* Nemalite, Amianthoid Magnesite, *Nuttall*, Am. Jour. Sci. iv, 19, 1822.

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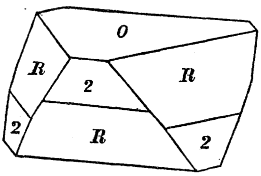

Rhombohedral; $R:R=82°\,15'$, $O:R=119°$; $a=1{\cdot}527$. Observed angles $O:R=119°$—$119°\,55'$, $O:2R=105°\,30'$. Cleavage: basal, eminent, folia easily separable. Usually foliated; massive. Also fibrous, fibers separable and elastic.

H.=1·5. G.=2·35, Haidinger. Lustre pearly. Color white, inclining to gray, blue, or green. Streak white. Translucent—subtranslucent. Sectile. Thin laminæ flexible.

Composition.—$\dot{\mathrm{M}}\mathrm{g}\,\dot{\mathrm{H}}$=Magnesia 68·97, water 31·03. Analyses by Bruce, (Min. Jour. i, 26); Wurtz, (This. Min. 3d edit., 682); Stromeyer, (Untersuch, p. 467); Thomson, (Min. i, 157), J. D. Whitney, (Jour. Bost. Soc. Nat. Hist. 1849, p. 36), Wurtz, (loc. cit.) Rammelsberg, (Pogg. lxxx, 284):

	Hoboken.	Hoboken.	Swinaness.	Hoboken.	Swinaness.	*Nemalite.*	*Nemalite.*	*Nemalite.*
$\dot{\mathrm{M}}\mathrm{g}$	70	69·11	66·67	68·345	67·98	62·89	66·05	64·86
$\dot{\mathrm{H}}$	30	30·42	30·39	30·902	30·96	28·36	30·13	29·48
$\dot{\mathrm{M}}\mathrm{n}$	—	——	1·57	0·637	1·57	——	——	——
$\dot{\mathrm{F}}\mathrm{e}$	—	0·47	1·18	0·116		4·65	5·63	4·05
$\dot{\mathrm{C}}\mathrm{a}$	—	——	0·19	——	——	$\ddot{\mathrm{C}}$ 4·10	——	$\dddot{\mathrm{S}}\mathrm{i}$ 0·27
	100, B.	100·00, W.	100·00, S.	100·00, S.	100·51, T.	100·00, Wh.	101·81, W.	98·65, R.

The fibrous variety is called Nemalite.

B.B. loses weight, becomes opaque and friable, but does not fuse. In the matrass gives off water. Entirely soluble in the acids without effervescence; gives the test of magnesia.

Brucite accompanies other magnesian minerals in serpentine. Occurs in considerable veins traversing serpentine, at Swinaness in Unst, one of the Shetland Isles, where it is sometimes found in regular crystals; at Pyschminsk in the Urals, and at Goujot in France. It is also found in the same rock at Hoboken, N. J., opposite the city of New York, in veins which are sometimes an inch in width, rarely in minute polished crystals, as above figure; also in Richmond Co., N. Y., and on the peninsula east of New Rochelle, Westchester Co.

The fibrous variety (nemalite) occurs at Hoboken, and Xettes in the Vosges.

This mineral was discovered and described by the late Dr. Bruce of New York.

Altered Forms.—Changed through carbonated waters, to hydromagnesite, as at Hoboken.

GIBBSITE, *Torrey*, N. Y. Med. and Phys. Jour. 1, 68. Hydrargillite, *G. Rose*, Pogg. xlviii, 564. Felsobanyite.

Hexagonal; in small crystals with replaced lateral edges and eminent basal cleavage. Planes vertically striate. Occasionally in lamello-radiate spheroidal concretions. Usually stalactitic or small mammillary and incrusting, with smooth surface and often a faint fibrous structure within.

H.=3—3·75. G.=2·3—2·4; from Richmond, 2·385, B. Silliman, Jr.; Hydrargillite of the Ural, 2·287, Hermann. Color white, grayish, greenish, or reddish-white. Lustre of *O* pearly; of surface of stalactites faint. Translucent. A strong argillaceous odor when breathed on. Tough.

Composition.—$\ddot{\bar{\text{Al}}}\dot{\text{H}}^3$=Alumina 65·56, water 34·44. Analyses: 1, Torrey, (loc cit.); 2, 3, 4, B. Silliman, Jr., (Am. Jour. Sci. [2], vii, 411); 5, 6, Smith and Brush, (Am. Jour. Sci., [2], xvi, 51, 1853); 7, Hermann, (J. f. pr. Chem. xl, 11); 8, Kobell, (J. f. pr Chem. xli, and l, 491):

		$\ddot{\bar{\text{Al}}}$	$\dot{\text{H}}$	$\dddot{\bar{\text{P}}}$
1.	Richmond, Mass.,	64·8	34·7	——=99·5, Torrey.
2.	"	63·446	34·477	—— $\dot{\text{M}}$g 0·3, insol. 1·777=100, B. S.
3.	"	64·955	34·073	0·590 $\dot{\text{M}}$g 0·3, insol. ·082=100, B. S.
4.	"	64·160	34·151	*trace* $\dot{\text{M}}$g 0·3, insol. 1·627=100·238, B. S.
5.	"	64·24	33·76	$\ddot{\text{S}}$i 1·33, $\dddot{\bar{\text{P}}}$ 0·57, $\dot{\text{M}}$g 0·10, $\ddot{\bar{\text{F}}}$e *tr*=100, S. & B.
6.	"	63·48	34·68	" 1·09, " *tr* " 0·05, " *tr*=99·30, S.&B.
7.	*Hydrarg.*, Ural.	64·03	34·54	1·43=100, Herm.
8.	" Villa Rica,	65·6	34·4	——=100, Kobell.

Silliman, Jr., did not find the phosphoric acid attributed to the Gibbsite by Hermann, and ascertained that the silica of Thomson's analyses was due to a mixture with allophane, with which mineral it is often associated. More recent results confirm this fact. The species hydrargillite therefore falls into Gibbsite.

In a matrass, yields water. B.B. infusible; on charcoal decrepitates, becomes opaque, and crystals exfoliate; phosphoresces. A fine blue with cobalt solution. Dissolves wholly in concentrated sulphuric acid.

The crystallized gibbsite (hydrargillite of authors) was discovered by Lissensko in the Schischimskian mountains near Slatoust in the Ural. The larger crystals were 1 to 2 inches long. This species occurs with corundum at Gumuch-dagh, Asia Minor; also on Corundum of Unionville, Pa.; in Brazil, resembling wavellite. The stalactitic occurs at Richmond, Mass., in a bed of limonite; also at Lenox, Mass.; at the Clove mine, Union Vale, Duchess Co., N. Y., on limonite; in Orange Co., N. Y.

This species was named after Col. George Gibbs, the original owner (after extensive foreign travel) of the large Gibbs' cabinet of Yale College.

Appendix to Hydrous Oxyds.

VÖLKNERITE, *Hermann*, J. f. pr. Chem. xl, 11, and xlvi, 257.

Hexagonal. Cleavage: basal, eminent; lateral, distinct. Also lamellar massive.

G.=2·04. Color white. Lustre pearly, and feel greasy.

Composition.—$\dot{\text{Mg}}^6\ddot{\bar{\text{Al}}}+16\dot{\text{H}}$.=Alumina 16·29, magnesia 38·05, water 45·66=100. Analysis by Hermann (loc. cit.) $\dot{\text{Mg}}$ 37·07, $\ddot{\bar{\text{Al}}}$ 16·95, $\dot{\text{H}}$ 46·87=100.

In a matrass yields much water. B.B. exfoliates somewhat and gives out light, but infusible. A weak rose-red with cobalt solution. With the fluxes intumesces and affords a clear colorless glass.

Occurs at the mines of Schischimsk, district of Slatoust, implanted on talc schist. Named in honor of Captain Völkner.

Hydrotalcite of Hochstetter, (J. f. pr. Ch. xxvii, 376) is referred to Völknerite by Hermann, (ib. xlvi, 237,) part of the alumina being replaced by peroxyd of iron, $=\dot{\text{Mg}}^6(\ddot{\bar{\text{Al}}}, \ddot{\bar{\text{Fe}}})+16\dot{\text{H}}$. It is a foliated pearly mineral, translucent, or in thin folia transparent, with a greasy feel, and hardness=2·0. Hochstetter obtained

$\ddot{\bar{\text{Al}}}$ 12·00, $\ddot{\bar{\text{Fe}}}$ 6·90, $\dot{\text{Mg}}$ 36·30, $\dot{\text{H}}$ 32·06, $\ddot{\text{C}}$ 10·54, insoluble 1·20=99·60.

It occurs at Snarum in Norway.

Houghite of Shepard, (Am. J. Sci. [2], xii, 210), resembles Völknerite, and is probably the same compound. The color is white; lustre faint, pearly. H.=2·5. G.=2·0–2·1. It is the material of pseudomorphous spinel, near Oxbow, and in Rossie near Somerville, St. Lawrence Co., New York. The crystals are in all conditions from the pure spinel to octahedrons with rounded edges and pitted or irregular surfaces, and it also occurs in flattened nodules. The surfaces are sometimes soft and altered, when the edges or angles have the hardness of spinel. Mr. S. W. Johnson, who has redescribed the mineral, obtained in one analysis, (Am. Jour. Sci., [2], xii, 363), $\ddot{\bar{\text{Al}}}$ 19·743, $\dot{\text{Mg}}$ 36·292, $\ddot{\text{C}}$ 8·458, insoluble spinel, &c., 8·264, silica 3·020, water (by diff.) 24·223. The whole loss by ignition in one trial was 40·86 p. c. This would give 33 to 34 p. c. of water. He observes that his results are not satisfactory and that he intended completing them. They are sufficient to show a close relation to the above species. It is associated with dolomite, spinel, phlogopite, graphite and serpentine in crystals, (pseudomorphous.)

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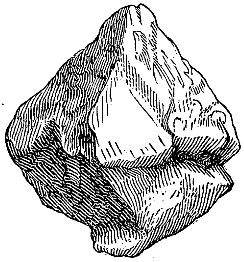

PSILOMELANE, *Haid.* Compact and Fibrous Manganese Ore. Black Hematite. Compact Gray Oxyd of Manganese. Black Iron Ore. Schwarzeisenstein, *W.* Schwarzbraunstein, *Haus.* Schwarzmanganerz, *L.* Hartmanganerz. Manganese Oxydé Hydraté Concretionnê, *H.*

Massive and botryoidal.

H.=5—6. G=3·7—4·328. Lustre submetallic. Streak brownish-black, shining. Color iron-black, passing into dark steel-gray. Opaque.

Composition.—$\dot{\text{R}}\,\ddot{\text{Mn}}^2+\dot{\text{H}}$ mixed with $\ddot{\text{Mn}}$, Ramm., a large part of the superoxyd being considered mechanically combined. Analyses: 1, 2, Turner, (Edinb. Trans. xi); 3, Fuchs, (Schw. J. lxii, 255); 4, Rammelsberg, (Handw. ii, 73); 5, Clausbruch, (Ramm. 1st Supp. 121); 6, Scheffler, (Arch. d. Pharm. xxxv, 260); 7, Ebelmen, (Ann. d. Mines, [3,] xix, 155); 8, Rammelsberg, (Pogg. lxviii, 512):

	$\ddot{\bar{\text{Mn}}}$	$\dot{\text{Mn}}$	O	$\dot{\text{Ba}}$	$\dot{\text{K}}$	
1. Schneeberg,		69·80	7·36	16·36	——	, $\ddot{\text{Si}}$ 0·26, $\dot{\text{H}}$ 6·22=100, Turner.
2. Romanêche,		70·97	7·26	16·69	——	, $\ddot{\text{Si}}$ 0·95, $\dot{\text{H}}$ 4·13=100, Turner.
3. Baireuth,		81·8	9·5	——	4·5,	$\dot{\text{H}}$ 4·2=100, Fuchs.
4. Horhausen,		81·36	9·18	——	3·04,	$\ddot{\text{Si}}$ 0·53, $\dot{\text{Cu}}$ 0·96, $\ddot{\bar{\text{Fe}}}$ 1·43, $\dot{\text{Ca}}$ 0·38, $\dot{\text{Na}}$ and $\dot{\text{Mg}}$ 0·32, $\dot{\text{H}}$ 3·39=100·61, Ramm.
5. Ilmenau,	——	77·23	15·82	0·12	5·29,	$\dot{\text{Ca}}$ 0·91, $\dot{\text{Cu}}$ 0·40, $\ddot{\text{Si}}$ 0·52=100·29, Cl.
6. "		83·3	9·8	5·8	——	, $\dot{\text{Ca}}$ 1·8, $\ddot{\bar{\text{Al}}}$ 2·1, $\ddot{\bar{\text{Fe}}}$ 0·3, $\ddot{\text{Si}}$ 1·7, $\dot{\text{H}}$ 4·3=99·1, Scheffler.

	$\dot{Mn}$	O	$\dot{Ba}$	$\dot{K}$
7. Gy, H. Saône,	70·60	14·18	6·55	4·05, $\dot{Mg}$ 1·05, $\overset{\cdots}{\bar{F}e}$ 0·77, $\overset{\cdots}{Si}$ 0·60, $\dot{H}$ 1·67=99·47, Ebelmen.
8. Heidelberg,	70·17	15·16	8·08	2·62, $\dot{Ca}$ 0·60, $\dot{Mg}$ 0·21, $\dot{Cu}$ 0·30, $\dot{Co}$ 0·54, $\overset{\cdots}{Si}$ 0·90, $\dot{H}$ and loss 1·43=100, Rammelsberg.

In analyses 5 and 6, Rammelsberg considers 50 and 40 per cent. of the superoxyd of manganese a mixture, and a similar allowance is made by him for the others. As the mineral occurs only massive, the nature of the species cannot be satisfactorily ascertained. No. 7 contains potassa as well as baryta. No. 5 is anhydrous.

B.B. yields water, gives a violet color to borax, and is completely soluble in muriatic acid, excepting a small quantity of silica, affording chlorine.

This is a common ore of manganese. It is frequently in alternating layers with pyrolusite. It occurs in botryoidal and stalactitic shapes, in Devonshire and Cornwall; at Ihlefeld, in the Hartz; also at Johanngeorgenstadt, Schneeberg, Ilmenau, Eglersburg, Siegen, etc.

It forms mammillary masses, at Chittenden, Irasburgh, and Brandon, Vt.

Named from ψιλος, *smooth* or *naked*, μελας, *black*.

NEWKIRKITE.

Occurs in small needles, under the microscope apparently rectangular prisms. H.=3—3·5. G.=3·824. Lustre metallic, splendent. Color a brilliant black. Opaque. Rather sectile.

Composition.—According to Muir, (Thom. Min. i, 509): $\overset{\cdots}{\bar{M}n}$ 56·30, $\overset{\cdots}{\bar{F}e}$ 40·35, $\dot{H}$ 6·70 =103·35.

Forms a coating on red Hematite at Newkirchen, in Alsace.

WAD. EARTHY COBALT. CUPREOUS MANGANESE. Earthy Manganese. Bog Manganese. Manganschaum. Groroilite, *Berthier.* Schaumartiger Wad-Graphit, *M.*—Erdkobold. Schwarzer Erdkobalt, *Haid.* Cobalt Oxidé Noir, *H.* Asbolan, *Breit.* Kakochlor, *Breit.*—Kupfermanganerz. Lampadite.

The manganese ores here included occur in amorphous and reniform masses, either earthy or compact, and sometimes incrusting or as stains. They are mixtures of different oxyds and cannot be considered chemical compounds or distinct mineral species.

H.=0·5—6. G.=3—4·26; often loosely aggregated and feeling very light to the hands. Color dull black, bluish or brownish black.

Composition.—Rammelsberg considers them related essentially to Psilomelane under the formula $\dot{R}\,\ddot{Mn}+\dot{H}$ (or $\dot{H}^2$), but mixed with other ingredients.

Wad or Bog Manganese consists mainly of oxyds of manganese and water, with some oxyd of iron, and often silica, alumina, lime or baryta. *Groroilite* occurs in roundish masses of a brownish-black color and reddish brown streak; it is from Groroi in Mayenne, Vicdessos and Cautern, in France. Hardness sometimes 6 to 6·5.

Cupreous Manganese (Kupfermanganerz) contains, besides hydrous oxyds of manganese, 14 to 25 per cent. of black oxyd of copper, and 4 to 18 per cent. of oxyd of cobalt, with various impurities. G.=3·1—3·2.

Pelokonite is a variety of cupreous manganese, having a liver-brown streak; H. =3; G.=2·567.

Earthy Cobalt (*Asbolan*) is a wad in which oxyd of cobalt sometimes amounts to 33 per cent.

Analyses: 1, Klaproth, (Beit. iii, 311); 2, 3, Turner, (Edinb. J. Sci. N. S., ii, 213); 4, 5, Berthier, (Ann. Ch. Phys. li, 19); 6, Wackenroder, (Kastn. Archiv. xiii, 302, xiv, 257); 7, Scheffler, (Arch. d. Pharm. xxxv, 260); 8, Rammelsberg, (Pogg. lxii, 157); 9, Igelström, (Jahresb. xxv, 342); 10, 11, Beck, (Rep. Min. N. Y., p. 55);

12, Berthier; 13, Bahr, (J. f. pr. Ch. liii, 308, fr. Oefv. Ak. Förh. 1850, p. 240); 14, Klaproth, (Beit. ii, 308;) 15, Döbereiner, (Gilb. Ann. lxvii, 333); 16, Rammelsberg, (Pogg. liv, 551); 17, Kersten, (Schw. J. lxvi, 1); 18, Rammelsberg, (Pogg. liv, 545); 19, Böttger, (ib); 20:

I. *Wad.*

	$\dot{Mn}$	$\ddot{\overline{Mn}}$	O	$\ddot{\overline{Fe}}$	$\dot{Ba}$	$\dot{Cu}$	$\dot{H}$
1. Clausthal,	68·		——	6·5	1·0	——	17·5, $\dddot{Si}$ 8·0, C 1·0, Klaproth,
2. Devonshire,	79·12		8·82	——	1·4	——	10·66=100 Turner.
3. Derbyshire,	——	38·59	——	52·34	5·4	——	10·29, insol. 2·74=109·36, T.
4. Vicdessos,	69·8	——	11·7	——	——	——	12·4, $\ddot{\overline{Al}}$ 7·0=100·9, Berthier.
5. *Groroilite,*	62·4	——	12·8	6·0	——	——	15·8, clay, 3·0=100, Berthier.
6. Baden,	——	32·73	——	9·33	——	4·0	31·33, $\dot{Pb}$ 12·33, $\dot{Pb}$ 8·0, $\ddot{\overline{Ce}}$ 0·33, $\dddot{Si}$ 0·13, quartz 2·60, W.
7. Ilmenau,	66·5	——	12·1	1·0	8·1	——	9·8, $\dddot{Si}$ 2·5=100, Scheffler.
8. Rübeland,	67·50	——	13·48	1·01	0·36	——	10·30, $\dddot{Si}$ 0·47, $\dot{Ca}$ 4·22, $\dot{K}$ 3·66, =100, Ramm.
9. Westgothland,	——	82·51	——	0·77	——	——	5·58, $\dddot{Si}$ 1·43, $\ddot{\overline{Al}}$ 6·30, $\dot{Ca}$ 1·91, $\dot{Mg}$ 0·69=99·21, Iglst.
10. Hillsdale, N.Y.	——	68·50	——	16·75	——	——	11·50, insol. 3·25=100, Beck.
11. Austerlitz, "	——	58·50	——	22·00	——	——	17·00, insol. 2·50=100, Beck.
12. Siegen,	58·5	——	10·4	5·7	——	——	12·9 (with loss,) $\ddot{\overline{Al}}$ 10·7, quartz 1·8, Berthier.
13. Skidberg,	66·16			2·70	15·34	$\dot{Co}$ 0·02	12·07, $\dddot{Si}$ 0·92, $\ddot{\overline{Al}}$ 0·75, $\dot{Ca}$ 0·59, $\dot{Mg}$ 0·28, $\dot{K}$ 0·28=99·11, Bahr.

II. *Earthy Cobalt,* (Asbolan.)

	$\dot{Mn}$	$\ddot{\overline{Mn}}$	O	$\ddot{\overline{Fe}}$	$\dot{Ba}$	$\dot{Co}$	$\dot{Cu}$	$\dot{H}$
14. Oberlausitz,	——	16·0	——	——	——	19·4[a]	0·2	17·0, $\dddot{Si}$24·8, $\ddot{\overline{Al}}$20·4=97·8, K.
15. Camsdorf,	31·21	——	6·78	——	——	32·05	——	22·90=92·94, Döbereiner.
16. "	40·05	——	9·47	4·56	0·50	19·45	4·35	21·24, $\dot{K}$ 0·37=99·94, Ramm.

[a] With oxyd of Manganese.

III. *Cupreous Manganese.* Kupferschwärze, or Black Copper, *in part.*

	$\dot{Mn}$	$\ddot{\overline{Mn}}$	O	$\ddot{\overline{Fe}}$	$\dot{Ba}$	$\dot{Co}$	$\dot{Cu}$	$\dot{H}$
17. Schlackenwald,	——	74·10	——	0·12	——	——	4·80	20·10, $\dddot{Si}$0·3, gypsum 1·05 =100·47, Kersten.
18. Camsdorf,	49·99	——	8·91	4·70	1·64	0·49[b]	14·67	14·46, $\dot{Mg}$ 0·69, $\dot{K}$ 0·52, $\dddot{Si}$ 2·74 $\dot{Ca}$ 2·25=101·06 R.
19. "	53·22	——	9·14	1·88	1·70	0·14[b]	16·85	16·94, $\dot{K}$ 0·65 $\dot{Ca}$ 2·85=103·44, Böt.
20. Lauterberg,	——	30·05	——	29·00	——	——	11·50	29·45.

[b] With oxyd of nickel.

The following formulas have been suggested for several of the above results:—

No. 5.—$\ddot{\overline{Mn}}\,H=\ddot{Mn}$ 83·17, $\dot{H}$ 16·83.

7 and 8.—($\dot{Mn}$, $\dot{Ca}$, $\dot{Ba}$, $\dot{K}$) $\ddot{Mn}^2+3\dot{H}$, mixed with $\ddot{Mn}$ (*Ramm.*) suggesting a relation to Psilomelane. For No. 8, $\dot{R}\,\ddot{Mn}^4+3\dot{H}$, *Berz.*

9.—2 ($\ddot{\overline{Mn}}$, $\ddot{\overline{Al}}$)+$\dot{H}$, *Svanberg.*

No. 13 has H.=6·5; G.=4·254.

15.—($\dot{Co}$, $\ddot{\overline{Mn}}$)+6$\dot{H}$?

16.—($\dot{Co}$, $\dot{Cu}$) $\ddot{Mn}^2+4H$ mixed with $\ddot{Mn}$—or near Psilomelane, *Ramm.*

17.—$\ddot{\overline{Mn}}+2\dot{H}$, mixed with $\dot{Cu}$, *Kersten.*—$\dot{Cu}\,\ddot{\overline{Mn}}^3+6\,\ddot{\overline{Mn}}\,\dot{H}^3$, *Berz.*—or $\dot{Cu}\,\ddot{\overline{Mn}}\,H^9+3\ddot{\overline{Mn}}^2\,\dot{H}^3$.

18, 19.—$\dot{R}\,\ddot{Mn}^2+2\dot{H}$, *Ramm.;* but mixed with some brown iron ore, oxyd of manganese and other impurities. This is the general formula given by Rammelsberg for the above minerals.

The above ores are results of the decomposition of other ores—partly of oxyds, and partly of manganesian carbonates. They occur at the localities above mentioned, and many other places. Wad or Bog manganese is abundant in the counties of Columbia and Duchess, N. Y., at Austerlitz, Canaan Centre, and elsewhere, where it occurs as a marsh deposit, and according to Mather has proceeded from the alteration of brown spar; also in the southwest part of Martinsburg, Lewis Co., in a swamp. There are large deposits of this bog manganese at Blue Hill Bay, Dover, and other places in Maine.

Earthy Cobalt occurs with cobalt pyrites at Riechelsdorf in Hesse, Saalfeld in Thuringia, at Nertschinsk in Siberia; at Alderly Edge in Cheshire. An earthy cobalt occurs at Mine la Motte, Missouri, which contains 10 or 11 per cent. of oxyd of nickel, besides oxyd of cobalt and copper with iron, lead and sulphur; also near Silver Bluff, South Carolina, affording 24 per cent. of oxyd of cobalt to 76 of oxyd of manganese.

Cupreous manganese is found at Schlackenwald, and at Camsdorf near Saalfeld; at Lauterberg in the Hartz; *Pelokonite*, a variety of it, H.=3, G.=2·5—2·6, is from Chili, where it occurs with Chrysocolla, (Richter, Pogg. xxi, 591; Kersten, Schw. J. lxvi, 7).

ATACAMITE, *Jameson*. Salzkupfererz, *W.* Remolinite, *B.* and *M.*

Trimetric. $I:I$=112° 20′, $O:1\bar{i}$=131° 29′; $a:b:c$=1·131 : 1 : 1·492. Observed planes, I, 1, $1\bar{i}$ $\breve{i}\breve{i}$, $\overset{\smile}{i2}$, $\overset{\smile}{i4}$, $\breve{i}\breve{i}$, $1\breve{i}$. $\overset{\smile}{i2}:\overset{\smile}{i2}$ (ov. $\breve{i}\breve{i}$) =106° 34′, $\overset{\smile}{i4}:\overset{\smile}{i4}$ (ib.)=139 °4′, $1\breve{i}:1\breve{i}$ (top)=105° 40′, $I:1$=143° 42′, 1 : 1 (mac.)=126° 40′. Usual in modified rectangular prisms, and rectangular octahedrons. Cleavage: $\breve{i}\breve{i}$ perfect, $1\bar{i}$, imperfect. Occurs also massive lamellar.

H.=3=3·5. G.=4—4·3; 3·7, Breit. Lustre adamantine—vitreous. Color various shades of bright green, rather darker than emerald, sometimes blackish green. Streak apple-green. Translucent—subtranslucent.

Composition.—$Cu\,Cl+3\dot{C}u\,\dot{H}$=Oxyd of copper 55·8, chlorid of copper 31·5, water 12·7=100. Others, as that of Cobija, afford the formula $Cu\,Cl+3\dot{C}u\dot{H}^2$= Oxyd of copper 49·6, chlorid of copper 27·9, water 22·5=100. Analyses: 1, Berthier, (Ann. d. Mines, [3], vii, 542); 2, Ulex, (Ann. Ch. u. Pharm. lxix, 361).

1. Bolivia, Cobija,	Cl 14·92	50·00	21·75,	Cu 13·33=200, Berthier.
2. Chili,	" 16·13	56·23	11·99	" 14·56, $\ddot{Si}$ 1·10=100, Ulex.

B.B. tinges the flame bright green or blue, and gives off fumes of muriatic acid; on charcoal, the copper is reduced to the metallic state. In acids easily soluble.

This species was originally found in the state of sand in the Atacama province, northern part of Chili. It occurs in different parts of Chili, especially at Los Remolinos; also in veins in the district of Tarapaca, Bolivia; at Tocopilla, 16 leagues north of Cobija, is an important locality in Bolivia; with malachite in South Australia; it also invests some of the lavas of Vesuvius and Etna, being formed by the action of the volcano; Schwarzenberg in Saxony, is another locality.

It is sometimes ground up in Chili, and sold under the name of *Arsenillo*, as sand for letters.

II. OXYDS OF ELEMENTS OF THE ARSENIC GROUP.

I. ARSENIC DIVISION.

1. ARSENOLITE GROUP.—Composition $R\,O^3$. Monometric.

Arsenolite, $As\,O^3$. Senarmontite, $Sb\,O^3$.

2. VALENTINITE GROUP.—Composition $R\,O^3$. Trimetric.

Valentinite, $Sb\,O^3$. ? Bismuth Ochre, $Bi\,O^3$.

3. KERMESITE GROUP.—Composition $R\,O^3$, (S replacing part of O). Monoclinic.

Kermesite, $Sb\,(O,S)^3$.

4. CERVANTITE GROUP.—Composition RO^4 or RO^3+RO^5.

Cervantite, SbO^3+SbO^5.

5. VOLGERITE GROUP.—Composition $R\,O^5+5H$.

Appendix.—Bleinierite, $\dot{P}b^3\,Sb\,O^5+4\dot{H}$; Ammiolite.

II. SULPHUR DIVISION.

SULPHUROUS ACID GROUP.—Composition RO^2.

Sulphurous Acid, $S\,O^2$.

SULPHURIC ACID GROUP.—Composition $R\,O^3$.

Sulphuric Acid, $S\,O^3$.

WOLFRAMINE GROUP.—Composition $R\,O^3$. Monometric.

Wolframine, $W\,O^3$. Molybdine, $M\,O^3$.

I. OXYDS OF ARSENIC, ANTIMONY, ETC.

ARSENOLITE, Arsenous Acid. Arsenite, *Haid.* White Arsenic. Arsenikblüthe. Arsenic oxidé, *H.*

Monometric; f. 11. Usual in minute capillary crystals, stellarly aggregated, or crusts investing other substances. Also botryoidal and stalactitic.

H.=1·5. G.=3·698, Roget and Dumas. Lustre vitreous or silky. Color white, occasionally with a yellowish or reddish tinge. Streak white. Transparent—opaque. Taste astringent, sweetish.

Composition.—$\ddot{A}s$=Oxygen 24·24, arsenic 65·76.

B.B. completely volatilized in white fumes. In the inner flame blackens, and gives off an alliaceous odor. Slightly soluble in hot water.

Found accompanying ores of silver, lead, arsenical iron, cobalt, nickel, etc., at Andreasberg in the Hartz, and formed by the decomposition of other species. Occurs also at Joachimsthal in Bohemia, at Kapnik in Hungary, and in the old mines of Biber in Hanau.

It differs from pharmacolite, which it much resembles, in being soluble.

Haidinger's name Arsenite, being a general name for salts of arsenous acid, we have changed it to Arsenolite.

Native Arsenic is often covered by a blackish crust or powder, which has been considered a suboxyd ($\grave{\mathrm{A}}\mathrm{s}$); but according to Suckow, it is a mixture of metallic arsenic and Arsenous acid.

Arsenphyllite. Breithaupt has thus named a mineral of the composition of Arsenolite, occurring under a trimetric form, homœomorphous with Valentinite.

SENARMONTITE, *D.*—*H. de Senarmont*, Ann. Ch. Phys. [3], xxxi, 504.

Monometric; in simple octahedrons, (f. 11). Cleavage: octahedral, in traces. Also granular massive.

H.=2—2·5. G.=5·22—5·3. Lustre resinous, inclining to subadamantine. Transparent—translucent. Colorless or grayish. Streak white.

Composition.—$\dddot{\breve{\mathrm{S}}}\mathrm{b}$ (like Valentinite)=Oxygen 15·68, antimony 84·32, with sometimes 1 p. c. of lead and 1 to 3 p. c. of grayish clay. Soluble in muriatic acid. B.B. like Valentinite.

From the province of Constantine, Algeria, at Sensa, and also from Perneck near Malaczka in Hungary. The octahedrons are sometimes more than a centimeter in diameter.

VALENTINITE, *Haid.* White Antimony. Oxyd of Antimony. Antimony Bloom. Weisspiessglanzerz, *W. Hof.* Spiesglanzweiss. Antimonblüthe, *L.* Antimonoxyd. Exitèle, *Beud.* Antimoine Oxidé, *H.*

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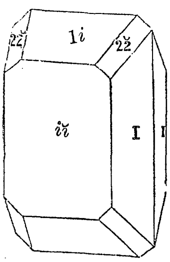


Trimetric. $I:I=136°\ 58'$; $O:1\bar{i}=105°\ 35'$; $a:b:c=3·5868:1:2·5365$. Observed planes, I, $i\breve{i}$, $\frac{1}{3}\breve{i}$, $1\breve{i}$, $4\breve{i}$, $2\breve{2}$. $1\breve{i}:1\breve{i}$ (adj.)$=70°\ 32'$, $\frac{1}{3}\breve{i}:\frac{1}{3}\breve{i}=129°\ 32'$, $I:i\breve{i}=111°\ 31'$. Often in rectangular plates with the lateral edges beveled, and in acicular rhombic prisms. Cleavage: I, highly perfect, easily obtained. Twins: plane of composition $i\breve{i}$, producing an aggregation of thin plates. Also massive; structure lamellar, columnar, and granular.

H.=2·5—3. G.=5·566, crystals from Bräunsdorf. Lustre adamantine, $i\breve{i}$ often pearly; shining. Color snow-white, occasionally peach-blossom red, and ash-gray to brownish. Streak white. Translucent—subtransparent. Sectile.

Composition.—SbO^3=Oxygen 15·68, antimony 84·32. Analysis by Vauquelin, (Hauy's Min. iv, 274):

Oxyd of Antimony 86, Ibid. and iron 3, Silica 8=97.

Fuses in the flame of a candle, and before the blowpipe is entirely volatilized, covering the charcoal with a white coating.

This species results from the alteration of gray antimony, native antimony, and other antimonial ores.

The tabular crystallizations of this species occur in small quantities at Przibram in Bohemia, in veins traversing primitive rocks; and the prismatic, at Bräunsdorf, near Freiberg in Saxony, Malaczka in Hungary, Allemont in Dauphiny, and elsewhere in Europe.

Antimonophyllite contains oxyd of antimony, and occurs in thin inequiangular six-sided prisms. Locality unknown.

BISMUTH OCHRE. Oxyd of Bismuth. Wismuthochre, *W.* Bismuth Oxydé, *H.*

Crystalline form not observed. Occurs massive and disseminated, pulverulent, earthy; also passing into foliated.

G.=4·3611, Büsson. Lustre adamantine—dull, earthy. Color greenish-yellow, straw-yellow, grayish-white. Fracture conchoidal—earthy.

Composition.—$\dddot{Bi}$=Oxygen 10·35, bismuth 89·65, along with some iron and other impurities. Analysis by Lampadius, (Handb. z. Chem. Ann. p. 286):

Oxyd of bismuth 86·4, oxyd of iron 5·1, carbonic acid 4·1, water 3·4=99.

Suckow obtained for another derived from the decomposition of aciculite, (Die Verwitt. im Min. 14), $\dddot{Bi}$ 96·5, $\dddot{As}$ 1·5, $\dddot{\overline{Fe}}^2$, $\dot{H}^5$ 2·0=100.

B.B. on charcoal, easily reduced to the metallic state, and subsequently the greater part may be dissipated.

Occurs pulverulent at Schneeberg in Saxony, at Joachimstahl in Bohemia, and with native gold at Beresof in Siberia. Dr. Jackson reports an oxyd of bismuth not carbonated, as occurring with the tetradymite of Virginia. An earthy steatitic mineral from Agnes in Cornwall, afforded Macgregor, Oxyd of bismuth 28·8, carbonic acid 51·3, peroxyd of iron 2·1, alumina 7·5, silica 6·7, water 3·6.

KERMESITE. Red Antimony. Rothspiesglaserz, *W.* Rothspeissglanzerz, *Haus.* Antimonblende, *L.* Antimoine Hydro-Sulfuré. Antimoine Oxydé Sulfuré, *H.* Pyrantimonite, *Br.* Pyrostibite, *Gl.* Kermesome, *Chapman.* Kermes, B. & M.

Monoclinic. C=77° 51′; $O : ii$=102° 9′, $O : 1i$ (plane on acute edge)=115° 36′, $O : \frac{1}{3}i$=149° 57′. Cleavage: basal. Usually in tufts of capillary crystals, consisting of elongated, slender six-sided prisms.

H.=1—1·5. G.=4·5—4·6. Lustre adamantine, inclining to metallic. Color cherry-red. Streak brownish-red. Feebly translucent. Sectile. Thin leaves slightly flexible.

Composition.—SbO^3+2SbS^3=Oxyd of antimony 30·2, sulphuret of antimony, 69·8 =100. Analyses: H. Rose, (Pogg. iii, 453, the sulphur separately determined):

1. Antimony 74·45, oxygen 5·29, sulphur 20·49.
2. " 75·66, " 4·27, " 20·49.

B.B. fuses readily on charcoal, and at last is entirely volatilized. In nitric acid it becomes covered with a white coating.

Results from the change of gray antimony. Occurs in veins in quartz, accompanying gray and white antimony, at Malaczka near Posing in Hungary, at Bräunsdorf near Freiberg in Saxony, and at Allemont in Dauphiny.

The *tinder ore* has been shown to be wholly distinct from red antimony.

CERVANTITE, *D.* Antimonoxyd. Antimonsaures Antimonoxyd. Antimonocher, *in part.*

In acicular crystallizations. Also massive, as a crust, or a powder.

G.=4·084. Lustre greasy, bright, or earthy. Color Isabella-yellow, sulphur-yellow, or nearly white.

Composition.—SbO^3+SbO^5=Oxygen 19·9, antimony 80·1. Analysis by Dufrenoy:

O	Sb	$\dot{Ca}\,\ddot{C}$	$\dddot{\overline{Fe}}$	
16·85	67·50	11·45	1·50	*insol.* 2·70=99·80.

C. Bechi obtained from needle crystals from Pereta, Tuscany, O 19·47, Sb 78·83, Fe 1·25, gangue 0·75=100·30, giving the same formula, (Amer. Jour. Sci., [2], xiv, 61).

B.B. infusible; but easily reduced on charcoal. Soluble in muriatic acid. Found with gray antimony, and resulting from its alteration at Cervantes, in Galicia, Spain, Chazelles in Auvergne, Felsobanya, Kremnitz and elsewhere in Hungary.

Stibiconise, *Beud.* (Antimonochre, Spiessglanzocher, *Haus.*, Stiblite, *Blum.*,) is considered a mixture of valentinite, cervantite, and hydrous antimonic acid, by G. H. O. Volger, (Entwick. Min. 1854, 72). It occurs massive, and yellowish in color; H.=5·5. G.=5·28. Blum and Delffs obtained in an analysis (J. f. pr. Chem. xl, 318), O 19·54, Sb 75·83, As *tr.*, H 4·63. From Goldkronach in Bavaria.

VOLGERITE. Hydrous Antimonic Acid. Antimonocher, *in part.*

A white powder or crust ocurring with cervantite, and resulting from its alteration, having the formula, according to Volger, (Entw. Min., 77), $\mathrm{Sb\ O^5{+}5\ \dot{\bar{H}}}$= oxygen 18·8, antimony 60·3, water 21·0.

A white antimony from the province of Constantine, Algeria, analyzed by E. Cumenge, (Ann. d. M. [4], xx, 80), afforded O 17, Sb 62, $\dot{\bar{\mathrm{H}}}$ 15, $\dddot{\bar{\mathrm{F}}\mathrm{e}}$ 1, gangue 3=98.

Bleinierite, *Nicol.* (Bleinière, *Haus.* Antimonate of Lead. Antimonsaures Bleioxyd.) Probably a mechanical mixture of lead and antimony ochres. Occurs amorphous, reniform, spheroidal; also earthy or incrusting; structure often curved lamellar. H.=4. G.=3·933, Karsten; 4·6—4·76, Hermann. Lustre resinous, dull, or earthy. Color gray, brownish, yellowish. Streak grayish or yellowish. Opaque.

Composition.—$\mathrm{\dot{P}b^3\ \overset{\cdot\cdot}{\dddot{S}}b{+}4\dot{\bar{H}}}$, according to Hermann=Antimonic acid 31·3, oxyd of lead 62·0, water 6·7. Analyses: 1, Plaff, (Schw. J. xxvii, 1); 2, Hermann, (J. f. pr. Chem. xxxiv, 179):

1. $\mathrm{\overset{\cdot\cdot}{\dddot{S}}b}$ 43·96, $\mathrm{\dddot{A}s}$ 16·42, $\mathrm{\dot{P}b}$ 33·10, $\mathrm{\dot{C}u}$ 3·24, $\dddot{\bar{\mathrm{F}}\mathrm{e}}$ 0·24, $\mathrm{\dddot{S}i}$ 2·34, $\mathrm{\dddot{S}}$ 0·62, Fe Mn 3·32 =103·23, P.
2. $\mathrm{\overset{\cdot\cdot}{\dddot{S}}b}$ 31·71, $\mathrm{\dot{P}b}$ 61·83, $\dot{\bar{\mathrm{H}}}$ 6·46=100, Hermann.

B.B. on charcoal fuses to a metallic globule, gives out fumes of antimony, and finally yields a bead of lead. From Nertschinsk, Siberia, and supposed to result from the decomposition of other ores of antimony.

AMMIOLITE, *D.* Antimonite of Quicksilver, *Domeyko.* Annales des Mines, 4th ser. vi, 183. Quecksilberoxyd Antimonigsaures.

A red powder, consisting, according to Domeyko, of

$\mathrm{\overset{::}{S}b}$ 12·5, $\mathrm{\dot{H}g}$ 14·0, $\dddot{\bar{\mathrm{F}}\mathrm{e}}$ 22·3, $\mathrm{\dddot{S}i}$ 26·5, $\dot{\bar{\mathrm{H}}}$ and loss 24·7=100,

being an antimonite of quicksilver mixed with clay and hydrated oxyd of iron.

From the mines of mercury in Chili, accompanying ores of antimony, copper, and mercury. Also at Silberg, near Olpe, Westphalia, where it is produced by the decomposition of a quicksilver gray copper. The name Ammiolite is derived from *αμμιον*, *vermilion.*

This mineral may be only a mixture, and is therefore placed here with the oxyds, rather than among the salts.

II. OXYDS OF SULPHUR, TUNGSTEN, MOLYBDENUM, ETC.

SULPHUROUS ACID.

Gaseous. G.=2·234, Thenard. Colorless. Taste acid. Odor pungent.

Composition.—$\ddot{S}$=Sulphur 50·0, oxygen 50·0. Dissolves readily in water, forming an acid solution, which reddens vegetable blues; destroys life and extinguishes combustion.

Sulphurous acid is evolved from most active volcanoes. The sulphur about volcanoes is sometimes produced by the meeting of this gas with sulphuretted hydrogen, causing a mutual decomposition and a deposition of sulphur.

SULPHURIC ACID.

Liquid. G.=1·85. Colorless. Odor pungent. Taste intensely acid.

Composition.—$\dot{H}\,\dddot{S}$=Sulphuric acid 81·6, and water 18·4=100.

This acid, in a dilute state, has been found in the neighborhood of several volcanoes. It occurs near Sienna, in the cavities of the small volcanic mountain named Zocolino, and in a cavern near Aix, in Savoy. Water strong with sulphuric acid occurs at Alabama, Genessee Co., N. Y.; also at Tuscarora, near Brantford, at Chippewa, Niagara, and at St. David's, Canada West. The first afforded W. J. Craw and H. Erni for 1000 parts of water, (Am. J. Sci. [2], ix, 449:

Free $\dddot{S}$	$\dot{Fe}\dddot{S}$	$\bar{\ddot{A}}l\,\dddot{S}^3$	$\dot{Ca}\dddot{S}$	$\dot{Mg}\dddot{S}$	$\dot{K}\dddot{S}$	$\dot{Na}\dddot{S}$	$\dddot{Si}$	NaCl	
2·0122	0·4356	0·3702	1·1065	0·4592	0·1061	0·1196	0·0656	———	=4·6750, Erni.
2·0070	0·4266	0·3232	1·1161	0·5305	0·0822	0·0945	0·0363	0·0684	=4·6848, Craw.

The specific gravity of the water is 1·00482 at 15° C., Erni.

The Tuscarora water afforded T. S. Hunt 4·2 parts of sulphuric acid in 1000, with above 2 of the sulphates of iron, alumina, lime, magnesia, besides traces of alkalies, and some sulphuretted hydrogen, (Logan's Geol. Rep. 1847, 150). Sulphuric acid results from the oxydation of sulphuretted hydrogen.

Paramo de Ruiz in New Granada, and Rio Vinagre, are volcanic localities.

WOLFRAMINE, *Lettsom* and *Greg.* Tungstic Ochre, *B. Silliman,* Am. J. Sci. iv, 52. Tungsten ochre, *Nicol.* Wolframochre, *Haus.* Scheelsaure, *Naumann.*

Monometric. In cubes, also pulverulent and earthy. Color bright yellow, or yellowish-green.

Composition.—$\dddot{W}$ or pure tungstic acid=Oxygen 20·7, tungsten 79·3.

B.B. on charcoal becomes black in the inner flame, but infusible. A clear glass in the outer flame with borax; with more of the mineral enamel-white on cooling; in the inner flame a yellowish glass, but if a larger proportion be added, it is blood-red on cooling.

Occurs at Lane's mine, Monroe, Ct., filling small cavities in other ores of tungsten, or coating them, and has resulted from their decomposition. Also found at St. Leonard, near Limoges, rarely in distinct cubes of a sulphur-yellow color on wolfram and quartz, a fine specimen of which is contained in the cabinet of M. Adams of Paris; also with wolfram in Cumberland. Also in Cabarras Co., N. C.

MOLYBDINE, *Lettsom* and *Greg.* Molybdena Ochre. Molybdänocher, *Karsten.*

An earthy yellow powder or incrustation.

Composition.—$\dddot{M}o$=Oxygen 34·29, molybdenum 65·71.

B.B. on charcoal fuses to a slag. With borax forms a colorless glass in the outer flame and a brown glass in the inner. Reduced with soda. Easily soluble in muriatic acid, and the solution is rendered blue by metallic iron.

Occurs with molybdenite, from which it is probably derived, at the foreign localities of this species; also at Westmoreland, N. H., and Chester, Delaware Co., Pennsylvania.

Molybdate of Iron ?—Deep yellow and sub-fibrous, or in tufted imperfect crystals; and also pulverulent. According to an imperfect analysis by D. D. Owen, (Proc. Ac. N. Sci. Philad., vi, 108), contains $\dddot{M}o$ 40, $\ddot{\overline{F}}e$ 35, $\dot{M}g$ 2, Alkali 8, $\dot{H}$ 15. B.B. fuses easily. From the gold region, California, near Nevada City.

III. OXYGEN COMPOUNDS OF CARBON, BORON, AND SILICON.

Carbonic acid,	$\ddot{C}$.
Sassolin,	$\dddot{B}$.
Quartz,	$\dddot{S}i$.

CARBONIC ACID.

Gaseous. G.=1·5245. Colorless. Taste, slightly acid. Excites a pungent sensation in the nostrils, and destroys life.

Composition.—$\ddot{C}$=Carbon 27·27, oxygen 72·73. Extinguishes combustion.

Evolved from many mineral waters, and also about some volcanoes. The Saratoga and Ballston waters owe their briskness to this gas, which is constantly escaping. The mineral waters of Germany are famous localities. Near Naples, on lake Albano, there is a small cave called Grotto del Cane, which is filled with carbonic acid to the level of its entrance; the lake is supposed to occupy the crater of a volcano and the hot baths of San Germano are situated on its banks.

SASSOLIN, *Reuss.* Boracic Acid. Acid boracique, *H.*

Triclinic. $I : I'=118^\circ\ 30'$, $O : I=95^\circ\ 3'$, $O : I'=80^\circ\ 33'$ B. and M. Twins, compounded parallel to the base. Cleavage: basal very perfect. Usually in small scales, apparently six-sided tables, and also in stalactitic forms, composed of small scales.

H.=1. G.=1·48. Lustre pearly. Color white, except when tinged yellow by sulphur; sometimes gray. Feel smooth and unctuous. Taste acidulous, and slightly saline and bitter.

Composition.—$\dddot{B}\dot{H}^3$=Boracic acid 56·4, water 43·6. The native stalactitic salt, according to Klaproth, (Beit. iii, 97), contains mechanically mixed, sulphate of magnesia and iron, sulphate of lime, silica, carbonate of lime, and alumina. Erdmann has stated, (J. f. pr. Ch. xiii, 7, 8), that sassolin contains 3·18 per cent. by weight of ammonia, and instead of being pure boracic acid, that it is a borate of ammonia.

Fuses in a candle, and at first tinges the flame green; but this color disappears when the water of crystallization has evaporated. The cooled globule is glassy, and opaque if any gypsum is present.

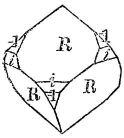
Found abundantly in the crater of Vulcano, one of the Lipari isles, forming a layer on the sulphur, and around the fumaroles or exits of the sulphureous exhalations. It is obtained for the arts from the volcanic fumaroles of Tuscany. The first locality known was at Sasso, whence the name, Sassolin. The hot vapors at the lagoons or boiling springs of Tuscany, consist largely of boracic acid. The vapors are made to pass through water, which absorbs the boracic acid; the waters are then evaporated by means of the steam from the springs. They yield seven to eight thousand pounds troy per day.

These lagoons spread over a surface of about 30 miles, and in the distance, clouds of vapor are seen rising in large volumes among the mountains. On approaching the places, the earth seems to pour out boiling water, as if from volcanoes of various sizes, and the heat in the immediate vicinity is intolerable and the sulphurous smells suffocating. (Am. Jour. Sci. xxxvii, 1836, 270, and [2], ix, xi, 199; Quart. J. Geol. Soc. vi, 367.)

QUARTZ. Flint. Silex. Chalcedony. Agate. Jasper. Hornstone. Cat's Eye. Amethyst. False Topaz. Rose Quartz. Prase. Chrysoprase. Cantalite. Iron Flint. Heliotrope. Eisenkiesel. Berg-crystal. Kalzedon.

Rhombohedral. $R : R = 94° 15'$, $O : R = 128° 13'$; $a = 1{\cdot}0999$. Observed planes: rhombohedrons, $\frac{1}{2}$, 1 (R), $\frac{3}{2}$, 2, 3, 4, 5, 6, –11, –7, $-\frac{7}{2}$, –2, $-\frac{3}{2}$, –1, $-\frac{1}{2}$; pyramids, 12, 22; gyroidal forms, between 22 and i to left, $l\ 3\frac{3}{2}$, $l\ 4\frac{4}{3}$, $l\ 5\frac{5}{4}$, $l\ 6\frac{6}{5}$, $l\ 8\frac{8}{7}$, $l\ 13\frac{13}{12}$; ib. between 22 and i to right, $r\ \frac{12}{5}\ \frac{12}{7}$, $r\ \frac{8}{3}\ \frac{8}{5}$, $r\ 3\frac{3}{2}$, $r\ \frac{10}{3}\ \frac{10}{7}$, $r\ \frac{11}{3}\ \frac{11}{8}$, $r\ 4\frac{4}{3}$, $r\ 13\ \frac{13}{12}$; ib. betweeen 22 and $R\ \frac{5}{3}\ \frac{5}{3}$, $\frac{9}{8}\ \frac{9}{8}$; between 22 and –1, $\frac{4}{3}\ \frac{4}{3}$; prisms i, $i2$, $i\frac{6}{5}$, $i\frac{3}{2}$. Hemihedral, or tetartohedral in 22, and all the forms following, of the above, excepting i and $i2$. Faces R often brighter than –1; i generally striated horizontally.

335



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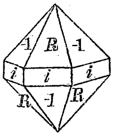

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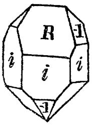

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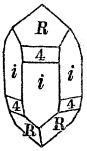

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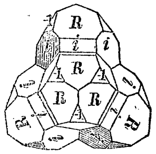

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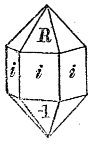

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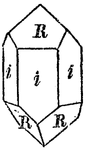

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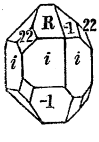

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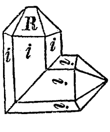
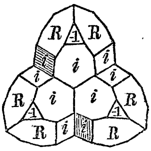


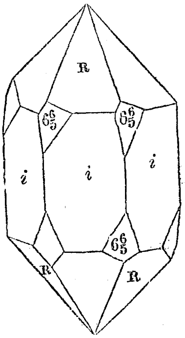
343 B



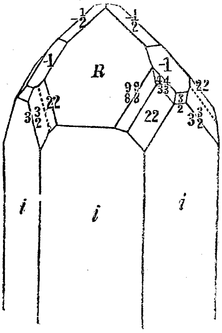
$i : R = 141° 47'$
$i : \frac{3}{2} = 154° 43'$
$i : 2 = 158° 31'$
$i : 3 = 165° 18'$
$i : 22 = 142° 2'$
$i : 3\frac{3}{2} = 154° 55'$
$i : 4\frac{4}{3} = 161° 31'$
$i : 6\frac{6}{5} = 167° 59'$
$i : 8\frac{8}{7} = 171° 8'$
$i : 13\frac{13}{12} = 174° 39'$
$i : \frac{4}{3}\frac{4}{3}$ (ov. 22) $= 125°28'$
$i : \frac{9}{8}\frac{9}{8}$ (ov. 22) $= 118°7'$
$i : i = 120°$
$i : i\frac{6}{5} = 171° 33'$
$R : 1$ –(ov. i) $= 103° 34'$.
$R : -1$ (adj.) $= 133° 44'$.
$R : i$ (ov. 22) $= 113° 8$.
$R : 22 = 151° 6'$.
$R : \frac{9}{8}\frac{9}{8} = 175° 1'$.
$-1 : \frac{4}{3}\frac{4}{3} = 167° 40$.

Cleavage: *R*, -1, and *i* very indistinct; sometimes effected by plunging a heated crystal into cold water. Twins: face of composition, *o*, (basal plane); plane truncating pyramidal edge, (f. 342); *R*, (f. 343 A, B, (Rose), opposite views of the same crystal). The two crystals in twins compounded parallel to *o*, sometimes penetrate one another very irregularly, while the external planes are regular and even. Also f. 345, 346, metagenic twins, (p. 131). Figs. 188, 189, 193 represent distorted crystals. Also stalactitic and mammillary forms. Often massive, either impalpable, or coarse granular. Sometimes coarsely tabular and reticulated.

344 A

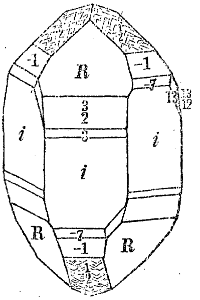


344 B



Milk Row Quarry.

344 C



Quebec.

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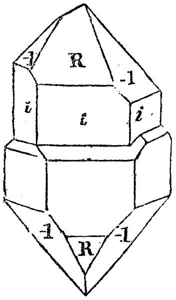

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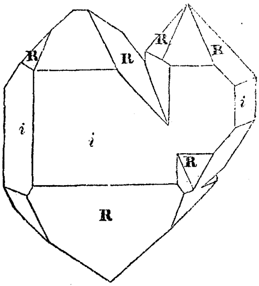

H.=7. G.=2·5—2·8; 2·6413—2·6541, Beudant; 2·6701, Haüy. Lustre vitreous, sometimes inclining to resinous; splendent—nearly dull. Colorless, when pure; often various shades of yellow, red, brown, green, blue, black. Streak white, of pure varieties; if impure, often the same as the color, but much paler. Transparent—opaque. Fracture perfect conchoidal—subconchoidal. Tough—brittle—friable.

Composition.—Pure silica in the insoluble state, that is, not taken up by a potash solution. Impure varieties contain variable quantities of oxyd of iron, alumina, oxyd of manganese, nickel, &c. B.B. alone undergoes no change, but with soda, fuses readily with effervescence to a transparent glass.

The varieties arise either from crystallization, mode of formation, or impurities; and are naturally distributed into three series. (1st), presenting the bright glassy lustre of broken *quartz crystal;* (2d), presenting the glistening subvitreous or waxy lustre, and translucency, or subtransparency of *Chalcedony;* (3d), with the nearly dull lustre, dull colors, and opacity of *Jasper.*

I. *The vitreous varieties.*

Rock crystal includes pure crystals of quartz. This stone, when cut for jewelry, is called "white stone." An *asteriated* variety contains whitish impurities or opacity arranged along the diametral planes.

Amethyst is a clear purple or bluish-violet variety of quartz crystal. The color is supposed to be due to a small percentage of oxyd of manganese. But Heintz, in an analysis of a Brazilian specimen, obtained, besides silica, 0·0187 oxyd of iron, 0·6236 lime, 0·0133 magnesia, and 0·0418 soda; and he considers the color owing to a compound of iron and soda.

Rose quartz has a rose-red or pink color, and is transparent, or nearly so. G. 2·6569 before heating, 2·6578 after heating, E. Wolff. It becomes very pale on exposure to the light. Usually massive, and often much cracked. The lustre is vitreous, sometimes a little greasy. The color is attributed by Fuchs to oxyd of titanium, who detected 1 to 1½ per cent. in specimens from Rabenstein, near Bodenmais. Berthier states that the color is due to organic matter. It probably arises from manganese, the color being similar to that of manganese spar.

False topaz is a light yellow pellucid variety of quartz crystal. It resembles yellow topaz, but is distinguished by its crystalline form, and the absence of cleavage.

Smoky quartz, or *Cairngorm stone*, has a brownish smoky tint. The crystals are often pellucid; but occasionally the color is so deep as to render them nearly opaque, except in thin fragments.

Milky quartz, as the name implies, has a milk-white color. It is a massive vitreous variety, and one of the most common. It has sometimes a *greasy* lustre, and is then called *greasy* quartz.

Prase is a leek-green variety of massive quartz.

Aventurine quartz is minutely spangled throughout the mass with yellow scales. It is usually translucent, and of a gray, brown, or reddish-brown color.

Siderite. An indigo or Berlin-blue variety, from Golling, near Saltzburg.

Ferruginous quartz is of an opaque-red, brownish-red, or ochre-yellow color, which is due to oxyd of iron. It occurs in distinct crystals; the crystals are sometimes minute and aggregated into masses, like the grains of sand in sandstone.

II. *Chalcedonic varieties.*

Chalcedony has usually the subdued lustre of wax, either translucent or subtransparent; some milk-white varieties opaque. Occurs in mammillary and botryoidal shapes; also as stalactites, in cavities lined or roofed with chalcedony. According to Fuchs, it is true quartz with some opal disseminated through it.

Chrysoprase. An apple, or leek-green variety of chalcedony; it is colored by nickel.

Carnelian. A reddish variety of chalcedony, generally of a clear bright tint. Passes into common chalcedony through grayish-red varieties. Heintz by his analysis shows that the color is due to oxyd of iron; he found peroxyd of iron 0·050 per cent., alumina 0·081, magnesia 0·028, potash 0·0043, soda 0·075.

Sard, a deep brownish-red chalcedony, of a blood-red color by transmitted light.

Agate, a variegated chalcedony, the colors in clouds, spots, or bands, the banded consisting of parallel or concentric layers, and either in straight, circular, or zigzag forms. The last are called *fortification* agates, from a resemblance to the angular outlines of a fortification. In other agates the colors are owing to foreign matter disseminated through the mass. *Moss agate* or *Mocha stone* is a chalcedony containing within dendritic or moss-like delineations of an opaque brownish-yellow color, which are due to oxyd of manganese or iron.

Onyx. Resembles agate, but the colors, usually a light clear brown and an opaque white, are arranged in flat horizontal planes. When the layers consist of sard and white chalcedony, the stone is called *sardonyx.*

Cat's eye. A translucent quartz, presenting a peculiar opalescence, or glaring internal reflections, when cut *en càbochon,* which effect is owing to filaments of asbestus. The color is commonly light greenish-gray—sometimes yellow, red or brownish.

Flint. Somewhat allied to chalcedony, but more opaque, and of dull colors, usually gray, smoky-brown, and brownish-black. The exterior is often whitish, from mixture with lime or chalk, in which it is imbedded. Lustre, barely glistening, subvitreous. Breaks with a deeply conchoidal fracture and a sharp cutting edge. The flint of the chalk formation consists largely of the remains of infusoria, sponges, and other marine productions. The silica of flint, according to Fuchs, is partly soluble silica, easily taken up by a solution of potash. There is usually one per cent. or so of alumina and peroxyd of iron, with one or two of water.

Hornstone. Resembles flint, but more brittle, the fracture more splintery. *Chert* is a term often applied to hornstone, and to any impure flinty rock, including the jaspers.

Plasma. A faintly translucent chalcedony, approaching jasper, having a greenish color sprinkled with yellow and whitish dots, and a glistening lustre.

III. *Jaspery varieties.*

Jasper. A dull red, yellow, brown, or green siliceous rock, sometimes blue or black, compact, nearly or quite opaque, and presenting little beauty until polished. When the colors are in stripes it is called *Striped* or *Riband Jasper.* *Egyptian Jasper* is zoned with colors, and forms nodules. *Porcelain Jasper* is nothing but baked clay, and differs from true jasper in being fusible on the edges before the blowpipe. *Red porphyry* often resembles jasper, but is nearly pure feldspar, and is also somewhat fusible.

Blood stone or *Heliotrope.* Color, deep green, with interspersed, blood-red spots, like drops of blood.

Lydian stone, Touchstone, or *Basanite.* A velvet black siliceous stone or flinty jasper, used on account of its hardness and black color for trying the purity of the precious metals. The color left on the stone after rubbing the metal across it, indicates to the experienced eye the amount of alloy.

Besides the above, there is a light spongy variety of quartz, called *float stone*—*quartz nectique* of Haüy—which is so light as to float on water. It consists of fibres or filamentary crystals, aggregated into a spongy or porous mass. *Siliceous sinter* is a light cellular quartz. This term is also applied to a similar variety of opal. *Tabular quartz* consists of thin plates, either arranged parallel, or crossing one another and leaving open cells.

Yellowish white earthy deposits, like chalk in appearance, occurring in the lower part of the chalk formation at Farnham, England, and elsewhere, are found by J. T. Way to contain 40·30 per cent. of *soluble* silica (soluble in solutions of caustic potash or soda on boiling in open vessels) and 41·23 of insoluble silica, with 14·50 alumina, etc. (Qu. J. Chem. Soc. vi, 102). It is therefore related to opal.

Granular quartz is a massive quartz rock, of a granular texture. Its colors are various, always dull. Itacolumite is a fissile quartzose rock, containing some mica. *Buhrstone* is a cellular flinty quartz rock. *Phthanite* (Kieselschiefer) is a flinty fissile rock, gray, black or greenish. *Sandstone* usually consists of quartz sand. *Flexible sandstone* is a fissile variety, thin slabs of which are somewhat flexible; it is a variety of itacolumite. *Silicified wood* is wood petrified by silica or quartz. It has usually the structure of the original wood. A delicate *fibrous quartz* occurs at Orange river, near the Cape of Good Hope.

Haytorite is a name given to pseudomorphous quartz having the form of Datholite.

Quartz, in some of its varieties, occurs in almost every rock-stratum. It is an essential constituent of granite, gneiss, and mica slate, and other allied rocks. The chalcedonic varieties occur principally in the vesicular cavities of basaltic and allied rocks. Flint occurs imbedded in chalk. Hornstone is sometimes imbedded in limestone. Jasper is associated with limestone, like hornstone, and also with basaltic rocks and porphyry.

Switzerland, Dauphiny, Piedmont, the Carrara quarries, and numerous other foreign localities, afford fine specimens of rock crystal. The most beautiful amethysts are brought from India, Ceylon, and Persia, where they occur in geodes, and as pebbles; inferior specimens occur in Transylvania, in large crystalline groups; in the vicinity of Cork, and on the island of May, in Ireland. The *false topaz* is met with in Brazil. *Rose quartz* occurs in a vein of manganese, traversing the granite of Rabenstein, near Zwiesel, in Bavaria. *Prase* is found in the iron mines of Breitenbrunn, near Schwartzenberg, in Saxony. The amygdaloids of Iceland, and the Faroe Islands, afford magnificent specimens of *Chalcedony;* also Hüttenberg and Loben in Carinthia, &c. A small blue variety, in cubical crystals, (pseudomorphs of fluor), occurs at Treszytan, in Transylvania. The finest *carnelians* and *agates* are found in Arabia, India, Surinam, and Saxony. Perthshire, and other parts of Scotland, afford smaller, but handsome specimens. *Chrysoprase* occurs at Kosemütz in Silesia. *Aventurine quartz* at Cape de Gata in Spain. *Cat's eye,* in Ceylon, the coast of Malabar, and also in the Hartz and Bavaria. *Plasma,* in India and China, whence it is usually brought in the form of beads. *Heliotrope,* in Bucharia, Tartary, Siberia, and the island of Rum in the Hebrides. *Float stone,* in the chalk formation of Menil Montant, near Paris, and in some of the Cornish mines. The banks of the Nile afford the Egyptian jasper; the striped jasper is met with in Siberia, Saxony, and Devonshire. A *yellow jasper* is found at Vourla, bay of Smyrna, in a low ridge of limestone, to the right of the watering place, between the harbor and the high hills back. It is associated with opal, chrysoprase, and hornstone, and these minerals seem to occupy in the limestone the place of hornstone, which is found in various parts of the adjoining country, and also at Napoli di Romania, in Greece. The plains of Argos are strewn with pebbles of *red jasper.* A variety of sandstone occurs in thin layers at Villa Rica, Brazil, remarkable for its flexibility, owing apparently to the dissemination of small scales of mica through the mass; a similar *flexible sandstone* occurs in the North Carolina gold region.

Quartz crystals are abundant in Herkimer Co., N. Y., at Middleville, Little Falls, Salisbury, and Newport. They lie loose in cavities in the calciferous sand-rock, or imbedded in loose earth, and sometimes, according to Beck, in powdered anthracite. Fine dodecahedral crystals are obtained at the beds of specular iron in Fowler, Hermon, and Edwards, St. Lawrence Co., New York. In Gouverneur, crystals occur with tourmaline, &c., in limestone, which have rounded angles as if they had been partially fused. On the banks of Laidlaw lake, Rossie, there are large implanted crystals. The Sterling ore bed, Antwerp, Jefferson Co., affords interesting dodecahedral crystals. Four miles east of Warwick, crystals presenting the primary form occur in jasper. At Palatine, Montgomery Co., crystals occur having one end terminated with the usual pyramid, while the other is rounded and smooth. Diamond Rock, near Lansingburg, is an old but poor locality. At Ellenville lead mine, Ulster Co., N. Y., in elegant groups. At Diamond Island and Diamond Point, Lake George, quartz crystals occur, as in Herkimer Co. Crystals with unusual modifications occur sparingly at the Charlestown syenite quarry, Mass., one of which from the cabinet of Mr. J. E. Teschemacher is represented in fig. 344 B. It has the adjacent planes, 22 and $3\frac{3}{2}$ uneven, and $-\frac{1}{2}$ with a triangular furrow but sharp edges; the rest are lustrous; with the reflective goniometer, reflecting the sun's rays, $R: \frac{9}{8}\,\frac{9}{8}, = 175°$. Pelham and Chesterfield, Mass., Paris and Perry, Me., Benton, N. H., Sharon, Vt., and Meadow Mount, Md., are other localities of quartz crystal. Near Quebec, fig. 344 C., and other crystals similar, but the inverse. At Chesterfield, small unpolished *rhombohedrons* have been found in granite. Paris, Me., affords handsome crystals of brown or smoky quartz. In large crystals often perfect and weighing several pounds at Minnesota mine, Lake Superior, occasionally enveloped in metallic copper, as if cast around the crystals. Drusy quartz, of brown, apple-green, and other tints, occurs at Newfane, Vt. For other localities, see the catalogue of localities in the latter part of this volume.

Rose quartz occurs at Albany, and Paris, Me., Acworth, N. H., Williamsburg, Mass., Southbury, Conn., and Port Henry, Essex Co., N. Y.; *smoky quartz* at Goshen, Mass., Richmond Co., N. Y., &c.; *amethyst* in trap at Keweenaw Point, Pic Bay, and Gargontwa, on Lake Superior; also in the same rock at Bristol, Rhode Island, and sparingly throughout the trap region of Massachusetts and Connecticut; in Surry, New Hampshire; in Pennsylvania in East Bradford, Aston, Chester, and Providence, (one fine crystal over 7 pounds in weight), in Chester Co.; very handsome at the Prince vein, Lake Superior, but now hardly obtainable as the mine is not worked; also very large fine crystals near Greensboro, N. C. Crystallized green quartz occurs in talc, at Providence, Delaware Co., Penn. Chalcedony and agates of moderate beauty are found in the same trap region; more abundantly about Lake Superior, the Mississippi, and the streams to the west; at Natural Bridge, Jefferson Co., N. Y.; about the Willamet, Columbia, and other rivers in Oregon; abundant and beautiful on N. W. shore of Lake Superior. Belmont's lead mine, St. Lawrence Co., N. Y., has afforded good chalcedony and chrysoprase, associated with calc spar. Red jasper is found on Sugar Loaf Mt., Maine, and in pebbles on the banks of the Hudson at Troy. Yellow jasper occurs with chalcedony at Chester, Mass. Heliotrope occupies veins in slate at Bloomingrove, Orange Co., N. Y.

Quartz, chalcedony, prase, carnelian, hornstone, constitute many of the pseudomorphs formed by substitution,(see chapter on Chemical Mineralogy). Pseudomorphs, after hexagonal and scalenohedral crystals of calcite and cubes of fluor, occur at Westhampton, Mass.; after heavy spar, probably, in Rutherford Co., N. C. often filled with water. Petrified wood consists of quartz, and sometimes of chalcedony or agate, of rare beauty.

Quartz crystals occasionally occur of enormous size. A group in the museum of the university at Naples, weighs nearly half a ton. A crystal, belonging to Sig. Rafelli of Milan, measures three and a quarter feet in length, and five and a half in circumference, and its weight is estimated at eight hundred and seventy pounds; another at Paris is three feet in diameter, and weighs eight hundred weight. About a century since, a drusy cavity was opened at Zinken, which afforded 1000 cwt. of rock crystals, and at that early period brought $300,000. One crystal weighed 800 pounds. A group from Moose Mountain, New Hampshire, at Dartmouth College, weighs 147½ pounds, and contains 48 crystals; four of them are from 5 to 5½ inches in diameter, ten from 4 to 4¾ inches. A crystal from Waterbury, Vt., 2 feet long and 18 inches through, weighs 175 pounds.

Crystals often exhibit internal iridescences, owing to fissures or fractures. Foreign substances frequently penetrate or thoroughly permeate crystals of quartz. Oxyd of iron has already been alluded to as one of these permeating substances. Chlorite is sometimes so thoroughly intermingled, that the crystals appear to be composed entirely of this material; their hardness, however, shows their siliceous nature. Anthracite, asbestus, actinolite, tourmaline, silver and copper are other penetrating substances. Specimens containing acicular crystals of rutile are often very beautiful. The most interesting of the substances occurring in quartz are the fluids, which occupy small cavities in the interior of crystals; they are either water, peculiar resinous liquids, or mineral solutions. Mr. Allan describes a crystal of amethyst in his collection, having four cavities partly filled with a bituminous fluid; at 83° F., the fluids dilates and fills all the cavities, and on cooling reappears with ebullition.

Silica is held in solution in the Geysers of Iceland and New Zealand, whose solvent powers are due to their temperature, and a small quantity of alkali present. It is also present in traces in ordinary waters, as alkaline silicates.

Several varieties of this species have long been employed in jewelry. The *amethyst* has always been esteemed for its beauty. Like most other stones, it is less brilliant by candle light; it appears to best advantage when surrounded with pearls and set in gold. The color of the amethyst is often irregularly diffused, as is well described by Pliny, "ad viciniam crystalli descendet albicante purpuræ defectu," purple, gradually fading into white. It was called *amethyst*, *αμέθυστος*, on account of its pretended preservative powers againt intoxication, from *α*, *not*, and *μεθυω*, *to intoxicate.* This is not, however, the only *amethyst* of the ancients. The violet colored sapphire, the violet fluor spar, (scalpturis faciles, Plin. *easily graven*), and some other purple species, were designated by the same name; and it has been supposed that garnet was also included.

Cameos are in general made of onyx, which is well fitted for this kind of miniature sculpture. The figure is carved out of one layer, and stands in relief on another of different color. The most noted of the ancient cameos, is the Mantuan vase at Brunswick. It was cut from a single stone, and has the form of a cream pot, about seven inches high and two and a half broad; on its outside, which is of a brown color, there are white and yellow groups of raised figures, representing

Ceres and Triptolemus in seach of Proserpine. The Museo Borbonico, at Naples, contains an onyx measuring eleven inches by nine, representing the apotheosis of Augustus, and another exhibiting the apotheosis of Ptolemy on one side, and the head of Medusa on the other; both are splendid specimens of the art, and the former is supposed to be the largest in existence.

The carnelian (sarda of Pliny) receives a fine polish, and is often rich in color; but is too common to be much esteemed. When first obtained from the rock, carnelians are usually gray or grayish-red; they receive their fine colors from an exposure of several weeks to the sun's rays, and a subsequent heating in earthen pots. The colors of agate, when indistinct, may be brought out by boiling in oil, and afterwards in sulphuric acid; the latter carbonizes the oil absorbed by the apparently porous layers, and thus increases the contrast of the different colors. Agate is often made into mortars for chemical and pharmaceutical preparations, and according to Pliny, it was employed for the same purpose by the physicians of his day. The royal collection at Dresden contains a table service of German agate; and at Vienna, in the imperial cabinet, there is an oval dish twenty-two inches in length, formed from a single stone. The agate, or *achates* of the Greeks, was so called from the river Achates, in Sicily, whence, according to Theophrastus, these stones were originally brought. *Iaspachates* corresponded to our jasper agate; *Sardachates* contained layers of the sard, or carnelian; *Dendrachates* (from *δενδρον, a tree* and *achates*) was moss agate; *Hœmachates* (from *ἁιμα, blood*, and *achates*) was an agate, sprinkled with spots of red jasper, (Moore's An. Min.)

Jasper admits of a brilliant polish, and is often formed into vases, boxes, knife-handles, &c. It is also extensively used in the manufacture of Florentine mosaics. The iaspis of the ancients, whence our word jasper is derived, appears to have included the green or blue colored variety, together with some other stones, not of the jasper kind.

Quartz is distinguished by its *Hardness*,—Scratching glass with facility; *Infusibility*,—Not fusing before the blowpipe; *Insolubility*,—Not attacked by water or the acids; *Uncleavability*,—One variety is tabular, but proper cleavage is never distinctly observed. To these characteristics the action of soda may be added.

OPAL. Hyalite. Müller's Glass. Hydrophane. Menilite. Cacholong. Siliceous Sinter. Pearl Sinter. Fiorite. Girasol. Eisenopal, *Haus.* Manganopal. Schwimmkiesel. Quartz hyalin concretionée. Quartz rèsinite, *H.* Opalus, Pæderos, *Pliny.* οπαλλιος. Michaelite. Alumocalcite. Geyserite.

Massive, amorphous; sometimes small reniform, stalactitic, or large tuberose.

H.=5·5—6·5. G.=1·9—2·3. Lustre vitreous, frequently subvitreous, and often inclining to resinous, and sometimes to pearly. Color white, yellow, red, brown, green, gray, generally pale; dark colors arise from foreign admixtures. Streak white. Sometimes a rich play of colors, or different colors by refracted and reflected light.

There are many varieties of this species. The *precious opal* exhibits a play of rich colors. *Fire opal* or *girasol* presents bright hyacinth-red and yellow reflections. *Common opal* and *semi-opal* are common varieties not opalescent. *Hydrophane* is not transparent, but becomes so when immersed in water. *Cacholong* is nearly opaque, and of a porcelain or bluish white color; it adheres to the tongue, and contains a small portion of alumina, with 3·5 p. c. of water. It is closely allied to hydrophane, and often associated with it. *Hyalite*, or *Muller's glass*, occurs in small reniform, botryoidal, and occasionally stalactitic shapes, either colorless and pellucid, or white. *Menilite* is brown and opaque, occurring in compact reniform masses, occasionally slaty. *Opal jasper* contains several per cent. of iron, and is the analogue in this species of jasper in the preceding. *Silicious Sinter* is a loose silicious aggregate, deposited by the Geysers of Iceland, where it presents porous stalactitic, fibrous, "cauliflower-like," and occasionally compact concretions, called *geyserite* by Damour. *Pearl sinter*, or *fiorite*, occurs in the cavities of volcanic tufa, in smooth and shining globular and botryoidal masses, which have a pearly lustre. *Wood opal* has a peculiar ligneous structure. *Michaelite* (from the island of St. Michaels, Azores) is a white fibrous pearly variety. Sp. gr.=1·88. *Alumocalcite* is an impure opal, of a bluish milk-white color, containing 6 per cent. of lime. Some if not all the deposits of silicious earth formed of infusorial remains, consist of soluble silica, and the name *Randanite* has been applied to a variety, composed mainly of silica of this kind. (See analyses below).

Composition.—Silica in the soluble or gelatinizing state, but often combined with insoluble Silica; more or less hydrous, but the water is not considered essential.

Analyses: 1, Klaproth, (Beit. iv); 2—6, Damour, (Bull. Geol. de France, 1848, 161); 7, Klaproth; 8, Forchhammer, (Pogg. xxxv, 331); 9, Stucke, (Rose, Beschreib, p. 73); 10, Damour, (loc. cit.); 11, Pattison, (Phil. Mag., [3], xxv, 495); 12, Damour, (loc. cit.); 13, G. J. Brush, (communicated); 14, Damour, (loc. cit.); 15, Klaproth, (Beit. iv, 156); 16, Mallet, (Phil. Mag. [4], v, 285); 17, Damour, (loc. cit.); 18, Schaffgotsch, (Pogg. lxviii, 147); 19, Forchhammer, (loc. cit.); 20, Wrightson, (Ann. Ch. Pharm. liv. 358):

		$\ddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{H}}$
1.	*Fire opal*, Mexico,	92·00	7·75 $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·25=100, Klaproth.
2.	*Limpid*, " G.=2.029,	91·12	8·88=100, Damour.
3.	*Chatoyant*, " 2·024,	89·90	10·10, and some combust., Damour.
4.	*Geyserite, white*, "	91·23	8·77=100, Damour.
5.	" *gray opaque*, 2·081,	92·59	7·41=100, "
6.	*Silex resinite*, Iceland, 2·095,	92·03	7·97=100, "
7.	*Menilite*, Menil Montant,	85·50	11·00 $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·5, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 1·5, $\dot{\mathrm{C}}\mathrm{a}$ 0·5, Klaproth.
8.	*Fire opal*, Faroe,	88·73	7·97, $\dot{\mathrm{K}}$, $\dot{\mathrm{N}}\mathrm{a}$ 0·34, $\dot{\mathrm{C}}\mathrm{a}$ 0·49, $\dot{\mathrm{M}}\mathrm{g}$ 1·48 $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 0·99, Forch.
9.	*Semi-opal*, Hanau,	82·75	10·00, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 3·00, $\dot{\mathrm{C}}\mathrm{a}$ 0·25, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 3·50=99·50 S.
10.	*Iceland*, Geyser,	87·67	10·40, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·71, $\dot{\mathrm{C}}\mathrm{a}$ 0·40, $\dot{\mathrm{N}}\mathrm{a}$ 0·82, $\dot{\mathrm{K}}$ *tr.*, =100, Damour.
11.	*Sil. incrust*, N. Z. G.=1·968,	77·35	7·66, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 9·70, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 3·72, $\dot{\mathrm{C}}\mathrm{a}$ 1·74=100·17,
12.	*Prec. opal*, Hun., G=2·099,	93·90	6·10=100, Damour. [Pattison.
13.	*Fire opal*, Georgia, G.=2·07,	91·89	5·84, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 1·40, $\dot{\mathrm{M}}\mathrm{g}$ 0·92=100·06, Brush.
14.	*Silex resinite*, Mex., G.=1·21,	95·40	4·60=100, Damour.
15.	*Yellow opal*, (*Pechopal*) Telk.	93·50	5·00, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 1·0, Klaproth. [=99·86, Mallet.
16.	*Sil. incrust*, N. Zeal.,	94·20	3·06, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 1·58, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·17, $\dot{\mathrm{C}}\mathrm{a}$ *tr.*, Cl Na 0·85
17.	*Hyalite*, Waltsch, Bohemia,	96·94	3·06, Damour.
18.	" Bohemia,	95·5	3·0, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·8, $\dot{\mathrm{C}}\mathrm{a}$ 0·2=99·5, Sch.
19.	*Cacholong*, Faroe,	95·32	3·47, $\dot{\mathrm{K}}$ 0·07, $\dot{\mathrm{N}}\mathrm{a}$ 0·06, $\dot{\mathrm{C}}\mathrm{a}$ 0·06, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 0·2, $\dot{\mathrm{M}}\mathrm{g}$ 0·4=99·58, F.
20.	*Semi-opal*, Schiffenberg,	90·20	2·73, $\dot{\mathrm{F}}\mathrm{e}$ 4·11, $\dot{\mathrm{M}}\mathrm{g}$ 0·86, $\dot{\mathrm{K}}$ 0·8, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 1·86, $\dot{\mathrm{N}}\mathrm{a}$ 0·9, $\dddot{\mathrm{S}}$ 0·31, W.
21.	" Kaschau,	92·16	$\dot{\mathrm{H}}$ and $\ddot{\mathrm{C}}$ 5·75, $\dot{\mathrm{F}}\mathrm{e}$ 2·00, $\dot{\mathrm{C}}\mathrm{a}$ 0·28.

The precious opal of Hungary afforded Kobell 10·94 p. c. of water. A resin opal from Vourla, Smyrna, afforded Mr. G. J. Brush, 5·10 p. c. of water. G.=2·054. (This. Min. 3d edit. p. 691). Another from near Harmanjick, Asia Minor, contains, according to J. L. Smith, 3 per cent. of magnesia, besides 92 $\ddot{\mathrm{S}}\mathrm{i}$ and 4·15 $\dot{\mathrm{H}}$. A hyalite, called water opal, from Pfaffenreith, afforded Schmitz 35 per cent. of water. For other analyses, see Schnabel and v. der Mark, Verh. nat. Ver. Rheinl. 1852, 377, 459, 561; Bickell, Ann. Chem. Pharm. lxx, 290.

The *Randanite* of Salvetat, (*silice gelatineuse*), corresponds to the formula $\ddot{\mathrm{S}}\mathrm{i}^2\dot{\mathrm{H}}$ when dried at 16° C. and $\ddot{\mathrm{S}}\mathrm{i}^4\dot{\mathrm{H}}$ when dried at 100° C. Fournet and Salvetat obtained, (Ann. Ch. Phys., [3], xxiv, 348):

1. Ceyssat, Sol. $\ddot{\mathrm{S}}\mathrm{i}$ 87·20, $\dot{\mathrm{H}}$, $\ddot{\mathrm{C}}$, and org. matters 10·00, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ and $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 2·00, sand 0·89, F.
2. Algiers, Sol. $\ddot{\mathrm{S}}\mathrm{i}$ 80, $\dot{\mathrm{H}}$ 9, insol. $\ddot{\mathrm{S}}\mathrm{i}$ 6·48, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 1·41, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·55, $\dot{\mathrm{C}}\mathrm{a}$ 0·56, $\dot{\mathrm{N}}\mathrm{a}$, $\dot{\mathrm{K}}$, and loss 2·00, S.

It occurs as a fine earth or in compact earthy masses, and consists mainly of the casts of infusoria.

The *Michaelite* afforded Kobell, $\ddot{\mathrm{S}}\mathrm{i}$ 83·65, $\dot{\mathrm{H}}$ 16·35.

B.B. opal is infusible, but gives out water and becomes opaque. Some varieties containing iron turn red.

Opal occurs in short irregular veins in porphyry: also in the vesicular cavities of amygdaloid. Common opal sometimes occurs in limestone. Menilite is met with in clay slate. Some varieties are found with galena and blende, in metalliferous veins. It also occupies the interior of fossils in sandstone.

The precious opal occurs in porphyry at Czerwenitza, near Kashau in Hungary, at Frankfort, and at Gracias a Dios in Honduras, S. A. Fire opal is brought from Zimapan in Mexico, and from the Faroe Islands. The common opal is abundant in Hungary, in Faroe, Iceland, the Giants' Causeway, and the Hebrides; found also within a half mile, and to the southwest, of the watering place at Vourla, the harbor of Smyrna, along with yellow jasper and hornstone, imbedded in a low ridge of compact limestone, of a light yellow or grayish-white color; colors wax-yellow or grayish-green, occasionally white. Hungary affords also the *hydrophane.* The Giants' Causeway affords small masses resembling mountain cork, which though opaque, become translucent on immersion in water. *Cacholong* occurs in loose masses on the river Cach, in Bucharia, whence its name. *Hyalite* occurs in amygdaloid at Schemnitz, in Hungary, and in clinkstone at Waltsch, in Bohemia. *Menilite* is found imbedded in adhesive slate, at Menil Montant, near Paris. *Wood opal* forms large trees in the pumice conglomerates of Saiba, near Neusohl, and Kremnitz in Hungary, in Faroe, near Hobart Town, Tasmania, and other trap countries.

The *Randanite* is abundant near Algiers, and was taken for Kaolin; also at Ceyssat, near Randan in the Puy de Dome.

Hyalite occurs in the United States, sparingly at the Phillips ore bed, Putnam Co., N. Y. in thin coatings on granite; and rarely with the auriferous quartz of Cabarras Co., N. C.; also in Burke and Scriven Cos., Georgia. In Georgia it lines cavities in a siliceous shell-rock. The Suanna spring in Florida, affords small quantities of siliceous sinter. Good fire-opal is obtained in Washington Co., Ga.

The precious opal, when large, and exhibiting its peculiar play of colors in perfection, is a gem of high value. It is cut with a convex surface. The largest mass of which we have any knowledge, is in the imperial cabinet of Vienna; it is nearly as large as a man's fist, and weighs 17 ounces, but contains numerous fissures, and is not entirely free from the matrix. This stone was used as a gem by the Greeks and Romans, and was called opalus; also *pæderos*, *παιδερως*, in allusion to its color and lustre, as expressed in the Orphic poem, *ἱμερτοῦ τέρενα χρόα παιδὸς*, "having the delicate complexion of a lovely youth," (Moore's An. Min.)

II. OXYGEN DOUBLE BINARY COMPOUNDS, OR SALTS.

1. *Acid of the form* RO^3.

I. Silicates. Combinations of oxygen bases with Silica.

Appendix. Unarranged Silicates containing Titanic acid or Columbic acid.

II. Columbates, Niobates, Tungstates, Molybdates, Chromates, Vanadates.

III. Sulphates, Selenates.

IV. Borates.

2. *Acid of the form* $R^2\ O^5$ $(=R\ O^{\frac{5}{2}}.)$

V. Phosphates, Arsenates, Antimonates.

3. *Acid of the form RO^2.*

VI. Titanates.

VII. Carbonates.

4. *Acid of the form R^2O^3 ($RO^{\frac{3}{2}}$.)*

VIII. Oxalates.

I. SILICATES.

I. *Anhydrous.*

[The different species of Silicates are widely varied in their characters through the mutual replacements of lime, potash, soda, magnesia, protoxyd of iron, and other protoxyds, represented by the general expression ($\dot{\mathrm{R}}$;) and also of the peroxyds, alumina, peroxyd of iron, etc. ($\ddot{\mathrm{R}}$). The mere presence of one or another of these bases affords therefore no ground for distinctions in classification. The only general fact of a constant character is the almost total absence of magnesia from the feldspars, (and also the zeolites), and, in fact, from all those species in which the protoxyds and peroxyds are to one another in the ratio of 1 : 1, ($1\dot{\mathrm{R}} : 1\ddot{\mathrm{R}}$,) that is, which have 1 : 3 for the oxygen ratio.

I divide the anhydrous silicates, as has been explained, into a few grand groups, dependent on the oxygen ratio for the oxygen of the bases and silica; these ratios being, $1:3$, $1:2$, $1:1\frac{1}{2}$, $1:1$, $1:\frac{3}{4}$ or less than $\frac{3}{4}$.)

The feldspars, although seemingly unconformable to this system, still have been shown to have the type-ratio 1 : 1, this occurring in Anorthite; the additional silica in the other species, being added without changing the crystallization or typical structure.

A general principle is here indicated which modifies the law of ratios, and which is exemplified also in the micas, scapolite, hornblende, and some other species.

It has been observed that while some species contain water, without its affecting the crystalline form, so there are silicates, not hydrous, in which there is an addition of accessory substances which do not modify the form, and which substances thus appear to be in a certain sense unessential. Thus Sodalite, Hauyne and Nosean, have each the ratio 1 : 3 : 4, and a common formula, with the addition of some $\mathrm{Na\,Cl}$ for Sodalite, $\dot{\mathrm{C}}\mathrm{a}\,\dddot{\mathrm{S}}$ for Hauyne, and $\dot{\mathrm{N}}\mathrm{a}\,\dddot{\mathrm{S}}$ for Nosean. By considering these as ingredients essential to the type, the species would be widely separated from their congeners.

The above facts contain the principles upon which the anhydrous silicates are arranged. They are more fully developed in the chapter on Chemical Mineralogy and Classification.

Besides the ordinary chemical formulas, which have the advantage of a familiar form and look, we add the condensed formulas, explained in our chapter on Chemical Mineralogy. There is little reason to doubt that the protoxyds and peroxyds replace one another, 3 parts of $\dot{\mathrm{R}}$ replacing $1\dddot{\bar{\mathrm{R}}}$; or generally that proportions of oxyds equal in amount of included oxygen are mutual substitutes in compounds. Thus $\dot{\mathrm{R}}^3$, $\dddot{\bar{\mathrm{R}}}$ and $\bar{\mathrm{R}}$ are equivalents. In this view, the complex silicates are simply silicates of a single complex base. Thus the general garnet formula is $(\dot{\mathrm{R}}^3, \dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$; under which the following are among the special formulas,

Garnet,	$(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$,	Idocrase,	$\left\{\begin{array}{l}(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}},\\(\frac{3}{5}\dot{\mathrm{R}}^3+\frac{2}{5}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}},\end{array}\right.$
Epidote,	$(\frac{1}{3}\dot{\mathrm{R}}^3+\frac{2}{3}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$,		

which differ from one another only in the ratio of $\dot{\mathrm{R}}^3$ to $\dddot{\bar{\mathrm{R}}}$, it being 1 : 1 in Garnet, 1 : 2 in Epidote, 1 : 1 or 3 : 2 in Idocrase—the fractions within the brackets equaling together a unit and indicating this ratio. Such formulas give the constitution of the species with all the precision of the old formulas, exhibiting the exact relations of the constituents, without any hypothesis as to their atomic groupings.]

The following are the subdivisions of the *Anhydrous Silicates.*

I. EDELFORSITE SECTION.—Oxygen ratio of bases and silica, 1 : 3.

II. AUGITE SECTION.—Oxygen ratio, 1 : 2.

III. EULYTINE SECTION.—Oxygen ratio, 1 : 1½.

IV. GARNET SECTION.—Oxygen ratio, 1 : 1.

V. MICA SECTION.—Oxygen ratio in type, 1 : 1; Structure micaceous.

VI. FELDSPAR SECTION.—Oxygen ratio in type, 1 : 1; Oxygen ratio of protoxyds and peroxyds, 1 : 3.

VII. ANDALUSITE SECTION.—Oxygen ratio 1 to *less* than 1.

I. EDELFORSITE SECTION.

EDELFORSITE. Neutral Silicate of Lime. Ædelforsite, *Kobell.*

Fibrous or feathery, and massive.

H.=6. (?) G.=2·58. Lustre shining. Color white or grayish. Transparent.

Composition.—$\dot{\mathrm{Ca}}\dddot{\mathrm{Si}}$=Silica 62·2, lime 37·8. B.B. fuses to a white translucent glass. Gelatinizes.

Edelforsite is found at Aedelfors in Smaoland, Cziklowa in the Bannat, and at Gjelleback in Norway.

MANCINITE.

Plumose and shining, with two unequal cleavages inclined to one another, 92°. Color brown.

Composition.—$\dot{\mathrm{Zn}}\,\dddot{\mathrm{Si}}$, probably, according to Jacquot, (Ann. d. Mines, [3], xix, 703). From Mancino near Leghorn. The species is a doubtful one.

II. AUGITE SECTION.

The oxygen ratio for the bases and silica in the Augite Section, is 1 : 2 ; varying in the species hornblende and acmite, to 1 : 2¼.

1. AUGITE GROUP. Crystallization monoclinic.

WOLLASTONITE,	$\dot{\mathrm{Ca}}^3\cdot\dddot{\mathrm{Si}}^2$,	HORNBLENDE,	$\dot{\mathrm{R}}^4\,\dddot{\mathrm{Si}}^3=\dot{\mathrm{R}}^3\,\dddot{\mathrm{Si}}^{\frac{9}{4}}$
PYROXENE,	$\dot{\mathrm{R}}^3\,\dddot{\mathrm{Si}}^2$,	ACMITE,	$(\dot{\mathrm{R}}+\dddot{\bar{\mathrm{R}}})\,\dddot{\mathrm{Si}}^3=(\dot{\mathrm{R}}^3,\,\dddot{\bar{\mathrm{R}}})\,\dddot{\mathrm{Si}}^{\frac{9}{4}}$
RHODONITE,	$\dot{\mathrm{Mn}}^3\,\dddot{\mathrm{Si}}^2$	? WICHTYNE,	$(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}^2$(?)
SPODUMENE,	$(\frac{1}{5}\dot{\mathrm{R}}^3+\frac{4}{5}\dddot{\bar{\mathrm{R}}})\,\dddot{\mathrm{Si}}^2$	? SORDAWALITE,	$(\frac{3}{5}\dot{\mathrm{R}}^3+\frac{2}{5}\dddot{\bar{\mathrm{R}}})\,\dddot{\mathrm{Si}}^2$ (?)

2. BABINGTONITE GROUP.—Triclinic.

BABINGTONITE.

3. BERYL GROUP.—Hexagonal.

BERYL,	$(\frac{1}{2}\dddot{\bar{\mathrm{B}}}\mathrm{e}+\frac{1}{2}\ddot{\bar{\mathrm{A}}}\mathrm{l})\,\dddot{\mathrm{Si}}^2$	EUDIALYTE,	$(\frac{2}{3}\dot{\mathrm{R}}^3+\frac{1}{3}\ddot{\mathrm{Zr}})\,\dddot{\mathrm{Si}}^2$.

WOLLASTONITE, *H.* Tabular Spar. Table Spar. Grammite. Schaalstein, *W.* Tafelspath, *M.*

Monoclinic. *C*=69° 48′, *I*:*I*=87° 28′, *O* : 2*i*=137° 48′; *a*:*b*:*c*:=0·4338 : 1 : 0·89789. Observed planes as in the annexed figure.

O : 1*i*=160° 30′.
O : 3*i*=139° 53′.
O : 5*i*=130° 42′.
O : -1*i*=154° 25′.
O : 3*i*=114° 16′.
O : *ii*=110° 12′.
ii : -1*i*=95° 23′.
ii : *I*=133° 44′.
ii : 2=132° 14′.
ii : $2\breve{i}_4$=120° 50′.
ii : $i_{\frac{3}{2}}$=145° 8′.
ii : $\breve{i}_2$=115° 34′.

Rarely in distinct tabular crystals. Cleavage: *O* most distinct; *ii* less so; 1*i* and -1*i* in traces. Twins: composition-face *ii*. Usually cleavable massive, with the surface appearing long fibrous, fibres parallel or reticulated, rather strongly coherent.

H.=4·5—5. G.=2·78—2·9 ; 2·785—2·895, (United States), Thomson ; 2·805, (Bannat), Haidinger. Lustre vitreous, inclining to pearly upon the faces of perfect cleavage. Color white, inclining to gray, yellow, red, or brown. Streak white. Subtransparent—translucent. Fracture uneven, sometimes very tough.

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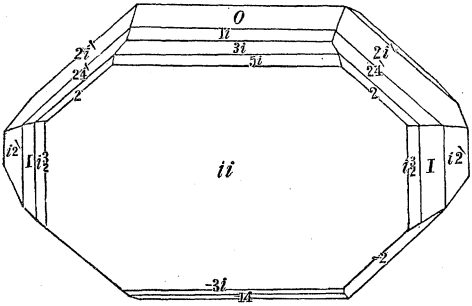

Composition.—$\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}^2$=Silica 51·9, lime 48·1. Analyses: 1, Stromeyer, (Untersuch., 1, 356); 2, H. Rose, (Gilb. Ann. lxxii, 70); 3, Kobell, (J. f. pr. Ch. xxx, 469); 4, Weidling, (K. V. Ac. Förh., 1844, 92); 5, Bonsdorff, (Schw. xxxiii, 368); 6, Vanuxem, (J. Ac. Nat. Sci. Philad. ii, 182); 7, Beck, (Min. N. Y. 271); 8, J. D. Whitney, (Bost. J. Nat. Hist. v, 486); 10, J. B. Bunce, (This Min. 3d Edit., 696):

		$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{H}}$	
1.		51·445	47·412	——	0·401	0·076,	$\ddot{\bar{\mathrm{Mn}}}$0·257=99·591, Str.
2.	Perhoniemi,	51·60	46·41	——	——	——	gangue 1·11=99·12, Rose.
3.	C. di Bove,	51·50	45·45	0·55	——	2·00	=99·50, Kobell.
4.	Göckum,	50·724	43·802	0·879	0·849	——	$\dot{\mathrm{Mn}}$ 0·334, $\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$ 2·732, W.
5.	Skräbböle,	52·58	44·45	0·68	$\ddot{\bar{\mathrm{Fe}}}$ 0·13	0·99	=99·83, Bonsdorff.
6.	Willsborough,	51·67	47·00	——	" 1·35	——	=100·02, Vanuxem.
7.	Diana,	51·90	47·55	——	" 0·25	——	=99·70, Beck.
8.	Cliff Mine,	49·09	46·38	0·14	——	2·96,	$\dot{\mathrm{Mn}}$ 0·48, $\ddot{\bar{\mathrm{Al}}}$ 0·23, Whit.
9.	"	49·6	44·87	——	——	2·96,	$\dot{\mathrm{Mn}}$ 0·93, $\ddot{\bar{\mathrm{Al}}}$ 1·28, Whit.
10.	Grenville, U C.	53·05	45·74	——	1·20=99·99, Bunce.		

In the matrass no change. B.B. on charcoal, fuses on the edges to a colorless bead: affords with borax a transparent glass and leaves a siliceous skeleton with salt of phosphorus; with some soda, a blebby glass, with more, swells up and infusible. With muriatic acid, gelatinizes. Phosphoresces when heated.

Wollastonite is found in regions of granite and granular limestone; also in basalt and lavas.

It occurs in the copper mines of Cziklowa in the Bannat of Temeswar, and also at Dognaszka and Nagyag. It accompanies garnet, fluor, and native silver, in limestone, at Pargas in Finland, and Kongsberg in Norway; also at Perhoniemi, Skräbböle, Finland. At Castle Rock, Edinburgh, it is met with in basalt, associated with prehnite, presenting a fibrous radiated structure. A greenish-white variety occurs in lava at Capo di Bove, near Rome.

In the United States, this species occurs at Willsborough, N. Y., forming the sides of a large vein of garnet, traversing gneiss; abundant at Lewis, ten miles south of Keeseville, with colophonite; half a mile north of Lewis corners, with garnet and quartz; at Roger's Rock, near the line between Essex and Warren Cos. with garnet and feldspar; Diana, Lewis Co., about a mile from the Natural Bridge, in abundance, of a snow-white color; at Boonville, Oneida Co., in boulders, with garnet and pyroxene: also at Grenville, Canada, with sphene and green coccolite; at St. Jerome and Morin, C. E., with apatite, in large tabular masses of a fibrous structure, in Bucks Co., Penn., three miles west of Attleboro', associated with scapolite, pyroxene and sphene; of a red color at the Cliff Mine, Kewenaw Point, Lake Superior, and on Isle Royale, a very tough variety, but now exhausted.

Named after the English Chemist, Wollaston; also *tabular spar* from its lamellar forms and structure.

Dr. Thomson has described under the name of *Wollastonite*, a mineral from Kilsyth, occurring in greenstone veins. It differs from tabular spar in containing some silicate of soda. Formula, $\dot{N}a\,\dddot{S}i+\dot{C}a^3\dddot{S}i^2$, or near acmite. It is referred by J. D. Whitney, to Pectolite.

PYROXENE, *Haüy*. Augite. Coccolite. Diopside. Sahlite. Alalite. Mussite. Pyrgom. Fassaite. Pentaclasite. Jeffersonite, *Keating*. Asbestus, *in part*. Bronzite. Paulite. Green Diallage. Kokkolit, Baikilit, Omphazit, *W.* Pentaklasit, *Haus.* Malacolithe, *Haüy*. Funkite. Hudsonite, *Beck.* Polylite, *Thom.* Ægerine, *in part.* Breislakite, *Brocchi.*

Monoclinic; $C=73°\ 59'$, $I:I=87°\ 5'$, $O:2\grave{\imath}=131°\ 17'$; $a:b:c=0{\cdot}5412:1:0{\cdot}91346$.

$O:1i=155°\ 51'$.
$O:-1i=148°\ 35'$.
$O:-3i=109°\ 31'$.
$O:ii=106°\ 1'$.
$O:1=146°\ 9'$.
$O:2=130°\ 6'$.
$O:-1=137°\ 49'$.
$O:-2=114°\ 28'$.
$O:1\grave{\imath}=150°\ 20'$.
$O:i\grave{\imath}=90°$.
$2\grave{\imath}:2\grave{\imath}(\text{ov.}O)=82°\ 34'$.
$ii:1i=130°\ 10'$.
$ii:-1i=105°\ 24'$.
$ii:i2=152°\ 15'$.
$ii:I=133°\ 33'$.
$ii:i\grave{_2}=115°\ 25'$.
$ii:i\grave{_3}=107°\ 35'$.
$i2:i2(\text{ov.}ii)=124°\ 30'$.
$i\grave{_2}:i\grave{_2}(\text{ov.}ii)=50°\ 50'$.
$i\grave{\imath}:3\grave{_3}=143°\ 34'$.
$-1:-1=120°\ 32'$.
$-2:-2=95°\ 30'$.
$1:1=131°\ 24'$.
$2:2=111°\ 10'$.

			O				
$1i$			1				$1\grave{\imath}$
			2				$2\grave{\imath}$
						$\frac{5}{2}\acute{5}$	
					$3\acute{3}$		
							$4\grave{\imath}$
ii	$i3$	$i2$	I	$i\acute{2}$	$i\acute{3}$		$i\grave{\imath}$
							$4\grave{\imath}$
			-3				
$-3i$				$-\frac{8}{3}\acute{2}$			
			-2				$2\grave{\imath}$
$-1i$			-1				$1\grave{\imath}$
$-\frac{1}{2}i$							

Observed Planes.

Cleavage: *I* rather perfect, often interrupted; *ii* and *iì* imperfect. Crystals usually thick and stout. Twins: face of composition *ii*, (f. 357). Often coarse lamellar, in large masses, parallel to *O* or *ii*. Also granular—particles coarse or fine; and fibrous, fibres often fine and long.

H.=5—6. G.=3·23—3·5. Lustre vitreous, inclining to resinous; some pearly. Color green of various shades, verging on one side to white or grayish-white, and on the other to brown and black. Streak white—gray. Transparent—opaque. Fracture conchoidal—uneven. Brittle.

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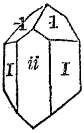

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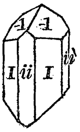

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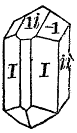

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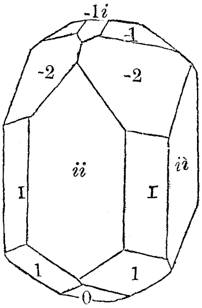

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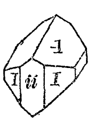

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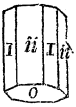

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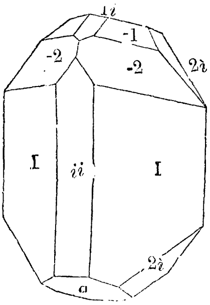

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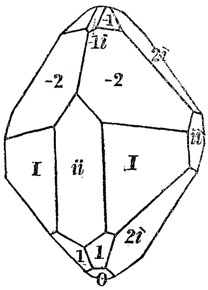

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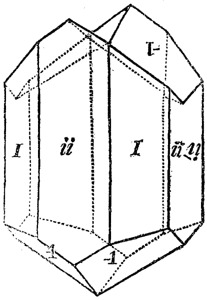

Long Pond, N. Y.

Composition.—$\dot{R}^3\dddot{Si}^2$, in which $\dot{R}$ may be lime, magnesia, protoxyd of iron or manganese, or even soda; and in some instances alumina enters into the composition without changing essentially the crystallization, and usually replaces silica. When R=(Ca, Mg), the color is white or light green; when R=(Ca, Fe), the color varies in shade of green to black, according to the proportion of oxyd of iron; if R=Mn, the color is flesh-red, and the mineral is *manganese spar.* It may also be (Ca, Mn), or (Ca, Mg, Fe), or (Fe, Mn), and when iron is abundant the mineral is very dark green or black.

There are other kinds arising from mode of crystallization, the species being sometimes in distinct crystals, sometimes thin foliated, sometimes granular, and often fibrous or asbestiform. The following are the prominent varieties:—

1. *Diopside, White Augite, White Malacolite, Mussite.*—Of white, grayish, or grayish-green color, either crystallized, lamellar or granular. The granular, when coarse and somewhat friable, is called *white coccolite.* *Alalite* is a diopside from Ala in Piedmont. *Mussite* has a grayish-green color, and is lamellar parallel to the base, the lamellæ sometimes contorted; it is from Mussa in Piedmont. These varieties contain the bases magnesia and lime, with little or no iron, and usually no alumina, $(\dot{Ca}, \dot{Mg})^3\dddot{Si}^2$. G.=3·23—3·26. *Diopside* is from δις, *two-fold,* and οψις, *appearance;* malacolite, from μαλακος and λιθος.

Sahlite resembles diopside, but has a dingy greenish color, and is coarse foliated, arising from composition parallel to *O;* from Sahla, Sweden. *Baikalite* is a green variety, from Lake Baikal. *Pyrgom* is a dingy variety of sahlite, (named from the Greek πυργωμα.) *Omphazite* is a foliated leek-green variety. The same constitution as above, but usually with some iron. G.=3·23—3·3.

Pyroxene, (from πυρ, *fire,* and ξενος, *stranger*).—Besides its general use, this name is specially applied to the green or grayish-green crystals, often of large size *Green Malacolite* is another name for this variety. *Fassaite* is handsome grass-green or pistachio green, with high lustre; from the Fassa valley, Piedmont. *Green Coccolite* is a granular friable variety, consisting of bright green shining granules, named from *κοκκος, a grain.* *Funkite* is a green coccolite. *Lherzolite* has a deep green, or olive-green color, and occurs both crystallized and lamellar; from Lake Lherz in the Pyrenees. *Baikalite* (from Lake Baikal) is an olive-green sahlite. These species contain the bases lime, magnesia, and protoxyd of iron, $(\dot{\mathrm{C}}\mathrm{a}\ \dot{\mathrm{M}}\mathrm{g},\ \dot{\mathrm{F}}\mathrm{e})^3\dddot{\mathrm{S}}\mathrm{i}^2$. G.=3·25—3·3.

Jeffersonite is a dark-green crystallized foliated variety, from Mine Hill, Franklin, New Jersey: it has the same constitution and angles as the last, with some oxyd of zinc. $(\dot{\mathrm{C}}\mathrm{a},\ \dot{\mathrm{F}}\mathrm{e},\ \dot{\mathrm{M}}\mathrm{g},\ \dot{\mathrm{Z}}\mathrm{n})^3\ \dddot{\mathrm{S}}\mathrm{i}^2$ G.=3·6. Named after Mr. Jefferson.

Augite (from *αυγη, lustre*) includes the black and greenish-black crystals, common in basaltic and volcanic rocks. It contains the same bases as the last, together with alumina. $(\dot{\mathrm{C}}\mathrm{a},\ \dot{\mathrm{F}}\mathrm{e},\ \dot{\mathrm{M}}\mathrm{g})^3(\dddot{\mathrm{S}}\mathrm{i},\ \dddot{\mathrm{A}}\mathrm{l})^2$. G.=3·33—3·36; 3·359, Etna; 3·356, Eiffel; 3·358, Fassa. Alumina is also contained at times in some of the above varieties. *Ægirine* of Brevig is a black or greenish-black to leek-green pyroxene; G.=3·432—3·504, (Pogg. lxxx, 315).

Breislakite occurs in wool-like forms at Vesuvius and Capo di Bove. Its crystallographic identity with pyroxene has been shown by Chapman, (Phil. Mag. xxxvii, 444, 1850). Named after Breislak, an Italian geologist.

Hedenbergite is a black pyroxene, containing largely of iron, little or no magnesia, and no alumina. $(\dot{\mathrm{C}}\mathrm{a},\ \dot{\mathrm{F}}\mathrm{e})^3\dddot{\mathrm{S}}\mathrm{i}^2$. G.=3·5. Named after the Swedish Chemist, L. Hedenberg.

Hudsonite, from Orange Co., N. Y., near the Hudson river, is black and cleavable like Hedenbergite, but differs in having a considerable part of the silica replaced by alumina, $(\dot{\mathrm{C}}\mathrm{a},\ \dot{\mathrm{F}}\mathrm{e},)^3(\dddot{\mathrm{S}}\mathrm{i},\ \dddot{\mathrm{A}}\mathrm{l})^2$. G.=3·5, Beck; 3·43—3·46, Brewer; streak green; often has a brown tarnish. It also contains at times some manganese. *Polylite* is the same compound.

A pure iron-augite analyzed by Grüner, (Anal. 47), has been called *Grünerite.*

Diallage, (from *διαλλαγη, difference,* alluding to the dissimilar cleavage).—Thin foliated and easily cleavable; laminæ brittle; color various shades of green, gray, and brown, and sometimes bronze or pearly-metallic. G.=3·11—3·227. It includes *Schiller spar* (in part) and *Bronzite.* Bronzite has a greenish-brown or brownish color, and metalloidal lustre; it cleaves in three directions, two of which meet at an angle of 87°. G.=3·125. From Gulsen in Styria.

Hypersthene, (from *υπερ* and *σθενος, very strong* or *tough*), bears nearly the same relation to diallage that the dark varieties of pyroxene bear to the light. It contains a large proportion of iron and little lime, yet varies much in this respect, and some varieties, not distinguished by external characters, have the composition nearly of diallage. Its colors are grayish or greenish-black, and copper-red, with a bright metallic-pearly lustre. It cleaves easily, but not into as thin folia as the preceding. G.=3·3—3·6. The *Paulite* (G.=3·389) is from the island of St. Paul. *Labrador Hornblende* and *Metalloidal Diallage* are here included. The *Bronzite* has clove-brown and pinchbeck brown colors, with a metallic-pearly lustre. G.=3·2—3·5. Cleavage orthodiagonal, very perfect. *Diaclasite* of Hausmann (analysis 43) is between diallage and hypersthene in composition, but has the pale colors of diallage, passing into brass-yellow. Named from *διακλαω, to cleave through.*

Analyses: I.—1, Nordenskiöld, (Schweig J. xxxi, 457); 2, H. Rose, (Schw. xxxv, 86); 3, T. Wachtmeister, (Schw. xxx, 334); 4, Hermann, (J. f. pr. Ch. xxxvii, 190); 5, Wackenroder, (Kastn. Archiv. xiii, 84); 6, Kussin, (Ramm. 4th Suppl. 12); 7, Reutersköld, (Jahresb. xxv, 362); 8, Richter, (Pogg. lxxxiv, 384).

II. 9, Seybert, (Am. J. Sci. iv, 340); 10–13, H. Rose, (loc. cit.); 14, Wolff, (J. f. pr. Ch. xxxiv, 236); 15, Hochstetter, (J. f. pr. Ch. xxvii, 375).

III. 16–20, Kudernatsch, (Pogg. xxxvii, 577); 21, Gmelin, (Leonh. u. Bronn, N. Jahrb. 1840, 549); 22, Delesse, (Ann. d. Mines, [4], xii, 293); 23, Rammelsberg, (Pogg. lxxxiii, 458); 24–26, Waltershausen, (Vulk. Gest. 107 to 110).

IV. 27, T. S. Hunt, (Logan's Geol. Rep. 1853).

V. 28, 29, Smith and Brush, (Am. J. Sci., [2], xvi, 369); 30, Thomson, (Min. i, 495):

VI. 31, 32, Köhler, (Pogg. xiii, 101); 33, Delesse, (Ann. d. M. [4], xvi); 34–36, Regnault, (Ann. des M. [3], xiii, 147); 37, Kobell, (J. f. pr. Ch. xxxvi, 303); 38, Schafhäutl, (Ann. d. Ch. u. Ph. li, 254); 39, Beck, (Min. N. Y., p. 310); 40, Seybert; 41, Muir, (Thom. Min. i, 202); 42, Damour, (Ann. des Mines, [4], v. 157; 43, Köhler, (loc. cit.); 44, T. S. Hunt, (communicated).

VII. 45, Meitzendorf, (Pogg. lii, 626); 46, Gruner, (Compt. Rend. xxiv, 794); 47, Beck, (This Min. 3d Edit. 692); 48–50, Scheerer and Richter, (Pogg. lxxxiv, 331):

I. *White or pale green, containing little or no iron.*—Analyses 2 to 7 correspond nearly to the formula $(\frac{1}{2}\dot{\mathrm{C}}\mathrm{a}+\frac{1}{2}\dot{\mathrm{M}}\mathrm{g})^3\ddot{\mathrm{S}}\mathrm{i}^2$=Silica 55·7, magnesia 18·5, lime 25·8. G. of 4, 3·28; of 6, 3·37; of 7, 3·27.

		$\ddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{n}$	$\ddot{\bar{\mathrm{A}}}\mathrm{l}$
1.	Pargas, *bh-gn.*	55·40	22·57	15·70	2·50	2·83	——$\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·43=99·43, Nord.
2.	Wermland, *ywh.*	55·32	16·99	23·01	——	——	——$\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 2·16, $\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 1·59, R.
3.	Norway, *wh.*	57·40	16·74	23·10	——	——	0·43 " 0·20=97·87, Wacht.
4.	Achmato'sk, *wh.*	53·97	17·86	25·60	2·00	0·57	——=100, Herm.
5.	Fassa, "	54·15	18·22	24·74	2·51	——	0·20, $\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·18=100 Wack.
6.	Brazil,	55·61	17·82	25·11	1·20	——	——=99·74, Kussin.
7.	Langbanshyttan,	53·56	16·27	23·86	4·48	1·87	0·25=100·29, Reut.
8.	Reichenstein,	54·50	18·96	21·41	3·00	——	1·10, $\dot{\mathrm{H}}$ 1·19=100·16, Richt.

II. *Dark green to black, containing lime and iron, with more or less magnesia and no alumina.* Analyses, 10 and 11=$(\frac{1}{2}\dot{\mathrm{C}}\mathrm{a}+\frac{3}{8}\dot{\mathrm{M}}\mathrm{g}+\frac{1}{8}\dot{\mathrm{F}}\mathrm{e})^3\ddot{\mathrm{S}}\mathrm{i}^2$=Silica 53·7, magnesia 13·4, lime 24·9, protoxyd of iron 8·0. Analyses 13 and 14=$(\frac{1}{2}\dot{\mathrm{C}}\mathrm{a}+\frac{1}{2}\dot{\mathrm{F}}\mathrm{e})^3\ddot{\mathrm{S}}\mathrm{i}^2$=Silica 48·6, lime 22·5, protoxyd of iron 28·9. G. of 15=3·174.

9.	L. Champl. *gn.*	50·38	6·83	19·33	20·40	*trace*	1·83=98·77, Seybert.
10.	Dalecarlia, "	54·08	11·49	23·47	10·02	——	—— $\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·61=99·67, Rose.
11.	" "	54·55	15·25	20·21	8·14	——	0·14 " 0·73=99·02.
12.	Wermland, *bk.*	53·36	4·99	22·19	17·38	0·09	——=98·01, Rose.
13.	Tunaberg, *Hed.*	49·01	2·98[a]	20·87	26·08	——	——=98·94, Rose.
14.	Arendal, *bk.*	47·78	——	22·95	27·01	——	——=97·74, Wolff.
15.	Azores,	50·40	2·40	21·10	22·00	——	2·99, ign 0·30=99·19, Hochstetter.

[a] With some Mn.

III. *Black or brownish-black, containing alumina, with magnesia, lime and iron;* mostly from basalt and porphyry. G. of 21, 2·705; of 24, 2·886; of 25, 3·204.

16.	Rhone,	50·11	15·72	18·66	7·55	——	6·68=98·72, Kudernatsch
17.	Vesuvius,	50·90	14·43	22·96	6·25	——	5·37=99·91, "
18.	Etna,	50·55	13·01	22·29	7·96	——	4·85=98·66, "
19.	Fassa,	50·15	13·48	19·57	12·04	——	4·02=99·26, "
20.	Eifel,	49·39	13·93	22·46	7·39	——	6·00=99·25, "
21.	Wetterau,	56·80	5·05	4·85	12·06	$\ddot{\bar{\mathrm{M}}}$ 3·72	15·32, $\dot{\mathrm{N}}\mathrm{a}$ 3·14, $\dot{\mathrm{K}}$ 0·34, G.
22.	Vosges,[a]	49·16	15·95	18·87	7·19	$\dot{\mathrm{M}}$ *trace*	5·08, $\dot{\mathrm{H}}$ 2·26=98·51, Del.
23.	Härtlingen,	47·52	12·76	18·25	13·02	$\dot{\mathrm{M}}$ 0·40	8·13=100·08, Ramm.
24.	Etna, *black,*	47·63	12·90	20·87	11·39	0·21	6·74 $\dot{\mathrm{H}}$ 0·28=100·02, Walt.
25.	" *gnh. bk.*	51·70	21·11	18·02	4·24	——	4·38 " 0·49=99·94, "
26.	Iceland,	49·87	16·16	22·00	5·92	——	6·05=100, Walt.

[a] This augite forms with the feldspathic mineral Vosgite, the porphyry of Ternuay.

IV. *White aluminous,* like diopside in appearance.

27.	Perth, C. W.	50·90	18·14	23·74	$\ddot{\bar{\mathrm{F}}}$ 0·35	——	6·15, ign 0·90=100·18, H.

V. *Black, containing alumina, with iron and lime without magnesia. Hudsonite* corresponds to the formula $\dot{\mathrm{R}}^3(\ddot{\mathrm{S}}\mathrm{i}, \ddot{\bar{\mathrm{A}}}\mathrm{l})^2$.

28.	*Hudsonite*	39·30	2·98	10·39	30·40	0·67	9·78, $\dot{\mathrm{K}}$, 2·48, Na 1·66, ign 1·95=98·61, S. & B.
29.	"	38·58	3·02	10·32	30·57	0·52	11·05, $\dot{\mathrm{K}}$, $\dot{\mathrm{N}}\mathrm{a}$ 4·16, ign. 1·95=100·17, S. & B.
30.	*Polylite,*	40·04	——	9·42	34·08	6·60	21·54, $\dot{\mathrm{H}}$ 0·4=102·08, Th.

VI. *Thin foliated.* Nos. 31 to 33, *Diallage;* 34 to 37, *Bronzite;* 38, *Vanadiferous Bronzite;* 39, 40, a kind of *Hypersthene;* 41, 42, *Hypersthene*; 44, ib., from Chateau Richer, Canada; 43, *Diaclasite* of Hausmann.

	$\ddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dddot{\text{Al}}$
31. Hartz,	53·71	17·55	17·06	8·08		2·82, $\dot{\text{H}}$ 1·04=100·27, K.
32. Florence,	53·20	14·91	19·09	8·67	0·38	2·47, $\dot{\text{H}}$ 1·77=100·49, K.
33. Odern, *diallage*,	49·30	17·61	15·43	9·43	0·51	5·50, $\ddot{\text{Er}}$ 0·30, ign. 0·85=98·93, Delesse.
34. Piedmont,	50·05	17·24	15·63	11·98	——	2·58, $\dot{\text{H}}$ 2·13=99·61, Reg.
35. Ural,	52·60	16·43	20·44	5·35	——	3·27, " 1·59=99·68, "
36. Ultenthal,	55·84	30·37	——	10·78	——	1·09, " 1·80=99·98, "
37. Greenland,	58·00	29·66	——	10·14	1·00	1·33=100·13, Kobell.
38. Genoa, G. 3·25,	49·50	14·12	18·12	3·28	——	5·55, $\ddot{\text{V}}$ 3·65, $\dot{\text{Na}}$ 3·75, $\dot{\text{H}}$ 1·77, S.
39. Lake George,	45·45	18·00	24·33	11·49	——	——=99·27, Beck.
40. Wilmington,	52·17	11·33	20·00	10·73	——	4·00, $\dot{\text{H}}$ 1·0=99·23, Seyb.
41. Skye, *Hypers.*	51·35	11·09	1·84	33·92	——	——, " 0·5=98·70, Muir.
42. Labrador, "	51·36	21·31	3·09	21·27	1·32	0·37=98·72, Damour.
43. Baste, *Diacl.*	53·74	25·09	4·73	11·51	0·23	1·34 $\dot{\text{H}}$ 3·76=100·40, Köh.
44. Canada, *Hyp.*	51·35	22·59	1·68	20·56	——	3·70, ign. 0·10=99·93, H.

VII. *Asbestiform varieties.* Analysis 45 has the composition of a diopside; 46 is an iron-augite, with the formula $\dot{\text{Fe}}^3\ddot{\text{Si}}^2$=Silica 57·1, protoxyd of iron 54·3; G.=3·713. No. 50 is from Zillerthal; oxygen ratio 13·94: 29·70 (water excluded.)

45. Zillerthal,	55·87	20·33	17·76	4·31	1·12	——=99·39, Meitzendorf.
46. Collobrières,	43·9	1·1	0·5	52·2	——	1·9=99·6, Gruner.
47. Staten Id.,	55·20	30·73	——	11·82	——	$\dot{\text{H}}$ 2·25=100, Beck.
48. Tyrol,	57·50	23·09	13·42	3·88	——	" 2·36=100·25, Scheerer.
49. Reichenstein,	55·85	23·99	11·66	5·22	$\dddot{\text{Al}}$ 0·56	" 2·15, $\dot{\text{Cu}}$ 0·40=99·83, Rr.
50. *Rock Cork*,	57·20	22·85	13·39	4·37	——	" 2·43=100·24, Scheerer.

Jeffersonite afforded Hermann, (J. f. pr. Chem. xlvii, 13, 1849):

51. $\ddot{\text{Si}}$ 49·91 $\dot{\text{Ca}}$ 15·48 $\dot{\text{Mn}}$ 7·00 $\dot{\text{Zn}}$ 4·39 $\dot{\text{Fe}}$ 10·53 $\dddot{\text{Al}}$ 1·93, $\dot{\text{Mg}}$ 8·18, ign. 1·20.

Other analyses: by Lory, (Bull. Soc. Geol. Fr. [2], vii, 540); Delesse, (Ann. d. M. [4], xviii, 309, xx, 145); A. Erdmann, (K. V. Ac. H. 1848, and Ramm., 5th Suppl., 58); Deville (Etudes, 1848); Breidenstein, (Ramm. 5th Suppl., 60); Frölich, (ib. 62.

B.B. the whitish or pale varieties fuse with some effervescence to a colorless glass; with borax afford a clear glass. Varieties containing iron afford an iron reaction, which is more intense the greater the proportion. The *Hedenbergite* and dark augites fuse readily to a shining black glass. *Diallage* yields some water in a matrass, and becomes of a paler color; on charcoal it fuses with difficulty on the edges to a gray slag; with borax it forms a glass colored with iron. *Bronzite* becomes of a paler color, but alone is infusible. *Hypersthene* generally fuses on charcoal rather easily to a grayish-green glass, not clear. *Hudsonite* fuses with effervescence to a black magnetic bead; with soda, a manganese reaction.

Pyroxene is principally confined to crystalline or volcanic rocks, and is associated at different localities with granite, granular limestone, serpentine, greenstone, basalt or lavas. Diallage occurs generally in serpentine or greenstone; and hypersthene with feldspar and quartz forms *hypersthene rock,* which occurs extensively in some districts of crystalline rocks.

Pyroxene, with labradorite or oliglocase, forms *Greenstone* or *Diabase;* and when the texture is very compact, it constitutes *Melaphyre,* which is reddish-brown to black. With labradorite and magnetite, forms *Dolerite* or *Basalt,* often crystalline granular, and called basalt more especially when the texture is impalpable. Pyroxene is common in lavas, and is a constituent of Tufas.

Foreign localities are numerous and we mention but few.

Augite occurs at Aussig and Teplitz, in Bohemia, in large crystals imbedded in basalt; and in small highly polished crystals in the lavas of Vesuvius, with nepheline, idocrase, and mica. Diopside is met with in crystals at Ala, in Piedmont, associated with garnets and talc in veins traversing serpentine. Its more tranparent crystals from this locality are sometimes cut and worn as gems. Sahlite is met with in granite rocks at Sahla, and elsewhere. Baikalite occurs principally on the borders of Lake Baikal. Omphazite accompanies granular garnet at the Sau Alp, in Carinthia, and near Hof, in Bayreuth, with the smaragdite variety of hornblende, which it much resembles.

White subtransparent crystals are met with at Bytown, Lower Canada, in limestone, often measuring an inch by one and a half inches; grayish-green in limestone with phlogopite at Grand Calumet, Id.; crystals sometimes 1 ft. long and 4 in. wide, and having attached small crystals of greenish hornblende, at the high falls of the Madawaska, Canada. White flattened prismatic crystals, two or three inches long by one or two in breadth, occur in dolomite at Canaan, Conn.; large green crystals in the limestone of Trumbull; small transparent crystals with granular pyroxene, in Reading, Conn., on the turnpike near the line of Danbury. The Bolton quarries, Mass., afford good crystals. The dolomite of New York Co., N. Y., affords white crystals, often several inches long, and also the abandoned quarries at Kingsbridge, about 208th street. In Orange Co. there are interesting localities, affording, besides fine crystals, many of the massive varieties, from white to black colors, the former in limestone, the latter usually with magnetic iron; at Two-Ponds, in Monroe, in simple or grouped crystals, often large, associated with scapolite, zircon, and sphene in white limestone: another, half a mile east of Greenwood furnace, along with mica in limestone, where one crystal was obtained six inches long and ten in circumference; two and a half miles north of Edenville, gray crystals. Near Amity and Fort Montgomery, are other good localities. Dark green or black crystals in limestone a mile northwest of Edenville. In Putnam Co., near Patterson, grayish-white crystals are abundant, strewed over the surface and in limestone. In Westchester Co., white at the Sing Sing quarries. Other good localities in New York, are at Rogers' Rock, Lake George, massive, and granular, (coccolite), of gray, green, and brown colors; on the banks of Vrooman lake, near Oxbow; in Diana, Lewis Co., in black crystals; at Fine, St. Lawrence Co., where the crystals are very large. Franklin, N. J., also affords good pyroxene. Massive varieties occur at most of the above mentioned localities. Crystals of black augite in trap at Montreal, Boucherville and Rougemont Mountains, C. E. A beautiful green coccolite, and also crystals (f. 356) occur near Long Pond, Essex Co., N. Y., and a black coccolite in Monroe, Orange Co., a mile west of Coffee's Hotel; at Willsboro', N. Y., green *coccolite* is associated with sphene and tabular spar. A lamellar variety of a dark-green and bronze color is abundant in the Forest of Dean, Orange Co., N. Y., along with black coccolite; and fine sahlite with coccolite about three miles southeast of Greenwood furnace. *Diopside* occurs on Hustis's farm, Phillipstown, N. Y., and in the Bolton limestone quarry. Raymond and Rumford, Maine, afford massive varieties, diopside, sahlite, &c. At Berkshire, Mass., a white variety is abundant. A broad lamellar *sahlite* of a white color at Watertown, Conn., at the lime quarry near the Naugatuck, and a less interesting grayish-green variety at the verd antique quarries of Milford and New Haven. Both crystals and granular pyroxene near Attleboro', Penn. *Diopside* in Burnett's quarry, Pennsbury. *Diallage* in serpentine in Westfield and Blanford, Mass., at Deer Isle, Maine, Cooptown, Harford Co., Md. A massive fassaite with red sapphire and sphene, at Burgess, Canada West.

Hypersthene is stated to occur in Essex Co., in much of the granite of that region, often associated with labradorite; also near Wilmington, Delaware. But the mineral from these localities, although presenting the external characters of this variety, differ much from one another in composition, (analyses 39, 40), and still more from the Labrador hypersthene, (analysis No. 42). It is also found with andesite rock at Chateau Richer and at St. Adèle, Mille Isles, Canada, (analysis 44), grayish-black and brown, with laminæ curved. The *Hudsonite* of Beck (analyses 28 and 29) occurs in a vein of quartz in Cornwall, Orange Co., N. Y. The *Polylite* of Thomson may possibly come from the same locality; Thomson attributes it to Hoboken, which Beck states must be an error.

Pyroxene was thus named by Haüy from πυρ, fire, and ξενος, stranger, in allusion to its occurrence in lavas, where Haüy supposed it did not belong, or was a stranger.

Crystals of this species have been obtained by fusion, and are not unfrequent, of a black color, among the iron slags of Sweden. Mitscherlich and Beudant have formed white crystals by heating together silica, lime, and magnesia.

Altered Forms.—Pyroxene undergoes alteration in different ways, as has been well explained by Bischof. When containing much protoxyd of iron, as in many varieties, the iron, if moisture is present, undergoes oxydation, becoming brown or brownish-red and hydrated, or of a red color and anhydrous; or is carbonated and becomes gradually removed and the result uncolored, if carbonic acid is present. In an early stage of alteration, crystals often develop a basal cleavage. The carbonic acid of infiltrating waters when lime is present, carries off the lime, leaving the most of the magnesia, as in the change to *Rensselaerite;* or by continuing its action, carries off the magnesia and gives origin, if the pyroxene is aluminous, to a hydrous silicate of alumina, like *Cimolite;* an addition of alumina may probably take place through the accompanying decomposition of associated feldspar. Acted on by sulphuric or sulphurous acid about volcanoes, the protoxyd bases are rapidly removed, and a hydrous aluminous silicate is left, and often a siliceous deposit or sinter. Acted on by alkaline carbonates in solution, a similar result is produced, but alkalies take the place of the removed bases, and an alkaline silicate of alumina or of iron and alumina is formed, as *Green earth;* or under different circumstances there is a change to *mica.* Acted on by waters containing traces of bicarbonate of magnesia in solution, magnesia is exchanged for the lime, and thus *pyrallolite, hypersthene* and *hornblende,* may be formed from Augite; and the removal of the lime entirely, and its replacement by magnesia, gives origin to *serpentine, steatite, talc, saponite.* Silicates of iron and magnesia may also proceed from the action of alkaline silicates or carbonates.

Tufas consist largely of altered augite, and are formed from augitic sands under the action of steam or heated waters, thus becoming a hydrous silicate of alumina, etc.; such, according to Bunsen, is the *Palagonite* of Waltershausen

The following are analyses and descriptions of some of the more prominent results of alteration.

1, 2, Waltershausen, (Vulk. Gest. 305); 3, Beudant; 4, Beck, (Min. N. York, 297); 5, Nordenskiöld, (Schw. J. xxxi, 386); 6, Köhler, (Pogg. xi, 192); 7, Rammelsberg, (3d Suppl. 106, and Pogg. xlix, 387); 8, Klaproth, (Beit., ii, 180, v, 22); 9, Svanberg, (K. V. Ac. H. 1840, and Pogg. lvii, 165); 10, 11, Smith & Brush, (Am. J. Sci., [2], xvi, 368); 12, Svanberg, (Pogg. liv, 267); 13, 14, Rammelsberg, (Pogg. xlix, 387); 15, Delesse, (Bib. Univ. Genève, June, 1848, 106); 16, 17, Waltershausen, (loc. cit., 301); 18, Rammelsberg, (loc. cit.); 19, Klaproth, (Beit., i, 291); 20, Ilimoff, (Ann. J. M. Russ., 1841, 336); 21, Rammelsberg, (loc. cit):

1. Calcareo-magnesian.—1. *Hydrosilicite.* 2. *Ibid.*

	$\dddot{\mathrm{Si}}$	$\overline{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1.	44·90	——	4·60	33·32	2·11	1·86	13·21=100, Waltershausen.
2.	43·31	3·14	8·66	28·70	1·70		14·48=100, Waltershausen.

II. Magnesian.—3. *Sahla, Pseudomorph.* 4. *Rensselaerite.* 5. *Pyrallolite.* 6. *Schiller Spar.* 7. *Ibid.* 8. *Saponite,* Cornwall. 9. *Ibid.* 10. *Thalite,* Lake Superior. 11. *Ibid.* 12. *Piotine.*

	$\dddot{\mathrm{Si}}$	$\overline{\dddot{\mathrm{Al}}}$	$\overline{\dddot{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
3.	60·65	——	——	4·18	25·20	4·97	$\dot{\mathrm{Mn}}$ 0·78	——	4·38=100·16, Beud.
4.	59·75	——	3·40	——	32·90	1·00	——	——	2·85=99·90, Beck.
5.	56·62	3·38	0·99	——	23·38	5·58	$\dot{\mathrm{Mn}}$ 0·99	——	3·58Bit and loss 6·38, Nor.
6.	43·08	1·73	——	10·91	26·16	2·75	“ 0·57	——	12·43 $\overline{\dddot{\mathrm{Cr}}}$ 2·37=100, Köhler.
7.	41·48	6·49	——	16·61	27·24	——	——	——	10·13=101·95, Ramm.
8.	45·00	9·25	1·00	——	24·75	——	——	0·75	18·00=98·75, Klap.
9.	46·8	8·0	0·4	——	33·3	0·7	——	——	11·00=100·2, Svanb.
10.	45·60	4·87	2·09	——	24·10	1·07	0·45		20·66=98·84, S. and B.
11.	48·89	7·23	2·46	——	24·17	——	0·81		15·66=99·22, S. and B.
12.	50·89	9·40	2·06	——	26·52	0·78	——	——	10·5=100·15, Svanb.

III. Alkaline.—13. *Green Earth,* Fassa. 14. *Ibid.* 15. *Green Earth,* Mt. Baldo. 16. *Green Earth,* Iceland. 17. *Ibid.*

	$\ddot{\text{Si}}$	$\ddot{\overline{\text{Al}}}$	$\ddot{\overline{\text{Fe}}}$	$\dot{\text{Fe}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	$\dot{\text{H}}$
13.	45·87	11·18	——	24·63	0·28	1·50	6·72		9·82=100, Ramm.
14.	39·48	10·31	8·94	15·66	1·70	$\dot{\text{Ca}}\ddot{\text{C}}$	15·24, alkali	and $\dot{\text{H}}$	8·67=100, Ramm.
15.	51·25	7·25	——	20·72	6·16	——	1·92	6·21	6·49=100, Del.
16.	52·04	4·93	——	25·54	4·26	1·38	——	6·03	5·19=99·37, Walt.
17.	60·09	5·28	——	15·72	4·95	0·09	2·51	5·04	4·44=98·12, Walt.

IV. Aluminous.—18. Bilin, *Pseudomorph.* 19. *Cimolite,* Argentiera. 20. *Cimolite,* Alexandrowski.

	$\ddot{\text{Si}}$	$\ddot{\overline{\text{Al}}}$	$\ddot{\overline{\text{Fe}}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{H}}$
18.	60·63	23·08	4·21	0·91	1·28	9·12=99·23, Rammelsberg.
19.	63·00	23·00	1·25	——	——	12·00=99·25, Klaproth.
20.	63·52	23·55	——	——	——	12·00=99·07, Ilimoff.

V. Siliceous.—21. Vesuvius, *Pseudomorph.*

	$\ddot{\text{Si}}$	$\ddot{\overline{\text{Al}}}$	$\ddot{\overline{\text{Fe}}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{H}}$
21.	85·31	1·58	1·67	1·70	2·66	5·47=98·42, Rammelsberg.

Hydrosilicite, Waltershausen, (Analyses 1, 2).—Occurs amorphous or as a crust, at Palagonia and Aci Castello, in Sicily, associated or mixed with Herschelite, Phillippsite and Calcite. Formula $\dot{\text{R}}^3\,\ddot{\text{Si}}^2+3\dot{\text{H}}$, or a hydrous augite.

Rensselaerite, Emmons, (Analysis 4).—Compact steatitic, with an unctuous feel, fine compact texture, either gray, whitish, greenish, brownish, or at times black, H.=3—4, G.=2·87. Translucent. Has often the cleavage of pyroxene. On account of its softness, translucency and fine texture, it is worked in a lathe into inkstands and other forms. Occurs over large areas in Northern New York, in the towns of Fowler, Dekalb, Edwards, Russel, Gouverneur, Canton and Hermon, St. Lawrence Co.

Pyrallolite, Nordenskiöld, (Analysis 5).—Cleavable or granular massive, and like pyroxene. H.=3·5—4. G.=2·555—2·594. White, sometimes greenish; subtranslucent to opaque. Formula $\dot{\text{Mg}}^3\,\ddot{\text{Si}}^2$ with water. B.B. at first blackens and then becomes white. From Storgord in Finland, in limestone, with pyroxene and scapolite. Closely related to the Rensselaerite.

Schiller Spar, (Analyses 6, 7).—Cleavable, massive, like some pyroxene. H.=3·5—4. G.=2·5—2·76. Lustre metallic pearly, to subvitreous. Dark green, inclining to pinchbeck brown. Subtranslucent. B.B. fuses on thinnest edges. From Baste in the Hartz with serpentine. It is considered an altered augite by G. Rose. The name is from the German for a play of colors or lustre. Called also *Bastite.*

Saponite, Seifenstein, (Analyses 8–11).—Occurs like Green Earth in amygdaloidal cavities. It is soft, almost like butter, brittle on drying; white, yellowish, bluish, reddish,—not adhering to the tongue. B.B. fuses with difficulty on the edges. Wholly soluble in sulphuric acid. From Lizard's Point, Cornwall; amygdaloid of northern shore of Lake Superior Region, (Owen's *Thalite,* Proc. Acad. Philad. 1852, and Am. J. Sci., [2], xiii, 420, Anal. 10, 11); Svärdsjö in Dalarne, (*Piotine* of Svanberg, Pogg. liv, 267, Analysis 12).

Green Earth, (*Seladonite*).—Earthy or a minutely crystalline appearance, dark olive green, to celandine green, and quite soft, with an unctuous feel. It occurs in amygdaloidal cavities. The green earth from Mt. Baldo is nearly apple green; G.=2·907. That from Iceland where it occurs with zeolites, afforded a trace of vanadium; G.=2·677. Analyses of *Green Earth* Nos. 13 to 17; 13, 14, Fassa, 15, Mt. Baldo, 16, 17, Iceland.

Picrophyl according to Breithaupt is also altered *Augite.*

Cimolite, (Analyses 18–20).—Massive, earthy, very soft. G.=2·18—2·30. Color white, grayish. Lustre of steak greasy. Absorbs water but does not fall to pieces. Corresponds in composition nearly to $\ddot{\overline{\text{Al}}}\,\ddot{\text{Si}}^3+3$ (or 2) $\dot{\text{H}}$. B.B. infusible. The original Cimolite was from Cimolis, on the island of Argentiera, Greece. Analysis 18 is of a pseudomorph after augite from Bilin, identical in composition with Cimolite.

Acmite is considered by Bischof and Rose, pyroxene altered by the alkaline process.

Augite altered to *Hornblende* is found in *Uralite*, which has the form of Augite, with the cleavage and composition of hornblende. Pyroxene from Taberg and Pargas, and a variety from the Azores, also have a hornblende composition, while some hornblendes, as a tremolite from Pennsylvania, and a hornblende from Härtlingen, have the composition of Augite. These transitions are explained by Bischof, as above, (see p. 164). Scheerer considers them cases of paramorphism, or a change from one of the two forms of a dimorphous compound to the other, augite and hornblende being dimorphous. The annexed table shows the relations in form of the two species referred to the augite type; it presents the symbols of the planes in hornblende. Sandberger has observed crystals of augite and hornblende forming a macle together; and in some cases the hornblende crystals are implanted around the augite. Sandberger and Blum regard facts of this kind as proving that the two species may form simultaneously. (Sandberger, Pogg., lxxxiii, 453).

O				
$1i$		12		$1\grave{\imath}$
			$\frac{3}{2}\grave{\frac{3}{2}}$	
ii	$i6$	$i2$	$i\grave{\frac{3}{2}}$	$i\grave{\imath}$
			$-\frac{3}{2}\grave{\frac{3}{2}}$	
$-2i$		-22		
$-1i$		-12		$1\grave{\imath}$

Observed Planes in Hornblende, (p. 171), referred to the Augite Axes.

Other pseudomorphs after augite, are as follows:—steatite and serpentine by alteration; opal, quartz, limonite, calcite, by substitution.

Palagonite of von Waltershausen occurs amorphous and in grains and fragments forming much of volcanic tufa or conglomerate, H.=4—5. G.=2·4—2·7. Lustre vitreous or greasy, or like pitchstone. Color amber-yellow, yellowish-brown, garnet-red, colophonite-brown, blackish. Streak yellow.

Composition.—Analyses by von Waltershausen (Vulk. Gesteine, 1853). Means after gangue excluded:

			$\dddot{Si}$	$\dddot{\bar{A}l}$	$\dddot{\bar{F}e}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
I.	1.	Krisuvik,	40·68	14·59	14·24	6·95	7·65	1·84	0·45	13·60=100.
II.	2.	Hecla,	40·75	8·42	17·99	8·64	4·54	0·62	0·44	18·60=100.
	3.	Laxá,	42·28	11·14	16·71	5·68	6·39	——	1·80	16·00=100.
	4.	Val di Noto,	38·69	13·61	14·51	8·38	6·13	1·07	1·35	16·26=100.
III.	5.	Galapagos,	38·07	13·03	9·99	7·54	6·58	0·70	0·94	23·15=100.
	6.	"	36·94	11·56	10·71	7·95	6·28	0·55	0·78	25·23=100.
IV.	7.	Südafell,	41·46	10·91	18·12	8·54	4·80	0·64	0·40	14·49=99·37.
	8.	Val di Noto,	41·26	8·60	25·32	5·59	4·84	1·06	0·54	12·79=100.
V.	9.	"	40·86	10·07	20·54	4·46	3·28	3·99	1·10	15·70=100.
VI.	10.	"	34·99	6·02	20·50	6·08	11·02	0·92	0·93	19·54=100.

Waltershausen calculates for chrysolite and sometimes carbonate of lime present in the above, and makes out for the correct composition, as mean results for many analyses under the above types, I to VI:

		$\dddot{Si}$	$\dddot{\bar{A}l}$	$\dddot{\bar{F}e}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
I.	*Palagonite,*	41·90	12·72	16·74	6·71	6·86	1·92	0·99	12·16=$\dot{R}^3\dddot{Si}^2+2\dddot{\bar{R}}\dddot{Si}+6\dot{H}$.
II.	"	40·62	11·03	15·86	7·23	5·44	0·62	1·53	17·67= " " $+9\dot{H}$.
III.	"	38·96	12·75	10·71	5·96	6·53	0·65	0·90	23·26=$\dot{R}^3\dddot{Si}+2\dddot{\bar{R}}\dddot{Si}+12\dot{H}$.
IV.	*Korite,*	44·07	12·00	19·47	5·53	4·95	0·70	0·44	12·84=$\dot{R}\dddot{Si}+\dddot{\bar{R}}\dddot{Si}+3\dot{H}$.
V.	*Hyblite,*	40·86	10·22	20·68	4·53	2·61	4·05	1·12	15·93= " " $+4\dot{H}$.
VI.	*Notite,*	36·96	6·36	21·66	3·26	11·64	0·97	0·99	18·16=$\dot{R}^2\dddot{Si}+\dddot{\bar{R}}\dddot{Si}+5\dot{H}$.
VII.	*Trinacrite,*	31·82	5·25	33·95	2·57	4·57	4·19	3·42	14·22=$\dot{R}^3\dddot{Si}+3\dddot{\bar{R}}\dddot{Si}+9\dot{H}$.

The *Korite* is a hydrous labradorite; it is in dull brown grains, and is associated with *Sideromelane*, which has the same composition excepting the absence of water. It may well be doubted whether these substances are, all of them, distinct chemical compounds.

Waltershausen makes out another allied compound which he calls *Trinacrite*, constituted as above given. It is dull brown and cleavable or micaceous, and is mixed with his *Siderosilicite*, a hydrous silicate of peroxyd of iron and alumina. It may be remarked that decomposed chrysolite in one of its stages has the brown appearance and structure of the mixed Trinacrite and Siderosilicite.

Bunsen regards the Palagonite of Iceland, (Pogg. lxxxiii, 219, and Ann. Ch. Phys. [3], xxxviii, 237), as consisting of silicates $\dot{\mathrm{R}}^3\ \dddot{\mathrm{Si}}^2+\mathrm{Aq}$ and $\dddot{\bar{\mathrm{R}}}\ \dddot{\mathrm{Si}}+\mathrm{Aq}$, combined with one another. To the Palagonite of Iceland, he gives the formula, $\dot{\mathrm{R}}^3\ \dddot{\mathrm{Si}}^2+2\dddot{\bar{\mathrm{R}}}\ \dddot{\mathrm{Si}}+\mathrm{Aq}$, to that of the Galapagos, $\dot{\mathrm{R}}^3\ \dddot{\mathrm{Si}}^2+\dddot{\bar{\mathrm{R}}}\ \dddot{\mathrm{Si}}+\mathrm{Aq}$; and he observes that the palagonite occurs as the basis of the basaltic tufas of Germany, France, Azores, Canaries, Cape Verdes, Tortugas, and probably also of the Pacific Islands. He gives analyses which show great uniformity of composition in the basaltic tufas, and compares it with the constitution of pyroxene, the alteration of which is the source of the peculiarities of the tufa. He also observes that the Palagonite may be made artificially by putting powdered basalt into a large excess of caustic potash in fusion and pouring on water; the product, after washing, is hydrated, pulverulent, and gelatinizes with weak acids, and its composition is like that of the purest palagonite of Iceland. The origin of the Palagonite is hence attributed to the alteration of pyroxene rocks, in which process the iron is peroxydized.

BOLTONITE, *Shepard.* Disseminated massive. Cleavage rather distinct in one direction; in two others oblique to the first, indistinct. H.=5·5. G.=2·8—2·9, Shepard; 3·008, Silliman. Lustre vitreous. Streak white. Color bluish-gray, yellowish-gray, wax-yellow, yellowish-white. The darker colors turn yellow on exposure. Transparent—translucent.

Composition.—Analysis by Silliman, Jr., (Am. J. Sci., [2], viii, 392):

$$\dddot{\mathrm{Si}}\ 46{\cdot}062,\quad \dddot{\bar{\mathrm{Al}}}\ 5{\cdot}667,\quad \dot{\mathrm{Mg}}\ 38{\cdot}149,\quad \dot{\mathrm{Fe}}\ 8{\cdot}632,\quad \dot{\mathrm{Ca}}\ 1{\cdot}516=100{\cdot}026.$$

This gives the formula $\dot{\mathrm{R}}^2\ \dddot{\mathrm{Si}}+\frac{1}{3}\dot{\mathrm{Mg}}^2\ \dddot{\bar{\mathrm{Al}}}$ or $\dot{\mathrm{R}}^2(\dddot{\mathrm{Si}}, \dddot{\bar{\mathrm{Al}}})$. But it is quite probable that the species is an altered augite.

B.B. alone, it is bleached and rendered transparent, but does not fuse. With borax it forms a transparent glass.

Boltonite is disseminated through white limestone at Bolton, Mass., and also at Roxbury and Littleton.

Mr. Saemann attributes the change of color in boltonite to minute grains of magnetic iron disseminated in the substance of the crystals, which undergo change on exposure, and leave the mineral of a lighter color than it was when fresh.

Thomson's *bisilicate of magnesia,* (Ann. Lyc. Nat. Hist. N. Y., iii, 50), the analysis of which has been referred to this species, is shown by Silliman (loc. cit.) to be actinolite.

RHODONITE, *Beud.* Manganese Spar. Bisilicate of Maganese, *Thomson.* Rother Mangankiesel. Kieselmangan. Photizite, *Dumenil.* Allagite. Corneous Manganese. Bustamite, *Brongn.* Fowlerite. Marceline, *Beud.* Dyssnit, *Kobell.* Paisbergit, *Igelström.*

Monoclinic, and like pyroxene, *I* : *I*=87° 7′. Observed planes, *I ii*, *ii*, *O*. Cleavage: *I* perfect; *O* less perfect. Usually massive. H.=5·5—6·5. G.=3·4—3·68; 3·612, Langbanshytta; 3·634, Siberia; 3·63, Hermann, Stirling. Lustre vitreous. Color light brownish-red, flesh-red, sometimes greenish, or yellowish, when impure. Streak white. Transparent—opaque. Fracture conchoidal—uneven. Brittle.

Fowlerite is the crystallized Rhodonite of Franklin, N. J.; it is often black externally from alteration. Named after Mr. S. Fowler. The name *Rhodonite* alludes to the red color.

Photizite is a mixture of Rhodonite and carbonate of manganese. *Marceline* (from St. Marcel) is an impure silicate into which the Rhodonite changes on exposure. *Bustamite,* from Mexico, is grayish-red, and at times somewhat fibrous; it contains much lime. *Allagite* is greenish-gray, verging towards black, and is somewhat fibrous, resembling altered bustamite; named from *αλλαγη*, *change,* alluding to change on exposure.

Opsimose of Beudant, from Franklin, N. J., is the fowlerite partially altered.

The *dyssnite* of Kobell, is from the same region and of similar character. Thomson's analysis of fowlerite (Ann. Lyc. N. Y., iii, 28) is from a partially altered specimen of this kind.

Composition.—$\dot{Mn}^3\dddot{Si}^2$=Silica 45·9, protoxyd of manganese 54·1=100, or a true manganese augite; usually $(\dot{Mn}, \dot{Ca})^3\dddot{Si}^2$ or $(\dot{Mn}, \dot{Fe}, \dot{Ca})^3\dddot{Si}^2$. Analyses: 1, Berzelius, (Afhandl. i, 110, iv, 382); 2, 3, Ebelmen, (Ann. d. Mines, [4], vii, 8); 4, Dumas, (Ann. des Sci. Nat. viii, 411); 5, Ebelmen, (loc. cit.); 6, 7, Hermann, (J. f. pr. Chem. xlvii, 6, 8); 8, A. Schlieper, (this Min., 3d edit., 463); 9, Igelström, (J. f. pr. Chem, liv, 190).

	$\dddot{Si}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Fe}$
1. Langbanshytta,	48·00	49·04	3·12	0·22	——=100·38, Berzelius.
2. Algiers,	45·49	39·46	4·66	2·60	6·42=98·63, Ebelmen; G.=3·599.
3. St. Marcel,	46·37	47·38	5·58	——	——=99·23, Ebelmen.
4. *Bustamite,*	48·90	36·06	14·57	——	0·81=100·34, Dumas; G.=3·12—3·35.
5. "	44·45	26·96	14·43	0·64	1·15, $\dot{Ca}\,\ddot{C}$ 12·27=99·90, Ebelmen.
6. Stirling, N. J.,	46·48	31·52	4·50	3·09	7·23, $\dot{Zn}$ 5·85, ign. 1·00=99·67, H.
7. Cummington,	48·91	46·74	2·35	2·00	*trace*=100, Hermann. G.=3·42.
8. "	51·21	42·65	2·93	*trace*	4·34=101·13, Schlieper.
9. *Paisbergite,*	46·46	41·88	8·13	0·91	3·31=100·69, Igelström. G.=3·63.

Schlieper found his specimen (one furnished by the author and seemingly unaltered) to consist partly of carbonate of manganese and other bases. By digestion in concentrated muriatic acid, it afforded 90·15 per cent. of silicate of manganese, and 9·85 soluble portion. The latter gave on analysis,

$\dot{Mn}\,\ddot{C}$ 50·52, $\dot{Fe}\,\ddot{C}$ 8·60, $\dot{Ca}\,\ddot{C}$ 37·17, $\dot{Mg}\,\ddot{C}$ 2·44, $\dot{H}$ and loss 1·27=100.

Ten per cent. of carbonates had been previously found in the Cummington mineral, by E. Hitchcock. Allowing that the ten per cent. of carbonates in Schlieper's specimen had been formed at the expense of the bases in the Rhodonite, and also that there was some free silica in minute points or grains, as was obvious to the eye, the oxygen ratio cannot be taken as different from that of Rhodonite.

B.B. becomes dark brown, and melts to a reddish-brown glassy globule; with the fluxes gives the reaction of manganese. In powder, partly dissolves in muriatic acid, and the insoluble part becomes of a white color. Darkens on exposure to the air, and often becomes nearly black.

Occurs at Langbanshytta, near Phillipstadt in Sweden, in iron ore beds, in broad folia, and also granular massive; also at Elbingerode, in the Hartz; in the district of Ekatherinenburg, in Siberia; with gray copper ore at Kapnik, in Transylvania; in Cornwall. *Paisbergite* is from Paisberg's iron mine in Phillipstadt, Sweden.

Occurs in boulders in the town of Cummington, Mass., and some of the neighboring towns, and has been observed also in Warwick, of the same State, on the other side of the Connecticut. Also in an extensive bed on Osgood's farm, Blue Hill Bay, Maine; in Irasburgh and Coventry, Vt.; near Winchester and Hinsdale, N. H. An ore from Stirling, New Jersey, gave Thomson the angle 123° 30′, which is near the angle of hornblende, but we have not been able to verify the result. Thomson's analysis of this ore, if correct, would make it a manganese augite or Rhodonite, (Min. i, 515), and this sets aside his measurements, or at least throws doubts upon them. He found the specific gravity 3·586.

The Fowlerite which occurs in large crystals with franklinite, at the Franklin Furnace, Hamburgh, at Stirling, N. J., has been analyzed by W. Camac, (Am. J. S. [2], xiv, 418), and the following composition obtained:—

$\dddot{Si}$	$\dot{Mn}$	$\dot{Fe}$	$\dot{Zn}$	$\dot{Ca}$	$\dot{Mg}$
42·20	25·37	11·00	4·15	9·66	5·27; feldspar 3·56=101·20.

This gives the oxygen ratio for the silica and protoxyds 3 : 1·85, corresponding nearly to 9 $\dot{\bar{R}}$, 5 $\dddot{Si}$. The result needs confirmation.

A rose-colored ore from Kapnik, in concretionary forms afforded Brandes, $\dddot{Si}$ 53·50, $\dot{Mn}$ 41·93, $\dot{Fe}$ 1·00, $\dddot{\bar{Al}}$ 1·24, $\dot{H}$ 3·00, and it has been considered a trisilicate, $\dot{Mn}\,\dddot{Si}$; G.=2·8. Its purity is denied by Dufrénoy, who attributes part of the silica to the quartz with which it is associated.

Mangan-Amphibole, Hermann, (J. f. pr. Chem. xlvii, 7). Hermann separates from Rhodonite, without good reason, the Cummington Manganese spar under the idea that it is a hornblende, and not a manganese augite. He unites with it Thomson's Stirling ore.

Altered Forms.—Rhodonite changes partly to a carbonate, by the action of waters holding alkaline carbonates in solution, as exemplified in remarks above; and also becomes altered by the tendency of protoxyd of manganese to pass to a higher state of oxydation, accompanied with the absorption of water. By the last process, the red color becomes brown and black, and indefinite compounds or mixtures result, which may be either partly silicates, or wholly an oxyd of manganese. *Marceline* and *Allagite*, etc., are of this kind. The following also probably belong here as altered Rhodonite.

Stratopeite, Igelström.—From the Pajsberg iron mine in Philipstadt. Amorphous, massive. Easily scratched with a knife blade. G.=2·64. Color pitch-black, brown or brownish red in thin splinters. Streak brown. Fracture flat conchoidal. B.B. fuses to a black translucent globule. With muriatic acid, much chlorine is evolved.

The following are analyses of this and other allied impure silicates by Igelström, Bahr, and Svanberg, (Oefv. V. Ak. Förh. 1850, 1851, and J. f. pr. Ch. liii, 308, liv, 190).

	$\ddot{\text{Si}}$	$\dddot{\overline{\text{Al}}}$	$\dddot{\overline{\text{Fe}}}$	$\dddot{\overline{\text{Mn}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$
1. *Stratopeite*,	35·43	——	10·27	32·41	——	8·04	13·75, Igelström.
2. Klapperud,	36·20	1·11	0·70	47·91	0·61	4·43	9·43=100·39, Bahr.
3. "	36·11	0·90	11·31	42·00	0·70	0·57	9·43=101·39, Svanberg.
4. "	34·72	1·09	10·45	42·64	0·56	0·36	9·76=99·98, Bahr.
5. "	23·69	0·61	9·14	56·21	0·50	0·39	9·51=100·05, B.
6. "	33·81	1·03	7·53 $\dot{\text{Mn}}$	46·18	0·72	1·42	9·57=100·26, B.
7. "	43·30	6·80	4·57 $\dot{\text{Mn}}$	9·88	15·96	11·90	6·13, $\dot{\text{Co}}$ 0·39=98·93.

Igelström writes for *Stratopeite*, (Anal. 1), the formula $\dot{\text{Mg}}^3\,\ddot{\text{Si}}^2+4\,(\dddot{\overline{\text{Mn}}},\,\dddot{\overline{\text{Fe}}})\,\ddot{\text{Si}}+12\,\dot{\text{H}}$. A related mineral has been called *Neotokite;* formula deduced, $\dot{\text{Mg}}\,\ddot{\text{Si}}+4\,(\dddot{\overline{\text{Mn}}},\,\dddot{\overline{\text{Fe}}})\,\ddot{\text{Si}}+8\,\dot{\text{H}}$; G.=2·70. *Wittingite* is similar; formula given it, $2\,(\dddot{\overline{\text{Fe}}},\,\dddot{\overline{\text{Mn}}})\,\ddot{\text{Si}}+3\,\dot{\text{H}}$; G.=2·71—2·76; from Wittinge, Finland.

Analyses 2 to 4 are of a dull lead gray mineral; they give the oxygen ratio for the peroxyds, silica and water, 2 : 2 : 1. Analysis 5 gives the ratio 2·5 : 1·5 : 1; color pure black; fracture earthy; rather soft; G.=3·207. Analysis 7 is of a light yellow mineral, hard and without distinct cleavage; lustre between vitreous and greasy; G.=3·320; the oxygen ratio which the analysis gives for the protoxyds, peroxyds, silica and water is, 2·5 : 1 : 5 : 1·2.

SPODUMENE, *d'Andrada.* Triphane, *H.*

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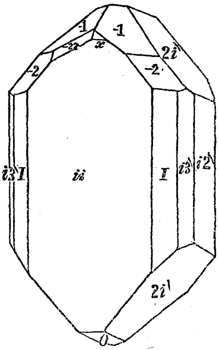

Monoclinic. *C*=69° 40′, *I* : *I*=87°, *O* : 2*i* =130° 30′.

O : *ii*=69° 40′. *ii* :-2=117° 19′.
O :-1=134° 12′. *ii* :-22=125° 12′.
O :-2=110° 50′. *ii* :-1=101° 6′.
ii : *I*=133° 30′. *ii* :-2=134° 19′.
ii : *i*3̆=107° 33′. *I* :-2=145° 50′.
2*i* : 2*i* (top)=80°. *I* :-1=121° 28′.
ii : 2*i*=139° 30′. -1 :-1=116° 19′.
ii : 2*i*=102° 54½′. -2 :-2=91° 24′.

Crystals large. Cleavage : *ii* very perfect; *I* also perfect; 1*i* in traces, seen in striæ on *ii*. Twins, face of composition *ii*. Also cleavable massive.

H.=6·5—7. G.=3·1—3·2; 3·17, Haidinger; 3·188, Thomson, specimen from Dublin Bay; 3·132—3·137, Rammelsberg. Lustre pearly. Cross fracture vitreous. Color grayish green, passing into greenish white and grayish white, rarely faint reddish ; streak uncolored. Translucent—subtranslucent. Fracture uneven.

Composition.—$(\frac{1}{5}\dot{R}^3+\frac{4}{5}\dddot{R})\dddot{Si}^2$=Silica 64·5, alumina 29·3, lithia 6·2.

Analyses: 1, R, Hagen, (Pogg. xlviii, 361); 2, Thomson, (Min. i, 302); 3, 4, Rammelsberg, (Pogg. lxxxv, 544); 5–8, Smith and Brush, (Amer. Jour. Sci. [2], xvi, 372):

	$\dddot{Si}$	$\dddot{Al}$	$\dddot{Fe}$	$\dot{Li}$	$\dot{Na}$	$\dot{Ca}$
1. Utö,	66·136	27·024	0·321	3·836	2·683	——=100, Hagen.
2. Killiney,	63·812	28·508	$\dot{Fe}$ 0·828	5·604	——	0·728, $\dot{H}$ 0·36=99·84, Thom.
3. Utö,	65·02	29·14	$\dot{Fe}$ *trace.*	5·47	0·46	0·50, $\dot{K}$ 0·14, $\dot{Mg}$ 0·15, R.
4. Tyrol,	65·53	29·04	$\dot{Fe}$ 1·42	4·49	0·07	0·97, $\dot{K}$ 0·07, $\dot{Mg}$ 0·07, R.
5. Norwich,	64·04	27·84	0·64	5·20	0·66	0·34 ign. 0·50, $\dot{K}$ 0·16=99·38, S. & B.
6. "	63·65	28·97		5·05	0·82[a]	0·31 " 0·50=99·30, S. & B.
7. "	63·90	28·70		4·99	0·80[a]	0·26 " 0·60=99·25, "
8. Sterling,	64·50	25·30	2·55	5·65	1·10[a]	0·43 " 0·30, $\dot{Mg}$ 0·06=99·89, S. & B.

[a] With some soda ; in 5, 6, 7, magnesia, *trace.*

In a specimen from Sterling, Mass., Hagen found $\dddot{Si}$ 65·247, $\dddot{Al}$ $\dddot{Fe}$ 27·556 ; and in another from Tyrol, $\dddot{Si}$ 66·027, $\dddot{Al}$ 26·451.

B.B. loses translucency and color, intumesces and fuses to a glassy globule; gives the reaction of lithia.

Occurs on the island of Utö, in Südermanland, Sweden, with magnetic iron ore, quartz, tourmaline, and feldspar; also near Sterzing and Lisens in the Tyrol, and of a pale green or yellowish color, imbedded in granite, at Killiney Bay, near Dublin, and at Peterhead in Scotland.

It occurs in granite at Goshen, Mass., associated at one locality with blue tourmaline and beryl; also at Chesterfield, Chester, Norwich, and Sterling, Mass.; at Windham, Maine, near the bridge, along with garnet and staurotide; at Brookfield, Ct., a few rods north of Tomlinson's tavern, in small grayish or greenish white individuals looking like feldspar. At Norwich, Mass., it is associated with triphyline, mica, beryl, and albite; one crystal from this locality was 16½ inches long, and 10 inches in girt.

Named from σποδος, *ashes*, because the mineral becomes ashy before the blowpipe.

The following are the angles obtained with the common goniometer, from the Norwich crystals: *O* : *ii*=69° 40′, *ii* : *I*=133° 30′, *ii* : *i*3=107°, 2*ì* : 2*ì* (top)=80°, *iì* : 2*ì*=139° 45′, *ii* : 2*ì*=103°, *ii* : -2=116°, *ii* : -1=100° 30′, *ii* : *x*=140°, *iì* : -2 =134°, *i*3 : -2=142°, *I* : -2=144°, -1 : -1=117°, -2 : -2=92°.

Altered Forms.—*Killinite* of Thomson (Min. i, 330) has the appearance of spodumene, and occurs with it at Killiney Bay. Mallet states that it affords by cleavage a prism of 135°, which is very nearly the angle between the diagonal and prismatic cleavage of spodumene, both of which are perfect. H.=4. G.=2·56. Lustre vitreous, weak. Color greenish-gray, brownish, or yellowish. *Composition.* According to Lehunt and Blythe (loc. cit.) and Mallet, (Rammelsberg's 5th Sup. 143):

	$\dddot{Si}$	$\dddot{Al}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Mn}$	$\dot{K}$	$\dot{H}$
1.	49·08	30·60	2·27	0·68	1·08	——	6·72	10·00=100·43, L.
2.	47·93	31·04	2·33	0·72	0·46	1·25	6·06	10·00=99·80, Bl.
3.	52·89	33·24	3·27	1·45	——	——	4·94	3·67, $\dot{Li}$ 0·46=99·92, M.

HORNBLENDE. Amphibole. Green diallage. Actinolite. Actinote. Tremolite. Calamite. Pargasite. Smaragdite. Asbestus, in part. Amianthus. Amianthinite. Amianthoid. Lotalite. Strahlstein, Tremolith, Kalamit, Amiant, *W.* Grammatit. Byssolith, *Haus.* Carinthine, Anthophyllite, *Schumacher.* Cummingtonite, *Dewey.* Breislakite, *Brocchi.* Raphilite, *Thom.* Arfvedsonite, *Brooke.* Ægirin, *Tamnau,* in part. Kymatin, *Breit.* Diastatite, *Breit.*

Monoclinic. $C=75^\circ\ 2'$, $I : I=124^\circ\ 30'$, $O : 1\grave{i}=164^\circ 10'$, $a:b:c=0{\cdot}5527 : 1 : 1{\cdot}8825$. Crystals sometimes stout, often long and bladed. Cleavage: I highly perfect; ii, $i\grave{i}$, sometimes distinct. Lateral planes often longitudinally striated. Twins: face of composition ii, as in f. 362, a twin of the form represented in f. 361.

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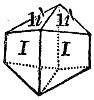

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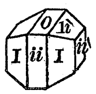

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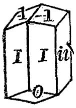

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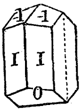

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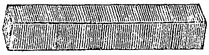

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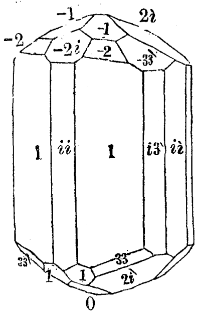

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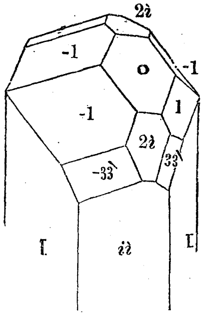

$O : 1i=155^\circ\ 33'$.
$O : -1i=149^\circ$.
$O : -2i=124^\circ\ 56'$.
$O : ii=104^\circ\ 58'$.
$O : 1=152^\circ\ 36'$.
$O : -1=145^\circ\ 35'$.
$O : -2=121^\circ\ 29'$.
$O : 2\grave{i}=150^\circ\ 26'$.
$O : i\grave{i}=90^\circ$.
$O : I=103^\circ\ 12'$.
$i\grave{i} : i3=99^\circ\ 57'$.

$i\grave{i} : i\grave{3}=147^\circ\ 39'$.
$i\grave{3} : i\grave{3}=115^\circ\ 18'$.
$i\grave{i} : 3\grave{3}=124^\circ\ 14'$.
$i\grave{i} : -3\grave{3}=130^\circ\ 15'$.
$2\grave{i} : 2\grave{i}(\text{ov.}O)=120^\circ\ 52'$.
$1 : 1=154^\circ\ 26'$.
$1 : -1=148^\circ\ 28'$.
$-2 : -2=131^\circ\ 36'$.
$3\grave{3} : 3\grave{3}=111^\circ\ 32'$.
$-3\grave{3} : -3\grave{3}=99^\circ\ 30'$.

O				
$1i$		1		
				$2\grave{i}$
			$3\grave{3}$	
ii	$i3$	I	$i\grave{3}$	$i\grave{i}$
			$-3\grave{3}$	
$-2i$		-2		$2\grave{i}$
$-1i$		-1		

Observed Planes.

Imperfect crystallizations: fibrous or columnar, coarse or fine, fibres often like flax; sometimes lamellar; also granular, coarse or fine, and usually strongly coherent; sometimes friable.

H.=5—6. G.=2·9—3·4. Lustre vitreous to pearly on cleavage faces; fibrous varieties often silky. Color between black and white, through various shades of green, inclining to blackish green. Streak uncolored or paler than color. Sometimes nearly transparent; usually subtranslucent—opaque. Fracture subconchoidal, uneven.

Composition.—$\dot{R}^4\ddot{S}i^3=\dot{R}^3\ \ddot{S}i^{\frac{9}{4}}=\dot{R}^3\ddot{S}i^2+\dot{R}\ddot{S}i$.

Isomorphism leads to the same variations of constitution in hornblende, as in pyroxene, and $\dot{R}$ may be either lime, magnesia, protoxyd of iron or manganese. Alumina replaces silica, in some varieties. The prominent varieties are the following:—

Tremolite, (fr. Tremóla valley, Switzerland), Grammatite, (fr. *γραμμη, a line*).—White, grayish, greenish, or yellowish-white specimens. Crystals often in long slender blades, either distinct and traversing the gangue, or aggregated in columnar and radiated masses. G.=2·93. Transparent—translucent. *Calamite* (fr. calamus, *a reed*) is asparagus green in crystals. *Raphilite* (fr. *ραφις, needle*) is an asbestiform tremolite from Lanark, Canada. Formula, $\dot{C}a\dddot{S}i+\dot{M}g^3\,\dddot{S}i^2$=Silica 60·7, lime 12·5, magnesia 26·8.

Actinolite, (fr. *ακτιν, a ray*), Actinote, Strahlstein. Bright-green bladed crystals or columnar forms; if in distinct crystals, *glassy actinolite*. The crystals are long, slender prisms, and break easily across the prism. The fibrous or radiated crystallizations are often named *asbestiform actinolite*. The green color is owing to a small proportion of oxyd of iron, and on account of the iron present, the specific gravity of actinolite is above that of tremolite, usually between 3·02 and 3·05.

Anthophyllite, (fr. anthophyllum). Fine columnar, or made up of acicular fibres of brown or grayish-brown color, often submetallic. G.=2·94—3·16. The cleavage affords prisms of 124° 30′, like other varieties of hornblende. Formula, $\dot{F}e\dddot{S}i+\dot{M}g^3\,\dddot{S}i^2$=Silica 58·6, magnesia 25·9, protoxyd of iron 15·5.

Asbestus, (fr. *ασβεστος, unconsumable*), when of a white color or some light shade, is a fibrous variety of tremolite or actinolite. The fibres are often as fine as flax, and may be separated with the fingers. By traversing limestone or the gangue that contains it, it often gives an asbestiform appearance to large masses of the rock. The more delicate varieties, presenting the lustre of satin, are called *Amianthus*, (fr. *αμιαντος, undefiled*).—The fibres of asbestus are sometimes so interlaced that the fibrous structure is not apparent; this variety is called *mountain leather*, and *rock* or *mountain cork;* the former occurs in flexible laminæ or sheets, resembling leather, and the latter has the feel and nearly the texture of cork: both are so light, owing to the loose interlacing of fibres, as to float on water.

Pargasite. Pargasite includes crystallized varieties (crystals usually thick and stout) of high lustre and rather dark shades of green; it is also granular.

Hornblende. The name hornblende, as originally applied, belonged only to the dark green and black varieties, whether in crystals or massive. It contains much iron and alumina; G.=3·1 to 3·4. The name alludes to the toughness.

Carinthine is a hornblende (aluminous and ferruginous) from Carinthia. G.=3·127.

Arfvedsonite. A black hornblende containing largely of iron and also soda, and, according to Brooke, having *I* : *I*=123° 55′. Lustre vitreous, inclining to resinous. G.=3·44. Formula, $\dot{N}a\dddot{S}i+\dot{F}e^3\dddot{S}i^2$=Silica 49·4, protoxyd of iron 39·3, soda 11·3. It is very fusible, melting even in the flame of a candle. Named after Professor Arfvedson of Sweden.

Ægirine, as analyzed by Plantamour, is a black hornblende related to Arfvedsonite. A black or greenish-black Brevig mineral so-called is pyroxene.

Hornblende Rock and *Amphibolite* are names of rocks consisting of hornblende, and having a crystalline granular texture, sometimes slaty.

Corneine is a compact hornblende rock of smooth fracture, extremely tough and sonorous when struck. The name is from the Latin for *horn.*

Diastatite. A hornblende from Wermland, differing a degree, according to Breithaupt, in the angle of the prism from hornblende. G.=3·09—3·1.

Uralite (from the Urals) has the cleavage structure and composition of hornblende, though the external form of augite, and is considered a pseudomorph. The two species are variously mingled in different specimens, showing the change in different stages of progress.

Analyses: 1, 2, 3, Bonsdorff, (Schw. J. xxxi, 414, xxxv, 123); 4, Seybert, (Am. J. Sci. vi, 333); 5, Damour, (Ann. Ch. Ph. [3], xvi); 5½, 6, Ramm., (5th Sup. 131, 1st Sup. 73); 7, Murray, (ib. 2d Sup. 60); 8, Bonsdorff; 9, T. S. Hunt, (Amer. J. Sci. [2], xii, 213, Phil. Mag. [4], i, 322); 10, Richter, (Pogg. lxxxiv, 367); 11, Vopelius, (Pogg. xxiii, 355); 12, 13, Thomson, (Rec. Gen. Sci. xvii); 14, Heintz, (Pogg. lviii, 168); 15, 16, Smith and Brush, (Am. J. Sci. [2], xvi, 48); 17, Kobell, (J. f. pr. Ch. xiii, 3); 18, Plantamour, (J. f. pr. Ch. xxiv, 300); 19, 20, Bonsdorff; 21, 22, 23, Hisinger, (Schw.

J. xxxi, 289); 24, Bonsdorff; 25, Arfvedson, (Jahresb. iv, 149); 26, Göschen, (Ramm. 2d Sup. 61); 27, Clausbruch, (Ramm. 1st Sup. 72); 27½, Kudernatsch, (Pogg. xxxvii, 585); 28, Rammelsberg, (Pogg. lxxxiii, 458); 29, 30, 31, Waltershausen, (Vulk. Gest. 111); 32, 33, Klaproth, (Beit. v, 150); 34, Hisinger.

I. *Tremolite and Actinolite, containing lime and magnesia, without alumina.*

		S⃛i	Ṁg	Ċa	Ḟe	Ṁn	Äl	
1.	Wermland, *white*,	59·75	25·00	14·11	0·50	——	*trace*	HF 0·94, Ḣ 0·10, B.
2.	Fahlun, “	60·10	24·31	12·73	1·00	0·47	0·42	“ 0·83, Ḣ 0·15, B.
3.	Taberg, *greenish*,	59·75	21·10	14·25	3·95	0·31	——	“ 0·76=100·12, B.
4.	Concord, Pa., *green*,	56·33	24·00	10·67	4·30	——	1·67,	Ḣ 1·03=100, Seyb.
5.	St. Gothard,	58·07	24·46	12·99	1·82	——	——	=97·34, Damour.
5½.	Gouverneur, N.Y. *wh.*	57·40	24·69	13·89	1·36	——	1·38,	Ḣ 0·40=99·12, R.
6.	*Kymatin, Asbestus*,	57·98	22·38	12·95	6·32	——	0·58	=100·21, Ramm.
7.	Taberg, “	59·50	19·30	12·65	8·60	——	——	=100·05, Murray.
8.	Tarentaise, “	58·20	22·10	15·55	3·08	0·21	0·14,	HF 0·66, Ḣ 0·14, B.
9.	*Raphilite*,	55·30	22·50	13·36	6·30	*trace*	0·40,	Ṅa 0·80, K̇ 0·25, ign. 0·30=99·31, Hunt.
10.	Reichenstein,	58·89	23·37	9·57	3·79	——	0·67,	Ḣ 3·60=99·89, Richter.

II. *Anthophyllite, containing magnesia and iron, without alumina.*

11.	Kongsberg,	56·74	24·35	——	13·94	2·38	——,	Ḣ 1·67=99·08, Vop.
12.	Perth, C. E.,	57·60	29·30	3·55	2·10	——	3·20,	Ḣ 3·55=99·30, Th.
13.	Tyrol, *Asbestus*,	54·92	26·08	——	12·60	——	1·64,	Ḣ 5·28=100·52, Th.
14.	Ural, “	59·23	31·02	——	8·27	——	0·19,	ign. 1·31=100, H.
15.	*Cummingtonite*,	51·09	10·29	*tr.*	32·07	1·50	0·95,	Ṅa 0·75, K̇ *tr.*, Ḣ 3·04 =99·69, S. & B.
16.	“	50·74	10·31	*tr.*	33·14	1·77	0·89	“ 0·54 K̇ *tr.*, Ḣ 3·04 =100·43, S. & B.

III. *Arfvedsonite, containing soda and iron, without alumina.*

17.	Greenland,	49·27	0·42	1·50	36·12	M̈n 0·62	2·00	Ṅa 8·00,[a] Cl 0·24, K.
18.	Brevig, *Ægirine*,	46·57	5·88	5·91	24·38	“ 2·07	3·41	“ 7·79, K̇ 2·96, T̈i 2·02, F. undermined=100·99, Plantamour.

[a] With trace of K̇.

IV. *Containing alumina, with lime and magnesia.*

19.	Aker, *Grammatite*,	47·21	21·86	12·73	2·28	0·57	13·94,	HF 0·9, Ḣ 0·44, B.

V. *Containing alumina, with iron, lime, and magnesia.* G. *of* 29=2·893; 31, 3·234.

20.	Pargas,	45·69	18·79	13·83	7·32	0·22	12·18,	HF 1·50=99·53, B.
21.	“	41·50	19·40	14·09	7·75	0·25	15·75,	Ḣ 0·5=97·24, H.
22.	Fahlun,	47·62	14·81	12·69	15·78	0·32	7·38	=98·60, Hisinger.
23.	Westmanland,	45·38	16·34	13·92	7·74	1·50	13·82,	Ḣ 0·23=98·92, H.
24.	Wetterau,	42·24	13·74	12·24	14·59	0·33	13·92	=97·06, Bonsd.
25.	Greenland, *Arfved.*	41·81	11·20	11·55	19·50	1·47	12·14	=97·67, Arfvd.
26.	Wolfsberg, Boh.	40·27	13·38	13·80	F̈15·34	——	16·36,	Ḣ 0·46=99·61, Gös.
27.	Carinthia, *Carin.*	46·03	18·48	10·23	Ḟ17·44	——	8·37	=100·55, Clausbruch.
27½.	*Uralite*,	53·03	12·90	12·47	16·37	——	4·56	=99·35, Kud.
28.	Härtlingen,	42·52	13·45	12·25	16·59	——	11·00,	Ṅa 1·71, K̇ 1·92, T̈i 1·01=100·45, R.
29.	Etna, V. d. Bove, *bk.*	43·84	11·70	12·05	21·79	——	9·27,	Ḣ 0·84=99·49, Walt.
30.	“ Mascali,	40·91	13·19	13·44	17·49	*tr.*	13·68	“ 0·85=99·56, Walt.
31.	“ Zoccolaro,	39·75	13·01	12·99	14·40	1·06	15·29	“ 1·02=97·52[b], Walt

[b] Probably 2 1-2 per cent. of alkali to be added, W.

VI. *Containing alumina, with iron and lime.*	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Fe}}$	$\dddot{\mathrm{Mn}}$	$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	
32. Westmanland,	42·00	2·25	11·00	30·00	0·25	12·00,	$\dot{\mathrm{H}}$ 0·75, $\dot{\mathrm{K}}$, *trace*=98·25, Klap.
33. Fuldaischen,	47·00	2·00	8·00	15·00	—	26·00,	$\dot{\mathrm{H}}$ 0·5=98·50, "
VII. *Containing alumina, with iron and magnesia.*							
34. Garpenberg,	53·50	11·35	4·65	22·52	0·35	4·40,	$\dot{\mathrm{H}}$ 0·6=97·10, His.

Cummingtonite is an anthophyllite variety containing largely of oxyd of iron resembling an asbestiform tremolite, often scopiformly arranged; color ash-gray, lustre silky. B.B. alone fuses with great difficulty. Formula, $(\frac{5}{8}\dot{\mathrm{F}}\mathrm{e}+\frac{3}{8}\dot{\mathrm{M}}\mathrm{g})^4\,\dddot{\mathrm{S}}\mathrm{i}^3$, Smith and Brush, (Anal. 15, 16.)

The analysis by Thomson, (Ann. Lyc. Nat. Hist. New York, iii, 50), referred by Shepard to *Boltonite*, is shown by B. Silliman, Jr., (Am. J. Sci. [2], viii, 391), to pertain probably to an actinolite from Bolton. The *Raphilite*, according to Hunt, has the augite oxygen ratio 2 : 1, (anal. 9).

The fluorine in many hornblendes is supposed to exist as fluorid of calcium, and this ingredient, according to Bonsdorff may constitute 1 part in 5 of the mineral.

B.B. the tremolite and pale varieties, containing no iron, fuse readily with intumescence to a glass nearly transparent to milk-white; and with borax form a transparent colorless glass. The lighter colored varieties containing iron, fuse alone with more or less difficulty to a dark yellowish glass, and with borax give a transparent glass, tinged with iron. The *darker green varieties* afford a deeper iron color. The hornblende, *containing alumina* and little iron, acts much like tremolite; but the black varieties fuse to a brilliant black bead, and the borax glass is tinged with iron. *Anthophyllite* fuses with great difficulty to a glass colored by iron. *Arfvedsonite* fuses readily with intumescence to a black magnetic globule.

Green or black hornblende is one of the constituents of syenite and greenstone, as well as hornblende rock and slate. Tremolite is most common in dolomite and granular limestone. Hornblende also occurs in granular limestone and in trachyte. Actinolite is found in the greatest perfection in talcose rocks. Asbestus often traverses serpentine rocks and granular limestones. Much of the so-called asbestus in serpentine is *Chrysotile.*

Aussig and Teplitz in Bohemia, Tunaberg in Sweden, and Pargas in Finland, afford fine specimens of the dark colored hornblendes. Actinolite occurs at Saltzburg and Greiner, in the Zillerthal; Tremolite at St. Gothard, in granular limestone or dolomite, the Tyrol, the Bannat, Gulsjö in Sweden, &c. *Calamite* occurs at Normarken in Sweden, in prisms in serpentine. Asbestus is found in Savoy, Saltzburg, the Tyrol; also in the island of Corsica, where it is so abundant that Dolomieu employed it in packing his minerals. Rock cork is obtained in Saxony, Portsoy, and Leadhills, where also mountain leather occurs. Oisans, in France, affords a variety of amianthus, composed of fibres having some degree of elasticity; it is the *amianthoide* of Haüy. *Anthophyllite* comes from Kongsberg, Norway, &c.

Arfvedsonite was brought first from Greenland, where it is associated with sodalite. It occurs also at Fredericksvärn, in Norway.

In the United States, black crystals of hornblende occur at Franconia, N. H.; at Chester, Mass.; at Thomaston, Me.; at Moultonboro', Me., in Syenite; at Willsboro', N. Y., presenting interesting crystalline forms; also near the bridge at Potsdam, St. Lawrence Co., N. Y.; near Greenwood Furnace, and in Warwick, Orange Co., N. Y. (f. 365.) Crystals of a dark green color occur near Two Ponds, and also a mile north, two and a half miles north, and a mile south of Edenville, together with gray or hair brown crystals and tremolite, sphene, and chondrodite, in granular limestone. Near Amity, hornblende occurs of various forms and colors, and often in large and perfect crystals: in dark green crystals, with ilmenite, at the Stirling mines, Orange Co.; at Gouverneur, in short green crystals, sometimes two or three inches in diameter, along with apatite; in Rossie, two miles north of Oxbow, the variety pargasite in neat bright green crystals. Pargasite occurs also at Phipsburg and Parsonsfield, Me. Gray hornblende or tremolite in good crystals is found at Bryam, N. J., and other varieties at Franklin and Newton of the same State.

Large flattened crystals of a white color abundant in dolomite at Canaan, Conn., between the falls and the post office, and other places in Litchfield Co.; also at Lee (one and a half miles southwest of the meeting house) and Newberg, Mass.; in Diana, Lewis Co., N. Y. Glassy actinolite in good specimens occurs in the steatite quarries of Windham, Readsboro' and New Fane, Vt., and at Middlefield and Blanford, Mass.; also near a hamlet called Pecksville, in Fishkill, N. Y. Radiated or asbestiform actinolite at the same localities; at Unity, Me.; at Brown's serpentine quarry, 3 miles N. W. of Carmel, Putnam Co., N. Y.; at Franklin, N. J.; at Carlisle, Pelham, and Windsor, Mass.; in Buckingham Co., Willis's Mt., Va. Actinolite occurs also in Pennsylvania, in Providence, Mineral Hill, Delaware Co.; at Unionville; at Kennett, Chester Co., often in fine crystals; radiated and asbestiform tremolite abundant in the dolomite of New England and New York; at Thomaston and Raymond, Me.; Lee and Great Barrington, Mass.; in New York at Dover, Kingsbridge, the Eastchester quarries, at Hastings and near Yonkers in Westchester Co.; at Knapp's quarry, Patterson, and on the banks of Yellow lake and elsewhere in St. Lawrence Co., N. Y. The same varieties occur at Franklin, N. J.; in Pennsylvania, at Chesnut Hill, near the Wissahiccon; near Philadelphia, at London Grove, Chester Co.; at the Bare Hills, Md.

Asbestus is met with at many of the above localities; at West Farms, Winchester, Wilton, and Milford, Conn.; at Brighton, Sheffield, Pelham, Newbury, and Dedham, Mass.; in New York, near Greenwood Furnace, Roger's farm in Patterson, Colton rock and Hustis's farm in Phillipstown, (both asbestus and amianthus), near the quarantine, Richmond Co., asbestus with the fibres between two and three feet in length; at Chesnut Hill, Penn.; Cooptown and Bare Hills, Md.; and Barnet's Mills, Fauquier Co., Virginia. Mountain leather occurs at the Milford quarries, Conn., also at Brunswick, New Jersey.

Cummingtonite is from Cummington and Plainfield, Mass.

A variety of hornblende, on the island of Corsica, admits of a high polish, and is the *Verde de Corsica duro.* Asbestus was manufactured into cloth by the ancients, who were acquainted with its incombustibility. This cloth was sometimes the material for napkins; which could be cleansed by throwing them into the fire. This material was also employed for the wicks of lamps in the ancient temples, and it is now used for the same purpose by the natives of Greenland. The name *amianthus* was applied to it because of the simplicity of the means of restoring it, when soiled, to its original purity. The best United States locality for collecting it for this purpose is near the quarantine, Richmond Co., New York. It is extensively used in making safes.

GEDRITE.—Resembles anthophyllite. Dufrénoy obtained $\ddot{Si}$ 38·81, $\ddot{\bar{Al}}$ 9·31, $\dot{Fe}$ 45·83, $\dot{Mg}$ 4·13, $\dot{Ca}$ 0·67, $\dot{H}$ 2·30. From Gedré in the Pyrenees.

ALTERED FORMS.—Alterations of Hornblende are mostly like those of Augite. Varieties often contain some water from hydration, (as in analyses 10, 12, 13, etc.) especially asbestiform or anthophyllite varieties. The ferruginous change by oxydation is common; and all varieties are exposed to alteration from infiltrating waters holding carbonates, silicates, etc., in solution, thus giving rise to magnesian, ferruginous, magnesio-ferruginous, (chlorite), alkaline, or aluminous forms. Beck has analyzed hornblende pseudomorphs from Warwick, N. Y., (Am. J. Sci. xlvi, 25); and Rammelsberg, another from Madrell, (Pogg. lxii, 142, and 2nd Suppl. 61.)

The so-called *Hydrous anthophyllite* of Thomson (from New York Island) is an altered asbestiform tremolite. Fresh specimens afforded Smith and Brush as the mean of two analyses, (Am. J. Sci. [2], xvi, 49), $\ddot{Si}$ 58·43, $\dot{Mg}$ 29·34, $\dot{Fe}$ 8·76, $\dot{Na}$ 0·88, $\dot{K}$ *tr.*, ignition 2·26, $\ddot{\bar{Al}}$ *tr.* =99·67, corresponding to the hornblende formula. Thomson found 11·45 per cent. of water, (Min. i, 209). It occurs also in Scotland.

Talc, steatite, serpentine, chlorite, mica, pinite, chabasite, limonite, magnetite, occur as hornblende pseudomorphs. Chabasite, as Bischof observes, has the same oxygen ratio for the bases and silica as hornblende; but part of the protoxyd of hornblende (the magnesia) is removed and alumina substituted, probably through the results of the decomposition of feldspar in progress at the same time.

Groppite, and perhaps *Rosite,* as L. Saemann has suggested to the author, may be altered Pargasite.

NEPHRITE. Jade. Beilstein.—A hard compact, light green, bluish, or whitish stone, translucent, tough, breaking with a splintery fracture and glistening surface; but varying in composition, and not a distinct mineral. G.=2·9—3·1. H.=6—7.

Composition.—Analyses: 1, Kastner, (Gehlen's J. ii, 459); 2, Rammelsberg, (1st Supp. 105, Pogg. lxii, 148); 3, 4, Schafhäutl, (Ann. d. Ch. u. Pharm., xlvi, 338); 5, 6, Damour, (Ann. Ch. Phys. [3], xvi):

	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Fe}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dddot{\overline{\mathrm{Fe}}}$	
1.	50·50	31·00	——	——	10·00	5·50,	$\dddot{\overline{\mathrm{Cr}}}$ 0·05, $\dot{\mathrm{H}}$ 2·75=99·80, Kastner.
2.	54·68	26·01	16·06	2·15	——	——,	$\dot{\mathrm{Mn}}$ 1·39, loss ign. 0·68=100·97, Ramm.
3.	58·91	22·42	12·28	——	1·32	2·70,	$\dddot{\overline{\mathrm{Mn}}}$ 0·91, $\dot{\mathrm{K}}$ 0·80, $\dot{\mathrm{H}}$ 0·25=99·60, Sch.
4.	58·88	22·39	12·15	——	1·56	2·81,	$\dddot{\overline{\mathrm{Mn}}}$ 0·83, $\dot{\mathrm{K}}$ 0·80, $\dot{\mathrm{H}}$ 0·27=99·70, Sch.
5.	58·46	27·09	12·06	1·15	——	——	=98·76, Damour.
6.	58·02	27·19	11·82	1·12	——	——	=98·15, Damour.

Damour's nephrite—white oriental specimens—affords the composition of tremolite—$\dot{\mathrm{Ca}}\,\dddot{\mathrm{Si}}+\dot{\mathrm{Mg}}^3\,\dddot{\mathrm{Si}}^2$. Schafhäutl obtained a similar result. Rammelsberg's specimen, as he states, approaches augite. B.B. fuses with difficulty on the thinnest edges; sometimes more easily to a gray mass or white enamel. It is found in connection with talcose rock or slate, and granular limestone.

Nephrite is worked into images and ornaments in China, New Zealand, and Northwest America. The name is from νεφρος, *kidney;* it was supposed to be a cure for diseases of the kidney. The so-called *Nephrite* of Smithfield, Rhode Island, named Bowenite, is identical with Serpentine in composition.

ACMITE, *Haidinger*, Akmite. Achmite.

Monoclinic, and like augite. *I* : *I*=86° 56′, *I* : *ii*=133° 28′, *a* : *a*=119° 30′, *a* : *ii*=103° 47′. Cleavage: *I* distinct; lateral less so. Plane *ii* often longitudinally striated. Twins: face of composition parallel to *ii*, common.

H.=6. G.=3·2—3·53; 3·43, Ramm. piece of a crystal; 3·53, same pulverized. Lustre vitreous, inclining to resinous. Streak pale yellowish-gray. Color brownish or reddish-brown; in the fracture blackish-green. Opaque. Fracture uneven—earthy. Brittle.

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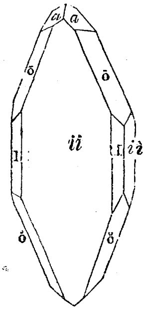

Composition.—$(\dot{\mathrm{Na}}+\dddot{\overline{\mathrm{Fe}}})\,\dddot{\mathrm{Si}}^3\ (=\dot{\mathrm{Na}}\,\dddot{\mathrm{Si}}+\dddot{\overline{\mathrm{Fe}}}\,\dddot{\mathrm{Si}}^2)$=Silica 55·07, peroxyd of iron 32·4, soda 12·6. Analyses: 1, Berzelius, (K. V. Ac. H. 1821, p. 160); 2, Lehunt, (Thomson's Min. i, 480):

	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Fe}}}$	$\dddot{\overline{\mathrm{Mn}}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{Ca}}$	
1.	55·25	31·25	1·08	10·40	0·72	titanic acid, *trace*=98·70, Berzelius.
2.	56·02	28·08	$\dot{\mathrm{Mn}}$3·49	13·33	0·89	$\dot{\mathrm{Mg}}$ 0·50, $\dddot{\overline{\mathrm{Al}}}$ 0·69=98·98, Lehunt.

Rammelsberg in analyses directed towards determining the condition of the iron, found 33·25—35·5—35·85—34·44 *peroxyd* of iron, and with the last, 54·13 silica.

B.B. readily fuses to a black bead, which is magnetic. Affords an iron-colored glass with borax; a silica skeleton with salt of phosphorus. With soda on platinum gives a manganese reaction. In powder partly decomposed by acids.

Acmite occurs at Rundemyr, about four miles north of Dunserud, near Kongsberg in Norway, nearly a foot long, imbedded in feldspar and quartz; the crystals are often macled and bent, and quite fragile.

Named from ακμη, *a point,* in allusion to the pointed extremities of the crystals.

G. Rose suggests that Acmite as hitherto observed, is probably in a somewhat altered condition, and that possibly the Ægirine of Brevig is Acmite in an unchanged state, (Kryst. Chem. Min., 1852, p. 76).

WICHTYNE, *Laurent.* Wichtisite, *Hausmann.*

Massive; cleavage parallel to the sides of a rhombic prism, nearly rectangular, according to Laurent.

Scratches glass. G.=3·03. Color black. Lustre dull. Fracture angular, or flat conchoidal.

Composition.—$(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\ddot{\bar{\mathrm{R}}})\,\dddot{\mathrm{Si}}^2$. Analysis by Laurent, (Ann. Ch. Phys. lix, 109):

$\dddot{\mathrm{Si}}$ 56·3, $\ddot{\bar{\mathrm{Al}}}$ 13·3 $\ddot{\bar{\mathrm{Fe}}}$ 4·0 $\dot{\mathrm{Fe}}$ 13·0 $\dot{\mathrm{Ca}}$ 6·0 $\dot{\mathrm{Mg}}$ 3·0 $\dot{\mathrm{Na}}$ 3·5=99·1.

B.B. fuses to a black enamel and becomes magnetic. Not attacked by acids.

From Wichtis in Finland. Dufrénoy observes that a specimen examined by him had no cleavage.

Glaucophane, Hausmann. Probably same as Wichtyne. Trimetric or monoclinic. In indistinct long thin six-sided prisms, made up of the planes *I* and *iĭ*, and longitudinally striated. Also granular massive. H.=5·5. G.=3·108. Color blue, lavender-blue, bluish-black, grayish. Streak-powder grayish-blue. Lustre vitreous to pearly. Translucent to opaque. Brittle. Powder slightly magnetic.

Composition.—$(\frac{3}{5}\dot{\mathrm{R}}^3+\frac{2}{5}\ddot{\bar{\mathrm{R}}})\,\dddot{\mathrm{Si}}^2$; or if the iron be partly peroxyd (5·4 $\ddot{\bar{\mathrm{Fe}}}$, 6·0 $\dot{\mathrm{Fe}}$) $(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\ddot{\bar{\mathrm{R}}})\,\dddot{\mathrm{Si}}^2$, like Wichtyne, Kengott. Analysis by Schnedermann, (J. f. pr. Chem. xxxiv, 238):

$\dddot{\mathrm{Si}}$ 56·49, $\ddot{\bar{\mathrm{Al}}}$ 12·23, $\dot{\mathrm{Fe}}$ 10·91, $\dot{\mathrm{Mn}}$ 0·50, $\dot{\mathrm{Mg}}$ 7·97, $\dot{\mathrm{Ca}}$ 2·25, $\dot{\mathrm{Na}}$ with *trace* $\dot{\mathrm{K}}$ 9·28=99·63.

B.B. becomes yellowish-brown, and melts easily and quietly to an olive-green glass. An iron reaction with the fluxes. In acids, partly soluble.

Occurs at the island of Syra, one of the Cyclades, in mica slate, along with garnet, hornblende, and mica. The name is from *γλαυκος*, bluish-green, and *φαινω*, to appear.

Violan of Breithaupt, (J. f. pr. Chem. xv, 321), resembles Glaucophane. It occurs massive with the cleavage of a rhombic prism. G.=3·233; H.=6. Lustre waxy. Color dark violet-blue. B.B. fuses to a clear glass; with borax in the outer flame a brownish-yellow glass, violet-red when cold; in the inner flame a yellow glass, colorless when cold. Found with Manganesian epidote at St. Marcel in Piedmont. Named from its color.

Sordawalite, *Nordenskiöld's* Bidrag, p. 86.—Massive; no cleavage apparent. H.=2·5. G.=2·53—2·58. Lustre vitreo-resinous, or like bitumen. Streak liver-brown. Color grayish or bluish-black. Opaque. Fracture conchoidal. Brittle.

Composition.—Analysis by Nordenskiöld,

$\dddot{\mathrm{Si}}$ 49·4, $\ddot{\bar{\mathrm{Al}}}$ 13·8, $\dot{\mathrm{Fe}}$ 18·17, $\dot{\mathrm{Mg}}$ 10·67, $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 2·68, $\dot{\mathrm{H}}$ 4·38=99·10.

Supposed by Berzelius to be a mixture of a silicate and phosphate, the silicate corresponding to $(\frac{1}{2}(\dot{\mathrm{Mg}}, \dot{\mathrm{Fe}})^3+\frac{1}{2}\ddot{\bar{\mathrm{Al}}})\,\dddot{\mathrm{Si}}^2$), which is essentially the formula of Wichtyne.

B.B. alone, it is difficultly fusible to a blackish globule. With borax it forms a green glass. Partly soluble in muriatic acid. Becomes reddish on exposure to the atmosphere.

Forms thin layers on trap, near the town of Sordawala in Finland; at Bodenmais in Bavaria, it is associated with magnetic pyrites. It resembles pit-coal in appearance.

Tachylyte. *Hyalomelan.*—Massive or in plates. No cleavage. H.=6·5. G.=2·5—2·54. Lustre vitreous to greasy. Color velvet-brown—black. Opaque. Fracture small conchoidal.

Composition.—Analysis by Gmelin, of the variety from Vogelsgebirge:

$\dddot{\mathrm{Si}}$	$\ddot{\mathrm{Ti}}$	$\ddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{H}}$ & Am
50·22	1·42	17·84	10·27	8·25	3·37	5·18	3·87	0·40	0·50=101·31,

leading to the formula $(\frac{1}{2}\dot{R}^3+\frac{1}{3}\ddot{\text{Al}})\,\dddot{\text{Si}}^{\frac{3}{2}}$. But the species is probably bad. It was named from *ταχυς, quick, λυω, to dissolve* or to fuse. A similar mineral from Säsebühl near Dransfeld, afforded Schnedermann,

$\dddot{\text{Si}}$ 55·74, $\ddot{\text{Al}}$ 12·40, $\dot{\text{Fe}}$ 13·06, $\dot{\text{Mg}}$ 6·92, $\dot{\text{Na}}$ 3·88, $\dot{\text{K}}$ 0·60, $\dot{\text{Mn}}$ 0·19, $\dot{\text{H}}$ 2·73=99·80.

B.B. melts easily with intumescence to a brown slag or opaque glass.

Occurs at Säsebühl in basalt and wacke, and resembles obsidian or gadolinite in external characters: also at Vogelsgebirge; sp. gr. of this variety, (called *Hyalomelan* [fr. *υαλος, glass, μελας, black*] by Hausmann), 2·7144. (*Breithaupt*, Kastner's Archiv. vii, 112. *Gmelin*, Pogg. xlix, 233).

On the north shore of Lake Superior occurs a mineral resembling Tachylyte; also in a trap dyke at Johnsburg, Warren Co., New York

BABINGTONITE, *Levy*, Ann. Phil. 2d ser. vii, 275.

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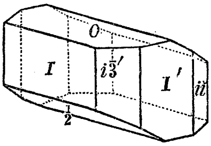

Triclinic. Observed planes as in the annexed figure, $O : I$=92° 34′, $O : I'$=88°, $O : \frac{1}{2}$=150° 25′, $I : I'$=112°30′, $I : \breve{i}\breve{i}$=132° 15′, $I' : \breve{i}\breve{i}$=115° 15′, $I' : i\bar{3}'$=155° 25′, $I : i\bar{3}'$=137° 5′, $\breve{i}\breve{i} : i\bar{3}'$ (over I)=90° 40′. Levy.

H.=5·5—6. G.=3·35—3·5. Lustre vitreous, splendent. Color dark greenish-black; thin splinters green in the direction of O, and brown transversely. Faintly translucent; large crystals, opaque, or faintly subtranslucent. Fracture imperfectly conchoidal.

Composition.—$(\dot{\text{Ca}}, \dot{\text{Fe}})^6\dddot{\text{Si}}^5$. Analyses: 1, Arppe, (Berz. Jahresb. xxii, 205); 2, R. D. Thomson, (Phil. Mag. xxvii, 123):

	$\dddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\ddot{\text{Al}}$
1.	54·4	2·2	19·6	21·3	1·8	0·3 ign. 0·9=100·5, Arppe.
2.	47·46	2·21	14·74	16·81	10·16	6·48 ign. 1·24=99·10, Thomson.

Reckoning the alumina with the silica, the two analyses essentially agree; but the mineral requires further investigation. G. of No. 2=3·355.

B.B. fuses easily to a black magnetic bead. With borax affords a clear amethystine globule, which becomes green in the reducing flame.

Babingtonite occurs in distinct crystals at Arendal, in Norway, associated with epidote and massive garnet, and in the Shetland Isles, imbedded in white quartz. It was named after Dr. Babington; it resembles some dark varieties of pyroxene.

In the United States it is said to coat crystals of feldspar, at Gouverneur, St. Lawrence Co., N. Y.

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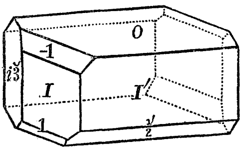

Small black polished crystals coating mica slate, or micaceous gneiss, at Athol, Mass., (fig. annexed), have been referred here by Shepard. The author's measurements give the following approximate angles, $O : I$=90°—91°, $O : I'$=85°, $O : \frac{1}{2}'$=153° 20′, $I : I'$=110° 30′ and 69° 30′, $I : i\breve{3}$=129°, $I' : i\breve{3}$=120° 30′, $O : -1$=135° 40′, $O : 1$=135° 30′, $O : i\breve{3}$=95° 30′, $I : \frac{1}{2}$=95° 30′.

BERYL. Emerald. Aquamarine. Smaragd. Emeraude, *H.* Davidsonite, *Richardson.* Goshenite, *Shepard.*

Hexagonal. $O : 1$=150° 3′: a=0·499.

$O : \frac{3}{2}$=139° 10′.
$O : 2$=130° 58′.
$O : 2\frac{8}{7}$=130° 58′.
$O : 12$=116° 37′.
$O : 22$=135° 4′.
$O : I$=90°.
$I : 3\frac{3}{2}$=142° 11′.
$I : 8\frac{8}{7}$=165° 30′.
$I : I$=120°.

Cleavage: basal imperfect; lateral, indistinct. Ocasionally coarse columnar and large granular.

O			
1			12
$\frac{3}{2}$			
2	$2\frac{8}{7}$		22
		$3\frac{3}{2}$	
$\frac{15}{2}$			
	$8\frac{8}{7}$		
I		$i\frac{3}{2}$	$i2$

Observed Planes.

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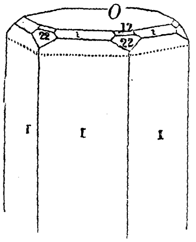

Haddam, Ct.

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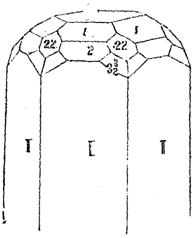

Siberia.

H.=7·5—8. G.=2·732, emerald, Haidinger; 2·678, apple-green. Lustre vitreous; sometimes resinous. Color pale green, emerald-green, passing into light-blue, impure yellow and white. Streak white. Transparent—subtranslucent. Fracture conchoidal, uneven. Brittle.

Composition.—$(\frac{1}{2}\bar{\dddot{\text{Be}}}+\frac{1}{2}\bar{\dddot{\text{Al}}})\,\dddot{\text{Si}}^2$=Silica 66·9, alumina 19·0, glucina 14·1=100. Analyses: 1, Du Menil, (Schw. J. xxxix, 487); 2, Berzelius, (Schw. J. xvi, 265, 277); 3, Klaproth, (Beit. iii, 215); 4, Moberg, (Acta Soc. Sci. Fenn. ii, 81); 5, Schlieper, (Ramm. 2d Supp. 34); 6, Bornträger, (Jahrb. Min. 1851, 185); 7, J. W. Mallet, (Am. J. Sci. [2], xvii, 180):

		$\dddot{\text{Si}}$	$\bar{\dddot{\text{Al}}}$	$\bar{\dddot{\text{Fe}}}$	$\bar{\dddot{\text{Be}}}$
1.	Siberia, *Beryl*,	67·00	16·50	1·00	14·50, $\dot{\text{Ca}}$ 0·50=99·50, Du Menil.
2.	Broddbo, "	68·35	17·60	0·72	13·13, $\bar{\dddot{\text{Ta}}}$ 0·72=100·52, Berzelius.
3.	*Emerald*,	68·50	15·75	1·00	12·50 $\bar{\dddot{\text{Cr}}}$ 0·30, $\dot{\text{Ca}}$ 0·25=98·30, Klaproth.
4.	" Finland,	67·359	16·465	1·497	12·747, $\bar{\dddot{\text{Ta}}}$ 0·280=98·348, Moberg.
5.	" S. Amer.	69·51	14·49	——	15·41, $\dot{\text{Mg}}$, $\dot{\text{Ca}}$ 1·64=101·05, Schlieper.
6.	*Beryl*, Hirschgasse,	66·90	18·15	2·95	12·20=100·20, Bornträger.
7.	" Goshen,	66·97	17·22	2·03	12·91, $\bar{\dddot{\text{Mn}}}$ *tr.*=99·13, Mallet.

Other analyses: Mallet, (Ramm. 5th Suppl. 66); W. Mayer, (Jahrb. Min. 1851, 185, and Lieb. Kopp, 1851, 779); Müller, (J. f. pr. Ch. lviii, 180).

B.B. alone unchanged or becomes clouded; at a high temperature the edges are rounded, and ultimately a vesicular scoria is formed. Glass with borax, clear and colorless for beryl, a fine green for emerald. Slowly soluble with salt of phosphorus without leaving a siliceous skeleton. A yellowish variety from Broddbo and Finbo yields with soda, traces of tin.

Emerald and beryl are varieties of the same species, the former including the rich green transparent specimens, which owe their color to oxyd of chrome, the latter, those of other colors. Fine emeralds are found in a vein of dolomite, which traverses a hornblende rock at Muzo, north of Santa Fé de Bogota.* A perfect hexagonal crystal from this locality, two inches long, is in the cabinet of the Duke of Devonshire; it measures across its three diameters $2\frac{1}{4}$ in., $2\frac{1}{5}$ in., $1\frac{7}{8}$ in., and weighs 8 oz. 18 dwts; owing to flaws, it is but partially fit for jewelry. A more splendid specimen, though somewhat smaller, weighing but 6 oz., is in the possession of Mr. Hope, of London. It cost £500. Emeralds of less beauty, but much

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* M. Lewy states that the rock is a black limestone, some parts of which contain fossils.

larger, occur in Siberia. One specimen in the Royal collection measures 14½ inches long and 12 broad, and weighs 16¾ pounds troy; another is 7 inches long and 4 broad, and weighs 6 pounds troy. Mount Zalora, in Upper Egypt, affords a less distinct variety, and was the only locality which was known to the ancients. Other localities are Canjargum in Hindostan, and Salzburg, where it is imbedded in mica slate.

Pliny speaks of the finest beryls as those "qui viriditatem puri maris imitantur,"—*green like the sea,*—and crystals of clear shades of sky-blue, or mountain-green, are hence termed *aquamarine.* This variety is found in Siberia, Hindostan, and Brazil. In Siberia they occur in the granite district of Nertschinsk, and in the Uralian and Altai ranges of Siberia. They have been obtained exceeding a foot in length, and are commonly striated longitudinally. The most splendid specimen of this variety of which we have any account, belongs to Don Pedro. It approaches in size, and also form, the head of a calf, and exhibits a crystalline structure only on one side; the rest is water-worn. It weighs 225 ounces troy, or more than 18½ pounds. The specimen is transparent, and without a flaw. Less clear crystals of beryl occur at the Mourne mountains, Ireland, county Down; rarely at Cairngorum in Aberdeenshire; at Limoges in France; Finbo and Broddbo in Sweden; Pfitscher-Joch, Tyrol; Bodenmais and Rabenstein in Bavaria, tin mines of Schlackenwald, also in Australia, and elsewhere.

Beryls of gigantic dimensions have been found in the United States, at Acworth and Grafton, N. H., and Royalston, Mass. One beryl from Grafton, N. H., weighs 2900 pounds; it is 32 inches through in one direction and 22 in another transverse, and is 4 feet 3 inches long. Another crystal from this locality, according to Prof. Hubbard, measures 45 inches by 24 in its diameters, and a single foot in length, by calculation weighs 1076 lbs., making it in all nearly 2½ tons. At Royalston, one crystal exceeded a foot in length. The smaller crystals are often limpid and a yellowish variety, forms a gem resembling chrysolite; the colors are mostly aquamarine, grass-green, and yellowish-green; one locality is in the southeast part of Royalston, near the school-house, on the land of Mr. Clarke; the best crystals are imbedded in quartz. A still better is situated 4 miles beyond the old one in South Royalston; some crystals of a sky-blue color in white quartz are beautiful. At Barre, Mass., there is a similar locality, though less remarkable; also at Pearl Hill, in Fitchburg, Goshen, and Chesterfield, Mass. At Compton, N. H., the beryls are as fine as at Royalston. Albany, in Maine, and Norwich, a few miles above Bethel, towards Waterford, afford fine large beryls with green and black tourmalines; crystals, often large, are also obtained at Streaked Mountain, with black tourmaline and mica; at Bowdoinham and Topham of a pale green or yellowish white color in veins of graphic granite; at Georgetown, Parker's Island, at the mouth of the Kennebec; at Wilmot, N. H.; with modified terminations, (f. 369), at Haddam, Conn., in a feldspar vein in gneiss, on the east side of the river; the crystals are limpid at the extremity for about a twelfth of an inch, as indicated by the dotted line in f. 369; the chrysoberyl locality affords less interesting specimens; also the Middletown feldspar quarry, and the granite of Chatham, near the cobalt mine. At Monroe, Conn., beryl occurs in a granite vein, and the crystals often consist naturally of several pieces separated by plates of quartz, (f. 194). Crystals, sometimes 10–12 in. long and 1½ in. in diameter, occur with black tourmalines at Leiperville and Chester, Penn., Delaware Co.; also less interesting at Mineral Hill.

The emerald derives its color from the presence of a minute quantity of oxyd of chrome, and beryl from oxyd of iron.

The species *Dioptase* and *Pyrosmalite* are homœomorphous with Beryl, and have the same oxygen ratio between the bases and silica, if the water and chlorine be excluded.

Altered Forms.—Kaolin, Mica, Limonite and Quartz, occur as pseudomorphs after Beryl, the last two by substitution, the others by alteration. The change to Kaolin is the same essentially as in feldspar. An altered beryl, from Tirschenreuth afforded H. Müller, (J. f. pr. Chem. lviii, 182), $\dddot{\mathrm{Si}}$ 58·8, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 24·7, $\dddot{\bar{\mathrm{B}}}\mathrm{e}$ 10·2, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 2·6, $\dot{\mathrm{H}}$ 2·5.

EUDIALYTE, *Stromeyer*. Eudyalite, *improper orthography*.

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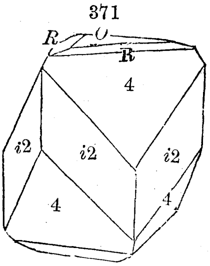

Rhombohedral. *R* : *R*=126° 25′, *O* : *R*=148° 38′; *a*=0·52793. Observed planes: rhombohedrons 1(*R*), 4, 1, –8, –2; scalenohedrons, 4^2, 4^3; prism *i*2.

O : 4=112° 18′. *i*2 : 4^3=166° 1′.
O : *i*2=90°. *i*2 : 4=143° 15′.
O : 2=129° 22′. 4 : 4=73° 30′.

Cleavage *O*, very perfect, *R*, imperfect. Also massive.

H.=6. G.=2·9036; 2·898, Levy. Lustre vitreous. Color brownish-red; streak uncolored. Opaque to slightly translucent. Fracture subconchoidal or splintery.

Composition.—$(\frac{2}{3}\dot{\text{R}}^3+\frac{1}{3}\ddot{\bar{\text{Z}}}\text{r})\dddot{\text{Si}}^2=2\dot{\text{R}}^3\dddot{\text{Si}}^2+\ddot{\bar{\text{Z}}}\text{r}\,\dddot{\text{Si}}^2$, Ramm. Analyses: 1, Pfaff, (Schw. J. xxix, 1); 2, 3, Stromeyer, (Gilb. Ann. lxiii, 379); 4, Rammelsberg, (Pogg. lxiii, 142):

	$\dddot{\text{Si}}$	$\ddot{\bar{\text{Z}}}\text{r}$	$\dddot{\bar{\text{F}}}\text{e}$	$\dddot{\bar{\text{M}}}\text{n}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	
1.	54·10	11·58	7·86	2·93	10·80	11·40,	HCl 0·30, $\dot{\text{H}}$ 1·66, $\dot{\text{Cu}}$ 0·92=101·55, Pfaff.
2.	53·33	11·10	6·75	2·06	9·78	13·82,	" 1·03, " 1·80=99·68, Stromeyer.
3.	52·48	10·90	6·86	2·57	10·14	13·92,	" 1·03, " 1·80=99·71, "

Rammelsberg makes the iron and manganese protoxyd, and thus gives

	$\dddot{\text{Si}}$	$\ddot{\bar{\text{Z}}}\text{r}$	$\dddot{\bar{\text{F}}}\text{e}$	$\dot{\text{Mn}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	
3, bis.	52·48	10·80	6·16	2·31	10·14	13·92,	Cl 1·00, ign. 1·80=98·70, Stromeyer.
4.	49·92	16·88	6·97	1·15	11·11	12·28,	$\dot{\text{K}}$ 0·65, Cl 1·19, ign. 0·37=100·52, R.

B.B. fuses to a grayish-green scoria or opaque glass. Intumesces and forms a pearl with salt of phosphorus. When pulverized, gelatinizes with acids.

Found at Kangerdluarsuk, in West Greenland, associated with arfvedsonite and sodalite, or imbedded in compact white feldspar. Crystals usually small, but sometimes an inch or more in length. The name alludes to its easy solubility in acids, from *εὖ*, *easily*, and *διαλυω*, *to dissolve*.

III. EULYTINE SECTION.

Oxygen ratio 1 : $1\frac{1}{2}$.

EULYTINE GROUP. Monometric. EULYTINE, $\text{Bi}\,\dddot{\text{Si}}^{\frac{3}{2}}$.

LEUCOPHANE GROUP. Trimetric? LEUCOPHANE $(\frac{1}{2}\dot{\text{Ca}}^3+\frac{1}{2}\ddot{\text{B}}\text{e})\dddot{\text{Si}}^{\frac{3}{2}}+\frac{1}{2}\text{NaF}$.

EULYTINE, *Breit.* Bismuth Blende. Kieselwismuth. Silicate of Bismuth, *Thom.*

Monometric: tetrahedral. Usually in minute crystals and edges often rounded, figs. 59, 61. Observed planes, 1, *O*, 22. Cleavage: dodecahedral, very imperfect. Twins: plane of compostion parallel to a dodecahedral face. Sometimes globular, and columnar, lamellar, or granular.

H.=4·5. G.=5·912—6·006. Lustre resinous or adamantine. Color dark hair-brown, yellowish-gray, grayish-white, and straw-yellow. Streak yellowish-gray or uncolored. Subtransparent—opaque. Fracture uneven. Rather brittle.

Composition.—$\dddot{\bar{\mathrm{Bi}}}^2\dddot{\mathrm{Si}}^3$, with some phosphate and fluorid of iron, Frankenheim. Analysis by Kersten, (Pogg. xxvii, 81):

$\dddot{\bar{\mathrm{Bi}}}$ 69·38, $\dddot{\mathrm{Si}}$ 22·23, $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 3·31, $\dddot{\bar{\mathrm{Fe}}}$ 2·40, $\dddot{\bar{\mathrm{Mn}}}$ 0·30, HF and $\dot{\mathrm{H}}$ 1·01=98·6.

The loss includes some HF. In a matrass decrepitates, and affords a trace of water. B.B. fuses to a dark-yellow mass, and gives out inodorous fumes. Fuses and froths on charcoal, staining it yellowish-brown, sometimes with a tinge of green. Fuses readily with soda, to a button, at first greenish-yellow, and then reddish-yellow, and finally affords metallic bismuth. With salt of phosphorus, it fuses to a yellow globule, with a silica skeleton, which becomes colorless on cooling.

Found near Schneeberg, Saxony, in quartz, and at Bräunsdorf, near Freiberg.

Atelesite.—Breithaupt thus names small monoclinic crystals containing bismuth, occurring at Schneeberg, with Bismuth Blende; they have a sulphur yellow color and adamantine lustre.

HYPOCHLORITE, Schüler, (Grüne Eisenerde). Minute crystalline. H.=6. G.=2·9—3. Lustre vitreous, feeble color, green. Streak light green. Brittle; fracture even to flat conchoidal.

Composition.—Analyses by Schüler:—

$\dddot{\mathrm{Si}}$ 50·24 $\dddot{\bar{\mathrm{Al}}}$ 14·65 $\dddot{\bar{\mathrm{Bi}}}$ 13·03 $\dot{\mathrm{Fe}}$ 10·54 $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 9·62 Mn *tr.*

or perhaps a mixture of a silicate of bismuth and iron, and a phosphate of alumina.

B.B. grows dark, but infusible; a yellow deposit on the coal. Insoluble in acids.

In minute crystals and grains, or massive and earthy, at Schneeberg, Johanngeorgenstadt, and Bräunsdorf in Saxony.

LEUCOPHANE, *Esmark*, Berz. Jahresbericht, xx and xxi. Leucofanite.

Trimetric, (Descl.) Cleavage: imperfect in three directions inclined to one another at angles of 53½° and 36½°. Usually massive and columnar.

H.=3·5—4. G.=2·974. Lustre vitreous on a cleavage surface. Color pale dirty green to wine-yellow; thin fragments transparent and colorless. Powder white, and strongly phosphorescent, whether heated or struck. Electric when heated. Optically biaxial, (Descl.)

Composition.—$(\tfrac{1}{2}\,\dot{\mathrm{Ca}}^3+\tfrac{1}{2}\,\dddot{\bar{\mathrm{Be}}})\dddot{\mathrm{Si}}^{\frac{3}{2}}+\tfrac{1}{2}\mathrm{Na\ F}=\dot{\mathrm{Ca}}^3\ \dddot{\mathrm{Si}}^2+\dddot{\bar{\mathrm{Be}}}\ \dddot{\mathrm{Si}}+\mathrm{NaF}$=Silica 45·3, lime 28·0, glucina 12·7, sodium 7·7, fluorine 6·3. Analysis by Erdmann, (K. V. Ac. H. f. 1840):

$\dddot{\mathrm{Si}}$ 47·82, $\dddot{\bar{\mathrm{Be}}}$ 11·51, $\dot{\mathrm{Mn}}$ 1·01, $\dot{\mathrm{Ca}}$ 25·00, Na 7·59, K 0·26, F 6·17=99·36.

B.B. fuses to a clear violet glass, which becomes clouded on cooling. With borax fuses easily to an amethystine glass; with salt of phosphorus dissolves except a skeleton of silica. Gives the reaction of fluorine.

Leucophane occurs in syenite with albite, elæolite, and yttrotantalite, on a small rocky islet near the mouth of the Langesundfiord in Norway, where it was found by Esmark. It resembles somewhat a light green variety of apatite.

The name leucophane is from λευκος, *white,* and ψαινω, *to appear.*

MELINOPHANE, *Th. Scheerer*, J. f. pr. Chem. lv. 449.

Dimetric or hexagonal; optically uniaxal, Descl. Massive, with a scaly and sometimes foliated structure. Cleavage in one direction. H.=5. G.=3·0, Richter. Lustre vitreous. Color sulphur, citron, or honey-yellow. Not phosphorescent. Brittle.

Composition, according to an approximative analysis by R. Richter, (loc cit.):

$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Be}}}$	$\ddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Mn}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	Na	F	$\dddot{\bar{\mathrm{Ni}}}$, $\ddot{\bar{\mathrm{Zr}}}$, $\bar{\mathrm{Ce}}$, $\dot{\mathrm{Y}}$.
44·8	2·2	12·4	1·4	1·1	31·5	0·2	2·6	2·3	0·3=98·8.

This analysis gives for the ratio of the oxygen of the protoxyds, peroxyds, and silica, if we suppose the fluorid as replacing protoxyds, 1½ : 1 : 3.

From the zircon-syenite of Norway, near Fredericksvärn, with elæolite, mica, fluor spar, and magnetic iron. An imperfect crystal in the cabinet of R. P. Greg, Esq. gave him M : M′=133°, and edge M : M′ replaced by a rough plane, apparently not equally inclined to M and M′. The place of this species in the system is doubtful.

IV. GARNET SECTION.

Oxygen ratio, for the bases and silica 1 : 1, varying to 1 : ¾, (Chondrodite), and 1 : $\frac{4}{3}$, (Scapolite).

1. CHRYSOLITE GROUP.—Trimetric.

CHRYSOLITE,	$(\dot{\mathrm{Fe}}, \dot{\mathrm{Mg}})^3\,\dddot{\mathrm{Si}}$,	TEPHROITE,	$\dot{\mathrm{Mn}}^3\,\dddot{\mathrm{Si}}$
MONTICELLITE,	$(\frac{1}{2}\,\dot{\mathrm{Ca}}+\frac{1}{2}\dot{\mathrm{Mg}})^3\dddot{\mathrm{Si}}$,	KNEBELITE,	$(\dot{\mathrm{Fe}}, \dot{\mathrm{Mn}})^3\dddot{\mathrm{Si}}$
FAYALITE,	$\dot{\mathrm{Fe}}^{\,3}\;\dddot{\mathrm{Si}}$,	CHONDRODITE,	$\dot{\mathrm{Mg}}^4\,\dddot{\mathrm{Si}}$

2. PHENACITE GROUP.—Hexagonal. R : R=115°—117°.

WILLEMITE,	$\dot{\mathrm{Zn}}^3\,\dddot{\mathrm{Si}}$,	PHENACITE,	$\dddot{\bar{\mathrm{Be}}}\,\dddot{\mathrm{Si}}$.

3. GARNET GROUP.—Monometric.

GARNET,	$(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$,	HELVIN,	$(\frac{2}{3}\dot{\mathrm{R}}^3+\frac{1}{3}\dddot{\bar{\mathrm{Be}}})\;\dddot{\mathrm{Si}}$, in which $\dot{\mathrm{R}}=(\dot{\mathrm{Mn}}, \dot{\mathrm{Fe}}, \mathrm{MnS}.)$
PYROPE,	$(\frac{1}{4}\dot{\mathrm{R}}^3+\frac{3}{4}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$.		

4. SCAPOLITE GROUP.—Dimetric.

ZIRCON,	$\ddot{\bar{\mathrm{Zr}}}\,\dddot{\mathrm{Si}}$,	MEIONITE,	$(\frac{1}{3}\dot{\mathrm{Ca}}^3+\frac{2}{3}\ddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}$.
IDOCRASE,	$(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$,	SCAPOLITE,	$(\frac{1}{3}\dot{\mathrm{R}}^3+\frac{2}{3}\ddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}^{\frac{4}{3}}$.
"	$(\frac{3}{5}\dot{\mathrm{R}}^3+\frac{2}{5}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$,	"	? $(\frac{1}{4}\dot{\mathrm{R}}^3+\frac{3}{4}\ddot{\mathrm{Al}})\dddot{\mathrm{Si}}$.
SARCOLITE,	$(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\ddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}$,	MELLILITE,	$(\frac{2}{3}\dot{\mathrm{R}}^3+\frac{1}{3}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$.

Dipyre may belong here. Taking 2*i* of Scapolite as the plane 1, (to which there is no objection), then *O* : 1 in Zircon and the Scapolite Group will equal 137°–139°. Idocrase diverges more widely, giving for the corresponding angle 133° 3′.

5. EPIDOTE GROUP.—Monoclinic.

EPIDOTE,	$(\frac{1}{3}\dot{\mathrm{R}}^3+\frac{2}{3}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$,	ZOISITE,	$(\frac{1}{4}\dot{\mathrm{R}}^3+\frac{3}{4}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$.
ALLANITE,	$(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$,	GADOLINITE,	$\dot{\mathrm{R}}^3\;\dddot{\mathrm{Si}}$.
"	$(\frac{3}{5}\dot{\mathrm{R}}^3+\frac{2}{5}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$.		

6. AXINITE GROUP.—Triclinic.

DANBURITE, $(\dot{Ca}^3, \dddot{B})\,\dddot{Si}$, AXINITE, $(\dot{R}^3, \ddot{R}, \dddot{B})\dddot{Si}$.

7. IOLITE GROUP.—Trimetic. Oxygen ratio for the bases and silica 1 : 1¼, as in some Mica, and perhaps not belonging to this section. Related to the Micas in the prismatic angle near 120°.

IOLITE, $(\frac{1}{4}\dot{R}^3+\frac{3}{4}\ddot{R})\dddot{Si}^{\frac{5}{4}}$.

CHRYSOLITE. Peridot, *H.* Olivine, Chusite. Limbelite, *Saussure.* Krisolith, *W.* Hyalosiderite. Batrachite, *Breit.* Glinkite, *Romanowski.* Monticellite, *Brooke.* Forsterite, *Levy.*

Trimetric. $I : I=94° 3'$; $O : 1\bar{i}=128° 27'$; $a : b : c=1{\cdot}2594 : 1 : 1{\cdot}0733$.

$O : 1\bar{2}=125° 45'$. $O : 1\breve{i}=130° 27'$. $i\breve{\tfrac{3}{2}} : i\breve{\tfrac{3}{2}}=(\text{ov.}\,i\breve{i})108° 50'$.
$O : 1=120° 9'$. $1 : 1(\text{mac.})=107° 46'$. $i\breve{2} : i\breve{2}(\text{ov.}\,i\breve{i})=123° 34'$.
$O : \frac{3}{2}\breve{\tfrac{3}{2}}=114° 48'$. $1 : 1(\text{br.})=101° 32'$. $i\bar{i} : 1\bar{2}=137° 22'$.
$O : \frac{1}{2}\breve{i}=149° 36'$. $i\bar{2} : i\bar{2}(\text{ov.}\,i\bar{i})=130° 2'$.

O						
						$\frac{1}{2}\breve{i}$
$1\bar{i}$	$1\bar{4}$	$1\bar{2}$	1			$1\breve{i}$
				$\frac{3}{2}\breve{\tfrac{3}{2}}$		
						$2\breve{i}$
$i\bar{i}$		$i\bar{2}$	I	$i\breve{\tfrac{3}{2}}$	$i\breve{2}$	$i\breve{i}$

Observed Planes.

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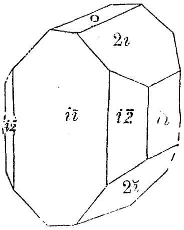

Cleavage: $i\breve{i}$ rather distinct. Massive and compact, or granular; usual in imbedded grains.

H.=6—7. G.=3·33—3·5; 3·441 of chrysolite, Haidinger; 3·33—3·345, olivine; 3·3514, chrysolite. Lustre vitreous. Color green—commonly olive-green, sometimes brownish, black in some iron chrysolites; rarely white. Streak uncolored. Transparent—translucent. Fracture conchoidal.

Chrysolite includes usually the transparent crystals of paler color, while *olivine,* (so called from the olive-green tint), is applied to imbedded masses or grains of inferior color and clearness.

Composition.—$\dot{R}^3\dddot{Si}$, in which $\dot{R}$ may be $\dot{Mg}$, $\dot{Fe}$, $\dot{Mn}$, $\dot{Ca}$, alone or in combination. Common chrysolite is usually $(\dot{Mg}, \dot{Fe})^3\dddot{Si}$. Analyses: 1, 2, Walmstedt, (K. V. Ac. H. 1824, ii, 359, and Schw. J. xliv, 25); 3, 4, Stromeyer, (Gött, gelehrt. Anz. 1824, 208; Pogg. iv, 193); 5, Walchner, (Schw. J. xxxix, 65); 6, W. v. Beck, (Verh. Russ, Min. Ges. St. Petersb. 1847); 7, Rammelsberg, (Pogg. li, 446); 8, Walmstedt, (ib.); 9, Waltershausen, (Vulk. Gest. 117); 10, Deville, (Et. Geol. Canaries); 11, Domeyko, (Ann. des. M. [4], xiv, 187):

		$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Fe}}$	$\ddot{\mathrm{Al}}$	$\dot{\mathrm{Mn}}$	
1.	Iserwiese,	41·54	50·04	8·66	0·06	0·25	=100·55, Walmstedt.
2.	Mt. Somma,	40·08	44·22	15·26	0·18	0·48	=100·24, “
3.	*Orient chrys.*	39·73	50·13	9·19	0·22	$\dddot{\mathrm{M}}$0·09,	$\dot{\mathrm{Ni}}$ 0·32=99·68, Stromeyer.
4.	Vogelsberg,	40·09	50·49	8·17	0·19	“ 0·20,	“ 0·37=99·51, “
5.	*Hyalosiderite,*	31·63	32·40	28·49	2·21	“ 0·48,	$\dot{\mathrm{K}}$ 2·69, Cr. *trace*, Walchner.
6.	*Glinkite,*	39·21	44·06	17·45	—	—	=100·72, Beck.
7.	*Batrachite,*	37·69	21·79	2·99	—		$\dot{\mathrm{Ca}}$ 35·45, $\dot{\mathrm{H}}$ 1·27=99·19, Ramm.
8.	Pallas meteorite	40·83	47·74	11·53	*trace*	0·29,	$\dot{\mathrm{Ca}}$ *trace*=100·39, Walmst.
9.	Etna,	41·01	47·27	10·06	0·64	—	$\dot{\mathrm{Ni}}$ 0·20, $\dot{\mathrm{H}}$ 1·04=100·22, Walm.
10.	C. Verdes, Fog.	40·19	35·70	15·27	0·80	2·27	$\dot{\mathrm{Ca}}$ 5·12=99·35, Deville.
11.	Antuco, Chili,	40·7	39·7	19·6	—	—	=100, Domeyko.

Berzelius detected oxyd of tin in the olivine of the Pallas meteorite, and Rummler a trace of arsenous acid. Other recent analyses: E. E. Schmid, (Pogg. lxxxiv, 51, Atacama); Erdmann (K. V. Ac. H. 1848, 15, Tunaberg).

No. 5, *Hyalosiderite* is $(\frac{1}{2}\dot{\mathrm{Mg}}+\frac{1}{2}\dot{\mathrm{Fe}})^3\dddot{\mathrm{Si}}$, with an excess of $\dot{\mathrm{Mg}}\,\dddot{\mathrm{Si}}$. It occurs at Kaiserstuhl in yellowish and reddish-brown crystals; H.=5·5. G.=2·875.

Tautolite, Breith. From volcanic rocks near Lake Laach, resembles hyalosiderite. H.=6·5: G.=3·865. Forms trimetric.

Forsterite, (Levy), from Vesuvius, is a white or colorless translucent chrysolite, occurring in small crystals, (Scacchi, Quad. Cryst. 63). *Monticellite* of Brooke, (Ann. Phil. 1831) is also Chrysolite. It is the *peridot blanc* of Scacchi. Formula $(\frac{1}{2}\dot{\mathrm{Ca}}^3+\frac{1}{2}\dot{\mathrm{Mg}}^3)\dddot{\mathrm{Si}}$, Scacchi.

Glinkite is greenish chrysolite from a talcose slate, in Perm, Russia, and occurring also in gneiss at Tunaberg with augite and garnet, (Analysis No. 6).

Batrachite, from Rinzoni, Tyrol, has the formula of Monticellite; G.=3·033. Said to have two cleavages meeting at 115° and 65°, and a third diagonal to them.

With the fluxes gives the reaction of iron. Scarcely attacked by muriatic acid, but easily gelatinizes with sulphuric acid. Berzelius says that it also forms a jelly with muriatic. Scacchi's Vesuvian variety is easily attacked by the acids. The iron chrysolites are fusible before the blowpipe; hyalosiderite forms a black magnetic bead. Others are infusible.

Chrysolite is found near Constantinople, at Vesuvius, and the Isle of Bourbon in lavas; imbedded in obsidian, at Real del Monte in Mexico; among sand at Expailly in Auvergne, in pale green transparent crystals. Olivine is of frequent occurrence in basalt and lavas. Crystals several inches in length, in greenstone at Unkel, on the Rhine; spheroidal masses at Kapfenstein in Lower Styria; and at Hecla and Vesuvius, and various volcanic regions. Olivine is common in the lavas and basalt of the Sandwich and other Pacific Islands. It occurs in imbedded grains, and in masses sometimes several inches through in boulders of coarsely crystallized basalt in Thetford and in Norwich, Vermont.

Crystals of this species are commonly very fragile, and therefore unfit for an ornamental stone. The word *chrysolite* is derived from *χρυσος, gold,* and *λιθος, stone,* in allusion to its color; *hyalosiderite* is from *ὑαλος, glass,* and *σιδηρος, iron.*

Fayalite, (Iron-chrysolite, Eisenperidot).—Fayalite is a pure iron-chrysolite. Color black, greenish or brownish, sometimes iridescent. Cleavage in two directions at right angles with one another. H.=6·5. G.=4·11—4·14; 4·006, Delesse.

Composition.—$\dot{\mathrm{Fe}}^3\dddot{\mathrm{Si}}$=Silica 29·55, protoxyd of iron 70·45.

Analyses: 1, Klaproth, (Beit. v, 222); 2, Thomson; 3, Delesse, (L'Institut, 1854; p. 52); 4, Gmelin:

		$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\ddot{\mathrm{Al}}$	$\dot{\mathrm{K}}$	
1.	Volc. glass,	29·50	66 00	—	4·0	0·25	=99·75, Klaproth.
2.	Slavcarrach, Ireland,	29·60	68·73	1·78	—	—	=100·11, Thomson.
3.	“ “	29·50	63·54	5·07	*tr.*	—	$\dot{\mathrm{Mg}}$ 0·30=98·41; Delesse.
4.	Fayal,	24·93	65·84	2·94	1·84	—	$\dot{\mathrm{Cu}}$ 0·60, FeS 2·77, Gmelin.

Fuses readily to a black globule which is magnetic. Easily attacked by acids.

From the Mourne Mts., Ireland, in Pegmatite; also from volcanic rocks at Fayal. The Obsidians or volcanic glass often approach Fayalite in composition.

Iron-chrysolite has been observed in crystals, as a furnace product, near Goslar.

ALTERED FORMS.—Alteration of chrysolite, often takes place through the oxydation of the iron; the mineral becomes brownish or reddish-brown and iridescent. It also splits into thin laminæ as the change goes on, sometimes so as to resemble a mica. A basalt thus changed was once pointed out to the author as a mica slate, although no further change had taken place than that here mentioned. Chusite and Limbelite are chrysolite more or less altered. The process may end in leaving the cavity of the crystal filled with limonite or red oxyd of iron. Under the action of carbonated waters, the iron is often carried off instead of being peroxydized, and also some of the magnesia is removed at the same time; and thus may come *serpentine, picrosmine, villarsite,* which often retain the crystalline form of chrysolite. A further change may produce steatite and other magnesian species.

TEPHROITE, *Breithaupt.*

Dimetric? Massive, with cleavage parallel to the sides of a square or rectangular prism; also granular.

H.=5·5—6. G.=4—4·12. Color ash-gray. Streak pale-gray. Darkens, on exposure, to brown and black.

Composition.—$\dot{M}n^3\dddot{S}i$=Silica 29·8, protoxyd of manganese 70·2. Analyses: 1, Thomson, (Min. i, 514); 2, Rammelsberg, (Pogg. lxii, 145):

1. Franklin,	$\dddot{S}i$ 29·64	$\dot{M}n$ 66·60	$\ddot{\bar{F}}e$ 0·92, Moisture 2·70=99·86, Thomson.
2. Sparta,	28·66	68·88	$\dot{F}e$ 2·92=100·46, Rammelsberg.

B.B. fuses easily to a black scoria. Gelatinizes perfectly in muriatic acid without evolving chlorine.

From Stirling, N. J., with franklinite, and at Sparta. This species has the general formula of a chrysolite.

A black silicate of manganese from Klapperud, Dalecarlia, having a submetallic lustre and yellowish-brown streak, afforded Klaproth, (Beit. iv, 137), $\dddot{S}i$ 25·0, $\dot{M}n$ 55·8, $\dot{H}$ 13·00=93·8=$\dot{M}n^3\dddot{S}i+3\dot{H}$, agreeing with the Tephroite, excepting the water. Klaproth obtained 60 per cent. of $\dot{M}n\ddot{\bar{M}}n$, whence the above is deduced by Berzelius.

KNEBELITE.

Massive, with an uneven and cellular surface, and quite hard.

G.=3·714. Lustre glistening. Color gray, spotted dirty-white, red, brown, and green. Opaque. Brittle. Fracture subconchoidal.

Composition.—$(\dot{F}e\,\dot{M}n)^3\,\dddot{S}i$, $\dot{F}e$ and $\dot{M}n$ being in equal proportions. Analysis by Döbereiner, (Schw. J xxi, 49); Silica 32·5, protoxyd of iron 32, protoxyd of manganese 35, and thus appearing to be a ferruginous tephroite. With muriatic acid decomposed, the silica separating. Unaltered alone before the blowpipe. Fuses with borax to a dark olive-green pearl.

Locality unknown. Named by Döbereiner after Major von Knebel.

CHONDRODITE, *d'Ohsson.* Condrodite, *H.* Maclurite, *Seybert.* Brucite, *Cleaveland.* Humite, *Bournon.*

Trimetric; often hemihedral in octahedral planes, producing forms monoclinic in character. $I : I$=94° 26′. Crystals of three types.*

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* Scacchi in Pogg. Ann. 1851, Ergänz. ii, 161. The author adopts a modified view of these types and their axes. (See Am. J. Sci., [2], xiv, 175).

The numbers given for the planes of these figures on page 59, vol. I, are based on a similar fundamental form, except that the longer lateral axis has twice the length here adopted.

Type I, $a : b : c = 1{\cdot}4678 : 1 : 1{\cdot}0805$; II, $1{\cdot}5727 : 1 : 1{\cdot}0805$; III, $1{\cdot}4154 : 1 : 1{\cdot}0805$.

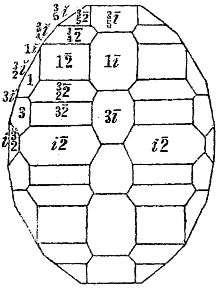
I. $O : 1\bar{\imath} = 124^\circ\ 16'$. $O : 1\bar{2} = 121^\circ\ 44'$.
$O : 1 = 116^\circ\ 34'$. $1\bar{\imath} : 1\bar{\imath}$ (bas) $= 111^\circ\ 28'$.
$O : 3\bar{\imath} = 102^\circ\ 48'$. $O : \tfrac{3}{2}\bar{2} = 112^\circ\ 24'$.
$O : 3\breve{\imath} = 103^\circ\ 47'$. $\breve{\imath}\tfrac{3}{2} : \breve{\imath}\tfrac{3}{2}$ (front) $= 71^\circ\ 32'$.

II. $O : 1\bar{\imath} = 122^\circ\ 27'$. $O : 4\bar{2} = 98^\circ\ 13'$.
$O : 2 = 103^\circ\ 8'$. $O : 2\breve{\imath} = 108^\circ\ 58'$.

III. $O : 1\bar{\imath} = 125^\circ\ 14\tfrac{1}{2}'$. $O : \tfrac{8}{7}\bar{2} = 119^\circ\ 17'$.
$O : 2\bar{\imath} = 109^\circ\ 27'$. $O : 8\bar{2} = 94^\circ\ 35'$.
$O : 4 = 97^\circ\ 23'$. $O : \tfrac{4}{3} = 111^\circ\ 15'$.
$O : \tfrac{4}{3}\breve{\imath} = 119^\circ\ 47'$. $1\bar{\imath} : 1\bar{\imath} = 109^\circ\ 31'$.
$O : 4\breve{\imath} = 100^\circ\ 48'$. $1\bar{\imath} : \tfrac{4}{3} = 134^\circ\ 23'$.
$O : \tfrac{8}{15}\bar{2} = 140^\circ\ 15'$. $\tfrac{4}{3} : \tfrac{8}{7}\bar{2}$ (ov. I) $= 126^\circ\ 52'$.

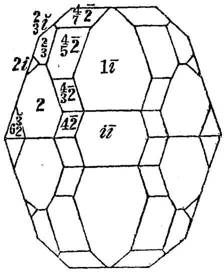
Fig. 376, left-handed hemihedral; 377, right-handed hemihedral. Observed angles in chondrodite (D): $1\bar{\imath} : 1\bar{\imath} = 112^\circ$ (mean of same in 3 types of Humite, $112^\circ\ 2'$), $1\bar{\imath} : \tfrac{4}{3} = 136^\circ$, $1\bar{\imath} : \tfrac{8}{7}\bar{2} = 157^\circ$, $\tfrac{4}{3} : \tfrac{8}{7}\bar{2}$ (over I) $= 127^\circ$, $I : I$ (side) $= 85^\circ$ ($85^\circ\ 34'$, calculated for Humite); $4\breve{\imath}$ on edge above it 168°.

373



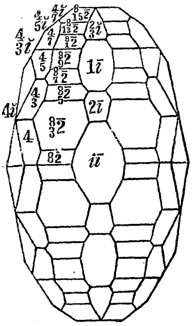
Humite: Type I.

374



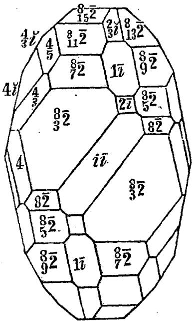
Humite: Type II.

375



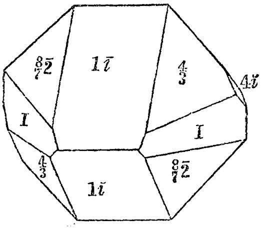
Humite; Type III.

376



Humite; hemihedral.

377



Chondrodite.

Compound crystals parallel to $\frac{4}{3}\breve{\imath}$ in the third type, and $\frac{2}{5}\check{\imath}$ in the second, the former sometimes producing stellate forms of six crystals, each hemihedral. Cleavage indistinct. Usually in imbedded grains or masses of a somewhat granular texture; sometimes in small implanted crystals.

H.=6—6·5. G.=3·118, from New Jersey, Thomson; 3·199, Finland, Haidinger; 3·234, white crystal, Type I; 3·199, brown of Type III; 3·186, yellowish, Type III; 3·177, yellow of Type II; Scacchi. Lustre vitreous—resinous. Color white, yellow, pale yellow or brown; sometimes red, apple-green, black, gray. Streak white, or slightly yellowish or grayish. Transparent—subtranslucent. Fracture subconchoidal—uneven.

Composition.—$\dot{\text{Mg}}^4\ddot{\text{Si}}$, with part of the oxygen replaced by fluorine, or 1 $\dot{\text{Mg}}^4\ddot{\text{Si}}$, with $\frac{1}{12}$ 4(Mg F, Si F^3) in chondrodite, $\frac{1}{18}$ in Type II for humite, $\frac{1}{27}$ in Type I, $\frac{1}{36}$ in Type III, Rammelsberg. Analyses: 1, Seybert, (Am. J. Sci., v, 336); 2, 3, 4, Rammelsberg, (Pogg. liii, 130, and 1st Supp. 38); 5, W. Fisher, (Am. J. Sci., [2], ix, 85); 6, 7, 8, Rammelsberg, (Pogg. lxxxvi, 413):

	$\ddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\ddot{\bar{\text{F}}\text{e}}$	$\dot{\text{F}}$	
1. New Jersey,	32·66	54·00	——	2·33	——	HF 4·09, $\dot{\text{H}}$ 1·0, $\mathring{\text{K}}$ 2·11, S.
2. " *yellow,*	33·06	55·46	3·65	——	7·60	= 99·77, Ramm.
3. Pargas, *yellow,*	33·10	56·61	2·35	——	8·69	=100·75, Ramm.
4. " *gray,*	33·19	54·50	6·75	——	9·69	=104·13, Ramm.
5. New Jersey, *red,*	33·35	53·05	5·50	——	7·60	= 99·50, W. Fisher.
6. *Humite, type* 1,	34·80	60·08	2·40	——	3·47	=100·75, Ramm.
7. " *type* 2,	33·26	57·92	2·30	$\dot{\text{Ca}}$ 0·74	5·04	$\ddot{\text{Al}}$ 1·06=100·32, Ramm.
8. " *type* 3,	36·67	56·83	1·67	——	2·61	= 97·78, Ramm.

B.B. on charcoal infusible, but becomes paler in varieties containing little iron, sometimes showing traces of fusion on the edges. With borax dissolves slowly but perfectly to a transparent glass slightly tinged by iron; if the glass is saturated it becomes cloudy by flaming. With salt of phosphorus in the open tube, affords fluorine.

Chondrodite occurs mostly in granular limestone. It is found near Abö, in the parish of Pargas in Finland, and at Aker and Gulsjö in Sweden; at Taberg in Wermland; in Saxony; on Loch Ness in Scotland; at Achmatowsk in the Ural, along with perofskite, and in the mines of Schischimsk with red apatite. The humite occurs at Somma, in ejected masses of a kind of granite rock, along with white olivine, mica, and magnetite.

Abundant in the counties of Sussex, N. J., and Orange, N. Y., where it is associated with spinel, and occasionally with pyroxene and corundum. At Bryam, orange and straw-colored chondrodite, and also a variety nearly black, occurs with spinel; at Sparta, a fine locality of honey-yellow chondrodite; a mile to the north of Sparta is the best locality of this mineral in New Jersey. It also occurs at Vernon, Lockwood, and Franklin. Chondrodite is abundant in Warwick, Monroe, Cornwall, near Greenwood Furnace, and at Two Ponds, and elsewhere in Orange Co., N. Y. Fine specimens may be obtained on the land of Mr. Houston, near Edenville. It is obtained also at Chelmsford, Mass., along with scapolite; in Harvy's quarry near Chaddsford, Pa., of yellow and orange colors and abundant. It occurs sparingly on the bank of Laidlaw lake in Rossie, N. Y.

Abundant in limestone at S. Crosby, Canada West, St. Jerome, St. Adèle, Grenville, etc.

The name chondrodite is from *Χονδρος, a grain,* alluding to its granular structure.

Altered Forms.—Chondrodite altered to Serpentine, has been observed at Sparta, N. J., with spinel and mica.

WILLEMITE, *Levy*, Ann. d. Mines, 4th ser. iv. 513. Siliceous Oxyd of Zinc, *L. Vanuxem* and *W. H. Keating*, Jour. Acad. Nat. Sci. Philad. 1824, iv, 8. Williamsite, Wilhelmite. Hebetine. Anhydrous Silicate of Zinc. Troostite, *Shepard.*

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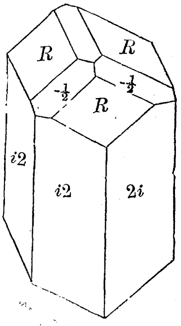

Rhombohedral. $R : R=115°$, $O : R=141° 39\frac{1}{2}'$; $a=0·685$. Observed planes in crystals from New Jersey, $R, -\frac{1}{2}, i2$; in those of Moresnet $\frac{3}{4}, I, O$. $I : \frac{3}{4}=120° 7'$, $\frac{1}{2} : \frac{1}{2}=142° 52'$, $\frac{3}{4} : \frac{3}{4}=128° 30'$, Levy, (127 °33′, from $R : R$ in the N. J. crystal). Cleavage: lateral distinct; basal also distinct. Also in grains or massive.

H.=5·5. G.=3·935, Moresnet, Thomson; 4·16—4·18, ib., Levy; 3·89—4, N. Jersey, Vanuxem and Keating; 4·02, ib., Hermann; 3·98, ib. in powder, Wurtz. Lustre vitreo-resinous, rather weak. Color whitish or greenish-yellow, when purest; flesh-red, grayish-white, yellowish-brown; often dark-brown when impure. Streak uncolored. Transparent to opaque. Brittle. Fracture conchoidal.

Composition.—$\dot{\mathrm{Z}}\mathrm{n}^3\dddot{\mathrm{S}}\mathrm{i}$=Silica 72·85, oxyd of zinc 27·15. Analyses: 1, 2, Vanuxem and Keating, (loc. cit.); 3, Hermann, (J. f. pr. Chem. xlvii, 11); 4, Thomson, (Min. i, 545); 5, Levy, (Ann. d. M. [4], iv, 515); Rosengarten, (Ramm. 3d Supp. 65); H. Wurtz, (Rep. Amer. Assoc. iv, 147):

	$\dddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{Z}}\mathrm{n}$	
1. Stirling,	25·44	68·06,	$\ddot{\bar{\mathrm{F}}}\mathrm{e}$ and $\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 6·50=100·00, Vanuxem and Keating.
2. "	25·00	71·33,	" 0·67 " 2·66=99·66, Vanuxem and Keating.
3. "	26·80	60·07,	$\dot{\mathrm{M}}\mathrm{n}$ 9.22, $\dot{\mathrm{M}}\mathrm{g}$ 2·91, $\dot{\mathrm{F}}\mathrm{e}$ *trace*, ign. 1·00=100, Hermn.
4. Moresnet,	26·97	68·77,	$\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 1·48, $\ddot{\bar{\mathrm{A}}}\mathrm{l}$ 0·66, ib. and *trace* $\dot{\mathrm{Z}}\mathrm{n}$, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·78, $\dot{\mathrm{H}}$ 1·25
5. "	27·05	68·40,	" 0·75, ign. 0·30=96·50, Levy. [=99·91, Thom.
6. Upper Silesia,	27·34	70·82,	$\dot{\mathrm{F}}\mathrm{e}$, 1·81=99·97, Rosengarten.
7. Stirling,	27·91	59·93,	$\dot{\mathrm{M}}\mathrm{n}$ 3·73, $\dot{\mathrm{F}}\mathrm{e}$ 5·35, $\dot{\mathrm{M}}\mathrm{g}$ 1·66, $\dot{\mathrm{C}}\mathrm{a}$ 1·60=100·18, W.

Other analyses, A. Delesse, Ann. d. M. [4], x, 213. Affords no water in a matrass. B.B. decrepitates and becomes opaque, but does not fuse, or only on the edges to a white enamel. With borax or salt of phosphorus, a transparent white globule, containing a cloud of silica. In powder gelatinizes easily in concentrated muriatic acid.

From Moresnet, in crystals and massive, the crystals but two or three millimeters long, and one thick. In New Jersey it occurs in large stout crystals at Stirling Hill, and also sparingly at Franklin.

This species was first correctly described and analyzed by Vanuxem and Keating.

PHENACITE. Phenakit, *Nordenskiöld*, K. V. Ac. H. 1823, 160, Pogg. xxxi, 57.

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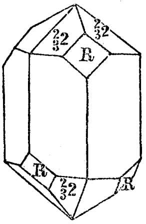

Rhombohedral; often hemihedral. $R : R=116° 40'$, $O : R=142° 41'$; $a=0·66$. Observed planes: rhombohedrons, $R, -2, -1, -\frac{1}{2}$; scalenohedrons, $1^2, 1^3, -2^2, \frac{2}{3}^2$ (beveling terminal edge of R); pyramids $\frac{2}{3}2$, $\frac{4}{3}2$; prisms, $I, i2, i\frac{3}{2}$.

$R : I=127° 19'$. $\frac{2}{3}2 : i2=113° 45'$.
$R : i2=121° 40'$. $\frac{1}{2} : \frac{1}{2}=144° 4'$.
$\frac{2}{3}2 : \frac{2}{3}2=156° 46'$. $2 : 2=87° 12'$.

Cleavage: R, and $i2$, imperfect. Twins: face of composition I.

H.=8. G.=2·969. Lustre vitreous. Colorless; also, bright wine-yellow, inclining to red. Transparent—opaque. Fracture similar to that of quartz.

Composition.—$\dddot{\text{Be}}$ $\dddot{\text{Si}}$=Silica 54·3, glucina 45·7=100. Analyses: 1, Hartwall, (Pogg. xxxi, 57); 2, Bischof, (Pogg. xxxiv, 525):

1. Ural, $\dddot{\text{Si}}$ 25·14 $\dot{\text{Be}}$ 44·47 $\dddot{\text{Al}}$ and $\dot{\text{Mg}}$ *trace*=99·61, Hartwall.
2. Framont, 54·400 45·567 $\dot{\text{Ca}}$ and $\dot{\text{Mg}}$ 0·96=100·063, Bischof.

B.B. alone remains unaltered; with borax fuses with extreme slowness, unless pulverized, to a transparent glass. With soda affords a white enamel; with more, intumesces and becomes infusible. Dull blue with cobalt solution.

Occurs with emerald in mica slate, in Perm, 85 wersts from Katherinenberg, in the Ilmen mountains, Siberia, with topaz and green feldspar; also in highly modified crystals with quartz, in the brown iron ore of Framont, in Alsace. Named from φέναξ, *a deceiver*, in allusion to its having been mistaken for quartz.

GARNET. Melanite. Pyrope. Grossularite. Topazolite. Almandine. Aplome. Essonite. Cinnamon stone. Greenlandite. Pyreneite. Colophonite. Allochroite. Granat. Ouvarovite or Uwarowite, *Hess.* Rothoffkit. Pirop. Kolophonit. Kaneelstein. Romanzovit, *Nordenskiöld.* Braunsteinkiesel, *W.* Grenat, *H.* Carbunculus. Polyadelphite, *Thom.*

Monometric: Observed planes: I, 22, $\frac{4}{3}\frac{4}{3}$, $\frac{3}{2}$, $3\frac{3}{2}$, $4\frac{4}{3}$, $i2$, O. Figs. 14 and 39, common; also 43, 17, 43 with planes $i2$, and 380, 381.

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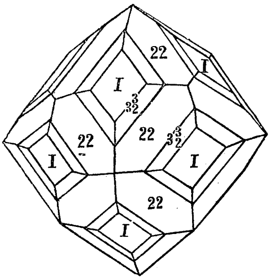
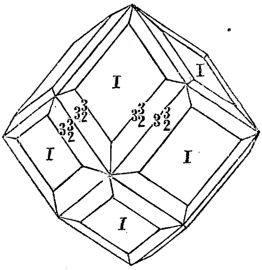


381



Cleavage: dodecahedral, sometimes distinct. Twins: face of composition, octahedral. Also massive; granular, coarse or fine, and sometimes friable; lamellar, lamellæ thick and bent.

H.=6·5—7·5. G.=3·15—4·3, 3·504, a white lime-garnet, anal. 10. Lustre vitreous—resinous. Color red, brown, yellow, white, green, black; some red and green colors often bright. Streak white. Transparent—subtranslucent. Fracture subconchoidal, uneven.

Garnet is a silicate of different bases—alumina, lime, magnesia, oxyds of iron and manganese, with sometimes oxyd of chrome. It has been divided into six subspecies.

I. Consisting of silicates of alumina and lime—*alumina-lime garnet,*—including cinnamon stone or essonite.

II. Containing alumina and magnesia,—*alumina-magnesia garnet.*

III. Consisting of silicates of alumina and iron—*alumina-iron garnet*—including almandine or precious garnet, with common garnet and colophonite in part.

IV. Consisting of alumina and manganese—*alumina-manganese garnet*—or manganesian garnet.

V. Consisting of silicates of iron and lime—*iron-lime garnet*—including allochroite, aplome, melanite and common garnet in part.

VI. Containing lime and chromic oxyd—*lime-chrome garnet.*

But these compounds pass into one another by imperceptible shades, as the following analyses show.

Composition.—$\dot{R}^3\dddot{Si}+\ddot{\bar{R}}\dddot{Si}=(\frac{1}{2}\dot{R}^3+\frac{1}{2}\ddot{\bar{R}})\dddot{Si}$. Analyses: 1, Arfvedson, (K. V. Ac. H. 1822, 87); 2, C. Gmelin, (Jahresb. v, 224); 3, 4, Klaproth, (Beit. iv, 319, v, 138); 5, T. Wachtmeister, (K. V. Ac. H. 1823); 6, 7, Karsten, (Karst. Arch. f. Min. iv, 388); 8, T. Wachtmeister, (loc. cit.); 9, Nordenskiöld, (Schw. J. xxxi, 380); 10, Croft, (G. Rose, Reise n. d. Ural, 132).

11, T. Wachtmeister, (loc. cit.); 12, Hisinger, (Schw. xxi, 258); 13, 14, Kobell, (ib. lxiv, 283); 15–17, Karsten, (loc. cit.); 17–20, T. Watchmeister, (loc. cit.); 21, Klaproth, (Beit. ii, 22, v, 131); 22, W. Watchtmeister, (Jahresb. xxv, 364); 23, Bahr, (Jahresb. xxv, 364); 24, A. Besnard, (Lieb. u. Kopp Jahresb. 1849, 745); 25, 26, Mallet, (J. Dubl. Geol. Soc. and Rammelsberg's 5th Supp. 125.)

27, H. Seybert, (Am. J. Sci. vi, 155, 1823); 28, Rammelsberg, (J. f. pr. Chem. lv. 487); 29, d'Ohsson, (Schw. J. xxx, 346); 30, Hisinger, (Jahresb. ii, 101); 31, Seybert, (Am. J. Sci. v, 118, where iron is made protoxyd); 32, Karsten, (loc. cit.); 33, 34, Bredberg, (K. V. Ac. H. 1822, i, 63); 35, Bucholz, (Scheerer's N. J. iv, 172); 36—41, Watchtmeister, (loc. cit.); 42, Thomson, (Ann. Lyc. N. York, 1829, iii, 9); 43, Vauquelin, (Jour. de Phys. Ann. viii, L. 94); 44, Klaproth, (Beit. v, 168, where the iron is made protoxyd); 45, Karsten, (loc. cit.); 46, Ebelmen, (Ann. des Mines, [4], vii, 19); 47, W. Fisher, (Am. J. Sci. [2], ix, 84); 48, Bahr (J. f. pr. Chem. liii, 312); 49, Weber, (Ramm. 5th Suppl., 193); 50, Baumann, (ib.); 51, Komonen, (Verh. min. Ges. St. Petersb. xxiii, 291); 52, Erdmann, (Jahresb, xxiii, 291):

I. *Lime-Garnet.*—*Grossular.*—$\dot{Ca}^3\dddot{Si}+\ddot{\bar{Al}}\dddot{Si}=(\frac{1}{2}\dot{Ca}^3+\frac{1}{2}\ddot{\bar{Al}})\dddot{Si}$=Silica 40·1, alumina 22·7, lime 37·2. Color pale greenish, clear red and reddish-orange, cinnamon color. G.=3·43—3·73. B.B. fuses to a glass or enamel slightly greenish; in powder, soluble in concentrated muriatic acid. *Cinnamon stone, essonite, grossular, wiluite, romanzovite, topazolite,* and *succinite* are names of varieties. *Grossular* or *wiluite* has a greenish color; G.=3·71. *Succinite* has an amber color, to which the name alludes. *Topazolite* has a topaz color. *Romanzovite* is brownish. *Cinnamon stone* or *essonite* (Kaneelstein, *Germ.*) has a clear cinnamon brown shade; G.=3·5—3·6.

	$\dddot{Si}$	$\ddot{\bar{Al}}$	$\ddot{\bar{Fe}}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Mg}$	$\dot{Ca}$
1. Malsjö, *Cin.*	41·87	20·57	3·93	——	0·39		33·94=100·70, Arfved.
2. Ceylon, "	40·01	23·00	3·67	——	——	——	30·57,$\dot{K}$0·59,ign.0·33,G.
3. " "	38·80	21·20	6·50	——	——	——	31·25=97·75,Klaproth.
4. Wilui, *Gross.*	44·00	8·50	12·00	——	*trace*	——	33·50=98, Klaproth.
5. " "	40·55	20·10	5·00	——	0·48	——	34·86=100·99, Wacht.
6. " "	38·25	19·35	7·33	——	0·50	2·40	31·75=99·58, Karsten.
7. St. Gothard, *Cin.*	37·82	19·70	5·95	——	0·15	4·15	31·35=99·12, Karsten.
8. Tellemark, *wh.*	39·60	21·20	——	2·00	3·15	——	32·30=98·25, Wacht.
9. *Romanzovite,*	41·21	24·08	7·02	——	0·92		24·76,ign. & loss1·98,N.
10. Urals, *white,*	36·86	24·19	——	——	——	——	37·15=98·10, Croft.

II. *Magnesia-Garnet.*—$(\dot{Mg}, \dot{Fe})^3\dddot{Si}+\ddot{\bar{Al}}\dddot{Si}=(\frac{1}{2}(\dot{Mg}, \dot{Fe})^3+\frac{1}{2}\ddot{\bar{Al}})\dddot{Si}$. Color deep coal-black. G.=3·157. Lustre somewhat resinous. B.B. easily fusible, intumescing and forming a dark grayish-green globule, which is not magnetic.

11. Arendal,	42·45	22·47	——	9·29	6·27	13·43	6·53=100·44, Wacht.

III. *Iron-Garnet,* or *Almandine.* $\dot{Fe}^3\dddot{Si}+\ddot{\bar{Al}}\dddot{Si}=(\frac{1}{2}\dot{Fe}^3+\frac{1}{2}\ddot{\bar{Al}})\dddot{Si}$=Silica 36·3, alumina 20·5, protoxyd of iron 43·2.—*Common Garnet, Precious Garnet.*—Dark red, brownish-red to black. *Allochroite* is fine grained massive, of a dark dingy color. *Precious garnet* is deep red and translucent or transparent. *Common garnet* is dingy red. G. of these varieties 3·7—4·21. B.B. fuse rather easily with an iron reaction.

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\ddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$
12. Fahlun, *Almand.*	39·66	19·66	——	39·68	1·80	——	——=100·80, Hising.
13. Zillerthal, *bn.*	39·12	21·08	6·00	27·28	0·80	——	5·76=100·04, Kobell.
14. Hungary, *prec.*	40·56	20·61	5·00	32·70	1·47	——	——=100·34, Kobell.
15. Zillerthal, "	39·62	19·30	——	34·05	0·85	2·00	3·28=99·10, Karsten.
16. Ohlapian,	37·15	18·08	——	31·30	0·30	10·15	0·36=97·34, Karsten.
17. Greenland,	39·85	20·60	——	24·85	0·46	9·93	3·51=99·20, Karsten.
18. Engsö, *dull red,*	40·60	19·95	——	33·93	6·69	——	——=101·17, Wacht.
19. N. York, "	42·51	19·15	——	33·57	5·49	——	1·07=101·79, Wacht.
20. Norway,	52·11	18·04	——	23·54	1·74	——	5·78=101·20, Wacht.
21. Oriental,	35·75	27·25	——	32·33	0·25	——	——=95·58, Klapr.
22. Garpenberg,	39·42	28·28	——	24·82	7·51	3.69	2·63=98·35, Wacht.
23. Brena, Westm.	37·16	19·30	——	37·65	3·19	2·03	0·90=100·23, Bahr.
24. Albërnreit, *bnh-r.*	38·76	21·00	——	32·05	6·43	3·95	——=102·19, Bern.
25. Wicklow, *black,*	35·77	19·85	——	38·07	5·04	——	——=98·73, Mallet.
26. Killiney, *brown,*	37·80	21·13	——	38·43	——	4·46	1·53=99·75, Mallet.

IV. *Manganese-Garnet, Spessartine,* Beud.—$(\frac{1}{2}\dot{\mathrm{Mn}}^3+\frac{1}{2}\ddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}$. Brownish-red. B.B. gives the reaction of manganese. G.=3·7—4·2.

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$
27. Haddam, Ct.	35·83	18·06	14·93	30·96=99·78, Seyb. G.=4·128.
28. "	36·16	19·76	11·10	32·18, $\dot{\mathrm{Ca}}$ 0·58, $\dot{\mathrm{Mg}}$ 0·22, Ramm.
29. Broddbo,	39·00	14·30	15·44	27·90, $\ddot{\mathrm{Sn}}$ 1=97·64, d'Ohsson.

V. *Iron-Lime Garnet—Melanite, Pyreneite.*—$\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}+\ddot{\bar{\mathrm{Fe}}}\dddot{\mathrm{Si}}=(\frac{1}{2}\dot{\mathrm{Ca}}^3+\frac{1}{2}\ddot{\bar{\mathrm{Fe}}})\dddot{\mathrm{Si}}$. Dark red, brownish-black, black; either dull or shining. Sometimes with a resinous lustre, then called *colophonite;* G. of Willsboro, 3·896, Seybert. *Melanite* has a velvet black color. *Pyreneite* is black or grayish-black, with often a submetallic lustre. G. of these varieties 3·6—4·0. *Aplome* has the faces striated parallel to the shorter diagonal, and is brown or orange brown, with G.=3·44.

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\ddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$
30. Westmanland,	37·55	——	31·35	——	4·70	——	26·74=100·34, His.
31. Willsboro', *coloph.*	38·00	6·00	28·06	——	——	——	29·00=101·06, Sey.
32. Schwarzenberg, *gn.*	36·85	4·05	25·35	——	0·95	——	32·32=99·52, Kars.
33. Sala,	36·62	7·53	22·18	——	——	1·95	31·80=100·08, Bred.
34. "	36·73	2·78	25·83	——	——	12·44	21·79=99·57, Bred.
35. Thuringia, *brown,*	34·00	2·00	27·84	——	3·15	——	30·75, $\dot{\mathrm{H}}$, $\dot{\mathrm{Cu}}$ 4·25, B.
36. Langbanshytta, *yw.*	35·10	——	29·10	——	7·08	——	26·91, $\dot{\mathrm{K}}$ 0·98=99·17, Wacht.
37. Altenau, *Aplome,*	35·64	——	30·00	——	3·02	——	29·21, $\dot{\mathrm{K}}$ 2·35, Wacht.
38. Hesselkulla, *bn.*	37·99	2·71	28·53	——	1·62	——	30·74=100·59, W.
39. " *gn.*	38·13	7·32	19·42	——	3·30	——	31·65=99·82, W.
40. Arendal, *bnh-bk.*	40·20	6·95	20·50	——	4·00	——	29·48=101·13, W.
41. Vesuvius, *bn.*	39·93	13·45	10·95	3·35	1·40	——	31·66=100·94, W.
42. Franklin, N. J. *gn.*	33·72	7·97	17·64	——	16·70	——	22·88=98·92, Thom.
43. Frascati, *black,*	34·00	6·4	25·5	——	——	——	33·0=98·9, Vauq.[K
44. " *black,*	35·50	6·00	26·00	——	——	——	32·50, $\ddot{\bar{\mathrm{Mn}}}$ 0·4=100·4,
45. " *black,*	34·60	4·55	28·15	——	——	0·65	31·80=99·75, Kars.
46. Beaujeu, *black,*	36·45	2·06	29·48	——	0·28	0·06	30·76, ign. 0·96, Eb.
47. Franconia, N.H. *bk.*	38·85	——	28·15	——	——	——	32·00=99·00, Fisher.
48. Gustafsberg, G=3·6,	37·80	11·18	15·66	4·97	0·13	*trace*	30·28=100·02, Bahr.
49. Polyadelphite,	34·83	1·12	28·73	——	8·82	1·42	24·05=98·97, Web.
50. "	35·47	3·10	28·55	——	5·41	2·13	26·74=101·40, Bau.

VI. *Lime-Chrome Garnet—Ouvarovite*$=\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}+(\ddot{\bar{\mathrm{Cr}}}, \ddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}=(\frac{1}{2}\dot{\mathrm{Ca}}^3+\frac{1}{2}(\ddot{\bar{\mathrm{Cr}}}, \ddot{\bar{\mathrm{Al}}}))\dddot{\mathrm{Si}}$. Color emerald green. G.=3·4184. H.=7·5. B.B. alone infusible; a clear chrome-green glass with borax.

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\ddot{\bar{\mathrm{Fe}}}$	$\ddot{\bar{\mathrm{Cr}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$
51. Bissersk,	37·11	5·88	——	22·54,	2·44	1·10	30·34, $\dot{\mathrm{H}}$ 1·01=100·42, K.
52. "	36·93	5·68	1·96	21·84	——	1·54	31·66, $\dot{\mathrm{Cu}}$ *trace*=99·58, E.

Polyadelphite of Thomson (anal. 49, 50) is a brownish-yellow garnet from the Franklin Furnace, New Jersey.

Garnet occurs imbedded in mica slate, granite, and gneiss, and occasionally in limestone, chlorite slate, serpentine, and lava.

The precious garnet occurs in Ceylon, Greenland, and Brazil. Common garnet is met with in dodecahedrons from three to four inches in diameter, at Fahlun in Sweden, Arendal and Kongsberg in Norway, and the Zillerthal; abundant smaller crystals in mica slate, in the Island of Mull, in Perth and Inverness, Shetland; green at Schwarzenberg in Saxony. The magnesia-alumina garnet occurs at Arendal with calc spar; *Melanite* in the Vesuvian lavas, and also near Rome; *Grossularite* near the Wilui River in Siberia, etc. *Cinnamon stone* in masses of considerable size in Ceylon, at Malsjö in Wermland, and at St. Gothard; *Romanzovite*, a similar variety, at Kimito, Finland; *Aplome* on the banks of the river Lena in Siberia, and at Schwarzenberg in Saxony; *Ouvarovite* in emerald-green dodecahedrons, at Bissersk in Russia, with chromic iron. Other localities as above.

In New Hampshire at Hanover, small clear crystals in syenitic gneiss; blood-red dodecahedrons at Franconia, in geodes in massive garnet, with calc spar and magnetic iron; at Haverhill, in chlorite, some 1½ in. in diameter; at Unity, on the estate of J. Neal, with actinolite and magnetic iron, and at Lisbon, near Mink Pond, in mica slate with staurotide; at Grafton, ¼ to 1 in. in diameter. In Massachusetts, at Carlisle, geodes of transparent cinnamon-brown crystals similar to figure 43, with scapolite in limestone; at Boxborough, in similar but less remarkable specimens; also in gneiss at Brookfield and Brimfield; massive with epidote, at Newbury, and in crystals at Bedford, Chesterfield, with the Cummington kyanite, and at the beryl locality of Barre. In Maine, beautiful yellow crystals or cinnamon stone (with idocrase) at Parsonsfield, Phippsburg, and Rumford; manganesian garnet at Phippsburg, as well as the finest yellow garnet in Maine; in mica slate near the bridge at Windham, with staurotide; in granite veins at Streaked Mountain, along with beryl; in large reddish-brown crystals at Buckfield, on the estates of Mr. Waterman and Mr. Lowe; the best red garnets in Maine, occur at Brunswick. In Vermont, at New Fane, in large crystals in chlorite slate; also at Cabot and Cavendish. In Connecticut, polished trapezohedrons, ½—1 in. in diameter, in mica slate, at Reading and Monroe; at Haddam, large brittle trapezohedrons of manganesian garnet, often 2 in. through, with chrysoberyl; at Lyme, large blackish brown crystals in limestone. In New York, in mica slate, in Dover, Duchess Co., small; at Roger's Rock, crystallized and massive, and colophonite of yellow, brown, and red colors, abundant; brown crystals at Crown Point, Essex Co.; a cinnamon variety, crystallized and massive, at Amity; on the Croton aqueduct, near Yonkers, in small rounded crystals, and a beautiful massive variety—the latter, when polished, forms a beautiful gem. In New Jersey, at Franklin, black, brown, yellow, red, and green dodecahedral garnets; also near the Franklin furnace. In Pennsylvania, in Chester Co., at Pennsbury, fine dark-brown crystals with polished faces, in granite; near Knauertown at Keims' mine, good aplome in handsome lustrous crystals; at Chester, brown; in Concord, color of pyrope; in Leiperville, red; at Mineral Hill, fine brown. In Delaware, cinnamon stone in trapezohedrons, at Dixon's quarry, 7 miles from Wilmington. Also at Knife rapids on the Mississippi; at Marmora, Canada West, dark red, at Grenville a cinnamon-stone. Colophonite forms a large vein in gneiss at Willsboro, Essex Co., N. Y., associated with tabular spar and green coccolite; also at Lewis, ten miles south of Keeseville, Essex Co.

The cinnamon stone from Ceylon and the precious garnet are used as gems when large, finely colored, and transparent. The stone is cut quite thin, on account of the depth of color, with a pavilion cut below and a broad table above bordered with small facets. An octagonal garnet measuring 8½ lines by 6½ has sold for near $700. Pulverized garnet is sometimes employed as a substitute for emery.

The garnet was, in part, the carbunculus of the ancients, a term probably applied also to the spinel and Oriental ruby. The Alabandic carbuncles of Pliny were so called because cut and polished at Alabanda. Hence the name Almandine, now in use. Pliny describes vessels of the capacity of a pint, formed from carbuncles, "non claros ac plerumque sordidos ac semper fulgoris horridi," devoid of lustre and beauty of color, which probably were large common garnets. The garnet is supposed also to have been the hyacinth of the ancients.

ALTERED FORMS.—Garnets containing protoxyd of iron, often become rusty and disintegrated through the oxydation of the iron, and sometimes are altered to red iron ore. The action of waters, containing traces of carbonic acid and carbonates and silicates in solution, result in the same changes nearly as with pyroxene, producing at different times, *steatite, serpentine, chlorite.* The lime in the lime garnets may be taken up by the carbonic acid of the waters; and if magnesia is combined with the carbonic acid (forming a bicarbonate) it may take the place of the lime, and thus give rise to a steatitic pseudomorph, or to a chlorite, if the iron partly remains. Alkaline carbonates seldom produce the changes, for alkaline pseudomorphs are rare. An excess of silica is to be expected in analyses, according to Bischof, since part of the bases are often lost through incipient change. Quartz also occurs with the form of garnet.

JELLETITE, Apjohn. Said to occur in rhombic prisms giving the angles 60°, the supplement of which 120° is the angle of the dodecahedron. H. above 7; G.= 3·741. Occurs as a yellowish, slightly greenish incrustation, and is compact in its texture. Composition, according to Wright, (J. Geol. Soc. Dublin, v, 119) $\dddot{\mathrm{Si}}$ 38·09, $\dddot{\bar{\mathrm{Fe}}}$ 33·41, $\dot{\mathrm{Ca}}$ 28·61=100·11, which, if a small part of the iron is protoxyd, would give the formula of a garnet.

Tritomite of Weibye, a hydrous species, is probably related in composition, as it is in form, to Garnet and Helvin; it appears to give, although a peroxyd silicate, the garnet oxygen ratio 1 : 1. See description under Hydrous Silicates.

PYROPE. Bohemian Garnet.

Monometric; cubic with uneven rounded faces. Generally in rounded grains. Cleavage none.

H.=7·5. G.=3·69—3·8. Lustre vitreous. Color blood-red. Transparent—translucent. Fracture conchoidal.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+3\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}$?$=(\frac{1}{4}\dot{\mathrm{R}}^3+\frac{3}{4}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$. Analyses: 1, Klaproth, (Beit. ii, 16, v, 171); 2, T. Wachtmeister, (K. V. Ac. H. 1825, 216); 3, Kobell, (Kastner's Arch. v, 165, viii, 447, ix, 344).

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dddot{\bar{\mathrm{Mn}}}$	$\dddot{\mathrm{Cr}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$
1. Bohemia,	40·00	28·50	16·50	0·25	2·00	10·00	3·50=100·75, Klaproth.
2. Meronitz,	43·70	22·40	——	——	6·52	5·60	6·72, $\dot{\mathrm{Fe}}$ 11·48, $\dot{\mathrm{Mn}}$ 3·68, W.
3. Stiefelberg,	42·08	20·00	1·51	0·32	3·01	10·20	1·99, " 9·10=98·21, Kob.

Fuses with some difficulty before the blowpipe to a black glass, and with borax yields an emerald-green globule.

From the mountains on the south side of Bohemia, imbedded in trap tufa and wacke; and also at Zöblitz in Saxony, in serpentine.

ALTERED FORMS.—Pyrope altered to talc, occurs at both of the above-mentioned localities.

HELVIN, *W.* Tetrahedral Garnet.

Monometric: tetrahedral. Figures 55 and 57. Cleavage: octahedral, in traces.

H.=6—6·5. G.=3·1—3·3; 3·216, Breithaupt. Lustre vitreous, inclining to resinous. Color wax-yellow, inclining to yellowish-brown, and siskin-green; streak uncolored. Subtranslucent. Fracture uneven.

Composition.—Analyses by Gmelin, (Pogg. iii, 53):

$\dddot{\mathrm{Si}}$ 33·26, $\dddot{\bar{\mathrm{Be}}}$ and some $\dddot{\bar{\mathrm{Al}}}$ 12·03, $\dot{\mathrm{Mn}}$ 31·82, $\overset{\prime}{\mathrm{Mn}}$ 14·00, $\dot{\mathrm{Fe}}$ 5·56, ign. 1·16=97·82.

" 35·27, " 8·03, " 1·45, " 29·34, " 14·00, " 7·99, " 1·16=97·24.

G. Rose writes the formula $(\dot{\mathrm{M}}\mathrm{n}, \dot{\mathrm{F}}\mathrm{e})^3 \dddot{\mathrm{Si}}^2 + \ddot{\bar{\mathrm{B}}}\mathrm{e}\,\dddot{\mathrm{Si}} + \mathrm{Mn\,S}, \mathrm{Mn\,O}$. If in this formula Mn S be considered as replacing a portion of protoxyd, the oxygen ratio for the bases and silica is 8 : 9. The analyses correspond as well to the ratio 9 : 9=1 : 1, which is the garnet ratio; the formula may then be $(\frac{2}{3}\dot{\mathrm{R}}^3 + \frac{1}{3}\ddot{\bar{\mathrm{B}}}\mathrm{e})\,\dddot{\mathrm{Si}}$ or $2\dot{\mathrm{R}}^3\,\dddot{\mathrm{Si}} + \ddot{\bar{\mathrm{B}}}\mathrm{e}\,\dddot{\mathrm{Si}}$, which (if $1\dot{\mathrm{R}} = \frac{4}{18}\,\mathrm{Mn\,S} + \frac{3}{18}\dot{\mathrm{F}}\mathrm{e} + \frac{11}{18}\dot{\mathrm{M}}\mathrm{n}$)=Silica 34·1, glucina 9·6, sulphuret of manganese 14·6, protoxyd of manganese 32·7, protoxyd of iron, 9·0=100.

B.B. on charcoal fuses with intumescence in the reducing flame, to a yellow opaque globule. With borax gives the reaction of manganese. With muriatic acid evolves sulphuretted hydrogen, and affords a jelly of silica.

Occurs in gneiss at Schwarzenberg in Saxony, associated with garnet, quartz, fluor, and calc spar; at Breitenbrunn, Saxony; also at Hortekulle, near Modum, in Norway. It was named by Werner in allusion to its yellow color, from ἥλιος, *the sun.*

ZIRCON, *W.* Hyacinth. Jargon. Zirconite. Silicate of Zirconia. Erdmannite. Ostranite, *Breithaupt.* Calyptolite, *Shepard.*

Dimetric. $O : 1i = 147° 21'$; $a = 0·6407$. Observed planes as in f. 387, with also planes 2 and 3.

$I : 1 = 132° 10'$. $ii : 1 = 118° 20'$. $ii : 44 = 155° 8'$.
$I : 2 = 151° 6'$. $ii : 1i = 122° 39'$. $1i : 1i$ (pyr.)$= 135° 11'$.
$I : 3 = 159° 48'$. $ii : 33 = 148° 17'$. $1 : 1$ (pyr.)$= 123° 19'$.

Cleavage: *I* imperfect; 1, less distinct. Also in irregular forms and grains.

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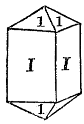

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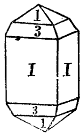

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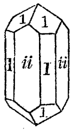

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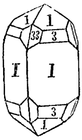

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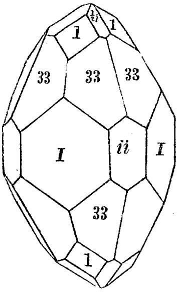
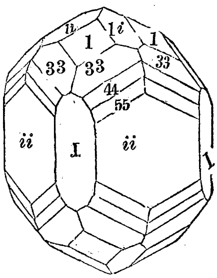


McDowall Co., N. C.

387



H.=7·5. G.=4·0—4·75; 4·505, Haidinger; 4·072 and 4·222, near Stockholm, Svanberg; 4·599 and 4·610, Ilmen, ib.; 4·453, Ceylon, ib.; 4·681, Thomson, Svanberg; 4·721, Lowry; 4·03 from Stockholm. Lustre more or less perfectly adamantine. Color red, brown, yellow, gray, white. Streak uncolored. Transparent—subtranslucent. Fracture conchoidal, and brilliant.

Composition.—$\ddot{\bar{\mathrm{Z}}}\mathrm{r}\,\dddot{\mathrm{Si}}$=Silica 33·2, zirconia 66·8=100, the zirconia, being partly the earth noria according to Svanberg. Analyses: 1, Berzelius, (K. V. Ac. H. 1824); 2, Vanuxem, (J. Acad. Sci. Philad. iii, 59); 3, W. Gibbs, (Pogg. lxxi, 559); 4, Henneberg, (J. f. pr. Chem. xxxviii, 508); 5, T. S. Hunt, (Am. J. Sci. [2], xii, 214); 6, C. M. Wetherill, (Trans. Amer. Phil. Soc. x, 346, and Am. J. Sci. xv, 443):

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Z}}}\mathrm{r}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	
1. Expailly,	33·48	67·16	——	=100·64, Berzelius.
2. N. Carolina; G.=4·453,	32·08	67·07	——	=99·15, Vanuxem.
3. Litchfield, Me. G.=4·7,	35·26	63·33	0·79	undecomp. 0·39=99·74, Gibbs.
4. G.=4·615—4·71,	33·85	64·81	1·55	$\dot{\mathrm{C}}\mathrm{a}$ 0·88=101·09, Henneberg.
5. Grenville, G.=4·625–4·602,	33·7	66·3	——	=101·0, Hunt.
6. Reading, Pa., G.=4·595,	34·07	63·50	2·02,	$\dot{\mathrm{H}}$ 0·50=100·09, Wetherill.

Not acted on by the acids, excepting by sulphuric after long digestion.

B.B. loses color, but is infusible alone, and also with carbonate of soda and salt of phosphorus. With borax melts with difficulty to a diaphanous glass, which with more of the flux is opaque. Klaproth discovered the earth zirconia in this species in 1789.

Hyacinth includes the bright colored varieties; *Zirconite* the grayish or brownish, frequently rough or opaque. The variety from Ceylon, which is colorless, or has a smoky-tinge, and is therefore sold for inferior diamonds, is sometimes called *jargon.*

Hyacinth occurs in the sand and alluvial deposits of certain rivers in Ceylon; at Expailly near Le Puy, France; at Ohlapian in Transylvania; Pfitsch in the Tyrol, (1 : 1=123° 25′, Kobell); at Bilin, in Bohemia; Sebnitz in Saxony; occasionally in volcanic tufa in Auvergne; also in Greenland; in the zircon syenite of Fredericksvärn in Norway; near Brevig, sometimes called *Erdmannite,* containing $\dddot{\mathrm{Si}}$ 33·43, $\ddot{\bar{\mathrm{Z}}}\mathrm{r}$ (with some Fe and Mn) 65·97, ign. 0·70, Berlin, Pogg, lxxxviii, 162; at Miask, in the Urals; in the iron mines of Arendal; also in Scotland, at Scalpay in Harris, and in the granite of Criffel in Kircudbrightshire; at Vesuvius with ryacolite, in white and blue octahedrons; at Santa Rosa, (Antioquia), New Grenada, in small colorless crystals.

In Buncombe Co., N. C., on the road from the Saluda Gap to Asheville, upon the first elevation after passing Green river, crystals are found loose in the soil, and imbedded in feldspar; in the sands of the gold washings of McDowall Co., N. C., (f. 386). In New York, cinnamon-red, at Hall's mine in Moriah, Essex Co., in a vein of quartz; near the outlet of Two Ponds, Orange Co., with scapolite, pyroxene, and sphene, in crystals sometimes 1 in. in length; on Deer Hill, a mile southeast of Canterbury, in the same Co., crystals abundant of a deep brownish-red or black color, and occasionally 1½ in. in length; chocolate-brown crystals in Warwick, at the southern base of Mount Eve, in limestone and scapolite; near Amity, and also in Monroe and Cornwall, at several localities, of white, reddish-brown, clove-brown, and black colors; at Diana in Lewis Co., in large brown crystals sometimes 2 in. long, with sphene and scapolite, but rare. In St. Lawrence Co., with apatite at Robinson's in the town of Hammond, near De Long's Mills; some of the crystals are 1½ in. long, and ½ inch wide, and they sometimes contain a nucleus of carbonate of lime. Crystals are found also at Rossie, (form *I*, 1, 3), at Johnsburg, in Warren Co., in New Jersey at Franklin, and in gneiss at Trenton; at Middlebury, Vt.; at Litchfield, Me.; near Reading, Pa., in large crystals in magnetic iron ore; in talcose slate at Easton, Pa.; at Grenville, St. Jerome and Mille Isles, Canada; in the Gold washings of the north fork of the American River and elsewhere in California.

Hyacinth occurs of sufficient dimensions to be valuable as a gem.

It is very doubtful whether the modern hyacinth is one of the stones that were called hyacinth (ὑάκινθος) by the ancients. Jameson seems to have supposed that they applied this name to the amethyst or sapphire.

Ostranite, Breit., is a zircon of a grayish-brown color. From Fredericksvärn?

Altered Forms.—Zircon is one of the most unalterable of minerals, as it contains no protoxyds, and only the most insoluble of peroxyds. It however passes to a hydrous state, and is probably acted on by alkaline waters, which attack the silica, and thus Œrstedite may have been formed. *Malacone, Œrstedite* and *Tachyaphaltite,* are probably altered zircon.

Malacone, Scheerer, (Pogg. lxii, 436). Dimetric like zircon; 1 : 1=124°40′ to 124° 57′ and 83° 30′. H.=6·5. G.=3·9—4·047. Brown and vitreous to subresinous, powder reddish brown or uncolored. Composition $\ddot{\bar{\mathrm{Z}}}\mathrm{r}\ \dddot{\mathrm{Si}}+\frac{1}{2}\dot{\mathrm{H}}$ (or $\frac{2}{3}\dot{\mathrm{H}}$). Analyses: 1, Scheerer, (loc. cit.); 2, Damour, (loc. cit.); 3, Hermann, (J. f. pr. Chem. liii, 32).

	$\dddot{Si}$	$\dddot{\bar{Zr}}$	$\dddot{\bar{Fe}}$	$\dot{Y}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{H}$
1. Hitteroe,	31·31	63·40	0·41	0·34	0·39	0·11	3·03=98·99, Scheerer.
2. Chanteloube,	30·87	61·17	3·67	——	0·08	——	3·09, $\dddot{\bar{Mn}}$ 0·14=99·02, D.
3. Ilmen Mts.,	31·87	59·82	$\dddot{\bar{Fe}}$3·11	——	——	$\dot{Mn}$1·20	4·00=100, Hermann.

B.B. like zircon, except it yields water. From Hitteroe in Norway, and Chanteloube, Haute Vienne, at the latter place occurring in thin plates rarely over 3 to 4 mm. thick and occasionally with crystals on their surface.

Calyptolite of Shepard, (Am. J. Sci., [2], xii, 210); occurs with chrysoberyl at Haddam, Ct., in minute, short square prisms like f. 382, of a dark brown or greenish brown color; angle 1 : 1 stated at 122°—124°. G.=4·34; H.=6·5. It yields some moisture, and is probably zircon somewhat altered.

Œrstedite, Forchhammer, (Pogg. xxxv, 630).—Dimetric; 1 : 1=123° 16½′. H.=5·5. G.=3·629. Reddish brown and splendent adamantine; opaque or subtranslucent.

Composition.—According to Forchhammer contains—

$\dddot{Si}$ 19·708 $\dot{Ca}$ 2·612 $\dot{Mg}$ 2·047 $\dot{Fe}$ 1·136 $\ddot{Ti}$ and $\dddot{\bar{Zr}}$ 68·965 $\dot{H}$ 5·532=100.

B.B. infusible, and according to Berzelius gives a trace of tin. Occurs in brilliant crystals at Arendal in Norway, and commonly on crystals of pyroxene. Named after Œrsted.

TACHYAPHALTITE, *Berlin*, Pogg. lxxxviii, 160.

Dimetric. In short thick prisms, 3 lines long; planes *I* and *ii*, with two octahedrons, one of 110° (edge of pyramid) and the other of 50°. Cleavage not distinct.

H.=5·5. G.=3·6. Lustre submetallic to vitreous. Color dark reddish-brown. Streak dirty yellow. Subtranslucent. Fracture conchoidal.

Composition.—Analysis by Berlin (loc. cit.):

$\dddot{Si}$	$\dddot{\bar{Zr}}$	$\dddot{\bar{Fe}}$	$\dddot{\bar{Al}}$	$\dot{Th}$?	$\dot{H}$
34·58	38·96	3·72	1·85	12·32	8·49=99·92.

B.B. infusible, but becomes dirty white; with borax dissolves with difficulty; with soda on platinum a dirty yellowish brown slag; in a tube gives water with a slight fluorine reaction. Partially decomposed by muriatic acid, after some time.

From granite veins in gneiss, near Krageroe, with sphene. The name of the species is from ταχυς, *quick*, and αφαλτος, the mineral flying readily from the gangue when struck.

IDOCRASE, *H.* Vesuvian. Egeran. Gökumite. Loboit, Frugardit, Idokras. Protheite, *Ure.* Wiluite. Cyprine. Xanthite, *Mather.*

Dimetric. *O* : 1*i*=151° 51′; *a*=0·53507.

O : 1=142° 53′.	*O* : *I*=90°.	*ii* : *i*2=153° 26′.
O : 2=123° 27 .	*I* : 1*i*=118° 9′.	*ii* : *i*3=161° 34′.
O : 22=129° 53′.	*ii* : 22=133° 20′.	1 : 1(ov.1*i*)=129° 29′.
O : 44=114° 23′.	*ii* : 33=144° 45′.	1 : 1(ov.*I*)=74° 14′.
O : $\frac{3}{2}$3=139° 46′.	*ii* : 44=152° 5′.	1*i*: 1*i* (pyr.)=141° 1′.

Cleavage: *I* not very distinct, *O* still less so. Twins: plane of composition 4*i*, (?) angle of divergence 56° to 60°; also *ii*. Columnar structure rare, straight and divergent, or irregular; occasionally granular.

H.=6·5. G.=3·349—3·45. Lustre vitreous: often inclining to resinous. Color brown to green; and the latter frequently bright and clear; occasionally sulphur-yellow, and also blue; sometimes green along the axis, and pistachio-green transversely. Streak white. Subtransparent—faintly subtranslucent. Fracture subconchoidal—uneven.

O				
$\frac{1}{8}$				
$\frac{1}{2}$				
1				1*i*
		$\frac{3}{2}$3		
2	22			2*i*
3		33		
4	42		44	
5				
I	*i*2	*i*3		*ii*

Observed Planes.

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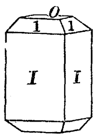

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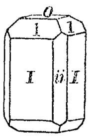

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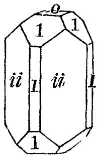

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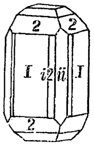

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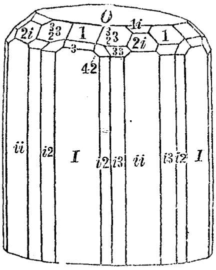

Sandford, Me.

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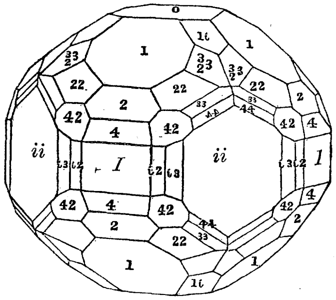


Vesuvius.

Composition.-$\dot{R}^3\dddot{Si}+\ddot{\bar{R}}\dddot{Si}=(\frac{1}{2}\dot{R}^3+\frac{1}{2}\ddot{\bar{R}})\dddot{Si}$=(if $\dot{R}=\frac{8}{9}\dot{Ca}+\frac{1}{9}\dot{Fe}$) Silica 39·6, alumina 22·5, lime 32·6, protoxyd of iron 5·3=100. Some analyses require $3\dot{R}^3\dddot{Si}+2\ddot{\bar{R}}\dddot{Si}=(\frac{3}{5}\dot{R}^3+\frac{2}{5}\ddot{\bar{R}})\dddot{Si}$=(if $\dot{R}$ equals as above) Silica 38·4, alumina 17·4, lime 38·0, protoxyd of iron 6·2=100. Analyses: 1–4, Magnus, (Pogg. xxi, 50); 5–8, Karsten, (Karsten's Archiv f. Min. iv, 391); 9, Varrentrapp, (Pogg. xlvi, 343); 10, Ivanoff, (Pogg. xlvi, 341); 11, 12, Kobell, (Kast. Arch. vii, 399); 13, Nordenskiöld, (Schw. J. xxxi, 436); 14, Thomson, (Min. i, 143); 15, Richardson, (ib. 262); 16–18, Hermann, (J. f. prakt. Ch. xliv, 193):

	$\dddot{Si}$	$\ddot{\bar{Al}}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mg}$
1. Vesuvius, *brown*,	37·36	23·53	3·99	29·68	——, $\dot{Mg}$ and $\dot{Mn}$ 5·21=99·77, M.
2. Slatoust, Ural,	37·18	18·11	4·67	35·79	0·77, $\dot{Mn}$ 1·49=98·01, Magnus.
3. Cziklowa, *green*,	38·52	20·06	3·42	32·41	2·99, $\dot{Mn}$ 0·02=97·42, "
4. Christiansand,	37·66	17·69	6·49	31·90	4·54, $\dot{Mn}$ 0·50=98·77, "
5. Vesuvius, G. 3·420,	37·50	18·50	6·25	33·71	3·10, $\dot{Mn}$ 0·10=99·16, Karsten.
6. Piedm. *gn.* G.=3·399,	39·25	18·10	4·30	33·95	2·70, $\dot{Mn}$ 0·75=95·25, Karsten.

		$\dddot{\text{Si}}$	$\dddot{\overline{\text{Al}}}$	$\dot{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$
7.	SassValley, *brown*,	38·40	18·05	3·10	36·72	1·50, $\dot{\text{Mn}}$ 0·65, $\dot{\text{Na}}$ 0·9=99·32, K.
8.	*Egeran*,	39·70	18·95	2·90	34·88	——, $\dot{\text{Mn}}$ 0·96, $\dot{\text{Na}}$ 2·10=99·49, K.
9.	Slatoust, Ural,	37·55	17·88	6·34	35·66	2·62, =99·95, Varrentrapp.
10.	" "	37·08	14·16	16·02	30·88	1·86=100, Ivanoff.
11.	Ala,	34·85	20·71	5·40	35·61	—, =96·57, Kobell.
12.	Monzoni,	37·65	15·42	6·42	38·24	—, =97·72, "
13.	*Frugardite*,	38·53	17·40	3·90	27·70	10·60, $\dot{\text{Mn}}$ 0·33=98·46, Nord.
14.	*Xanthite*,	35·09	17·43	—	33·08	2·00, $\dddot{\overline{\text{Fe}}}$ 6·37, $\dot{\text{Mn}}$ 2·80, $\dot{\text{H}}$ 1·68, T.
15.	*Cyprine*, G.=3·228,	38·80	20·40	8·35	32·00	——=99·55, Richardson.
16.	Achmat. G.=3·4,	37·62	13·25	0·60	36·43	3·79, $\dot{\text{Mn}}$ 0·5, $\dddot{\overline{\text{Fe}}}$ 7·12, $\ddot{\text{C}}$ 0·7, H.
17.	Slatoust, G.=3·42,	38·19	14·34	0·61	32·69	6·20, $\dot{\text{Mn}}$ 2·1, $\dddot{\overline{\text{Fe}}}$ 5·26, =99·39, H.
18.	" G.=3·35,	39·20	16·56	0·30	34·73	4·00, $\dot{\text{K}}$, $\dot{\text{Na}}$ 2·0, $\dddot{\overline{\text{Fe}}}$ 1·20, $\ddot{\text{C}}$ 1·50, H.

B.B. fuses easily with some intumescence to a translucent yellow globule, and forms with borax a diaphanous glass, tinged with iron. By fusion the specific gravity is reduced to 2·93—2·945, according to Magnus, without any change of composition. Cyprine in the reduction flame affords a red pearl from the copper present. Idocrase is attacked by the acids, and after heating wholly dissolves and gelatinizes. A *manganesian* idocrase from St. Marcel, Piedmont, has a sulphur to honey-yellow color, and gives an amethystine color with borax in the oxydation flame.

Idocrase was first observed in the ancient Vesuvian lavas, and was thence called Vesuvian. It has since been met with in serpentine, gneiss, and granular limestone.

The Vesuvian idocrase has a hair-brown or olive-green color, and is associated with glassy feldspar, garnet, mica, and nepheline. The crystals from Ala, in the Val-di-Brozzo, in Piedmont, are usually transparent and brilliant with a green or brown color, rarely black. Egg, near Christiania, in Norway, the Ural, Wilui river near Lake Baikal, Cziklowa in the Bannat, and Monzoni in the Fassa valley, are other localities. Sulphur-yellow crystals have been found at Monzoni. A light brown variety occurs in Donegal, Ireland. From Frugard, Finnland, comes the *frugardite;* from Gökum what has been called *gökumite*, and *loboite.* Liver-brown diverging groups, from Eger in Bohemia, have been called *egeran.* Crystals of a blue tint, called *cyprine*, come from near Tellemark, Norway; the color is attributed to copper.

At Phippsburg and Rumford, just below the falls in Maine, in crystals and massive with yellow garnet, pyroxene, &c., in limestone; also at Parsonsfield, Me., with the same materials, abundant; also at Poland and Sandford, (fig. 393), Me.; at Worcester, Mass., in a quartz rock, with garnet, but exhausted; yellowish-brown in crystals at Newtown, N. J., with corundum and spinel; half a mile south of Amity, N. Y., grayish and yellowish-brown crystals, sometimes an inch in diameter, in granular limestone; also at the village, and a mile east of the village, of yellow, greenish-yellow, and yellowish-brown colors. The *Xanthite*, which is from this vicinity, is identical in crystallization with common idocrase. Large brownish-yellow crystals occur at Clarendon, Canada West, in limestone with brown tourmaline.

Named from ειδω, *I see*, and κρασις, *mixture*, because the crystalline forms have much resemblance to those of some other species.

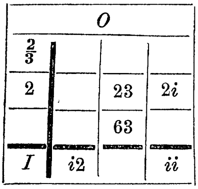
Altered Forms.—Alterations nearly as in garnet. Crystals from Maine often have the exterior, though still brilliant and glassy, cleavable easily from the part below, and equally so, parallel to all the smaller as well as larger faces, so that a pealed crystal has as brilliant and even planes as before. Idocrase has been observed altered to steatite and mica.

An Egeran, analyzed by Ficinus, (Schrift. Dresd. Min. Ges. i, 235), gave, Silica 43·00, alumina 14·70, peroxyd of iron 2·40, ib. of manganese 4·00, lime 30·00, soda 5·33=99·43. It is probably in an altered state, as Rammelsberg infers from the description of Ficinus.

The carbonic acid detected by Hermann in idocrase from Slatoust, (anal. 18), is evidence of alteration, and this acid and alkaline or earthy carbonates or bicarbonates in solution, are agents by which change is often produced.

Heteromerite of Hermann, is a light green mineral from Slatoust, containing according to v. Hauer, (Jahrb. Geol. Reichs. 1853, 155): $\dddot{\text{Si}}$ 43·29, $\dddot{\overline{\text{Al}}}$ 23·17, $\dddot{\overline{\text{Fe}}}$ 6·10, $\dot{\text{Ca}}$ 23·78, $\dot{\text{Mg}}$ 3·05. The oxygen ratio from the analysis is 1 : 1½ : 3.

SARCOLITE, *Thomson*. Sarkolith. Analcime carnea, *Monticelli*.



Observed Planes.

Dimetric; *O* : 1*i*=156° 5′; *a*=0·4435. Hemihedral in the planes 23, only the alternate occurring. *O* : 2=128° 33′, 2 : 2 (over terminal edge)132° 52′, *O* : $\frac{2}{3}$=157° 19′, *I* : 2=141° 27′. Crystals small.

H.=6. G.=2·545. Lustre vitreous. Color flesh-red, reddish-white. Transparent to subtransparent. Extremely brittle.

According to an imperfect analysis by Scacchi, (Quadri Crystallographici, Naples, 1842, p. 66), contains

$\dddot{\mathrm{Si}}$ 42·11 $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 24·50 $\dot{\mathrm{Ca}}$ 32·43 $\dot{\mathrm{Na}}$ 2·93=101·97,

corresponding nearly to the composition of idocrase, and formula $(\frac{1}{2}(\dot{\mathrm{Na}}, \dot{\mathrm{Ca}})^3+\frac{1}{2}\dddot{\bar{\mathrm{A}}}\mathrm{l})\dddot{\mathrm{Si}}$. B.B. fuses to a white enamel. With acids gelatinizes. Of rare occurrence at Mt. Somma.

MEIONITE, *H*. Mizzonite, *Scacchi*.

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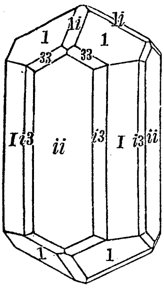

Dimetric: *O* : 1*i*=156° 18′; *a*=0·439. Observed planes, *O*, 13, *I*, 33, *i*3, 1*i*, *ii*; sometimes hemihedral in the planes 33, the alternate being wanting. *O* : 1=148° 10′, 1 : 1, pyr.=136° 11′, basal 63° 40′.

Cleavage: *ii* and *I* rather perfect, but often interrupted.

H.=5·5—6. G.=2·5—2·74; 2·734—2·737, v. Rath. Lustre vitreous. Colorless to white. Transparent to translucent; often cracked within.

Composition.—$\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}+2\dddot{\bar{\mathrm{A}}}\mathrm{l}\,\dddot{\mathrm{Si}}=(\frac{1}{3}\dot{\mathrm{Ca}}^3+\frac{2}{3}\dddot{\bar{\mathrm{A}}}\mathrm{l})\dddot{\mathrm{Si}}$=Silica 42·1, alumina 31·9, lime 26·0. Analyses: 1, L. Gmelin, (Schw. J. xxv, 36, xxxv, 348); 2, Stromeyer, (Unters. 378); 3, Wolff, (De Comp. Ekeberg. etc., Ramm., 2nd Suppl. 133); 4, v. Rath. (De Comp. Wern., Pogg. xc, and Ramm., 5th Suppl., 211):

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	
1.	Somma,	43·80	32·85	——	20·64	——	2·57[a]	——,	$\dot{\mathrm{F}}$e 1.07=100·93, Gm.
2.	"	40·53	32·73	——	24·24	——	1·81		$\dot{\mathrm{F}}$e 0·18=99·50, Str.
3.	"	42·07	31·71	——	22·43	——	0·45	0·31,	ign 0·31=97·29, Wolff.
4.	"	42·55	30·89	0·41	21·41	0·83	1·25	0·93,	" 0·19=98·46, Rath.

a With some $\dot{\mathrm{L}}$i.

B.B. a colorless glass; a clear glass with soda. With acids does not gelatinize, according to v. Rath., contrary to v. Kobell's statement.

Mizzonite, from Mt. Somma, afforded Scacchi the angles 1 : 1=135° 56′ and 64°08′; B.B. does not intumesce as much as Meionite, and is less easily attacked by acids.

Occurs in small crystals in geodes, usually in limestone blocks on Monte Somma, near Naples.

Meionite was named from μειων, *less*, the pyramid being less acute than in idocrase.

SCAPOLITE, *Werner*. Wernerite, *H.* Paranthine. Ekebergite. Nuttallite, *Brooke*. Tetraklasit, *Haus.* Glaucolite, *Fischer.* Atheriastite, *Weibye.* Terenite, *Emmons.* Porcellanspath, *Fuchs.* Stroganowite, *Hermann.* Schmelzstein, Skapolith, Spreustein, *Wern.*

Dimetric: *O* : 1*i*=156° 14½′; *a*=0·4398. Observed planes, *O*, *ii*, *I*, 1, 1*i*, *i*2, *i*3.

O : 1=148° 6′. *I* : *i*3=153° 26′. 1 : 1 (pyr.)=136° 7′.
I : 1=121° 54′. *ii* : *i*3=161° 34′. 1 : 1 (bas.)=63° 48′.
I : *i*2=161° 34′. *ii* : *i*2=153° 26′. 1*i* : 1*i* (pyr.)=146° 53′.

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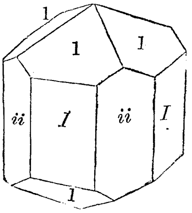

Cleavage: *ii* and *I* rather distinct, but interrupted. Also massive, granular, or with a faint fibrous appearance; sometimes columnar. H.=5—5·5, nearly 6, a subtransparent variety from Gouverneur, N. Y. G.=2·612—2·749. Lustre vitreous to pearly externally, inclining to resinous; cleavage and cross fracture surface vitreous. Color white, gray, blue, green, and red; colors usually light; streak uncolored. Transparent—faintly subtranslucent. Fracture subconchoidal. Brittle.

The species Scapolite undergoes but small variations in structure. It never becomes strictly fibrous, and usually occurs in distinct crystals which are occasionally of large size. The crystals when not glassy, are often rendered opaque externally or throughout by partial alteration, and sometimes have a chalky appearance over the surface, after exposure. The massive varieties have some resemblance to the feldspars. The following are names of so-called varieties.

Scapolite (named from σκαπος, *a club*) or *Wernerite* includes common grayish and white varieties. *Nuttallite* is essentially the name; colors bluish, grayish and dark greenish. *Paranthine* has included certain compact varieties and crystals of white and pale blue colors. *Ekebergite* is massive and subfibrous. The distinctions between these varieties are not well defined. *Porcelain Spar* is described as affording the prismatic angle 92°. But the analyses give the same oxygen ratio essentially as for Scapolite. G.=2·65—2·68. *Glaucolite* (Anal. 15, 26, 27) is referred to this place by G. Rose, as its cleavages are those of Scapolite and not of Labradorite; it is named from γλαυκος, *greenish-gray*. G.=2·72—2·9. Color lavender-blue, greenish; somewhat resembling blue Cancrinite.

Composition mostly $\dot{R}^3\dddot{Si}^2+2\dddot{Al}\,\dddot{Si}$,$=(\frac{1}{3}\dot{R}^3+\frac{2}{3}\dddot{Al})\dddot{Si}^{\frac{4}{3}}$=(if $\dot{R}=\dot{C}a$) Silica 49·3, alumina 27·9, lime 22·8.

Analyses: 1, v. Rath, (Pogg. xc); 2, 3, Wolff, (Foss. Ekeberg.); 4, 5, Rath, (loc. cit.); 6, Stadtmüller, (Am. J. Sci. [2], viii, 294); 7, H. Wurtz, (Am. J. Sci., [2], x, 325); 8, Hartwall, (Jahresb. iv, 155); 9, 10, Wolff, (loc. cit.); 11, 12, v. Rath, (loc. cit.); 13, Hartwall and Hedberg, (Jahresb. iv, 155); 14, Nordenskiöld, (Schw. J. xxxi, 417); 15, v. Rath, (loc. cit.); 16, Berg, (Jahresb. xxv, 356); 17, Wolff, (loc. cit.); 18, Ekeberg, (Afh. i Fys. ii, 153); 19, Fuchs, (Leonh. Tasch. f. Min., 1823, 94); 20, Kobell, (J. f. pr. Chem. i, 89); 21, Schafhäutl, (Ann. Ch. u. Pharm., xlvi, 325); 22, Hermann, (J. f. pr. Chem. liv, 420); 23, Wolff, (loc. cit.); 24, Hermann, (loc. cit.); 25, v. Rath, (loc. cit.); 26, Bergemann, (Pogg. ix, 267); 27, Giwartowsky, (Bull. Soc. Nat., Moscow, 1848, 548); 28, 29, Hermann, (loc. cit.)

Specific gravity of 1, 2·654; 2, 2·712; 3, 2·718; 4, 2·748; 5, 2·788; 6, 2·748 7, 2·704; 9, 2·623; 10, 2·733; 11, 2·763; 12, 2·751; 15, 2·666; 16, 2·34; 17, 2·735 22, 2·70; 23, 2·712; 24, 2·69; 25, 2·633; 26, 27, 2·65—2·72; 28, 2·80; 29, 2·74.

	$\dddot{\mathrm{S}}\mathrm{i}$	$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	$\ddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{K}}$	
1. Pargas, *gnh.*	45·46	30·96	——	17·22	——	2·29	1·31	$\dot{\mathrm{H}}$ 1·29=98·53, R.
2. "	45·10	32·76	——	17·84	——	0·76	0·68	ign 1·04=98·18, W.
3. Bolton,	48·79	28·16	0·32	15·02	1·29	4·52	0·54	ig. 0·74=99·36, W.
4. " *bkh-gn.*	45·57	23·65	3·38	20·81	1·23	2·46	0·63	$\dot{\mathrm{H}}$ 0·78=98·51, R.
5. " "	44·40	25·52	3·79	20·18	1·01	2·09	0·51	" 1·24=98·74, R.
6. "	45·79	30·11	1·86	17·40	——	*tr.*	3·48[a]	" 1·63=100·27, S.
7. " *blue,*	47·67	25·75	2·26	17·31	——	7·76	——	=100·77, Wurtz.
8. Pargas,	49·42	25·41	1·40	15·59	0·68	6·05	——	ign. 1·45=100, Har.
9. Wermland,	49·88	27·02	0·21	12·71	0·85	7·59	0·87	ign. 0·77=99·90, W.
10. Finland,	48·15	25·38	1·48	16·63	0·84	4·91	0·12	ign. 0·85=98·45, W.
11. Malsjö, *blue,*	47·24	24·69	*tr.*	16·84	2·18	3·55	0·85	$\dot{\mathrm{H}}$ 1·75=97·06, Rh.
12. Arendal, *ywh.*	45·05	25·31	2·02	17·30	0·30	6·45	1·55	$\dot{\mathrm{H}}$ 1·24=99·22, Rh.
13. Ersby,	48·77	31·05	——	15·94	——	3·25	——	$\dot{\mathrm{H}}$ 0·61=9 9·62, H.
14. "	43·83	35·43	——	18·96	——	——	——	$\dot{\mathrm{H}}$ 1.03, Nord.
15. L. Baikal, *Gl.*	46·60	27·20	1·53	15·98	0·48	4·70	0·60	$\dot{\mathrm{H}}$0·55=97·49,[b] Rh.
16. Drothems,	46·35	26·34	0·32	17·00	0·54	4·71	0·32	ign. 1·60, undec. 0·99 =98·17, B.
17. Hesselk. *Ekeb.*	49·26	26·40	0·54	14·44	——	6·14	0·65	ign. 0·69=98·12, W.
18 "	46·00	28·75	0·75	13·50	——	5·25	——	" 2·25=96·50, Ek.
19. *Porcelain Sp.*	49·30	27·90	——	14·42	——	5·46	——	$\dot{\mathrm{H}}$ 0·90=97·98, F.
20. "	50·29	27·37	——	13·53	——	5·92	0·17	=97·30, Kobell.
21. "	49·20	27·30	——	15·48	——	4·53	1·23	Cl0·92, $\dot{\mathrm{H}}$1·2, Schaf.
22. Bolton, *red,*	50·16	28·44	——	13·12	0·76	1·42	0·91	$\dot{\mathrm{M}}\mathrm{n}$ 0·14, $\dot{\mathrm{F}}\mathrm{e}$ 0·12, $\ddot{\mathrm{C}}$ 2·94, $\dot{\mathrm{H}}$0·8, $\dot{\mathrm{L}}\mathrm{i}$ tr.=98·81, H.
23. Arendal,	50·91	25·81	0·75	13·34	0·58	7·09	0·85	ign. 0·41=99·74, W.
24. Gullsjö,	52·94	27·64	——	9·10	——	6·89	0·54	$\dot{\mathrm{M}}\mathrm{n}$ 0·25, $\dot{\mathrm{F}}\mathrm{e}$ 0·3, $\ddot{\mathrm{C}}$ 1·50=99·72, Her.
25. Gouverneur,	52·25	23·97	——	9·86	0·78	8·70	1·73	$\dot{\mathrm{H}}$ 1,20=98·49, Rh.
26. *Glaucolite,*	50·58	27·60	$\dot{\mathrm{F}}$ 0·1	10·27	3·73	2·97	1·27	$\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·87, $\dot{\mathrm{H}}$ 1·73, Be.
27. "	50·49	28·12	" 0·4	11·31	2·68	3·10	1·01	$\dot{\mathrm{M}}\mathrm{n}$0·6 $\dot{\mathrm{H}}$1·79, Giw.
28. *Ekebergite,*	53·11	27·97	$\ddot{\bar{\mathrm{F}}}$ 2·84	9·73	0·39	4·83	0·86	$\dot{\mathrm{M}}\mathrm{n}$0·27=100,[c] Her.
29. Diana,	51·81	32·45	$\dot{\mathrm{F}}$ 2·53	9·76	——	2·38	0·79	$\dot{\mathrm{M}}\mathrm{n}$0·28, $\dot{\mathrm{H}}$0·30,[d] H.

[a] $\dot{\mathrm{N}}\mathrm{a}$ probably included.

[b] 1·35 p. c. of $\dot{\mathrm{C}}\mathrm{a}\,\ddot{\mathrm{C}}$ being excluded.

[c] 3·82 $\dot{\mathrm{C}}\mathrm{a}\,\dot{\mathrm{C}}$, excluded, Rammelsberg.

[d] 5·17 $\dot{\mathrm{C}}\mathrm{a}\,\ddot{\mathrm{C}}$ excluded.

Bischof and G. Rose consider pure scapolite as having the oxygen ratio of Meionite, 1 : 2 : 3 for the protoxyds, peroxyds, and silica=$(\frac{1}{3}\mathrm{R}^3+\frac{2}{3}\ddot{\bar{\mathrm{A}}}\mathrm{l})\,\dddot{\mathrm{S}}\mathrm{i}$=(if R=$\dot{\mathrm{C}}\mathrm{a}$) Silica 42·1, alumina 31·9, lime 26·0. But most of the analyses, as stated above, afford the ratio 1 : 2 : 4.

Analyses 1, 2, 6, give more nearly 1 : 2½ : 4.

No. 14 corresponds to the ratio 1 : 3 : 4=$(\frac{1}{4}\dot{\mathrm{C}}\mathrm{a}^3+\frac{3}{4}\ddot{\bar{\mathrm{A}}}\mathrm{l})\,\dddot{\mathrm{S}}\mathrm{i}$=Silica 43·2, alumina 36·8, lime 20·0. Nos. 24, 28, give the ratio 1 : 3 : 6 ; 25 the ratio 1 : 2 : 5 ; 29 the ratio 1 : 3½ : 6.

Other intermediate ratios are also presented by the analyses ; and even among specimens of the same locality. Thus Bolton alone has afforded to analysts the ratios (approximate)

1:2:4, 1·2:2:4, 1·2:2·25:4, 1:2·5:4, 1:3:6, 1:2½:6, 1:3·9:9,

and in one specimen analyzed by v. Rath the species contains potash replacing soda, (see beyond on Altered Forms.) It is obvious that the variations are largely due to alterations of one or two types. The ratio 1 : 2 : 4 is apparently the most prominent of these types, as recognized by Rammelsberg. Von Rath adopts, as a second, the Gouverneur scapolite, with the ratio 1 : 2 : 5.

Usually found in crystalline rocks, and in granular limestone, most common near its junction with granite; also in beds of magnetic iron, accompanying this rock. In the latter situation, scapolite occurs at Arendal, in Norway, and Wermland, in Sweden ; also in fine crystallizations in Pargas, Finland, &c. At Arendal it is associated with hornblende and garnet in limestone, and occurs in long slender crystals. *Wernerite* is found in short thick crystals at the same locality. *Paranthine* occurs in the limestone quarries of Malsjö in Wermland. Other localities as above. *Por-*

celain spar occurs in granular limestone at Obernzell in Bavaria. *Glaucolite* is found near Lake Baikal, Siberia, in veins in granite.

Good crystals occur at Gouverneur, N. Y., in granular limestone, with apatite, sphene, and augite; at Two Ponds in Orange Co., N. Y., reddish-white crystals with pyroxene, sphene, and zircon, one crystal 10 in. long and 5 in diameter; in Warwick of the same county, milk-white crystals near Amity, with pyroxene, sphene, and graphite; five miles south of Warwick, and two miles north of Edenville, near Greenwood Furnace, (planes 1, *I*, *i*2, *ii*), are other good localities; in Essex county, perfect crystals and massive, nearly fibrous, white and greenish-white, abundant near Kirby's graphite mine, four miles northwest of Alexandria, in Ticonderoga, associated with pyroxene; at Crown Point; in Lewis Co., N. Y., variety Nuttallite in fine crystals white, bluish, and dark gray, presenting the play of light usual with this variety; edges of the crystals often rounded. Bolton and Boxborough, Mass., afford good scapolite, both the common and the variety nuttallite, often in crystals sometimes large; also Chelmsford, Littleton, Chester, and Carlisle. At Parsonsfield and Raymond, near Dr. Swett's house, good crystals along with yellow garnet and adularia. At Franklin and Newton, N. J., and three miles west of Attleboro' crystallized scapolite occurs in limestone. At G. Calumet, Id., Canada, massive lilac-colored; in large crystals, at Hunterstown with sphene; at Grenville with pyroxene.

Massive scapolite occurs at many of the above localities; also at Marlboro', Vt.; Westfield, Mass.; Monroe, Conn., white and nearly fibrous; stone quarry at Paugatuck, Stonington, Conn.; West Point, N. Y., with pyroxene; and of white and bluish-white colors at Fall Hill, Monroe, in Orange Co., N. Y., along with lamellar pyroxene.

Canaanite of S. L. Dana is considered a grayish scapolite rock, from Canaan, Ct. Composition, $\dddot{\mathrm{Si}}$ 53·366, $\overset{\cdots}{\mathrm{\not{F}e}}$ 4·099, $\overset{\cdots}{\mathrm{\not{A}l}}$ 10·380, $\dot{\mathrm{Ca}}$ 25·804, $\dot{\mathrm{Mg}}$ 1·624 $\ddot{\mathrm{C}}$ 4·00=99·673.

Altered Forms.—Scapolite is exceedingly liable to alteration; and many of the analyses appear to have been made upon specimens that have lost part of their bases, so that the silica is in excess. The mineral in its more ordinary change loses its hardness and lustre. The action of carbonated waters is sufficient to produce this result, the carbonic acid taking up the lime; and by carrying off all the bases, the mineral may be thus reduced to a kaolin. By means of bicarbonate of magnesia in solution, *steatite* results. By alkaline carbonates in solution, alkalies may be introduced and lime removed, thus forming mica, algerite, etc., and perhaps zeolites; and the potash carbonate appears to be able under some circumstances to replace with potash, the soda of a soda silicate, as in algerite. By means of bicarbonate of iron in solution, an oxyd of iron may be introduced, the iron often peroxydizing in the process, and thus comes epidote after scapolite. *Atheriastite*, *Stroganowite*, *Terenite*, as well as *Algerite* are believed to be altered forms of scapolite.

Many of the analyses of scapolite already given, are to some extent of altered forms. The following are of specimens more altered.

I. Altered by removal of protoxyd bases, mostly by carbonic acid.

II. Altered by addition of oxyd of iron or magnesia without potash, and partial removal of bases.

III. Altered by addition of potash, and sometimes magnesia or oxyd of iron, and partial removal of bases.

Analyses: I, Brewer, (this Min., 3d edit., 680), 3, 4, Hermann, (J. f. pr. Ch. xxxiv, 177, and liv, 410); 5, Weibye and Berlin, (Pogg., lxxix, 299);—II, 6, 7, v, Rath, (Pogg., xc, 288);—III, 8, T. S. Hunt, (Am. J. Sci. [2], viii, 103); 9, Crossley, (this Min. 3d edit., 680); 10, J. D. Whitney, (Am. J. Sci., [2] xvi, 207); 11, 12, 13, v. Rath, (loc. cit.); 14, 15, Bischof, (Geol., ii, 1433):

		$\dddot{\mathrm{Si}}$	$\overset{\cdots}{\mathrm{\not{A}l}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$	
I. 1.	Franklin, N. J.,	46·39	29·09	5·13	1·97	——	*tr.*	1·80,	$\dot{\mathrm{Fe}}$ 2·04, $\dot{\mathrm{Ca}}\,\ddot{\mathrm{C}}$ 10·72=97·15, Brewer.
2.	" "	48·32	28·44	6·88	2·07	——	*tr.*	1·80,	$\dot{\mathrm{Fe}}$ 1·40, $\dot{\mathrm{Ca}}\,\ddot{\mathrm{C}}$ 10·72=99·64, Brewer.
3.	Diana, N. J.,	45·99	28·80	8·67	——	2·11	0·70	0·30,	$\dot{\mathrm{Fe}}$ 0·25, $\dot{\mathrm{Ca}}\,\ddot{\mathrm{C}}$ 8·67=98·29, Hermann.
4.	*Stroganowite*,	40·58	28·57	11·05	——	3·50	——	——	$\dot{\mathrm{Fe}}$, $\dot{\mathrm{Mn}}$ 0·89, $\dot{\mathrm{Ca}}$ C 14·55=100·14, Hermann.

		$\dddot{\rm Si}$	$\ddot{\rm Al}$	$\dot{\rm Ca}$	$\dot{\rm Mg}$	$\dot{\rm Na}$	$\dot{\rm K}$	$\dot{\rm H}$
	5. *Atheriastite,*	38·00	24·10	22·64	2·80	——	——	6.95, $\dot{\rm Fe}$ 4·82, $\dot{\rm Mn}$ 0·78=100·09, Berlin,
II.	6. Arendal, *black,*	29·52	15·77	9·02	8·50	0·58	0·37	10·89[a] $\ddot{\bar{\rm Fe}}$ 19·14, $\dot{\rm Ca}\ddot{\rm C}$ 4·62=98·45, v. Rath.
	7. " *epidote,*	37·92	19·21	22·68	0·25	0·39	0·23	2·51, $\ddot{\bar{\rm Fe}}$ 15·55=98·74, v. Rath.
III.	8. *Algerite,* N. J.,	49·82	24·91	——	1·15	——	10·21	7·57, $\dot{\rm Ca}\ddot{\rm C}$ 3.94 =99·45, Hunt.
	9 " "	49·96	24·41	——	5·18	——	9·97	5·06, $\dot{\rm Ca}\ddot{\rm C}$ 4.21, $\ddot{\bar{\rm Fe}}$ 1·48=100·27, Cr.
	10. " "	52·09	18·63[b]	——	*undetermined*			6·68, $\dot{\rm Ca}\ddot{\rm C}$ 4·41, $\dot{\rm Ca}^3\ddot{\bar{\rm P}}$ 8·22, Whitney.
	11. *Yellow,* Bolton,	49·99	23·01	3·35	1·73	0·35	7·09	4·23, $\dot{\rm Ca}\ddot{\rm C}$ 7·80, $\ddot{\bar{\rm Fe}}$ 1·64=99·19, v. Rath.
	12. *Red,* Arendal,	59·74	16·20	2·15	4·02	4·31	4·42	1·83, $\ddot{\bar{\rm Fe}}$ 7·90=100·57, v. Rath.
	13. *Mica,* "	44·49	24·91	2·14	0·36	1·11	6·71	3·44, $\ddot{\bar{\rm Fe}}$ 4·84=99·11, v. Rath.
	14. " "	(65·82)[c]	27·37[b]	——	0·42	0·42	5·77	0·20=100, Bis.
	15. " Pargas,	46·75	26·15	——	15·78	0·82	5·64	0·63=95·77, "

[a] With some bitumen. [b] With a little peroxyd of iron. [c] By loss and probably too high.

The *altered* scapolite of Franklin, N. J., (anal. 1, 2), is leek-green or yellowish-green, and has the forms of scapolite. H.=3·5. G.=2·78. Lustre subresinous or subvitreous. Very fusible. Occurs with quartz and calcite. The mineral from Diana, N. Y., (anal. 3), is in large crystals in calcite with sphenė, with the cleavage and appearance of scapolite. Color gray. H.=5·5. G.=2·74.

Stroganowite (Hermann) has a clear green color. H.=5·5. G.=2·79. Form and appearance nearly as in scapolite. Color light oil-green, yellowish green. Subvitreous, inclined to greasy. From near the Sludänka, a river in Dauria. Named after M. Stroganow.

Atheriastite, (Weibye), like scapolite in form and appearance. Green. Opaque. From the mines of Arendal.

The *Black* scapolite of Arendal (anal. 6) is altered by a large addition of magnesia and iron. Color grayish-black; streak grayish-white. Rather soft. G.=2·837. No cleavage. B.B. edges rounded with difficulty.

The *Epidote pseudomorph* of the same locality, (anal. 7), has received still more largely of oxyd of iron, without magnesia. It gives the oxygen ratio of epidote 1 : 2 : 3.

Algerite (Hunt) (anal. 8, 9, 10) occurs in slender square prisms, sometimes 2 or 3 inches long imbedded in calc spar. Yellowish to gray and usually dull. Brittle. H.=3—3·5; some crystals more altered, 2·5. G.=2·697—2·712 Hunt, 2·78, Crossley. From Franklin, Sussex Co., N. J. The varying results of analyses, and the presence of carbonate of lime, of magnesia, and the relations to known examples of altered scapolite, confirm the view derived from the form and appearances, that Algerite is an altered Scapolite. The *yellow* scapolite of Bolton examined by v. Rath (anal. 11) is a similar compound. It has H.=4·5, and G.=2·787; massive, with perfect rectangular cleavages. It is near to a mica in a composition, having received largely of potash in the change; oxygen ratio for $\dot{\rm R}$, $\ddot{\bar{\rm R}}$, $\dddot{\rm Si}$, 1 : 3·8 : 8·9.

The *Red* scapolite of Arendal (anal. 12) has H.=5. G.=2·852. Brownish or brick red. Difficultly fusible. Oxygen ratio 1 : 2·4 : 7·5. In the change, $\ddot{\bar{\rm Fe}}$, magnesia and potash have been introduced.

The *Mica pseudomorphs* of Arendal occur in quartz, and have the form according to v. Rath, of large crystals of scapolite, 6 inches long. The crystals are covered with mica externally, and within consist throughout of an aggregation of the same mica. The mica is greenish-white, translucent. H.=2—3. G.=2·833. Oxygen ratio, (from v. Rath), 1 : 5·6 : 10·5; perhaps 1 : 6 : 10½, giving 1 : 1½ for the oxygen of the bases and silica. The change from scapolite has consisted in the removal of lime, addition of $\ddot{\bar{\rm Fe}}$, and substitution of potash for soda. The *Pargas* mica pseudomorph is a magnesian mica.

Steatite pseudomorphs, formed by the substitution of magnesia, for other protoxyd bases, occur at Newton, in New Jersey, and Arendal in Norway. Nos. 6, 9, 12, 15, are examples of change in this direction.

A specimen of *Esmarkite,* according to L. Sæmann (private communication) given to Mr. Daubrée of Paris by M. Esmark, has the rectangular cleavages of scapolite, and is probably an altered form of this species. Two different minerals appear therefore to be confounded under this name. The analyses were made upon a mineral resembling hydrous iolite (see under Iolite) and not on the scapolite mineral.

MELLILITE, *F. de Bellevue.* Humboldtilite, *Monticelli* and *Covelli.* Somervillite, *Brooke.* Zurlite, *Ramondini.*

Dimetric; *O* : 1*i*=147° 15′; *a*=0·6432. Observed planes *O*, *I*, *ii*, 1*i*, *i*2. 1*i* : 1*i* (over *ii*)=65° 30′, 1*i* : 1*i* (over terminal edge)=134° 48′. Cleavage: basal distinct.

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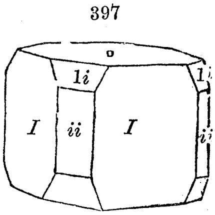

H.=5. G.=2·9—3·104. Lustre vitreous. Color brown, pale yellow, honey-yellow; greenish-yellow, reddish-brown. Translucent, and in thin laminæ, transparent; also opaque. Fracture conchoidal—uneven.

Composition.—2 $\dot{R}^3\dddot{Si}+\dddot{\bar{R}}\dddot{Si}$ or $(\frac{2}{3}\dot{R}^3+\frac{1}{3}\dddot{\bar{R}})\dddot{Si}$, analogous to the formula proposed for Helvin. Analyses: 1, Kobell, (Schw. J. lxiv, 293); 2, 3, 4, Damour, (Ann. Ch. Phys. [3], x, 59); 5, Kobell, (Kast. Arch. iv, 313):

	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	
1. *Humb.*, Somma,	43·96	11·20	——	31·96	6·10	4·28	0·38,	$\dot{Fe}$ 2·32=100·20, Kob.
2. " "	40·60	10·88	4·43	31·81	4·54	4·43	0·36=98·35,	Damour; G. 2·9.
3. *Mell.*, C. di Bove,	39·27	6·42	10·17	32·47	6·44	1·95	1·46=98·18,	" G. 2·95.
4. " "	38·34	8·61	10·02	32·05	6·71	2·12	1·51=99·36,	"
5. *Massive Gehlenite,*	39·80	12·80	2·57	37·64	4·64	——	0·30	$\dot{H}$ 2·00=99·75, Kobell.

No. 3, yellow crystals; No. 4, brown do. The massive gehlenite of Kobell comes under the formula of humboldtilite.

B.B. fuses with difficulty to a yellowish or blackish glass. With the fluxes the reaction of iron and silica. In the acids gelatinizes.

Humboldtilite occurs at Vesuvius in lava. *Mellilite* (fr. *mel, honey*) of yellow and brownish colors, is found at Capo di Bove near Rome, with nepheline. *Somervillite,* which Descloizeaux has shown to have the angles of this species, is found at Vesuvius in dull yellow crystals.

DIPYRE, *Haüy.* Schmelzstein, *W.*

In four-sided prisms, apparently dimetric like scapolite; ends rounded. Cleavage lateral and diagonal.

G.=2·646. Sufficiently hard to scratch glass. Color whitish or reddish. Lustre vitreous. Transparent to translucent. Opaque when weathered.

Composition.—4 $(\dot{Ca}, \dot{Na})\dddot{Si}+3\dddot{\bar{Al}}\dddot{Si}$, Delesse=Silica 53·8, alumina 26·2, lime 9·5, soda 10·5. Analysis by Delesse, (Compt. Rend. xviii, 994, 1844):

$\dddot{Si}$ 55·5, $\dddot{\bar{Al}}$ 24·8, $\dot{Ca}$ 9·0 $\dot{Na}$ 9·4 $\dot{K}$ 0·7.

B.B. becomes opaque and fuses with little intumescence to a white blebby glass. Melts easily with salt of phosphorus, except a skeleton of silica. Forms a limpid glass, with soda. Attacked with much difficulty by the strongest acids.

Occurs near Mauleon in the Lower Pyrenees, with talc or chlorite, in an unctuous argillite. Named from δις, *double*, and πυρ, *fire*, alluding to its both phosphorescing and fusing before the blowpipe.

Couzeranite of Charpentier. According to R. P. Greg, Jr., who has examined several crystals, couzeranite occurs in square prisms, giving *I* : *I*=90°, and *I* : *ii*= 135°. He suggests to the author that the species is Dipyre. It occurs in nearly the same region, (Couzeran in the Pyrenees), and resembles dipyre in appearance.

Composition, according to Dufrenoy, $\ddot{S}i$ 52·37, $\dddot{A}l$ 24·02, $\dot{C}a$ 11·85, $\dot{M}g$ 1·40, $\dot{K}$ 5·52, $\dot{N}a$ 3·96=98·55. B.B. nearly like Dipyre. It has been referred to labradorite, and according to Dufrenoy has an oblique form. The crystals are rough and may give varying measurements.

EPIDOTE, *H.* Zoisite, (in part.) Pistacite. Thallite. Withamite. Akanticon. Scorza. Delphinite. Arendalite. Bucklandite, *Levy.* Piemontischer Braunstein, *W.* Eisenepidot. Manganepidot. Thulite. Puschkinite, *Wagner.* Achmatit, *Hermann.*

Monoclinic; *C*=64 36′; *I* : *I*=63° 8′, *O* : 1ì=125° 4½′; *a* : *b* : *c* =0·8693 : 1 : 0·5514.

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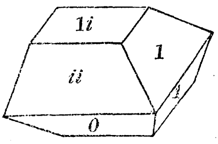

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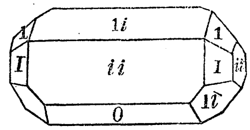

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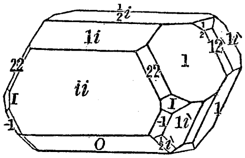

O : *ii*=115° 24′.
O : 1*i* (adj.)=128° 19′.
O : ½*i*=154° 03′.
O : 2*i*= 98° 57′.
O : 1=110° 59′.
O : ½=134° 55′.
O : -1=130° 11′.

O : *I* =102° 59′.
ii : 1*i*=116° 17′.
ii : ½*i*= 90° 33′.
ii : 1 =104° 49′.
ii : -1=117° 49′.
ii : 22=128° 5′.
1 : 1 (ov. 1*i*)=70°33′.

-1 : -1 (ib.)=96° 10′.
½ : ½ (ib.)=103° 30′.
22 : 22 (ib.)=96° 41′.
*i*2 : *i*2 (ov. *ii*)=101° 43′.
½ì : ½ì (ov. *O*)=109° 6′
1ì : 1ì (ib)=70° 9′.
ii : 1ì=75° 44′.

O				
⅓*i*				
½*i*		½		½ì
1*i*		1	12̀	1ì
$\frac{3}{2}$*i*				
2*i*	22			
ii	*i*2	*I*		*i*ì
-1*i*		-1		1ì
				½ì

Observed Planes.

Crystals lengthened in the direction of the orthodiagonal, or parallel to *ii*. Cleavage *ii* perfect; *O* less so. Twins: plane of composition *O*; also *ii*. Also columnar, divergent, or parallel; also granular, particles of various sizes, sometimes impalpable.

H.=6—7. G.=3·25—3·5. Lustre vitreous, *ii* inclining to pearly or resinous. Color green, brown, or gray, sometimes red, white, black; green usually yellowish; less yellow in the direction of the vertical axis, than at right angles with it. Streak uncolored, grayish, reddish. Subtransparent—opaque: generally subtranslucent. Fracture uneven. Brittle.

The species epidote includes:—

1. *Lime-and-iron-epidote, Pistacite,* or *epidote* proper.—Color yellowish-green, pistachio-green, passing to olive and leek-green. G.=3·35—3·5. Here fall *Puschkinite* and *Bucklandite*; the former of green, yellow, and red colors; G.=3·43;—the latter black; G.=3·51.

2. *Lime-epidote, Zoisite* in part.—Color gray or brown to white. In crystals usually deeply striated, and often columnar massive. G.=3·2—3·45.

3. *Manganesian-epidote.*—Color reddish-brown or reddish-black, dark violet-blue. Streak reddish. G.=3·404.

Cerium-epidote, containing cerium.

Withamite is a bright red variety; the crystals are pale straw-yellow in one direction across the prism. *Thulite* has a rose or peach-blossom red color. G.=3·1—3·34. *Allanite* is a true cerium-epidote.

Composition.—$\dot{R}^3\ddot{Si}+2\ddot{\bar{R}}\,\ddot{Si}=(\frac{1}{3}\dot{R}^3+\frac{2}{3}\ddot{\bar{R}})\,\ddot{Si}$; probably also for some varieties $3\dot{R}^3\ddot{Si}+2\ddot{\bar{R}}\,\ddot{Si}=(\frac{3}{5}\dot{R}^3+\frac{2}{5}\ddot{\bar{R}})\,\ddot{Si}$.

Analyses: 1, Bucholz, (Gehl. J. i, 200); 2, Besnard, (J. f. pr. Chem. v, 212); 3, Geffkin; 4, Rammelsberg, (3d Supp. p. 43, and Pogg. lxviii, 509); 5, Kühn, (Ann. d. Ch. u. Pharm. lix, 373); 6, Hermann, (J. f. pr. Chem. xliii); 7, Gmelin, (Pogg. xlix, 539); 8, N. J. Berlin, (Pogg. lxxviii, 414); 9, Geffken, (as above); 10, Rammelsberg, (2d Supp. 48); 11, 12, Kühn, (Ann. d. Ch. u. Pharm. lix); 13, Hermann, (loc. cit.); 14, Rammelsberg, (Pogg. lxxxiv, 453); 15, Baer, (J. f. pr. Chem. xlvii, 46); 16, 17, Hermann, (loc. cit.); 18, Osersky, (Bull. Soc. Nat. Moscow, 1841, 112); 19, Hartwall, (K. V. Ac. H. 1828, 171); 20, Sobrero, (Arsb. 1840, 218); 21, Geffken, (loc. cit.):

I. *Lime-epidote.* G. of No. 4, 3·387; of No. 6, 3·28; of No. 8, 3·34.

		$\ddot{Si}$	$\ddot{\bar{Al}}$	$\ddot{\bar{Fe}}$	$\dot{Fe}$	$\dot{Ca}$	
1.	Fichtelgebirge,	40·25	30·25	4·50	—	22·50,	$\dot{H}$ 2·00=99·50, Bucholz.
2.	Grossarl,	40·00	26·46	6·33	—	20·66,	$\dot{Mg}$ 3·6, $\dot{K}$ 1·5=98·55, B.
3.	Falltigel,	40·74	28·94	5·19	—	20·52,	$\dot{Mn}$ 1·78, $\dot{Mg}$ 4·75=101·92, Geff.
4.	Rothlaue,	44·56	23·72	8·33	—	24·71=101·32, Ramm.	
5.	Zwiesel, Bav.	40·62	29·18	6·19	—	22·67,	$\dot{Mg}$ 0·73, ign. 0·42=99·81, Kuhn.
6.	Falltigel, *gray*,	40·95	30·34	—	4·96	21·56,	$\dot{H}$ 0·56, $\ddot{C}$ 1·13=99·50, H.
7	*Thulite*, Soul'd,	42·84	31·14	2·29	—	18·73,	$\dot{Mg}$1·64 $\dot{Na}$1·89$\dot{H}$0·64=99·13, G.
8.	" Klodeberg,	40·28	31·84	1·54	—	21·42,	" 0·66 $\dot{Mn}$0·95, $\dddot{V}$0·22, ign. 1·32, (alk. *undet.*)=98·23, Berl.

II. *Lime-and-iron-epidote.* G. of No. 13, 3·37; No. 16, 3·51; No. 17, 3·43.

9.	Arendal,	36·14	22·24	14.29	—	22·86,	$\dot{Mg}$ 2·38, $\dot{Mn}$ 2·12=100·03, G.
10.	"	37·98	20·78	17·24	—	23·74,	" 1·11=100·85, Ramm.
11.	Geier, Erzgeb.	40·57	14·47	13·44	—	30·00,	" 2·76=101·24, Kühn.
12.	Dauphiny,	39·85	21·61	16·61	—	22·15,	" 0·3=100·52, "
13.	B. d'Oisans,	37·60	18·57	13·37	5·55	21·19,	" 1·40 $\dot{H}$0·46, $\ddot{C}$1·22=98·36, H.
14.	"	38·37	21·13	16·85	—	23·58,	" 0·17=100·22, Ramm.
15.	"	37·78	21·25	15·97	—	23·46,	" 0·60, $\dot{Na}$ 0·41=99·47, Br.
16.	*Bucklandite*,	36·97	21·84	10·19	9·19	21·14,	$\dot{H}$ 0·68 $\ddot{C}$a 0·32=100·33, Herm.
17.	*Puschinite*,	37·47	18·64	14·15	2·56	22·06,	$\dot{Na}$, $\dot{Li}$ (*tr.*) 2·28, $\dot{H}$ 0·65, $\ddot{C}$ 0·79, $\ddot{B}$ *trace*=98·60, Hermann.
18.	"	38·88	18·85	16·34	—	16·00,	$\ddot{\bar{Mn}}$ 9·26, $\dot{Mg}$ 6·1, $\dot{Na}$ 1·67, $\dot{Li}$ 0·46=98·56, Osersky.

III. *Manganesian Epidote.*

19.	St. Marcel,	38·47	17·65	6·60	—	21·65,	$\ddot{\bar{Mn}}$ 14·08, $\dot{Mg}$ 1·82=100·26, H.
20.	"	37·86	16·30	—	7·41	13·42,	$\ddot{\bar{Mn}}$ 18·96, $\dot{Mg}$4·82, $\ddot{Sn}$, $\dot{Cu}$0·4, S.
21.	"	36·87	11·76	10·33	—	22·78,	$\ddot{\bar{Mn}}$ 18·25=99·99, Geffken.

B.B. fuses on thin edges and swells up, but does not easily liquefy, the varieties containing most iron being most fusible; glass with borax colored by iron. The manganesian variety fuses readily with intumescence; glass with borax amethystine in the exterior flame. In acids the varieties are but partially decomposed, except after a strong heating. The specific gravity changes with heating. An Arendal specimen examined by Rammelsberg, (No. 15 above), had G.=3·403 before heating, 3·271 after heating. Most specimens of epidote afford a minute globule of tin before the blowpipe.

Arendal, in Norway, affords fine crystals, whence the name *Arendalite.* Occurs also in the Ural, Piedmont, Fichtelgebirge, Rothlaue in the Canton of Berne, Falltigel in Tyrol, Grossarl in Austria, Bourg d'Oisans, etc. In the last, Rammelsberg finds no Fe.

Bucklandite is from Achmatowsk, Arendal, and Lake Laach. *Puschkinite* is from west of the Urals, north of Katherinenburg. *Thulite* is from Souland in Tellemark, Norway, and also the iron mine near Klodeberg, Norway; specific gravity of the former 3·1—3·2, of the latter 3·34. The manganesian variety occurs at St. Marcel, in the valley of Aosta, in Piedmont.

At Franconia, N. H., both crystallized and granular epidote are abundant, the latter containing magnetic iron. Large crystals of unusual beauty are obtained at Haddam, Conn. Also in crystals at the gneiss quarries of Hadlyme and Chester; in limestone at Newbury, Mass.; in greenstone near Nahant; in hornblende slate at Rowe, Mass,; fine crystallizations in syenitic gneiss, at Athol, Mass., two miles southwest of the centre of the town; at Warren, N. H., with quartz and pyrites; at Cumberland, R. I., in a kind of trap; in gneiss at Harlem, on the banks of East River, near 38th st.; two miles southeast of Amity, N. Y., in quartz; two miles south of Carmel, Putnam Co., N. Y., with hornblende and garnet; two miles south of Coffee's, Monroe, Orange Co., N. Y., in granite; at Franklin, N. J., a massive variety occurs; six miles west of Warwick, N. Y., of a pale yellowish-green color, associated with sphene and pyroxene; in Pennsylvania, at E. Bradford; very common in the Lake Superior copper region, as a rock, and veinstone, the latter on the Ontanagon; at the Norwich mine it occurs beautifully radiated, with quartz and native copper. Zoisite, or gray epidote, in columnar masses, is found at Willsboro', Vt.; at Montpelier, of a bluish-gray color, associated with calc spar in mica slate; at Chester, Mass., in mica slate; also at Goshen, Chesterfield, Hinsdale, Heath, Leyden, Williamsburg, and Windsor in Massachusetts, and at Milford, Conn.; in Pennsylvania in West Bradford and West Goshen, Chester Co.; also in Kennet township and East Marlboro.

Altered Forms.—Epidote is less liable to alteration than most other silicates, and partly because the iron it contains is mainly peroxyd. Hermann found carbonic acid in several epidotes, an evidence of partial alteration; and J. D. Whitney describes a green mineral from Isle Royale with the composition of epidote, containing 5 per cent. of water, (Rep. Geol. L. Sup. 1851, 97).

ALLANITE. Cerine, *Hisinger*, (1811). Orthite, *Berz.*, (1815). Bagrationite. *Kokscharov.* Uralorthite, *Hermann.* Xanthorthit, *Hermann.*

Monoclinic, and isomorphous with epidote. $C=65° 5'$, $O : 1\bar{i} = 125° 25\frac{1}{2}$; $a : b : c = 0·8702 : 1 : 0·56137$. Observed planes as in the annexed figures, (Kokscharov.)

$O : ii = 114° 55'$.
$O : 1i = 128° 45'$.
$O : \frac{3}{2}i = 99° 35'$.
$O : \frac{1}{2}\bar{i} = 144° 53\frac{1}{2}'$.
$O : 1 = 111° 27'$.
$ii : 1i = 116° 20'$.
$ii : \frac{3}{2}i = 145° 30'$.
$ii : 1 = 105° 1'$.
$ii : -1 = 127° 40'$.
$ii : 1\bar{i} = 104° 8'$.
$1\bar{i} : 1\bar{i}$(top)$=70° 51'$.
$\frac{1}{2}\bar{i} : \frac{1}{2}\bar{i}$ “ $=109° 47'$.
$1 : 1i = 125° 45'$.
$1 : 1 = 71° 29'$.
$-1 : -1 = 96° 37'$.

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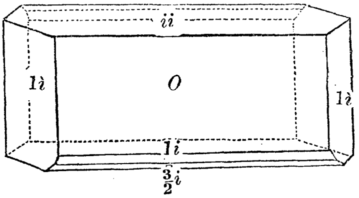

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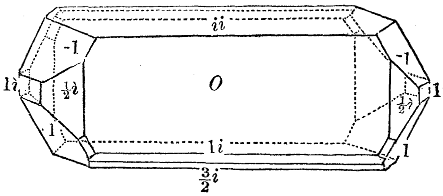

Crystals either long and slender, or flat tabular. Twins like those of epidote. Cleavage: *ii* in traces. Also massive, and in angular or rounded grains.

H.=5·5—6. G.=3·3—4·2. Lustre submetallic and pitchy or resinous—occasionally vitreous. Streak gray, greenish, or brownish-gray. Color pitch-brown, brownish-black, yellowish. Subtranslucent—opaque. Fracture uneven or subconchoidal. Brittle.

This species includes the following varieties:—

Allanite. G.=3·53—3·54, from Jotun Field; 3·79, from Snarum. Occurs in crystals, and in masses or grains.

Cerine. In crystals and crystalline masses. H.=6. G.=3·77—3·8, Hisinger. Lustre weak, greasy. Color brownish-black. In thin splinters, subtranslucent.

Orthite. Occurs in acicular crystals; also massive. Lustre vitreous, inclining to greasy. H.=5—5·75. G.=3·288; 3·63—3·65, from Fillefjeld; 3·546, Hitteroe, Ramm.; 3·373, Scheerer. Streak gray. Color pitch-brown. In very thin splinters subtranslucent.

Xanthorthite. Yellowish; G.=2·78—2·9, (anal. 16 and 18). Contains much water.

Bagrationite. Has the same angles as uralorthite, as shown by Kokscharov. G.=4·115.

Uralorthite. G.=3·41—3·60. *Pyrorthite* is an impure orthite containing bitumen.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}=(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$. Rammelsberg writes for the orthite of the Ural, $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}+\frac{1}{2}\dot{\mathrm{H}}$; for that of Hitteroe $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}+\dot{\mathrm{H}}$. Scheerer's analyses give $3\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+2\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}=(\frac{3}{5}\dot{\mathrm{R}}^3+\frac{2}{5}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$, which is the formula of some idocrase.

Analyses: 1, Stromeyer, (Pogg. xxxii, 288); 2, 3, Scheerer, (Pogg. li, 407, 465); 4, Credner, (Pogg. lxxix, 414); 5, Rammelsberg, (Pogg. lxxx, 285); 6, Bergemann, (Pogg. lxxxiv, 485); 7, Zschau, (N. Jahrb. 1852, 652); 8, Hisinger, (Afh. i, Fys. iv, 327); 9, Scheerer, (loc. cit.); 10, 11, Berzelius, (Hisinger's Min. Schwed.); 12, 13, Berlin, (Jahresb. xvii, 221); 14, 15, Scheerer, (Pogg. li, lvi, 479); 16, 17, 18, Bahr and Berlin, (Œfvers. Af. K. V. 1845, 86); 19, Hermann, (J. f. pr. Ch. xliii, 105); 20, Ulex and Choubine:

I. *Allanite,* (Anhydrous). 1, Iglorsoit; 2, Jotun Fjeld; 3, Snarum; 4, Krux, Thuringia, G.=3·79; 5, Chester Co., Pa.; 6, West Point, N. Y., G.=3·4917; 7, near Dresden.

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ce}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$
1.	33·02	15·23	15·10	21·60	11·08	——, $\dot{\mathrm{Mn}}$ 0·40, $\dot{\mathrm{H}}$ 3·0=99·40, Stromeyer.
2.	34·69	15·58	14·42	19·65[a]	11·90	1·09, $\dot{\mathrm{Mn}}$ 1·55, $\dot{\mathrm{H}}$ 0·52=99·40, Scheerer.
3.	35·75	15·49	15·19	19·96[a]	11·25	0·77=98·41, Scheerer.
4.	37·55	15·99	16·83	3·19	13·60	0·22, $\dot{\mathrm{La}}$ 9·30, $\dot{\mathrm{Y}}$ 0·56, $\dot{\mathrm{Mn}}$ 0·23, $\dot{\mathrm{H}}$ 1·80=99·27, Credner.
5.	31·86	16·87	12·26	21·27	10·15	1·67, $\dot{\mathrm{La}}$ 2·40, $\dddot{\bar{\mathrm{Fe}}}$ 3·58, ign. 1·11=101·17, R.
6	33·83	13·61	12·72	20·90[a]	9·36	1·40, $\dddot{\bar{\mathrm{Fe}}}$ 3·33, $\dot{\mathrm{Mn}}$ 0·82, $\dot{\mathrm{H}}$ 2·95=99·02, B.
7.	33·41	10·90	20·88[b]	20·73	10·52	——, $\dot{\mathrm{Y}}$ 0·69, $\dot{\mathrm{H}}$ 3·12=100·25, Zschau.

a With oxyd of Lanthanum. b With oxyds of iron and manganese.

II. *Cerine,* (Anhydrous). No. 8, from Bastnäs; 9, from Riddarhyttan.

8.	30·17	11·31	20·72	28·19	9·12	——, $\dot{\mathrm{Cu}}$ 0·87=100·38, Hisinger.
9.	32·06	6·49	——	23·80	8·08	1·16, $\dddot{\bar{\mathrm{Fe}}}$ 25·26, $\dot{\mathrm{La}}$ 2·45, $\dot{\mathrm{H}}$ 0·6=99·90, Sch.

III. *Orthite,* (Hydrous). 10, from Finbo; 11, Fahlun; 12, 13, Ytterby; 14, Fille Fjeld; 15, Hitteroe; 16, Erikberg, (*Xanthorthite*); 17, Thiergarten; 18, Kullberg, (*Xanthorthite*).

G. of 12 and 13, 3·5; of 15, 3·373; of 16, 2·78; of 17, 3·41; of 18, 2·88.

	$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ce}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	Y
10.	36·25	14·00	11·42	17·39	4·87	——	3·80, $\dot{\mathrm{Mn}}$ 1·36, $\dot{\mathrm{H}}$ 8·70=97·79, Berz.
11.	32·00	14·80	12·44	19·44	7·84	——	3·44, $\dot{\mathrm{Mn}}$ 3·40, $\dot{\mathrm{H}}$ 5·36=98·72, "
12.	36·24	8·18	9·06	4·98	5·48	0·61	29·81, $\dot{\mathrm{H}}$ 4·59, $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$ 0·61=99·96, B.
13.	33·60	12·58	13·48	4·56	9·59	1·60	20·83, $\dot{\mathrm{H}}$ 3·34, $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$ 0·62=100, B.
14.	34·93	14·26	14·90	21·43[a]	10·42	0·86	1·91, $\dot{\mathrm{H}}$ 0·52, $\dot{\mathrm{Mn}}$ 0·85=100·08, Sch.
15.	33·81	13·04	15·65[b]	20·50	9·42	0·38	1·45, $\dot{\mathrm{K}}$ 0·67, $\dot{\mathrm{H}}$ 3·38=98·30, Scheer.
16.	32·93	15·54	4·21	20·01[a]	6·76	2·15,	0·59, $\dot{\mathrm{Mn}}$ 0·39, $\dot{\mathrm{H}}$ and some $\ddot{\mathrm{C}}$ 17·55 =100·13, Br.
17.	33·05	15·29	16·64	20·55[a]	10·18	1·58[b],	1·18, ign. 1·24=99·71, Berlin.
18.	27·59	16·14	16·01	11·75[a]	2·28	4·94,	2·12, $\dot{\mathrm{Mn}}$ 1·55, $\dot{\mathrm{H}}$ 11·46, $\ddot{\mathrm{C}}$ 6·71= 100·55, Bahr.

a Including oxyd of Lanthanum and Didymium. b Containing also manganese. c Undetermined.

IV. *Uralorthite*, G.=3·4—3·647. From the Ilmen Mountains.

19.	35·49	18·21	13·03	10·85	9·25	2·06,	$\bar{\dddot{\mathrm{Mn}}}$ 2·37, $\dot{\mathrm{La}}$ 6·54, $\dot{\mathrm{H}}$ 2=99·80, Herm.
20.	34·47	14·36	7·67	14·79	10·20	1·08,	$\dot{\mathrm{Fe}}$ 8·24, $\dot{\mathrm{La}}$ 7·66, $\dot{\mathrm{H}}$ 1·56=100·03, U.

Rammelsberg has examined the orthite of Hitteroe, with special reference to its proportion of iron oxyds, (Pogg. lxxvi, 96), and corrects analysis 15 as follows: $\dddot{\mathrm{Si}}$ 33·81, $\bar{\dddot{\mathrm{Al}}}$ 13·04, $\bar{\dddot{\mathrm{Fe}}}$ 8·16, $\dot{\mathrm{Fe}}$ 8·30, $\dot{\mathrm{Ce}}$ 20·50, $\dot{\mathrm{Y}}$ 1·45, $\dot{\mathrm{Ca}}$ 9·42, $\dot{\mathrm{Mg}}$ 0·38, $\dot{\mathrm{K}}$ 0·67, $\dot{\mathrm{H}}$ 3·38=99·11, which gives, excluding the water, the formula above. The water amounts to 1 $\dot{\mathrm{H}}$, with this formula. The same composition is derived from Hermann's analysis, No. 19.

B.B. Allanite fuses with intumescence, to a dark glass or slag, sometimes magnetic. Cerine fuses easily. Orthite fuses slowly to a black blebby glass. Reaction of iron with the fluxes, and with soda a manganese reaction. Uralorthite intumesces, often very easily, and fuses on the edges to a black blebby glass.

Some allanites, and also some orthites, gelatinize with acids; others are imperfectly decomposed. Uralorthite is dissolved in acids, somewhat gelatinizing.

These varieties occur in albitic and common feldspathic granite, zircon-syenite, porphyry, and white limestone. *Allanite* occurs in Greenland, in granite; at Jotun Fjeld in Norway, in a kind of porphyry, and at Snarum in albite, along with rutile and apatite; at Plauensche Gründ, near Dresden; in granite near Suhl in the Thüringerwald. The Allanite from Jotun Fjeld gelatinizes with acids, while that from Snarum is not affected by acids; *Cerine* occurs at Bastnäs in Sweden with hornblende and copper pyrites. *Orthite* occurs in acicular crystals sometimes a foot long at Finbo near Fahlun, and at Ytterby in Sweden; at Skeppsholm near Stockholm, in black vitreous masses disseminated through gneiss; also at Krageröe, Hitteroe and Fille Fjeld in Norway, at Miask in the Ural; at Dresden. The name is derived from ορθος, *straight*. *Uralorthite* occurs with small crystals of zircon in flesh-red feldspar at Miask in the Ural.

In the United States in large crystals in Allen's vein at the gneiss quarries, Haddam, Conn.; in small crystals at the Bolton quarry, Mass.; at South Royalston in boulders; at Athol on the road to Westminster in gneiss; in a feldspathic rock in tabular crystals near West Point, and of similar character near Bay St. Paul, in Canada; in S. Mountain near Bethlehem, Pa., in crystals sometimes as large as the hand; in New Jersey, near Moriah, at Sandford ore bed. A massive pitch-black mineral from Monroe, Orange Co., N. Y.; a similar variety is found at East Bradford, Chester Co., Pa.; G.=3·5, (Anal. 5); at St. Paul's, Canada West.

With Allanite belong probably *Bodenite*, (*Breith.* Pogg. lxii, 273, *Kersten*, ib. lxiii, 135, *Kerndt*, J. f. pr. Chem. xliii, 219), and *Muromontite*, (*Kerndt*, J. f. pr. Chem. xliii, 228).

Bodenite occurs in long prismatic crystals, apparently rhombic, with $I:I$=110°—112°. H.=6—6·5. G.=2·523. Color brown, reddish-brown to nearly black, and lustre somewhat greasy. Analysis by Kerndt, (loc. cit.): $\dddot{\mathrm{Si}}$ 26·12, $\bar{\dddot{\mathrm{Al}}}$ 10·34, $\dot{\mathrm{Fe}}$ 12·05, $\dot{\mathrm{Y}}$ 17·43, $\dot{\mathrm{Ce}}$ 10·46, $\dot{\mathrm{La}}$ 7·57, $\dot{\mathrm{Ca}}$ 6·32, $\dot{\mathrm{Mg}}$ 2·34, $\dot{\mathrm{Mn}}$ 1·62, $\dot{\mathrm{K}}$ 1·21, $\dot{\mathrm{Na}}$ 0·84, $\dot{\mathrm{H}}$ 3·82=100. B.B. glows like gadolinite; in platinum forceps, fuses only on the edges after long heating, and gives to the flame the yellow color of soda in the outer flame. From Boden, near Marienberg, in the Saxon Erzgebirge, with oligoclase.

The *Muromontite* is found in grains half as large as a pea, and rarely larger; no trace of crystallization apparent. H.=7. G.=4·263. Color black or slightly greenish by reflection. Lustre vitreous or slightly greasy.

Analysis by Kerndt, (loc. cit.): $\dddot{\mathrm{Si}}$ 31·09, $\ddot{\bar{\mathrm{Al}}}$ 2·24, $\ddot{\bar{\mathrm{Be}}}$ 5·52, $\dot{\mathrm{Y}}$ 37·14, $\dot{\mathrm{Ce}}$ 5·54, $\dot{\mathrm{La}}$ 3·54, $\dot{\mathrm{Fe}}$ 11·23, $\dot{\mathrm{Mg}}$ 0·42, $\dot{\mathrm{Mn}}$ 0·91, $\dot{\mathrm{Ca}}$ 0·71, $\dot{\mathrm{Na}}$ 0·65, $\dot{\mathrm{K}}$ 0·17, $\dot{\mathrm{H}}$ and loss 0·85=100. B.B. like Bodenite. From Mauersberg, near Marienberg, in the Saxon Erzgebirge.

Altered Forms.—The hydrous varieties of allanite or orthite are properly altered forms of the species. They often contain carbonic acid. It is probable that the carbonates of lanthanum and of cerium proceed at times from the alteration of allanite.

ZOISITE, (in part.)

Monoclinic. *I* : *I*=116° 16′, *I*: *ii*=121° 52′, *i*2: *ii*=107° 16′, *i*2 : *i*2=145° 48′, Brooke and Miller. Crystals lengthened in the direction of the vertical axis, and usually deep striate. Cleavage clinodiagonal, very perfect. Lustre vitreous. Color grayish-white, gray, yellowish, brown, greenish-gray. Streak uncolored.

Analyses by Klaproth, (Beit. iv, 179, and v, 41):

1.	Carinthia,	$\dddot{\mathrm{Si}}$ 45·0	$\ddot{\bar{\mathrm{Al}}}$ 29·0	$\dddot{\bar{\mathrm{Fe}}}$ 3·0	$\dot{\mathrm{Ca}}$ 21·0=98, Klaproth.
2.	"	" 44·0	" 32·0	" 2·5	" 20·0, $\dot{\mathrm{Mn}}$ *trace*=98·5, Klaproth.

BB. in forceps intumesces and fuses without difficulty into a slightly translucent greenish-white irregular mass. With borax in the outer flame, or with salt of phosphorus, a transparent glass, light yellow, hot, colorless cold.

This species was separated from Epidote on crystallographic grounds by Brooke, in 1831, and is so published by Brooke and Miller. But only the analyses of the so-called Zoisite specimens from the Saualp in Carinthia by Klaproth are recognized by these authors as belonging certainly to the species. It does not appear to include all the lime-epidotes, as thulite, peculiarly a lime-variety, has the form and cleavage of epidote, and is placed with that species by Brooke and Miller. We therefore leave the other analyses under epidote until the subject is further investigated. Klaproth's analyses lead nearly to the formula $\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}+3\ddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}=(\frac{1}{4}\dot{\mathrm{Ca}}^3+\frac{3}{4}\ddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}$=Silica 43·2, alumina 36·8, lime 20·0. The rest give the formula of epidote.

Other localities mentioned by Brooke and Miller are Sterzing in the Tyrol, Fernleite in Fusch in Salzburg, Baireuth, Conradsreuth near Hof in Bavaria, and the Ural.

Mr. Brooke observes that the form is near that of Euclase.

GADOLINITE. Gadolinit, *W.* Ytterbyte.

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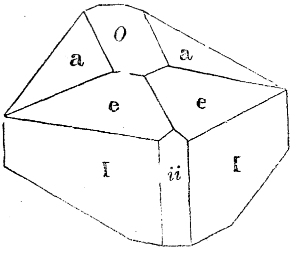

Monoclinic; rarely in crystals, with uneven faces. Angles, according to Levy, *I* : *I*=115°, *O* : *I*=95° 22′, *O* : e=112° 52′, *O* : *ii*=96° 30′, *O* : a =149° 49′, *I*: e=162° 50′. Brooke obtained *I*: *I*=119° 30′, *O* : *ii*= 90°, *O* : e=112° 33′, *I*: e=157° 27′, *O* : a=163° 8′, and supposes the crystals trimetric. Scheerer obtained *I* : *I*=115°, *O* : e=131°, a clinodiagonal prism (over *O*)=70¾°. No distinct cleavage. Usually massive, compact.

H.=6·5—7. G.=4·0—4·5; of Ytterby 4·097—4·226, but after heating 4·286—4·456, H. Rose; 4·35, from Hitteroe, Scheerer. Lustre vitreous, inclining to resinous. Color black, pitch-black, greenish-black. Streak greenish-gray. Subtranslucent—opaque. Fracture conchoidal.

Composition.—Approximately $\dot{R}^3\dddot{Si}$. Analyses: 1, 2, 3, Berzelius, (Afhand. iv, 148, 389); 4, Richardson, (Thom. Min. i, 410); 5, 6, Scheerer, (De foss. allanit, orthit, cerin, gadol. Berolini, 1840, and Pogg. lvi, 479); 7, 8, 9, 10, Berlin, (Dissert. Gadol. Upsal. 1844, and Ofvers. af K. V. Ac. 1845, 86):

		$\dddot{Si}$	$\dddot{\bar{Be}}$	$\dot{Y}$	$\dot{Ce}$	$\dot{Fe}$	$\dot{Ca}$	
1.	Finbo,	25·80	——	45·00	16·69	10·26	——	ign. 0·60=98·35, Berzelius.
2.	Broddbo,	24·16	——	45·93	16·90	11·34	——	ign. 0·60=98·93, Berzelius.
3.	Korarfvet,	29·18	2·00	47·30	$\dddot{\bar{Ce}}$ 3·40	$\dddot{\bar{F}}$ 8·00	3·15	$\dddot{\bar{Mn}}$ 1·30, $\dot{H}$ 5·20= 99·53, B.
4.	"	24·65	11·05	45·20	" 4·60	" 14·55	——	$\dot{H}$ 0·50=100·55, R.
5.	Hitteroe,	25·78	9·57	45·67	$\dot{C}$ 1·81	11·68	0·34	$\dddot{\bar{L}}a$ 4·75,=100·71, Scheerer.
6.	"	25·59	10·18	44·96	——	12·13	0·23	$\dddot{\bar{L}}a$ 6·33=99·42, Scheerer.
7.	Ytterby,	25·62	——	50·00	"7·90	14·44	1·30	$\dot{Mg}$ 0·54, $\dddot{\bar{Al}}$ 0·48, $\dot{K}$ 0·19, $\dot{Na}$ 0·18=100·65, Berlin.
8.	"	25·26	——	45·53	"6·08	20·28	0·50	$\dot{Mg}$, 0·11, $\dddot{\bar{Al}}$ 0·28, $\dot{K}$ 0·21, $\dot{Na}$ 0·20=98·45, Berlin.
9.	"	24·65	2·13	49·60	$\dddot{\bar{Ce}}$ 7·64[a]	15·03	0·46	$\dot{Mg}$, $\dot{Mn}$ *trace*=99·51, Berlin.
10.	"	24·85	4·80	51·46	"5·24[a]	13·01	0·50	$\dot{Mn}\dot{Mg}$ 1·11=100·97, B.

a With oxyd of Lathanum.

Of Berlin's analyses, the first two were of the glassy gadolinite; the others, excepting the last, did not present the glow of light when heated.

B.B. decrepitates and swells into cauliflower-like masses, but does not fuse into a bead; in the progress of the heat it exhibits a vivid glow, and the color becomes paler. With borax a dark glass deeply colored with iron, bottle-green in the reducing flame. Acted on by salt of phosphorus with great difficulty. A variety less glassy in appearance does not exhibit the glow on heating. Gelatinizes in muriatic acid.

Gadolinite occurs principally in the quarries of Korarfvet and Finbo, near Fahlun, in Sweden; also at Ytterby, near Stockholm; at each place indistinctly crystallized, and in rounded masses, which are often encircled with a yellow crust, and imbedded in coarse-grained granite. At Korarfvet crystals have been obtained four inches long. It has also been met with at Disko in Greenland; in trap near Galway, Ireland; imbedded in granite in Ceylon; at Finbo and Broddbo, and at Krageröe and Hitteröe in the southern part of Norway, crystals sometimes four inches across and twins at this last locality. Named after the Russian chemist, M. Gadolin.

DANBURITE, *Shepard*, Am. Jour. Sci. xxxv, 139.

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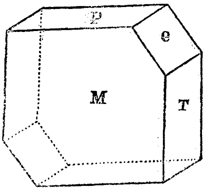

Triclinic. Approximate angles, P : M 110° and 70°, M : T 54° and 126°, P : T 93° nearly, P : e 135°. Cleavage: distinct, parallel to M and P, less so parallel to T. Crystals imbedded, and often an inch broad. Also disseminated massive, without regular form.

H.=7. G.=2·95, Silliman, Jr.; 2·957, Brush. Color pale yellow, whitish. Lustre vitreous, but usually rather weak. Translucent to subtranslucent. Very brittle.

Composition.—$\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}+3\ddot{\mathrm{B}}\,\dddot{\mathrm{Si}}=(\frac{1}{4}\dot{\mathrm{Ca}}^3+\frac{3}{4}\ddot{\mathrm{B}})\dddot{\mathrm{Si}}$=Silica 48·9, boracic acid 28·4, lime 22·7. Analyses by Smith and Brush, (Amer. J. Sci. [2], xvi, 365):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}\dddot{\bar{\mathrm{Fe}}}$	$\dddot{\bar{\mathrm{Mn}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\ddot{\mathrm{B}}$	ign.
1.	48·10	0·30	0·56	22·45	0·40	27·73	0·50=100.
2.	48·20	1·02		22·33	*undet.*	27·15	0·50=99·20.

B.B. fuses rather easily, and in the dark the flame is seen to have a decided green tinge, especially after having moistened and heated the mineral with sulphuric acid. Gives the boracic acid test as strongly as borax. Affords easily a transparent bead with soda or borax. Yields no water.

Occurs with oligoclase in dolomite at Danbury, Connecticut. It has some resemblance to Chondrodite in color, lustre, and brittleness, but is distinctly cleavable, although the planes of cleavage are often irregular.

AXINITE, *Karsten*. Thummerstein. Thumite. Yanolite.

Triclinic. Usual in thin oblique crystals with sharp edges; $P:u=135°\,10'$; $P:r=134°\,40'$; $u:r=115°\,17'$; $r:s=143°\,20'$; $u:s=152°\,5'$; $P:l=151°\,5'$. Cleavage: parallel to a plane on the acute edge $P:u'$, and also parallel to a plane replacing edge $x:P'$, but imperfect. Also massive, lamellar, lamellæ often curved; sometimes granular.

H.=6·5—7. G.=3·271, Haidinger; a Cornish specimen. Lustre highly glassy. Color clove-brown, plum-blue, and pearl-gray; exhibits trichroism, different colors, as cinnamon-brown, violet-blue, olive-green, being seen in different directions. Streak uncolored. Transparent to subtranslucent. Fracture conchoidal. Brittle. Pyroelectric.

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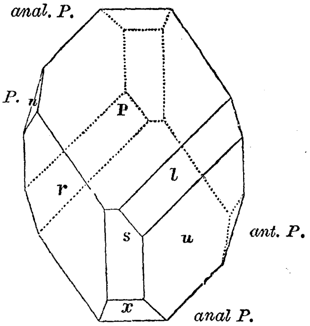


Composition.—$\dot{\mathrm{R}}^3\,\dddot{\mathrm{Si}}+2\dddot{\bar{\mathrm{R}}}\,\dddot{\mathrm{Si}}+\frac{1}{2}\ddot{\mathrm{B}}\,\dddot{\mathrm{Si}}=(\dot{\mathrm{R}}^3,\dddot{\bar{\mathrm{R}}},\ddot{\mathrm{B}})\dddot{\mathrm{Si}}$. According to Rammelsberg and Rose $\dot{\mathrm{R}}^3(\dddot{\mathrm{Si}},\ddot{\mathrm{B}})^2+2\dddot{\bar{\mathrm{R}}}(\dddot{\mathrm{Si}},\ddot{\mathrm{B}})$. Analyses: 1, Hisinger, (Min. Schwed., 170); 2, Wiegmann, (Schw. J. xxxii, 462); 3—6, Rammelsberg, (Pogg. 1, 363):

	$\dddot{\mathrm{Si}}$	$\ddot{\mathrm{B}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dddot{\bar{\mathrm{Mn}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	
1. Wermland,	41·50	——	13·56	7·36	10·00	25·84	——	——	ign. 0·30=98·56, His.
2. Treseburg,	45·00	2·00	19·00	12·25	9·00	12·50	0·25	——	=100, Wiegmann.
3. Dauphiny,	43·68	5·61	15·63	9·45	3·05	20·67	1·70	0·64	=100·43, Ramm.
4. "	43·46	*und.*	16·30	10·25	2·74	19·90	1·55	*und.*,	Ramm.
5. Treseburg,	43·74	——	15·66	11·94	1·37	18·90	1·77	——	$\ddot{\mathrm{B}}$, $\dot{\mathrm{K}}$ and loss 6·62, R.
6. Ural,	43·72	——	16·92	10·21	1·16	19·97	2·21	——	$\ddot{\mathrm{B}}$, $\dot{\mathrm{K}}$ and loss 5·81, R.

In the last two analyses Rammelsberg states that out of the last entry in each, 4·5 per cent. is not too large an estimate for the boracic acid.

B.B. fuses readily with intumescence to a dark-green glass, which becomes black in the outer flame; with borax yields an iron-colored glass which after long heating in the outer flame becomes amethystine.

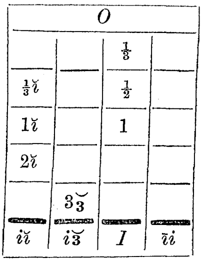
Axinite is pyroelectric with two axes, and the analogue and antilogue poles are situated, according to Rose, as marked in the figure.

Axinite occurs in implanted glassy clove-brown crystals, at St. Cristophe, near Bourg d'Oisans in Dauphiny, with albite, prehnite, and quartz; at Santa Maria, Switzerland; at the silver mines of Kongsberg, in smaller crystals; with hornblende or magnetic iron ore in Normark in Sweden, and of a dark color, at the Botallack mine in Cornwall, where it also occurs massive, forming a peculiar kind of rock with garnet and tourmaline; also at Thum near Ehrenfriedersdorf in Saxony, and called *Thumite* and *Thummerstein.* It occurs with gray cobalt, near Coquimbo, Chili; at Phipsburg, Maine, with yellow garnet and idocrase; also at Wales, Maine.

Axinite admits of a high polish, but is deficient in delicacy of color. It was named from αξινη, an axe, in allusion to the form of the crystals.

IOLITE. Dichroite. Peliom. Steinheilite. Cordierite, *H.* Sapphire d'eau. Hard Fahlunite.

Trimetric. In stout prisms often hexagonal. $O:1\breve{i}=150°\ 49'$, $O:1=132°\ 12'$, $I:I=60°\ 50'$, and $119°\ 10'$, $i\breve{3}:i\breve{3}=120°50'$.



Observed planes.

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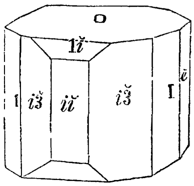

Cleavage: O and $i\breve{i}$ indistinct. Crystals often transversely divided, or foliated, parallel with O. Also massive, compact.

H.=7—7·5. G.=2·5969, Greenland, Stromeyer; 2·65—2·6643, Haddam, Thomson; Ostgothland 2·64, Südermanland 2·61, Schütz. Lustre vitreous. Color various shades of blue, light or dark, smoky-blue; often deep blue along the vertical axis, and brownish-yellow or yellowish-gray, perpendicular to it. Streak uncolored. Transparent—translucent. Fracture subconchoidal.

Composition.—$\dot{R}^3\,\dddot{Si}^2+3\dddot{\bar{R}}\,\dddot{Si}$, Berz. $=(\frac{1}{4}\,\dot{R}^3+\frac{3}{4}\,\ddot{\bar{Al}})\,\dddot{Si}^{\frac{5}{4}}$=Silica 49·6, alumina 33·8, magnesia 8·7, protoxyd of iron 7·9.

Analyses: 1, 2, 3, Stromeyer, (Unters. 329, 431); 4, 5, Schütz, (Pogg. liv, 565); 6, Scheerer, (Pogg. lxviii, 319, mean of two analyses); 7, Thomson, (Min. i, 278); 8, Jackson, (this Min. 2nd ed. 406, and Geol. Rep. New Hampshire, 184):

	$\dddot{Si}$	$\ddot{\bar{Al}}$	$\dot{Mg}$	$\dot{Mn}$	$\dot{Fe}$	$\dot{H}$
1. Bodenmais,	48·35	31·71	10·16	0·33	8·32	0·59=99·46, Stromeyer.
2. Greenland,	49·17	33·11	11·45	0·04	4·34	1·20=99·31, Stromeyer.
3. Fahlun,	50·25	32·42	10·85	——	4·01	1·66, $\ddot{\bar{Mn}}$ 0·68=99·87, Strom.
4. Ostgothland,	48·6	30·5	8·2	0·1	10·7	1·5, undec. 0·2=100·8, S.
5. Südermannland,	49·7	32·0	9·5	0·1	6·0	$\dot{Ca}$ 0·6, ign. 2·1, und. 0·6=100·6, S.
6. Krageroe,	50·44	32·95	12·76	——	——	$\dot{H}$ 1·02, $\ddot{\bar{Fe}}$ 1·07, $\dot{Ca}$ 1·12=99·36, S.
7. Haddam, Ct.	49·62	28·72	8·64	1·51	11·58	——, $\dot{Ca}$ 0·23=100·30, Thom.
8. Unity, Me.	48·15	32·50	10·14	0·28	7·92	0·50=99·49, Jackson.

B.B. fuses slowly on the edges to a blue transparent glass; with borax forms a clear bead. In powder attacked by concentrated acids, but not perfectly dissolved.

Iolite is met with at Bodenmais, in Bavaria, occasionally in perfect crystals 1½ in. thick. This variety has been called *peliom,* from its smoky-blue color, from πελιος.

It occurs in quartz, at Ujordlersoak, in Greenland; in granite at Cape de Gata, in Spain; at Arendal, in Norway; at Orijerfvi, in Finland, (Steinheilite); at Tunaberg, in Sweden, &c. Ceylon affords a transparent variety, in small rolled masses, of an intense blue color, the *sapphire d'eau* of jewelers.

At Haddam, Conn., associated with garnet and anthophyllite in gneiss; also abundant in quartz with garnet and yellowish-green feldspar, near the Norwich and Worcester Railway, between the Shetucket and Quinnebaug, where the gneiss has been quarried for the road. At Brimfield, Mass., on the road leading to Warren, near Sam Patrick's with adularia, in gneiss; also good at Richmond, N. H., in talcose rock, along with anthophyllite.

Iolite is occasionally employed as an ornamental stone, and when cut exhibits different colors in different directions. Named from *ιον, violet,* and *λιθος, stone; dichroite,* from its dichroism; *Cordierite,* after M. Cordier, the geologist.

Altered Forms.—The alteration of iolite takes place so readily by ordinary exposure, that the mineral is most commonly found in an altered state, or enclosed in the altered iolite. This change may be a simple hydration, (*Fahlunite,* etc.); or a removal of part of the protoxyd bases by carbonic acid; or the introduction of oxyd of iron through carbonate of iron; or of alkalies through waters containing alkaline carbonates, forming Pinite and mica; the first step in the change consists in a division of the prisms of iolite into plates parallel to the base, and a foliation of the surfaces of these plates; as the alteration proceeds, the foliation becomes more complete, but afterwards it is often lost.

Analyses: 1, Gmelin, (Kastn. Arch. i, 226); 2, Ficinus, (Schw. J. xxvi, 280); 3, Massalin, (Trommsdorff's N. J. iv, 2, 324); 4, Scott, (Ramm. Handw. ii, 61); 5, 6, Rammelsberg, (3d Supp. 94); 7–9, Marignac, (J. d. Pharm. Ch. [3], xii, 150); 10, 11, Trolle Wachtmeister, (K. V. Ac. H. 1827, p. 213); 12, Bonsdorff; 13, Erdmann, (Jahresb. 1841, 174); 14, C. T. Jackson, (2nd edit. p. 306); 15, Trolle Wachtmeister, (Pogg. xlv, 558); 16, Marignac, (J. de Pharm. et de Chem. [3], xii, 150); 17, Scheerer, (Pogg. lxviii, 323); 18, Erdmann, (K. V. Ac. H. 1840); 19, Wachtmeister, (K. V. Ac. H. 1827); 20, Nordenskiöld, (Jahresb. xii, 1833, 174); 21, Marignac, (v. Leonh. 1849, 201); 22, v. Hauer, (Jahrb. K. K. Geol. R., 1853, 147).

Analyses: 1 to 9, *Pinite* (or so called); 10, 11, *Fahlunite;* 12, *Bonsdorffite;* 13, *Esmarkite;* 14, *Chlorophyllite;* 15, 16, *Gigantolite;* 17, *Aspasiolite;* 18, *Praseolite;* 19, *Weissite;* 20, *Pyrargillite;* 21, 22, *Liebenerite.*

		$\dddot{\mathrm{Si}}$	$\dddot{\cancel{\mathrm{Al}}}$	$\dddot{\cancel{\mathrm{Fe}}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
1.	Auvergne,[a] *Pin.*	55·96	25·48	5·51	7·89	3·76	1·41, $\dot{\mathrm{Na}}$ 0·39=100·42, Gm.
2.	Neustadt, *red,* "	54·6	23·6	——	11·2	0·8	1·2, $\dot{\mathrm{Fe}}$ 7·8, $\dddot{\cancel{\mathrm{Mn}}}$1·6=100·8, F.
3.	" "	45·0	30·0	12·6	12·4	——	——=100, Massalin.
4.	Penig, "	48·00	28·00	9·66	11·35	——	3·0, $\dot{\mathrm{Ca}}$ 0·75=100·70, Scott.
5.	" "	47·00	38·36	$\dot{\mathrm{Fe}}$7·08	10·74	2·48	3·83, $\dot{\mathrm{Ca}}$ 0·79, $\dot{\mathrm{Na}}$ 1·07, R.
6.	Aue, "	46·83	27·65	7·84	6·52	1·02	7·80, $\dot{\mathrm{Ca}}$ 0·49, $\dot{\mathrm{Na}}$ 0·40, R.
7.	Auvergne, "	47·50	31·80	$\dddot{\cancel{\mathrm{Fe}}}$3·92	9·05	——	5·03, $\dot{\mathrm{Na}}$1·78, $\dot{\mathrm{Ca}}$0·92=100, M.
8.	Saxony, G. "	46·10	32.46	" 4·27	9·00	2·26	5·45, $\dot{\mathrm{Na}}$ 0·46=100, "
9.	Chamouny, G. "	44·70	31·64	" 6·57	7·89	2·86	5·39, $\dot{\mathrm{Na}}$ 0·95=100, "

a In porphyry. The magnesia in the analysis includes some manganese.

10.	Grafen, *Fahl.*	44·60	30·10	3·86	1·98	6·75	9·35, $\dot{\mathrm{Mn}}$ 2·24, $\dot{\mathrm{Na}}$ HF *tr.* $\dot{\mathrm{Ca}}$. 1·35=100·23, Wacht.
11.	" "	44·95	30·70	7·22	1·38	6·04	8·65, $\dot{\mathrm{Mn}}$ 1·90, $\dot{\mathrm{Ca}}$ 0·95, W.
12.	Abo, *Bonsd.*	45·05	30·05	5·30	——	9·00	10·60, (some $\dot{\mathrm{Mn}}$ with $\dot{\mathrm{Mg}}$)=100, B.
13.	Brevig, *Esmar.*	45·97	32·08	3·83	——	10·32	5·49, $\dot{\mathrm{Mn}}$ 0·41, $\dot{\mathrm{Ca}}$, Pb, Cu, Co, Ti, 0·45=98·55, Erdmann.
14.	Unity, *Chloroph.*	45·20	27·60	8·24	——	9·60	3·60, $\dot{\mathrm{Mn}}$ 4·08, $\ddot{\mathrm{P}}$ *tr.*=98·32, J.
15.	Tamela, *Gigant.*	46·27	25·10	14·04[a]	2·70	3·80	6·00, $\dot{\mathrm{Mn}}$ 0·89, $\dot{\mathrm{Na}}$ 1·20, F. *tr.* Wachtmeister.
16.	" "	42·59	26·78	14·21	5·44	2·72	5·70, $\dot{\mathrm{Mn}}$ 1·07, Marignac.

a Reckoned as protoxyd by Marignac, instead of peroxyd, which reduces an excess in the analysis of Wachtmeister, and conforms it to Marignac's determination.

		$\dddot{Si}$	$\ddot{\bar{Al}}$	$\ddot{\bar{Fe}}$	$\dot{K}$	$\dot{Mg}$	$\dot{H}$
17.	Krageroe, *Asp.*	50·40	32·38	2·34	——	8·01	6·73=99·86, Scheerer.
18.	Bräkke, *Pras.*	40·94	28·79	6·96[a]	——	13·73	7·38, $\dot{Mn}$ 0·32, $\dot{Pb}$, $\dot{Cu}$, $\dot{Ca}$, $\dot{Co}$, 0·50=98·62, Erdmann.
19.	Fahlun, *Weis.*	53·69	21·70	1·43	4·10	8·99	$\dot{H}$ and NH^3 3·20, $\dot{Mn}$ 0·63, $\dot{Na}$ 0·68, $\dot{Zn}$ 0·3=100·72, Wacht.
20.	Helsingfors, *Pyr.*	43·93	28·93	5·30	1·05	2·90[b]	$\dot{H}$15·47, $\dot{Na}$ 1·85=99·43, Nord.
21.	Fleimser, *Liebn.*	44·66	36·51	1·75	9.90	1·40	$\dot{H}$ $\ddot{C}$ 4·49, $\dot{Na}$ 0·92=99·63, M.
22.	" "	44·45	38·75$\ddot{\bar{F}}$?	2·26	6·45	*tr.*	" 4·75[c], $\dot{Na}$ 2·79, $\dot{Ca}$ 1·58=101·03, v. H.

[a] Reckoned as protoxyd by Erdmann. [b] With magnesia. [c] Loss.

Pinite includes the alkaline varieties of altered iolite, (analyses 1 to 9). In 6 or 12-sided prisms; cleavage often indistinct, sometimes basal; color gray to grayish-green or brown. H.=2·5. Analysis 5 corresponds in formula to iolite$+2\dot{H}$; 7, 8, 9, iolite $+3\dot{H}$, Marignac; 6, to iolite $+\ddot{\bar{Al}}\,\dddot{Si}^2+6\dot{H}$, Rammelsberg. B.B. whitens and fuses on edges. Occurs in Auvergne at the Puy-de-Dome, in decomposed feldspar porphyry; at Schneeberg in granite. *Oosite* related to pinite is from near Baden.

Fahlunite, Hisinger, (Anal. 10, 11), *Bonsdorffite or Hydrous Iolite of* Bonsdorff, (Anal. 12), *Esmarkite,* Erdmann, (Anal. 13), *Chlorophyllite,* Jackson, (Anal. 14).—These are very similar, occurring often in large 6 and 12-sided prisms, the form of the original iolite, (sometimes 6 inches across), with basal cleavage usually perfect and sometimes micaceous. Folia brittle. Color gray or grayish-green, greenish brown, dark olive green. Lustre pearly. G. in Fahlunite 2·6—2·79; in Esmarkite 2·709; in Chlorophyllite, 2·705. B.B. fuse only on the thinnest edges. Bonsdorffite and Fahlunite correspond to Iolite$+6\dot{H}$; Esmarkite, to Iolite$+3\dot{H}$; Chlorophyllite to Iolite$+2\dot{H}$; but the water is not constant, and the varieties are not distinct. *Fahlunite* occurs with iolite at Fahlun; *Bonsdorffite* at Abo; *Esmarkite* is from near Brevig; *Chlorophyllite* from Unity, Me., and Haddam, Ct.

Gigantolite, Nordenskiöld, (Anal. 15, 16).—Forms and cleavage as in the last; H. about 3·5, but on cleavage surface 2; G.=2·862—2·878. Greenish to dark steel-gray; between vitreous and waxy, approaching submetallic. Formula if part of the iron is peroxyd, ($\ddot{\bar{Fe}}$ 2·83, $\dot{Fe}$ 11·61), equivalent to Iolite $+3\dot{H}$. B.B. fuses with intumescence to a light greenish slag. From Tamela, Finland, in a gneissoid granite. Crystals large.

Aspasiolite, Scheerer, (Anal. 17). In prisms like the preceding, but cleavage less distinct. H.=3·5. G.=2·764. Greenish gray to whitish. Lustre weak. Composition, Iolite $+\ddot{\bar{Al}}\,\dddot{Si}^2+5\dot{H}$. B.B. infusible. From Krageroe in Norway, with quartz and iolite.

Praseolite, Erdmann, (Anal. 18). In prisms with basal cleavage, like the above. Green, with lustre greasy. Fracture flat-conchoidal and splintery. H.=3·5. G.=2·754. Composition if the iron is peroxyd, Iolite$+3\dot{H}$, Rammelsberg. B.B. fuses on thinnest edges only to a bluish green glass. From Bräkke, near Brevig, Norway, in granite.

Weissite, (Anal. 19). Similar to Fahlunite. Color blue, green. G.=2·8. Formula given, $\dot{R}^3\,\dddot{Si}^2+2\ddot{\bar{R}}\,\dddot{Si}^2$. From Fahlun, occurring in chlorite state in masses as large as hazlenuts.

Tennant has analyzed a mineral from Canada East, (Rec. Gen. Sci., 1836, May, 332), which has the composition of *Weissite,* affording $\dddot{Si}$ 55·05, $\ddot{\bar{Al}}$ 22·60, $\dot{Mg}$ 5·70, $\dot{Fe}$ 12·60, $\dot{Mn}$ *trace*, $\dot{Ca}$ 1·40, $\dot{H}$ 2·25=99·60. A relation to Weissite is doubtful.

Pyrargillite, Nordenskiöld, (Anal. 20). In prismatic forms; cleavage not distinct. H.=3·5. G.=2·5. Partly black, or bluish, liver-brown or dull red, and dull resinous. Odor argillaceous. Composition given, $\dot{R}\,\dddot{Si}+\ddot{\bar{Al}}\,\dddot{Si}+4\dot{H}$. B.B. infusible, becoming a little glazed in a strong heat. Soluble in muriatic acid. Near Helsingfors, Finland, in granite. Pyrargillite is referred to altered iolite by Bischof.

Liebenerite, (Anal. 21, 22). In 6-sided prisms, without distinct cleavage. H.=3·5. G.=2·814. Greenish-gray and somewhat greasy. Fracture splintery. Formula given $\dot{R}^3\,\dddot{Si}^2+6\ddot{\bar{Al}}\,\dddot{Si}+5\dot{H}$. B.B. whitens and intumesces, but does not fuse. From a red feldspar porphyry at Mt. Viesena, Fleimser Valley, in porphyry. Von Hauer states that his specimen had no appearance of alteration. The reference of this mineral here may not be correct.

Iberite, Svanberg, from Montalvan near Toledo, Spain, probably belongs here. It occurs in large six-sided prisms with basal cleavage. H.=2·5. G.=2·89. Vitreous to pearly. Composition according to Norlin, (Ofv. af. K. V. Ac. Förh., 1844, 219), $\ddot{\mathrm{S}}\mathrm{i}$ 40·90, $\ddot{\mathrm{A}}\mathrm{l}$ 30·74, $\dot{\mathrm{F}}\mathrm{e}$ 15·47, $\dot{\mathrm{M}}\mathrm{n}$ 1·33, $\dot{\mathrm{C}}\mathrm{a}$ 0·40, $\dot{\mathrm{M}}\mathrm{g}$ 0·81, $\dot{\mathrm{K}}$ 4·57, $\dot{\mathrm{N}}\mathrm{a}$ 0·04, $\dot{\mathrm{H}}$ 5·56=99·82. B.B. fuses to a dark pearl.

Huronite of Thomson, (Min. i. 384), from Canada, near Lake Huron, is considered an altered mineral near Fahlunite, by T. S. Hunt. Thomson in his analysis obtained, $\ddot{\mathrm{S}}\mathrm{i}$ 45·80, $\ddot{\mathrm{A}}\mathrm{l}$ 33·92, $\dot{\mathrm{F}}\mathrm{e}$ 4·32, $\dot{\mathrm{C}}\mathrm{a}$ 8·04, $\dot{\mathrm{M}}\mathrm{g}$ 1·72, $\dot{\mathrm{H}}$ 4·16=99·96. Infusible. Not attacked by acids.

4. MICA SECTION.

Oxygen ratio, (type ratio), 1 : 1; but ratio varying to 1 : $\frac{3}{2}$. Structure micaceous.*

MUSCOVITE,		$(\frac{1}{13}\dot{\mathrm{R}}^3+\frac{12}{13}\dddot{\mathrm{R}})\ \dddot{\mathrm{Si}}^{\frac{5}{4}}$.
MARGARODITE,	(in part),	$(\frac{1}{7}\dot{\mathrm{R}}^3+\frac{6}{7}\dddot{\mathrm{R}})\ \dddot{\mathrm{Si}}^{\frac{5}{4}}+n\dot{\mathrm{H}}$.
PHLOGOPITE,		$(\frac{3}{5}\dot{\mathrm{R}}^3+\frac{2}{5}\dddot{\mathrm{R}})\dddot{\mathrm{Si}}$.
BIOTITE,		$(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\dddot{\mathrm{R}})\dddot{\mathrm{Si}}$.
LEPIDOLITE,	(in part),	$(\dot{\mathrm{R}}^3,\dddot{\mathrm{R}})\ \dddot{\mathrm{Si}}^{\frac{3}{2}}$.
"	"	$(\dot{\mathrm{R}}^3,\dddot{\mathrm{R}})\ \dddot{\mathrm{Si}}^{\frac{4}{3}}$.
"	"	$(\dot{\mathrm{R}}^3,\dddot{\mathrm{R}})\ \dddot{\mathrm{Si}}$.
LEPIDOMELANE,		$(\frac{1}{4}\dot{\mathrm{R}}^3+\frac{3}{4}\dddot{\mathrm{R}})\mathrm{Si}$.

The micas have been considered as either monoclinic, trimetric or hexagonal. But Senarmont in his recent investigations has shown that monoclinic forms do not exist. He argues this from the fact that no twins have been observed in which the terminal faces are inclined to one another, while they are common parallel to the prismatic planes with these faces in one and the same plane, as observable by optical means when not otherwise apparent.

It is well known that slight admixtures of foreign ingredients change greatly the axes of polarization; moreover the same plate often varies several degrees in the apparent optical angle in different parts.

But notwithstanding the variations thus occasioned, there is still a wide interval between the common micas and the phlogopites, the former varying in the angle between the apparent axes, from 45° to 78°, the latter not exceeding 20°. The following are the results of the examinations of micas by Silliman, Jr., (Am. J. Sci., [2], x, 372, and Senarmont, (Ann. de Ch. et de Phys. [3], xxxiii, 391, xxxiv, 171. They are important as identifying localities, independently of their optical interest.

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* The species Margarite and Euphyllite appear to be homoœmorphous with the micas; but being hydrous they are arranged near chlorite.

I. *Observations of Silliman, Jr.*

1. *American Muscovite and Lepidolite; Angle from* 55° *to* 76°.

		Apparent Angle.
1.	New York Island, 4 m. from City, violet gray, containing black grains,	56° 20′–56° 40′
2.	Royalston, Mass., dark brown, fine crystal,	57° 30′
3.	ib. ib ib. ib. another,	58°–59°
4.	Pennsbury, Penn., smoky brown, striated,	59°
5.	Philadelphia, Penn., greenish gray, banded,	60° 30′–61°
6.	ib. ib. near Fairmount, smoky brown; resembles No. 4,	60°–62° 30′
7.	Oxford, Maine, light brown,	62° 42′–63°
8.	Monroe, Conn., brown with patches,	64° 30′–65° 30′
9.	Royalston, Mass., violet brown; in thick plates,	65°
10.	Local. ? greenish gray; in crystals,	65° 30′–66°
11.	Falls road, 2½ m. from Baltimore, transparent brown,	65° 30′–65° 40′
12.	Near Ellicott's Mills, Md., ib. ib.,	66° 30′
13.	"Jones Falls," near Baltimore, blackish green; symmetrically banded,	66° 15′–66° 30′
14.	Greenfield, Conn., greenish yellow,	66° 30′–67°
15.	Haddam, Conn., (Quarry Hill), clear brownish green,	67°
16.	Grafton, New Hampshire, light brown, transparent,	67° 30′
17.	Unionville, Penn., white, Corundum locality,	67°–67° 28′
18.	Acworth, N. H., greenish gray, in granite,	67° 15′–67° 30′
19.	Grafton, N. H., another specimen, light brown, with quartz and tourmaline,	68° 5′–68° 20′
20.	Templeton, Mass., transparent brown,	69° 30′–69° 40′
21.	Orange, Mass., ib. ib, beautiful crystals,	69° 30′–69° 40′
22.	Willimantic Falls, Conn., brownish green, transparent in granite,	69° 30′–69° 50′
23.	Pennsbury, Penn., brown crystals; another locality,	69° 27′–70°
24.	Royalston, Mass., dark brown; 2d locality,	69° 40′–70°
25.	Grafton, N. H., light brown; 3d specimen,	69°–69° 30′
26.	Middletown, Conn., brownish, feldspar quarry,	70°–70° 30′
27.	Chester, Hampden Co., Mass., greenish white,	70°–70° 30′
28.	Norwich, Mass., greenish yellow; Spodumene locality,	70° 30′
29.	Pennsbury, Penn., (3d local.), brownish green,	70°–70° 30′
30.	Goshen, Mass., greenish yellow, with spodumene,	70°–70° 30
31.	Greenfield, N. Y., brownish; Chrysoberyl locality,	70° 45′–71′
32.	Haddam, Conn., brownish; in large plates,	70°
33.	Gouverneur, N. Y., brownish-white, in boulder,	70°
34.	Templeton, Mass., (2d spec.,) transparent brown,	70° 15′
35.	Leiperville, Del. Co., Pa., faint greenish, plicated,	70° 30′–71°
36.	Jefferson Co., N. Y., greenish; in a boulder,	71°–71° 30′
37.	Hebron, Maine, light brown, transparent,	71° 40′–71° 50′
38.	Norwich, Mass., yellowish green transparent;	71° 45′
39.	Haddam, Conn., ib. ib.; Columbite locality,	71° 30′–71° 45′
40.	E. Chester, Westchester Co., N. Y., yellowish green boulder,	71° 30′–72°
41.	Paris, Maine, ib. ib.,	72° 15′–72° 30′
42.	ib. ib., ib. ib.,	72° 30′
43.	Brunswick, Maine, whitish brown, silvery,	72° 37′–72° 50′
44.	Gouverneur, N. Y.? fair rose color; no lithia,	73°–73° 5′
45.	Paris, Maine, whitish green; with green tourmaline,	74°–74° 30′
46.	ib. ib. ib. another,	73°
47.	Orange, N. H., gray, with flattened tourmaline, quartz and feldspar,	73° 74′
48.	Pounal, Maine, nearly colorless; lithia ? mica,	74° 50–75′

		Apparent Angle.
49.	Goshen, Mass., yellowish green; with indicolite,	75°
50.	ib. ib., another,	75° 30′–76°
51.	Lenox, Mass., rose-colored lithia (?) mica; with albite,	75°–75° 30′

2. *American Phlogopite.*

1.	Pope's Mills, St. Lawrence Co., N. Y., glassy transparent,	7°–7° 30′
2.	Edwards, N. Y., rich reddish brown,	10° ?
3.	St. Lawrence Co.? N. Y., yellowish,	10° ?
4.	Vrooman's Lake, N. Y., in long crystals of a yellow color,	10° 30′–10° 50′
5.	Edward's, N. Y., rich yellowish brown color,	11°
6.	Warwick, Orange Co., N. Y., in limestone, yellowish,	11° ?
7.	Falls of the Grand Calumet, Canada, yellowish green crystals many inches long,	13°–13° 12′
8.	Pope's Mills, St. Lawrence Co., N.Y., large crystals, fine yellowish brown,	13° 30′
9.	Edwards, N. Y.; 2d specimen, yellowish brown,	13° 30′
10.	Churches Mills, Rossie, N. Y., resembles the Pope's Mills,	13° 30′–14°
11.	Near Skinner's Bridge, Rossie, N. Y., silvery yellow mica,	14°
12.	Carlisle, Mass., rich yellowish brown,	14°
13.	Rossie, N. Y., near Mrs. Story's, light yellowish,	15°
14.	Pope's Mills, St. Lawrence Co., brownish yellow hexagonal crystal,	15°
15.	Natural Bridge, Jefferson Co., N. Y., rich yellow; associated with serpentine; same as analyzed by Meitzendorff,	15°
15. bis.	ib. ib., another specimen,	16°
16.	Edwards, N. Y., white silvery, curved crystals,	15° 30′–16° 30′
17.	Vicinity of Rossie, N. Y., rich yellow brown; probably the same as Gouverneur,	16° 7′–16° 15′
18.	Essex, N. Y., in limestone, deep rich brown color,	16° 30′
19.	Upper Ottawa, Canada, reddish yellow transparent,	17° 30′–18°
20.	Moriah, Essex Co., N. Y., very dark smoky red,	Estd. 16°–17°
21.	Gouverneur, N. Y., brownish copper red; Pope's Mills,	
22.	Somerville, N.Y., faint brownish,	5°–7°
23.	Burgess, Canada West, bronzy, almost metallic, semi-transparent if thin; opake in plates a line thick; slightly elastic only, found with apatite in sandstone,	Angle very low.
24.	Franklin, N. J., bronzy yellow,	About 14°
25.	Burgess, Canada West, whitish yellow,	About 10°
26.	Fine, St. Lawrence Co., N. Y., very dark olive brown,	Estd. 10°–12°
27.	Amity, N. Y., opake silvery white,	10°–12°
28.	Sterling Mine, Morris Co., N. J., rich yellowish brown, inclining to red: in limestone.	
29.	Suckasunny Mine, N. J., deep olive brown, inclining to yellow; in limestone.	
30.	Newton, N. J., yellow; imperfect and very small; in limestone.	
31.	Lockwood, Sussex, Co., N.J., deep olive brown, like the mica of Fine, N. Y.; in limestone.	

Nos. 20 to 27 are less transparent, and the observations are not exact. Besides the above American phlogopites, there is another found at Oxbow, N. Y., a brownish olive green variety at Warwick, Pa., of about 10°; a reddish coppery variety from St. Jerome, Canada, mentioned by Blake, (p. 221.)

II. *Observations of Senarmont.*[*]

(1.) *Micas whose optical axes are situated in the diametral plane of the longer diagonal.*

No.		Appar. Incl.
1.	Odontchelon, Daouria; gangue dolomite and diopside; brown; cryst.	1– 2°
2.	Loc. —— ? Hexagonal; transparent; brown, a little greenish,	1– 2°
3.	Loc. —— ? Hexag.; transparent; clear brown,	1– 2°
4.	Loc. —— ? Hexag.; transparent; copper-colored,	3– 4°
5.	Ceylon. Hexag.; transparent; clear green, nearly colorless,	3– 4°
6.	Philadelphia. Transparent; clear olive-green,	57–58°
7.	Siberia, in white quartz. Silvery, imperf. transparent,	57–58°
8.	Zillerthal, in albite. Silvery, imperf. transparent,	58–59°
9.	Arendal, in a feldspathic rock. Transparent; pale,	58–59°
10.	Loc. —— ? Transparent; gray, rhombs,	58–59°
11.	Loc. —— ? Hexag.; outer parts grayish-brown,	58–59°
	central parts colorless,	67°
12.	Loc. —— ? Transparent; clear brown,	58–59°
13.	Couzeran? Silvery, greenish-gray, with concave surface of cleavage,	60°
14.	St. Gothard, in quartzose gneiss; hexag.; silvery; clear gray,	60°
16.	Miask. Transparent; clear olive green,	62–63°
18.	Ekatherinenburg. Transparent; clear pale rose,	63–64°
21.	Schetank. Imperfectly transparent; rose-colored,	67°
23.	Brittany. Transparent, rhombic octahedrons; blond,	68°
24.	Kimito. Finland. Rhombic octahedrons; transparent; clear blonde,	67–68°
25.	Finland. Crystals, silvery; grayish green,	67–68°
27.	Aberdeen. Transparent; blonde,	68°
28.	Ekatherinenburg. Rhombic prisms in feldspar; cryst.; transparent; nearly blonde,	69–70°
29.	Loc. —— ? Colorless; but affords a central region,	70°
	an outer region,	60°
32.	American, probably; Lepidolite or rose mica,	74–76°
33.	Alençon. Hexag.; transparent; grayish blonde,	76–77°

(2.) *Micas with the optical axes in the diametral plane of the shorter diagonal.*

No.		Appar. Incl.
34.	Lake Baikal. Hexag.; deep brown; transparent,	1°
35, 36, 37, 38	—micas of unknown locality,	1– 4°
39.	Loc. —— ? Hexag.; deep bottle green,	15°
40.	Saxony. Hexag.; silvery, clear gray; transp., macled,	44°
42.	Zinnwald, with tin ore. Hexag.; silvery, greenish blonde by trp.	46–47°
43.	Loc. —— ? Hexag.; transparent; colorless;	50°
44.	Lepidolite; rhombic,	55°
46.	Piedmont. Rhombic; silvery reflection; grayish-green by trp.	63°
48.	St. Féréol, near Brives. Transparent; olive-green,	65°
49.	Milan. Hexag.; greenish-white; silvery; unctuous, not elastic,	65°
51.	Fossum, Norway. Hexag.; clear olive-green,	66°
52.	Scotland. Brown; in large thick crystals,	68°
54.	Tarascon (Ariége). Rhombic; transparent; colorless,	69°
55.	Ural, in graphic granite; octahedrons in quartz; silver lustre; color blonde,	72°
56.	Utö. Rhombs; lustre silvery; yellowish blonde by trp.,	72–73°

On examining different micas pressed between two plates of glass, and subjecting them to changes of temperature, Senarmont found no perceptible change in the optical axes.

Many of the micas that were reputed unaxial, and are properly *biotite*, were

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[*] The micas of doubtful locality in Senarmont's table are in general here omitted; but his numbering is retained.

shown by Silliman and also by Blake, to present the optical characters of a biaxial mica with a very small angle. This biaxial character, however, has been attributed by some to the lamellar structure of the mica. But Dove has recently shown by a new method, (Berichter Acad. Berlin, April, 1853), that they are actually biaxial, and they are so regarded by Senarmont. The greenish-black mica of Monroe, analyzed by von Kobell, is an example.

Mr. W. P. Blake gives the following list of such micas, part of which may be phlogopites, (Amer. Jour. Sci. [2], xii, 6):

1. Olive-green, from Greenwood furnace.
2. Silvery, from Easton, Pa.
3. Crimson, from Topsham, Maine.
4. Dark green, from Vesuvius, seven different varieties.
5. Deep copper red, from Franklin furnace, Sussex Co., N. J. (probably a phlogopite).
6. Dark bottle-green, from Moor's Slide, Ottawa, Canada.
7. Dark brownish-green, from St. Lawrence Co., N. Y.
8. Rich smoky yellow, and another dark brownish-red, from Hammcn, St. Lawrence Co., N. Y.
9. Dark brown, from Gouverneur, N. Y.
10. Dark green, from Monroe, Orange Co., N. Y.
11. Fiery red by transmitted light, from Moriah, Essex Co., N. Y.
12. Copper red, from St. N. Jerome, Canada East—angle 10°. A phlogopite.

No micas were examined by Mr. Blake but what gave indications of two axes, when they were not too dark for trial. The following are some of these darker varieties: a dark green by transmitted light, from Sussex Co., N. Y.; another from Middletown, Ct.; another from New York Island.

According to investigations thus far made, the muscovites vary in the apparent inclination of the axes between 44° and 75°; the phlogopites between 5° and 20°; the biotites range below 5°. Silliman, Jr., observes that the muscovites are confined to granitic and other igneous rocks, while the phlogopites are exclusively found in granular limestone and serpentine. The former contain in general potash or lithia, and little magnesia; and the latter contain magnesia, and often but little alkali.

MUSCOVITE, *D.* Oblique Mica. Biaxial Mica. Potash Mica. Common Mica. Glimmer, *in part.* Phengite, *Kob.* Muscovy Glass. Verre de Muscovie.

Trimetric; $I : I = 120°$. Occurring forms usually hemihedral, with a monoclinic aspect. Cleavage: basal eminent; occasionally also at right angles to two opposite sides of *O*, separating in

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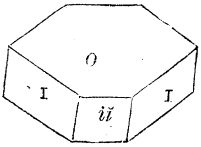

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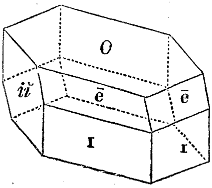

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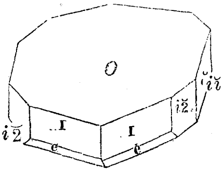

fibres. Twins: often observable by internal markings, or by polarized light; composition parallel to *I*. Folia sometimes aggregated in stellate, plumose, or globular forms; or in scales and scaly massive.

H.=2—2·5. G.=2·75—3·1. Lustre more or less pearly. Color white, gray, pale-green, and violet-yellow, sometimes brown and dark olive-green; colors different in axial and diametral directions. Streak uncolored. Transparent—translucent. Thin laminæ flexible and elastic, very tough. Sectile. Biaxial; angle between the axes of polarization 45°—75°.

Composition.—($\dot{R}^3$, $\dddot{\bar{R}}$) $\dddot{Si}^5_4$; mostly ($\frac{1}{13}\dot{K}^3+\frac{12}{13}\dddot{\bar{R}}$)$\dddot{Si}^5_4$. Analyses: 1, 2, H. Rose, (Schw. Jour. xxix, 282, and Gilb. Ann. lxxi, 13, and Pogg. i, 75); 3, Svanberg, (K. V. Ac. H. 1839, 155); 4, 5, 6, Rose, (loc. cit.); 7, Svanberg, (loc. cit.); 8, Schafhäutl, (Ann d. Ch. u. Pharm. xliv, 40):

	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dddot{\bar{Mn}}$	$\dot{Mg}$	$\dot{K}$	HF
1. Utö	47·50	37·30	3·20	0·90	——	9·60	0·56, $\dot{H}$ 2·63=101·59, Rose.
2. Broddbo,	46·10	31·60	8·65	1·40	——	8·39	1·12, $\dot{H}$ 1·00=98·26, Rose.
3. "	47·97	31·69	5·37	1·67	——	8·31	—–, F 0·72, Al 0·35, $\dot{H}$ 3·32, S.
4. Fahlun,	46·22	34·52	6·04	2·11		8·22	1·09, $\dot{H}$ 0·98, $\ddot{Ti}$ *trace*=99·18, R.
5. Kimito,	46·36	36·80	4·53	*trace*		9·22	0·71, $\dot{H}$ 1·84=99·52, Rose.
6. Ochotsk,	47·19	33·80	4·47	2·58		8·35	0·29, $\dot{H}$ 4·07, Ca 0·13=100·88, R.
7. Abborf.	39·45	9·27	35·78	——	3·29	5·06	—–, F 0·29, Ca 0·32, $\dot{Fe}$ 1·45, $\dot{Mn}$ 2·57=90·59, Svanberg.
8. *Fuchsite*,	47·95	34·45	1·80	——	0·72	10·75	—–, $\dot{F}$ 0·35, $\ddot{\bar{Cr}}$ 3·95, $\dot{Na}$ 0·37, Ca 0·42=100·76, Schaf.

In analyses 2 to 6 the oxygen of the protoxyds, peroxyds, and silica has the ratio 1 : 12 : 16; or as nearly 1 : 12 : 16¼, which gives for the oxygen ratio for the bases and silica 4 : 5, and affords the above formula.

The Abborforss mica (No. 7) gives closely the ratio 2 : 9 : 12.

Analysis No. 8 has nearly the ratio 1 : 9 : 12. The formula corresponding would be ($\frac{1}{10}\dot{R}^3+\frac{9}{10}\dddot{\bar{R}}$)$\dddot{Si}^6_5$.

B.B. fuses with some difficulty to a grayish-yellow blebby glass. Dissolves easily with borax and salt of phosphorus, leaving with the last a silica skeleton.

The variety composed of scales arranged in plumose forms is called *plumose mica;* and that with a diagonal cleavage, *prismatic mica.*

Mica is one of the constituents of granite, and its associate rocks, gneiss, syenite, and mica slate. It also occurs in more recent aggregate rocks; also in imbedded crystals in granular limestone, wacke, trachyte, and basalt. Coarse lamellar aggregations often form the matrix of crystals of topaz, tourmaline, and other mineral species. The *Fuchsite* is a green mica from Schwarzenstein in the Tyrol.

Siberia affords laminæ of mica, sometimes exceeding a yard in diameter; and other remarkable foreign localities are at Finbo in Sweden, and Skutterud in Norway.

Fine crystallizations of mica occur in granite at Acworth, Grafton, and Alstead, N. H., and the plates are at times a yard across and perfectly transparent; also at Paris and Streaked Mountain, Maine. In Massachusetts, at Chesterfield with tourmaline and Albite. Barre and South Royalston, in two localities with beryl, and at Mendon and Brimfield; at Chester, Hamden Co., Mass., faint greenish. A green variety occurs at Unity, Me., on the estate of James Neal; and prismatic mica at Russell, Mass. In Connecticut, at Monroe of a dusky brown color, having internal hexagonal bands of a darker shade; in brown hexagonal crystal at the Middletown feldspar quarry; at Haddam, pale brownish, with columbite, and also similar at another locality with garnets. Six miles southeast of Warwick, N. Y., crystals and plates sometimes a foot in diameter, in a vein of feldspar; a mile northwest of Edenville in six-sided and rhombic prisms; silvery, near Edenville; in St. Lawrence Co., eight miles from Potsdam, on the road to Pierrepont, mica is found in plates seven inches across; town of Edwards in large prisms, six-sided or rhombic; Greenfield, near Saratoga, in reddish-brown crystals with chrysoberyl; on the

Croton acqueduct near Yonkers, in rhombic prisms with a transverse cleavage. In Pennsylvania, in fine hexagonal crystals of a dark brown color at Pennsbury near Pennsville, Chester Co.; in Philadelphia Co. on the railroad near Philadelphia, smoky brown with hexagonal internal bands; at Chesnut Hill near the Wissahiccon, a green variety; at Leiperville, Delaware Co., faint greenish; in New Jersey, crystals are obtained at Newtown and Franklin. In Maryland, at Jones's Falls, a mile and three quarters from Baltimore; the plates show by transmitted light a series of concentric hexagons, the sides of which are parallel with the sides of a hexagonal prism. Other localities are given on pages 218 to 220.

Thomson has analyzed (Min. i, 360) a mica reported from Orange Co., N. Y., and stated to be in "fine rhomboidal prisms," and obtained $\dddot{\mathrm{Si}}$ 49·38, $\ddot{\bar{\mathrm{Al}}}$ 23·67, $\ddot{\bar{\mathrm{Fe}}}$ 7·31, $\dot{\mathrm{K}}$ 15·29, $\dot{\mathrm{Ca}}$ 6·13, $\dot{\mathrm{Li}}$ 0·06=101·89, affording the oxygen ratio 1 : 3 : 6=$\dot{\mathrm{R}}\dddot{\mathrm{Si}}+\ddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}$, corresponding to some Lithia micas.

Another mica from Chamouni, (probably biaxial, but not fully ascertained), afforded Delesse, (Ann. Ch. Phys. [3], xxv), $\dddot{\mathrm{Si}}$ 41·22, $\ddot{\bar{\mathrm{Al}}}$ 13·92, $\ddot{\bar{\mathrm{Fe}}}$ 21·31, $\dot{\mathrm{Mg}}$ 4·70, $\dot{\mathrm{K}}$ 6·05, $\dot{\mathrm{Na}}$ 1·40, $\dot{\mathrm{Ca}}$ 2·58, $\dot{\mathrm{Fe}}$ 5·03, $\dot{\mathrm{Mn}}$ 1·09, ign. 0·9, F 1·58=99·78. It gives the ratio 1 : 2½ : 4. G.=3·127.

A chrome mica afforded Schafhäutl (Ann. d. Ch. u. Pharm. xlvi, 325) $\dddot{\mathrm{Si}}$ 47·68, $\ddot{\bar{\mathrm{Al}}}$ 15·15, $\ddot{\bar{\mathrm{Fe}}}$ 5·72, $\dot{\mathrm{Mg}}$ 11·58, $\dot{\mathrm{K}}$ 7·27, $\ddot{\bar{\mathrm{Mn}}}$ 1·16, $\ddot{\bar{\mathrm{Cr}}}$ 5·91, $\dot{\mathrm{Na}}$ 1·17, $\dot{\mathrm{H}}$ 2·86, Fl *trace*=98·50.

Altered Forms.—Mica at times becomes hydrated, losing its elasticity and transparency, and often some portion of the alkalies and oxyd of iron.

Margarodite.—It is possible that *Margarodite* (analyses 6 to 11 below) may result from a change of this kind; it is a change in the oxygen ratio for the protoxyds, peroxyds and silica from 1 : 12 : 16·25 to 2 : 12 : 17·5, with the addition of some water, a change due partly to the added water, and perhaps partly also to the addition of magnesia and soda, as the analyses afford more soda and magnesia than exist in Muscovite. The formula corresponding to the above ratio is $(\frac{1}{7}\dot{\mathrm{R}}^3+\frac{6}{7}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}^{\frac{5}{4}}$. In appearance, and optical characters, this Mica resembles Muscovite; but it is much more pearly or silvery and less transparent and elastic; and it is often in radiated aggregations of scales or plates, a condition which would expose the mineral especially to alteration. G.=2·872, Schafhaütl, 2·79—2·81, Brewer; 2·817, Delesse; 2·831, Rammelsberg.

Gilbertite, (Anal. 4, 5), also is probably hydrous muscovite; it gives the oxygen ratio 1½ : 12 : 16, near some muscovite; but it has lost the alkalies or part of them. H.=2·75. G.=2·648. It is from Stonagwyn, St. Just, Cornwall.

Damourite of Delesse, appears also to be a Margarodite, and perhaps a hydrous Muscovite. The analysis corresponds to the formula$(\frac{1}{10}\dot{\mathrm{R}}^3+\frac{9}{10}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}^{\frac{6}{5}}+\frac{2}{3}\dot{\mathrm{H}}$. It has a scaly texture, a pearly lustre, yellow or yellowish-white color, and occurs associated with kyanite, at Pontivy, in Brittany.

Sericite of K. List, is regarded by him as near Damourite. H.=1. G.=2·897. Foliated in one direction, plates undulated. Lustre silky. Color greenish or yellowish-white. B.B. exfoliates strongly, and fuses on the edges with a bright light, to a grayish enamel. Decomposed slowly by muriatic acid. Oxygen ratio, if part of the iron is peroxyd, 1 : 3 : 6 : $\frac{3}{4}$. From a schist, with quartz, in the Taunus range, Western Germany.

Mica also occurs altered to *Steatite* or *Serpentine*, through the action of bicarbonate or silicate of magnesia in infiltrating waters.

A hydrous mica (Wasserglimmer, Morin, Ann. d. M. [3], xvii), afforded Morin, $\dddot{\mathrm{Si}}$ 34·8, $\ddot{\bar{\mathrm{Al}}}$ 10·2, $\dot{\mathrm{Ca}}$ 8·4, $\dot{\mathrm{Mg}}$ 8·1, $\dot{\mathrm{Fe}}$ 18·0, $\dot{\mathrm{Mn}}$ 5·0, $\dot{\mathrm{H}}$14·4=98·9. Oxygen ratio for the protoxyds, peroxyds, silica and water, 2·24 : 1 : 3·79 : 2·66.

The following are analyses of other hydrous micas: 1, J. D. Darrack, (this Min. 3d edit. 357); 2, Kussin, (Ramm. 4th Suppl. 75); 3, Smith and Brush, (Am. J. Sci. [2], xv, 210, xvi, 46); 4, Lehunt, (Thomson's Min. i, 235); 5, Thomson (ib.); 6, Schafhäutl; 7, Delesse, (Ann. d. Mines, [4], xvi, 202, 1849); 8, Rammelsberg, (Pogg. lxxxi, 38); 9, 10, 11, Smith and Brush, (Am. J. Sci. [2], xvi, 46, 47); 12, Delesse, (Ann. Ch. Phys. xv, 248); 13, K. List, (Ann. Ch. Pharm. lxxxi, 181):

	$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\bar{\dddot{\mathrm{Fe}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1. Unionville, *Musc.*	46·75	39·20	*tr.*	1·02	0·39	—	6·56	4·90=98·82, D.
2. Zsidovacs, “	48·07	38·41	*tr.*	—	—	—	10·10	3·42, $\bar{\dddot{\mathrm{Mn}}}$ *tr.*=100, K.
3. Litchfield, “	44·60	36·23	1·34	0·37	0·50	4·10	6·20	5·26, $\dot{\mathrm{Mn}}$ and F *tr.*= 100·6, S. and B.
4. Cornwall, *Gilb.*	45·15	40·11	$\dot{\mathrm{F}}$2·43	1·90	4·17	—	—	4·25=69·01, Lehunt.
5. ——? “	47·80	32·62	“ 5·18	1·60	—	9·23	—	4·00=100·42, Thom.
6. Zillerthal, *Marg.*,	47·05	34·90	$\bar{\dddot{\mathrm{Fe}}}$1·50	1·95	—	4·07	7·96	1·45=98·88, Schaf.
7. St. Etienne, “	46·23	33·08	3·48	2·10	—	1·45	8·87	4·12, $\dot{\mathrm{Mn}}$ and F *tr.*= 99·28, Delesse.
8. ——? “	47·84	32·36	3·06	1.28	0·29	1·55	10·25	2·43=99·06, Ramm.
9. Monroe, “	46·50	33·91	2·69	0·90	—	2·70	7·32	4·63, F 0·82, Cl 0.31, Smith & Brush.
10. “ “	45·70	33·76	3·11	1·15	—	2·85	7·49	4·90, F 0·82, Cl 0·31 Smith & Brush.
11. Chester Co., “	45·50	34·55	*tr.*	1·08	2·31	2·35	8·10	5·40=99·29, S & B.
12. *Damourite*,	45·22	37·85	*tr.*	—	—	—	11·20	5·25=99·52, Delesse.
13. *Sericite*,	49·00	23·65	—	0·94	0·63	1·75	9·11	3·41, $\dot{\mathrm{F}}$e 8·07, SiF^3 1·60, $\ddot{\mathrm{T}}$i 1·59=100·14, L.

The *Unionville* mica is whitish; ratio, exclusive of water, 1·61 : 18·32 : 24·29. That from *Zsidovacs* gives the ratio (excluding the water) 1 : 10·5 : 14·6, corresponding nearly to $(\frac{1}{11}\dot{R}^3+\frac{10}{11}\bar{\dddot{R}})\dddot{Si}^{\frac{5}{4}}+\frac{1}{2}\dot{H}$. The *Litchfield* mica is nearly colorless and pearly, and occurs with kyanite; G.=2·76; ratio 1·34 : 12 : 16·01. The *Margarodite* of St. Etienne is in graphic granite; that of Monroe, is associated with topaz and fluor; that of Chester Co., Pa., is found at the Poorhouse quarry, and is in small implanted crystals having a pearly talco-micaceous aspect, associated with implanted crystals of orthoclase, (Chesterlite).

Through Margarodite the mica section passes to the chlorite section; and if a distinct species, it should be arranged near Euphyllite.

PHLOGOPITE, *Breit.* Rhombic Mica. Magnesia Mica, in part.

Trimetric. In rhombic or hexagonal prisms, with refraction biaxial; *I* : *I*=120°. Color yellow or copper red: also white or colorless, and different shades of brown. Cleavage as in Muscovite. Angle between apparent optical axes 5° (or less) to 20°.

Composition.—$(\frac{3}{5}\dot{R}^3+\frac{2}{5}\bar{\dddot{R}})\dddot{Si}=3\dot{R}^3\dddot{Si}+2\bar{\dddot{R}}\dddot{Si}$, as in some Idocrase and Allanite. 1, Mean of three analyses by Meitzendorff, (Pogg. lviii, 157); 2, Svanberg, (K. V. Ac. H. 1839); 3, 4, 5, Crawe, (Am. J. Sci. [2], x, 396); 5, Delesse, (Bull. Soc. Geol. de Fr. [2], ix, 121):

	$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\bar{\dddot{\mathrm{Fe}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{K}}$	F
1. N. Y.,	41·30	15·35	1·77	28·79	—	9·70	3·30, $\dot{\mathrm{Na}}$, some $\dot{\mathrm{Li}}$ 0·05, ign. 0·28, M.
2. Sala,	42·65	12·86	$\dot{\mathrm{F}}$7.11	25·39	1·06	6·03	0·62, $\dot{\mathrm{Mg}}$0·36, Al0·1, $\dot{\mathrm{H}}$ 3·17, S.
3. Edwards, N. Y.,	40·15	17·36	—	28·10	—	10·56	4·20, $\dot{\mathrm{Na}}$ 0·63=101·00, Craw.
4. “	40·36	16·45	—	29·55	—	7·23	— “ 4·94, ign. 0·95=99·48, Craw.
5. “	40·36	16·08	—	30·25	—	6·07	2·65 “ 4·39=99·80, Craw.
6. Vosges,	37·54	19·80	$\dot{\mathrm{F}}$1·61	30·32	0·10	7·17	0·22 “ 1·00, ign. 1·51=99·97, Delesse.

The mica of No. 2 has not been examined optically; yet, as it agrees in atomic proportions with the *Phlogopite*, it appears to belong here. The oxygen ratio in this species is probably 3 : 2 : 5. Mr. Craw's analyses however, afford 1·77 : 1 : 2·69 =7 : 4 : 11, and Meitzendorff's nearly the same. The silico-fluorids in the former are about 1-24th and in the latter 1-30th. Delesse's analysis affords the ratio 3 : 2 : 4.

B.B. like common mica, fusing to a white enamel, and giving the reaction usually of fluorine.

No. 3, deep yellowish brown; 4, transparent and colorless; 5, from same crystal, but opaque from partial alteration.

This mica is especially characteristic of granular limestone. For localities see page 219. The Vosges mineral occurs like other phlogopites in limestone.

ALTERED FORMS.—The phlogopites are quite liable to change, losing their elasticity, becoming pearly in lustre, with often brownish spots, as if from the hydration of the oxyd of iron. No analysis has been made of the altered mineral. In some cases an alteration to steatite has been observed.

BIOTITE, *Hausmann.* Hexagonal Mica. Uniaxial Mica. Magnesia Mica. Rubellan, *Breit.* Meroxene, *Breit.* Glimmer, (in part). Rhombenglimmer, *Kengott.*

Trimetric? Usual in tabular prisms. Cleavage: basal, highly eminent. Also common in foliated masses. Refraction biaxial; angle between the axes less than 5°.

H.—2·5—3. G.=2·7—3·1. Lustre pearly; often submetallic on the terminal faces of the prism; splendent—shining. Colors various, as in the preceding species, usually dark-green or brown, or nearly black: sometimes white or colorless. Streak uncolored. Transparent—opaque. Thin laminæ flexible and elastic.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+\cancel{\dddot{\mathrm{R}}}\dddot{\mathrm{Si}}=(\tfrac{1}{2}\dot{\mathrm{R}}^3+\tfrac{1}{2}\cancel{\dddot{\mathrm{R}}})\dddot{\mathrm{Si}}$, as in Garnet. Analyses: 1, Klaproth, (Beit.); 2, H. Rose, (loc. cit.); 3, 4, 5, Kobell, (Kastn. Arch. xii, 29); 6, 7, Svanberg, (loc. cit.); 8, Kobell, (J. f. pr. Chem. xxxvi, 309); 9, Bromeis, (Pogg. lv, 112); 10, H. Rose, (Gilb. Ann. lxxi, 13); 11, Chodnev, (Pogg. lxi, 381, mean of 2 anal.); 12, Varrentrapp, (ibid.); 13, 14, Smith and Brush, (Am. J. Sci. [2], xvi, 45, 46); 16, C. Bromeis, (Bischof's Lehrb. d. Geol. ii, 1418):

		$\dddot{\mathrm{Si}}$	$\cancel{\dddot{\mathrm{Al}}}$	$\cancel{\dddot{\mathrm{Fe}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$
1.	Siberia,	42·50	11·50	22·00	9·00	10·00, $\cancel{\ddot{\mathrm{Mn}}}$ 2·0, ign. 1·00=98, Klaproth.
2.	"	40·00	12·67	19·03	15·70	5·61, HF 2·10, $\cancel{\ddot{\mathrm{Mn}}}$0·63, $\cancel{\ddot{\mathrm{Ti}}}$ and $\cancel{\dddot{\mathrm{Fe}}}$1·63, R.
3.	"	42·12	12·83	10·38	16·15	8·58, $\dot{\mathrm{Fe}}$ 9·36, $\dot{\mathrm{H}}$ 1·07=100·49, Kobell.
4.	Monroe, N. Y.,	40·00	16·16	7·50	21·54	10·83, HF 0·53, $\ddot{\mathrm{Ti}}$ 0·2, $\dot{\mathrm{H}}$ 3·0=99·76, K.
5.	Greenland,	41·00	16·88	4·50	18·86	8·76, HF *trace*, $\dot{\mathrm{Fe}}$5·05, $\dot{\mathrm{H}}$4·30=99·35, K.
6.	Pargas,	42·58	21·68	10·39	10·27	8·45, F 0·51, $\dot{\mathrm{Mn}}$ 0·75, $\dot{\mathrm{H}}$ 3·35, $\dot{\mathrm{Ca}}$ 0·56=99·80, Svanberg.
7.	Rosendale,	44·41	16·86	——	11·26	4·05, F 0·41, $\dot{\mathrm{Fe}}$ 20·71, $\dot{\mathrm{Mn}}$ 0·45, $\dot{\mathrm{H}}$ 1·13, $\dot{\mathrm{Ca}}$ 0·90, Ca, 0·43=101·60, Sv.
8.	Bodenmais,	40·86	15·13	13·00	22·00	8·83, $\dot{\mathrm{H}}$ 0·44=100·26, Kob.; G. 2·7.
9.	Vesuvius,	39·75	15·99	8·29	24·49	8·78, $\dot{\mathrm{Ca}}$ 0·87, ign. 0·75, undc. 0·1=
10.	L. Baikal,	42·01	16·05	4·93	25·97	7·55, HF 0·68=97·19, Rose. [98·62, B.
11.	Vesuvius,	40·91	17·79	11·02	19·04	9·96, $\dot{\mathrm{Ca}}$ 0·3=99·02, Chodnev.
12.	Zillerthal,	39·85	16·07	13·21	15·60	$\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$ and loss 13·68, $\dot{\mathrm{Ca}}$ 0·42=100, V.
13.	Monroe, N.Y.,	39·88	14·99	7·68	23·69	9·11, $\dot{\mathrm{Na}}$ 1·12, $\dot{\mathrm{H}}$ 1·30, F 0·95, Cl 0·44=99·16, S. & B.
14.	"	39·51	15·11	7·99	23·40	10·20 $\dot{\mathrm{H}}$ 1·35, F 0·95, Cl 0·44=68·95, S. & B.
15.	Putnam Co.,	39·62	17·35	5·40	23·85	8·95, $\dot{\mathrm{Na}}$ 1·01 $\dot{\mathrm{H}}$ 1·41, F 1·20, Cl 0·27=99·06, S. & B.
16.	Laach,	43·02	16·85	11·63	18·40	8·60, " 1·15, $\dot{\mathrm{Ca}}$ 0·71=100·36[a], B.

[a] Much ammoniacal water, on ignition, given off.

The above magnesia micas give for the most part for the oxygen of the protoxyds, peroxyds, and silica, the ratio 1 : 1 : 2, affording the above formula. The Pargas mica has the ratio ⅔ : 1 : 2. In composition, Biotite and Phlogopite appear to be distinct, although *optically no definite line can yet be drawn.*

B.B. fuses with difficulty to a grayish or blackish glass. With the fluxes an iron glass.—Localities as mentioned on page 221.

The species biotite was shown to be in part, at least, optically biaxial, by Silliman, Jr., and Blake, and this conclusion is confirmed by Senarmont, who takes the ground that the species is not rhombohedral. The annexed figure by Marignac, represents the rhombohedral aspect of a Vesuvian specimen, probably the same found to be biaxial by Silliman, Jr. Marignac gives the angles R : R=62° 46′, R : a=99° 40′ (99° 45′ by calculation), a on o=102° 28′, a on o'=98° 23′, a on o''=95° 37′.

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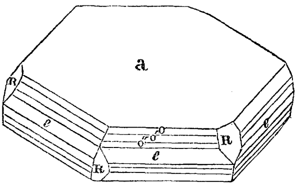

The mica from Greenwood Furnace, Monroe, N. Y., analyzed by von Kobell, (anal. 4), occurs in large and very regular rhombic prisms, (sometimes 5 or 6 inches across), oblique from an acute edge; and also in tetrahedral pyramids; the faces of the pyramids inclined to the cleavage plane at 113° to 114°; Kobell gives for the angle R : R (faces of the pyramid) 71° to 72°. This is the same mica with that analyzed by Smith and Brush, (anal. 13, 14), as Mr. Brush has assured himself by an examination of von Kobell's specimens at Munich. It is the *Rhombenglimmer* of Kengott, (Pogg. lxxiii, 661). In composition it is true biotite.

The Vesuvian biotite occurs in brilliant crystals, (*Meroxene*). A brownish-green biotite with a waxy structure and soapy feel, (anal. 15), occurs in Putnam Co., N. Y. G.=2·80. One of the "uniaxial" micas of Biot is stated to have come from Topsham, Maine.

ALTERED FORMS.—*Rubellan* is considered an altered biotite; it occurs in small hexagonal forms, of a red color, in a kind of wacke. Steatite is also a result of the alteration of this species, as in granite at Brünn and Thierscheim. Among the above analyses, several indicate incipient change, by the water and chlorine present. The mica of Putnam Co., N. Y., has even a soapy feel and is inelastic. Mica altered to Magnetite has also been observed in the Tyrol.

LEPIDOLITE. Lithia Mica. Lithion-glimmer. Lithionite, *Kob.* *In part,* Zinnwaldite, *Haid.*

Trimetric. Occurs often in oblique rhombic and hexagonal prisms of 119° to 120°; also in coarsely granular masses consisting of foliated scales. Cleavage: basal, highly eminent.

H.=2·5—4. G.=2·84—3. Lustre pearly. Color rose-red, violet gray, yellowish, whitish. Translucent. Apparent angle of optical axes 70°—78°.

Composition.—According to Rammelsberg, the analyses afford the following formulas, the fluorine replacing part of the oxygen:—

1. Ural, Chursdorf, Uto, Rozena, Zinnwald (Ramm.), Altenberg (Stein) $\dot{R}\dddot{Si}+\dddot{\bar{R}}\dddot{Si}\ [=(\frac{1}{4}R^3+\frac{3}{4}\dddot{\bar{R}})\ \dddot{Si}\,\frac{3}{2}.]$
2. Zinnwald, Rozena, (Ramm. anal. 16), $2\,\dot{R}\dddot{Si}+3\dddot{\bar{R}}\dddot{Si}$[=nearly $(\frac{1}{6}\,\dot{R}^3+\frac{5}{6}\dddot{\bar{R}})\ \dddot{Si}\,\frac{4}{3}$.]
3. Juschakowa, (anal. 19, 20), $3\,\dot{R}\dddot{Si}+2\dddot{\bar{R}}\dddot{Si}[=(\frac{1}{3}\dot{R}^3+\frac{2}{3}\dddot{\bar{R}})\dddot{Si}\,\frac{5}{3}.]$
4. Altenberg, (Turner, anal. 11), $\dot{R}^3\dddot{Si}+6\dddot{\bar{R}}\dddot{Si}[=(\frac{1}{7}\dot{R}^3+\frac{6}{7}\dddot{\bar{R}})\dddot{Si}.]$

Ratio of fluorine to oxygen, in the Ural, Chursdorf, Uto and Rozena micas 1 : 20; in the Altenberg, (Stein) 1 : 60; in the Zinnwald, 1 : 14, 1 : 11, 1 : 12; in the Juschakowa, 1 : 8; in Turner's Altenberg 1 : 25; in Rammelsberg's Rozena, (anal. 16), 1 : 12. The last is the prevailing ratio.

Analyses: 1, Klaproth, (Beit. i, ii, v); 2, Gmelin, (loc. cit.); 3, Kralowansky, (Schw. J. liv, 230); 4, 5, Gmelin; 6, Turner, (Edinb. J. Sci. iii, and vi, 61); 7, Klaproth; 8, Lohmeyer, (Pogg. lxi, 377); 9, Stein, (Ramm. 5th, Suppl., 119); 10, Rammelsberg, (ib., 119); 11—15, Turner, (loc. cit.); 16, Rammelsberg, (5th Suppl. 120); 17, 18, Regnault, (Ann. d. Mines, [3], xiii, 151,); 19, 20, Rosales, (Pogg. lviii, 154); 21, Stein, (J. f. pr. Chem. xxviii, 295):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dddot{\bar{\mathrm{Mn}}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Li}}$	HF
1.	54·50	38·25	0·75		—	4·00	—	—, $\dot{\mathrm{H}}$ and loss 2·50=100, Klap.
2.	49·06	33·61	—	1·40	—	4·19	3·59	3·44, $\dot{\mathrm{Mg}}$0·41, $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 0·11, $\dot{\mathrm{H}}$ loss 4·18, G.
3.	49·08	34·01	—	1·08	—	4·19	3·58	3·50 (with $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$), $\dot{\mathrm{Mg}}$ 0·41, $\dot{\mathrm{H}}$ and loss 4·15, K.
4.	52·25	28·35	—	—	3·66	6·90	4·79	5·07, $\dot{\mathrm{H}}$ *trace*=101·03, Gmelin.
5.	46·23	14·14	17·97	—	4·57	4·90	4·21	8·53, $\dot{\mathrm{H}}$ 0·83=101·39, "
6.	44·28	24·53	—	—	1·66	9·47	4·09	5·14, $\dot{\mathrm{Fe}}$ 11·33=100·50, Turner.
7.	47·00	20·00	15·50	1.75	—	14·50	—	—=98·75, Klaproth.
8.	42·97	20·59	14·18	0·83	—	10·02	1·60	—, F 6·35, $\dot{\mathrm{Na}}$ 1·41, Cl 0·21, ign. 0·22=98·38, Lohmeyer.
9.	48·65	17·67	—	—	1·24	8·60	2·41	F8·16, $\dot{\mathrm{Fe}}$ 14·57, $\dot{\mathrm{Mg}}$ 0·53, $\dot{\mathrm{Na}}$ 0·71=102·54, St.
10.	46·52	21·81	4·68	—	1·96	9·09	1·27	" 7·47, $\dot{\mathrm{Fe}}$ 6·80, " 0·44, $\dot{\mathrm{Na}}$ 0·39, $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 0·13=100·66, R.
11.	40·19	22·49	—	—	2·02	7·49	3·06	3·99, $\dot{\mathrm{Fe}}$ 19·78=99·25, Turner.
12.	50·91	28·17	—	—	1·08	9·50	5·67	4·11=99·44, Turner.
13.	50·35	28·30	—	—	1·23	9·04	5·49	5·20=99·61, Turner.
14.	50·82	21·33	—	—	*trace*	9·86	4·05	4·81, $\dot{\mathrm{Fe}}$ 9·08=99·95, Turner.
15.	40·06	22·90	27·06	—	1·79	4·30	2·00	2·71,=100·82, Turner,
16.	51·70	26·76	—	1·29	—	10·29	1·27	F 7·12, $\dot{\mathrm{Mg}}$ 0·24, $\dot{\mathrm{Ca}}$ 0·40, $\dot{\mathrm{Na}}$ 1·15, $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 0·16=100·38, Ramm.
17.	52·40	26·80	—	—	1·50	9·14	4·85	4·40=99·09, Regnault.
18.	49·78	19·88	13·22	—	—	8·79	4·15	4·25=100·07, "
19.	48·92	19·03	—	5·59	—	10·96	2·77,	F 10·44, Cl 1·31, $\dot{\mathrm{Ca}}$ 0·14, $\dot{\mathrm{Na}}$ 2·23, R.
20.	46·62	21·05	—	4·12	—	*und.*	*und.*,	F 10·01, Cl 1·01, $\dot{\mathrm{Ca}}$ 0·12. rest *und.* R.
21.	47·01	20·35	14·34	—	1·53	9·62	4·33,	F 1·43, Cl 0·40, ign 1·53=100·54, S.

1, 2, 3, from Rozena; 4, Chursdorf; 5—10, Zinnwald; 11, Altenberg; 12, 13, Utö; 14, 15, Cornwall; 16, 17, Rozena; 18, doubtful; 19, 20, Juschakowa, Ural; 21, Altenberg.

Fuses easily to a white or grayish glass, sometimes magnetic; the flame often purplish red at the moment of fusion. The Zinnwald mica has been called *Zinnwaldite.* More chemical investigations are required before the species Lepidolite can be correctly subdivided, or comprehended. Physically it is hardly distinct from Muscovite.

Foreign localities as above.

In the United States, a rose mica is obtained at the albite vein in Chesterfield, Mass., and at Goshen, Mass.; granular variety at Paris, Maine, with red tourmalines; also near Middletown, Conn. The Goshen mineral is of difficult fusibility and slight lithia reaction, and may not be of this species.

LEPIDOMELANE, *Soltmann*, Pogg. l, 664.

Hexagonal? Trimetric? In small six-sided tables, or an aggregate of minute scales. Cleavage basal, perfect.

H.=3. G.=3·0. Lustre of the scales adamantine, inclining to vitreous. Color of the scales black—occasionally a leek-green reflection. Streak mountain-green. Opaque, or translucent in very thin laminæ. Somewhat brittle.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+3\,\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}=(\frac{1}{4}\dot{\mathrm{R}}^3+\frac{3}{4}\dddot{\bar{\mathrm{R}}})\,\dddot{\mathrm{Si}}$. Analysis by Soltmann:

$\dddot{\mathrm{Si}}$ 37·40, $\dddot{\bar{\mathrm{Al}}}$ 11·60, $\dddot{\bar{\mathrm{Fe}}}$ 27·66, $\dot{\mathrm{Fe}}$ 12·43, $\dot{\mathrm{Mg}}$ & $\dot{\mathrm{Ca}}$ 0·26, $\dot{\mathrm{K}}$ 9·20, $\dot{\mathrm{H}}$ 0·60=99·49.

B.B. at a red heat, becomes pinchbeck-brown, and resembles magnetic pyrites; then fuses to a black opaque magnetic enamel. With borax forms a bottle-green glass. Dissolves easily in muriatic or nitric acid, leaving a skeleton of silica.

Occurs at Petersberg in Wermland. It was named, in allusion to its structure and color, from λεπις, *a scale*, and μελας, *black.*

5. FELDSPAR SECTION.

Type ratio for oxygen of bases and silica 1 : 1, and varying from this by the addition of silica to the type. Oxygen ratio for protoxyds and peroxyds 1 : 3 or 1 : 4.

I. LEUCITE GROUP.—Monometric.

Sodalite,	Oxygen ratio	1 : 3 : 4+	$(\dot{\text{Na}}+\dddot{\text{Al}})\dddot{\text{Si}}^{\frac{4}{3}}[+\frac{1}{3}\text{Na Cl}]$
Lapis-lazuli,			
Hauyne,	“	1 : 3 : 4+	$(\dot{\text{Na}}+\dddot{\text{Al}})\dddot{\text{Si}}^{\frac{4}{3}}[+\frac{2}{3}\dot{\text{Ca}}\,\dddot{\text{S}}]$
Nosean,	“	1 : 3 : 4+	$(\dot{\text{Na}}+\dddot{\text{Al}})\dddot{\text{Si}}^{\frac{4}{3}}[+\frac{1}{3}\dot{\text{Na}}\,\dddot{\text{S}}]$
Leucite,	“	1 : 3 : 8	$(\dot{\text{K}}+\dddot{\text{Al}})\dddot{\text{Si}}^{\frac{8}{3}}$

II. NEPHELINE GROUP.—Hexagonal.

Nepheline,	Oxygen ratio	1 : 3 : 4½	$(\dot{\text{Na}}, \dot{\text{K}}+\dddot{\text{Al}})\dddot{\text{Si}}^{\frac{3}{2}}$
Cancrinite,	“	1 : 3 : 4½+	$(\dot{\text{Na}}+\dddot{\text{Al}})\dddot{\text{Si}}^{\frac{3}{2}}[+\frac{1}{2}(\dot{\text{Na}}, \dot{\text{Ca}})\ddot{\text{C}}]$

III. FELDSPAR GROUP.—Triclinic or Monoclinic.

Anorthite,	Oxygen ratio	1 : 3 : 4	$(\dot{\text{Ca}}+\dddot{\text{Al}})\dddot{\text{Si}}^{\frac{4}{3}}$
Andesine,	“	1 : 3 : 8	$(\dot{\text{Ca}}, \dot{\text{Na}}+\dddot{\text{Al}})\dddot{\text{Si}}^{\frac{8}{3}}$
Labradorite,	“	1 : 3 : 6	$(\dot{\text{Ca}}, \dot{\text{Na}}+\dddot{\text{Al}})\dddot{\text{Si}}^{2}$
Oligoclase,	“	1 : 3 : 9	$(\dot{\text{Na}}, \dot{\text{Ca}}+\dddot{\text{Al}})\dddot{\text{Si}}^{3}$
Albite,	“	1 : 3 : 12	$(\dot{\text{Na}}+\dddot{\text{Al}})\dddot{\text{Si}}^{4}$
Orthoclase,	“	1 : 3 : 12	$(\dot{\text{K}}+\dddot{\text{Al}})\dddot{\text{Si}}^{4}$

IV. PETALITE GROUP.—Oxygen ratio for protoxyds and peroxyds 1 : 4.

Petalite,	Oxygen ratio	1 : 4 : 20	$(\frac{1}{5}\dot{\text{R}}^{3}+\frac{4}{5}\dddot{\text{Al}})\dddot{\text{Si}}^{4}$

[The above formulas are a direct expression of the oxygen ratios, and present to the eye the prominent fact that the species vary in the proportion of silica. They might also be written like the formulas of the Garnet and Augite Sections; thus for Anorthite of the Feldspar group, $(\frac{1}{4}\dot{\text{R}}^{3}+\frac{3}{4}\dddot{\text{Al}})\,\dddot{\text{Si}}$; for Andesine $(\frac{1}{4}\dot{\text{R}}^{3}+\frac{3}{4}\dddot{\text{Al}})\dddot{\text{Si}}^{2}$, &c.; the formula of Petalite is of this form. In either way, the species are better compared as to their composition, than by the old (and certainly not less hypothetical) formulas, which give for Anorthite $\dot{\text{R}}^{3}\dddot{\text{Si}}+3\,\dddot{\text{Al}}\,\dddot{\text{Si}}$; for Andesine $\dot{\text{R}}^{3}\dddot{\text{Si}}^{2}+3\dddot{\text{Al}}\dddot{\text{Si}}^{2}$; Labradorite $\dot{\text{R}}\,\dddot{\text{Si}}+\dddot{\text{Al}}\dddot{\text{Si}}$. It is obvious that the bare ratios serve better the purpose of the student than formulas like these last.

The species Leucite and Andesine are mutually dimorphous; so also Sodalite and Anorthite; also Orthoclase and Albite; which two species are besides closely homœomorphous. Again, the Anorthite ratio is supposed to recur in Scapolite. Through *Scapolite* the Garnet and Feldspar sections osculate, and through *Spodumene* and *Andesine* the Augite and Feldspar sections. Leucite is essentially an anhydrous analcime.]

SODALITE.

Monometric. In dodecahedrons; also f. 17, 18, 38, 39, 43. Cleavage: dodecahedral, more or less distinct. Twins: hexagonal prisms arising from a combination of dodecahedrons. Also massive.

H.=5·5—6. G. 2·26, Vesuvius; 2·289 Ural; 2·37, Greenland. Lustre vitreous inclining to greasy. Color gray, greenish, yellowish, white, and sometimes blue, lavender-blue. Subtransparent—translucent. Fracture conchoidal—uneven.

Composition.—$\dot{\mathrm{Na}}^3\dddot{\mathrm{Si}}+3\,\ddot{\overline{\mathrm{Al}}}\,\dddot{\mathrm{Si}}+\mathrm{Na\,Cl}=(\dot{\mathrm{Na}}+\ddot{\overline{\mathrm{Al}}})\dddot{\mathrm{Si}}^{\frac{4}{3}}[+\frac{1}{3}\mathrm{Na\,Cl}$=Silica 37·2, alumina 31·7, soda 19·1, sodium 4·7, chlorine 7·3=100. The name alludes to the *soda.* J. D. Whitney suggests that the color may be owing to ferric acid present.

Analyses: 1, Ekeberg, (Thomson's Ann. Phil. i, 104); 2, Thomson, (Trans. Royal Soc. Edinb. i, 390); 3, Arfvedson, (Jahresb. ii, 97); 4, Hofmann, (Pogg. xlvii, 377); 5, 6, Whitney, (Pogg. lxx, 431); 7, v. Borc, (Pogg. lxxviii, 413):

	$\dddot{\mathrm{Si}}$	$\ddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Na}}$	HCl	$\dddot{\overline{\mathrm{Fe}}}$
1. Greenland,	36·00	32·00	25·00	6·75	0·15=99·90, Ekeberg.
2. "	38·52	27·48	23·50	3·00	1·00, $\dot{\mathrm{Ca}}$ 2.7, ign, 2·1=98·30, T.
3. "	33·75	35·50	26·23[a]	5·30	——=100·78, Arfvedson.
4. Ilmen Mount.	38·40	32·04	24·47[a]	7·30	——, $\dot{\mathrm{Ca}}$ 0·32=102·53, Hofmann.
5. Litchfield, Me.,	37·30	32·88[b]	23·86	Cl 6·97,	$\dot{\mathrm{K}}$ 0·59=101·60, Whitney.
6. " "	37·63	30·93	25·48	$\dddot{\overline{\mathrm{Fe}}}$ 1·08,	rest undetermined, Whitney.
7. Lamö, Norway,	38·86	30·82	22·03	$\dot{\mathrm{K}}$ 0·51,	$\dot{\mathrm{Ca}}$ 1·21, $\dot{\mathrm{Mg}}$ 0·44, Cl *undet.*[c]=93·87, B.

[a] With some $\dot{\mathrm{K}}$. [b] With $\dddot{\overline{\mathrm{Fe}}}$. [c] Traces of Sn Mn, W, Mo.

The sodalite from Greenland fuses with difficulty before the blowpipe. The sodalite of Vesuvius forms a colorless glassy globule. Gelatinizes with nitric or muriatic acid.

Sodalite is met with in mica slate, granite, trap, basalt, and volcanic rocks.

Sodalite occurs in Greenland in mica slate, along with feldspar, hornblende, and eudialyte; at Vesuvius in white translucent dodecahedral crystals; massive and of a gray color imbedded in trap at the Kaiserstuhl in Brisgau; also near Lake Laach; in Sicily, Val di Noto, with nepheline and analcime; at Miask, in the Ural, blue in granite with elæolite and feldspar; in nodular masses at Lamö near Brevig, Norway, with elæolite, of a lavender-blue color. A blue variety occurs at Litchfield, Me., massive with distinct cleavage, associated with elæolite, zircon, and cancrinite.

Bergemann obtained for a greenish mineral occurring with elæolite at Brevig in Norway, (Pogg. lxxxiv, 492), $\dddot{\mathrm{Si}}$ 46·03, $\ddot{\overline{\mathrm{Al}}}$ 23·97, $\dot{\mathrm{Na}}$ 21·48, Cl 7·43, $\dddot{\dot{\mathrm{P}}}$ 0·86, $\dot{\mathrm{Ca}}$, $\dddot{\overline{\mathrm{Fe}}}$ *tr.*=99·77. It gives the formula $(\dot{\mathrm{Na}}+\ddot{\overline{\mathrm{Al}}})\,\dddot{\mathrm{Si}}^2+\frac{1}{2}\mathrm{Na\,Cl}$.

Altered Forms.—Sodalite occurs altered to Kaolin, like the feldspars.

LAPIS LAZULI. Lasurstein. Ultramarine.

Monometric. In dodecahedrons. Cleavage: dodecahedral, imperfect. Commonly massive, compact.

H.=5·5. G.=2·38—2·45. Lustre vitreous. Color rich Berlin or azure-blue. Translucent—opaque. Fracture uneven.

Composition.—A silicate of soda, lime, and alumina, with a sulphuret probably of iron and sodium. Analyses: 1, Klaproth, (Beit. i, 189); 2, Gmelin, (Schw. J. xiv, 329); 3, Varrentrapp, (Pogg. xlix, 515):

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{S}}$	$\ddot{\overline{\mathrm{Al}}}$	$\dddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
1.	46·0	4·0	14·5	3·0	17·5	——	2·0 $\ddot{\mathrm{C}}$ 10·0=97·0, Klaproth.
2.	49·	2·	11·	4.	16·	8·	— $\dot{\mathrm{Mg}}$ 2=92, Gmelin.
3.	45·50	5·89	31·76	—	3·52	9·09	0·12 Fe 0·86, Cl 0·42, S 0·95=98·11, V.

Lapis Lazuli fuses to a white glass, and if calcined and reduced to powder, loses its color, and gelatinizes in muriatic acid; with borax it effervesces, and forms a colorless glass.

It is usually found in granite or crystalline limestones. It is brought from Persia, China, Siberia, and Bucharia; the specimens often contain scales of mica and disseminated pyrites. On the banks of the Indus, it occurs disseminated in a grayish limestone.

The richly colored varieties of Lapis Lazuli are highly esteemed for costly vases and ornamental furniture; also employed in the manufacture of mosaics; and when powdered constitutes the rich and durable paint called *Ultramarine.* An artificial ultramarine equal to the native in color and permanency, and now extensively used in the arts, contains according to Varrentrapp,

$\dddot{Si}$ 45·604, $\dddot{S}$ 3·830, $\ddot{\bar{Al}}$ 23·304, $\dot{Ca}$ 0·021, $\dot{Na}$ 21·476, $\dot{K}$ 1·752, S 1·685, Fe 1·063, Cl *trace*=98·785.

A mineral from the Andes, occurring in large masses of a bright blue color with veins of carbonate of lime is referred to Lapis Lazuli by Mr. F. Field. He obtained (Quart. J. Chem. Soc. iv, 331), $\dddot{Si}$ 37·60, $\ddot{\bar{Al}}$ 11·21, S 1·65, Fe 0·08, $\dot{Mg}$ 0·36, $\dot{Na}$ 9·66, $\ddot{C}$ 15·05, $\dot{Ca}$ 24·10=99·71.

HAUYNE. Auina, *Monticelli.* Berzelin, *Necker.* Marialite, *Ryllo.*

Monometric. In dodecahedrons, (f. 14, 16, 18, 43). Cleavage: dodecahedral, sometimes distinct. Commonly in crystalline grains.

H.=5·5. G.=2·4—2·5. Lustre vitreous to greasy. Color bright blue, occasionally asparagus-green. Streak bluish-white. Subtransparent to translucent. Fracture flat-conchoidal—uneven.

Composition.—$\dot{Na}^3\dddot{Si}+3\ddot{\bar{Al}}\dddot{Si}+2\dot{Ca}\dddot{S}=(\dot{Na}+\ddot{\bar{Al}})\dddot{Si}^{4}_{3}[+\frac{2}{3}\dot{Ca}\dddot{S}$, from Whitney's analysis of Haüyne of Mt. Albano=Silica 32·1, alumina 27·3, lime 9·9, soda 16·5, sulphuric acid 14·21. Analyses: 1, Gmelin, (Schw. J. xiv, 325, xv, 1); 2, Varrentrapp, (Pogg. xlix, 515); 3—5, J. D. Whitney, (Pogg. lxx, 431):

	$\dddot{Si}$	$\dddot{S}$	$\ddot{\bar{Al}}$	$\dot{Ca}$	$\dot{K}$	$\dot{Na}$
1. Marino,	35·48	12·39	78·87	12·00	15·55	——, $\ddot{\bar{Fe}}$ 1·16, HS and loss 3·45, G.
2. Niederm'g,	35·01	12·60	27·41	12·55	——	9·12, Fe 0·17, Cl 0·58, S 0·24, $\dot{H}$ 6·2=98·34, Varrentrapp.
3. "	33·90	12·01	28·07	7·50	——	19·28=100·73, Whitney.
4. "	34·83	12·13	28·51	7·23	——	18·57, $\ddot{\bar{Fe}}$ 0·31=101·58, Whitney
5. Mt. Albano,	32·44	12·98	27·75	9·96	2·40	14·24=99·77, Whitney.

The Haüyne from Niedermendig gives the formula, according to Whitney,

$$\dot{Na}^3\dddot{Si}+3\ddot{\bar{Al}}\dddot{Si}+\dot{Na}\dddot{S},\ 2(\dot{Na}^3\dddot{Si}+3\ddot{\bar{Al}}\dddot{Si}+2\dot{Ca}\dddot{S}),$$

corresponding to a compound of 1 Nosean and 2 of the Albano Haüyne.

B.B. Haüyne decrepitates and fuses slowly to an opaque white or greenish-blue blebby glass. With borax effervesces and forms a glass which is yellow on cooling. Gelatinizes with muriatic acid.

Haüyne occurs in the Vesuvian lavas, on Somma; in basalt at Niedermendig, near Andernach on the Rhine.

NOSEAN. Nosin. Spinellane. Haüyne, *in part.*

Monometric, like Haüyne; in dodecahedrons. Often granular massive.

H.=5·5. G.=2·25—2·3. Color grayish, bluish, brownish; sometimes black. Translucent to nearly opaque.

Composition.—$\dot{Na}^3\dddot{Si}+3\ddot{\bar{Al}}\dddot{Si}+\dot{Na}\dddot{S}=(\dot{Na}+\ddot{\bar{Al}})\dddot{Si}^{4}_{3}[+\frac{1}{3}\dot{Na}\dddot{S}$=Silica 36·3, sulphuric acid 8·0, alumina 30·9, soda 24·8=100. Analyses: 1, 2, Bergmann, (Bullet. des Sci. 1823, iii, 406); 3, Varrentrapp, (Pogg. xlix, 515); 4, 5, J. D. Whitney, (Pogg. lxx, 431):

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{S}}$	$\ddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$
1. Lake Laach,	38·50	8·16	29·25	1·14	16·56, $\dot{\mathrm{Fe}}$ 1·50, $\dddot{\bar{\mathrm{Mn}}}$ 1·00, HS 3·00=99·11, B.
2. "	37·00	11·56	27·50	8·14	12·24, $\dot{\mathrm{Fe}}$ 1·15, $\dddot{\bar{\mathrm{Mn}}}$ 0·50, HS 1·50=99·59, B.
3. "	35·99	9·17	32·57	1·12	17·84, Fe 0·04, Cl 0·65, $\dot{\mathrm{H}}$ 1·85=99·22, Var.
4. "	36·52	7·66	29·54	1·09	23·12, $\ddot{\bar{\mathrm{Fe}}}$ 0·44, Cl 0·61, ign. 1·37=100·34, W.
5. "	36·53	7·13	29·42	1·62	22·97, $\ddot{\bar{\mathrm{Fe}}}$ 0·44, Cl 0·61, ign. 1·37=100·99, W.

B.B. loses color and fuses on the edges. Gelatinizes in acids, yielding no sulphuretted hydrogen.

From near Andernach on the Rhine, at Lake Laach, in loose blocks consisting largely of a glassy feldspar, with mica, magnetic iron, and occasionally zircon, the nosean occurring in cavities in the feldspar, in small grains or crystals; also found at Rieden and Volkersfeld in a leucite rock.

SKOLOPSITE, *Kobell*, J. f. pr. Chem. xlvi, 484.

Massive, imperfectly grauular; no trace of cleavage.

H.=5. G.=2·53. Color grayish-white, pale reddish-gray. Translucent in thin splinters. Rather brittle. Fracture splintery.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+\ddot{\bar{\mathrm{Al}}}\,\dddot{\mathrm{Si}}+\frac{1}{3}\dot{\mathrm{Na}}\dddot{\mathrm{S}}$. Analysis by Kobell, (loc cit.):

$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\ddot{\bar{\mathrm{Fe}}}$, $\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dddot{\mathrm{S}}$
41·13	15·42	2·49	0·86	15·48	2·23	1·30	10·06	4·09, with 7·78 of sodalite.

B.B. fuses with intumescence like idocrase, and forms a shining blebby greenish-white glass. With borax dissolves to a colorless glass. A sulphur reaction with soda on charcoal. Reaction of chlorine with salt of phosphorus and oxyd of copper. A trace of water which is not acid. In muriatic acid easily gelatinizes.

From Kaiserstuhl in Brisgau, with some carbonate of lime and magnetic iron.

LEUCITE, *Werner*. Amphigene, *H.*

Monometric. Usual form the trapezohedron, (f. 39). Cleavage: cubic, very imperfect. Surfaces of crystals even, but seldom shining. Often disseminated in grains; rarely massive granular.

H.=5·5—6. G.=2·483—2·49. Vitreous. Ash-gray or smoke-gray, white. Streak uncolored. Translucent—opaque. Fracture conchoidal. Brittle.

Composition.—$\dot{\mathrm{K}}^3\dddot{\mathrm{Si}}^2+3\ddot{\bar{\mathrm{Al}}}\,\dddot{\mathrm{Si}}^2=(\dot{\mathrm{K}}+\ddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}^{\frac{8}{3}}$=Silica 55·1, alumina 23·4, potash 21·5=100. Analyses: 1—4, Klaproth, (Beit. ii, 39); 5, Arfvedson, (Afhandl. i Fys. vi, 139); 6, Avdejev, (Pogg. lv, 107):

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{K}}$
1. Vesuvius,	53·750	24·625	21·350=99·725, Klaproth.
2. "	53·50	24·25	20·09=97·84, Klaproth.
3. Pompeii,	54·50	23·50	19·50=97·50, Klaproth.
4. Albano,	54·	23·	22·=99, Klaproth.
5. Vesuvius,	56·10	23·10	21·15, $\ddot{\bar{\mathrm{Fe}}}$ 0·95=101·30, Arfvedson.
6. "	56·05	23·03	20·40, $\dot{\mathrm{Na}}$ 1·02, $\dot{\mathrm{Ca}}$ *trace*=100·50, Avdejev.

B.B. infusible, except with borax or carbonate of lime, with which it melts with difficulty to a clear globule. A fine blue with cobalt solution.

Leucite is abundant in trachyte between Lake Laach and Andernach, on the Rhine. Vesuvius, however, presents the finest and largest crystallizations. Near Rome, at Borghetta to the north, and Albano and Frescati to the south, some of the older lavas appear to be almost entirely composed of it.

The Leucitic lava of the neighborhood of Rome has been used for the last two thousand years at least, in the formation of mill-stones. Mill-stones of this rock have lately been discovered in the excavations at Pompeii.

Named from λευκος, *white*, in allusion to its color; and because its form is similar to a common variety of garnet, it has been designated *white garnet*.

ALTERED FORMS.—Feldspar and Kaolin occur with the form of Leucite, as a result of its alteration. Leucite changed to glassy feldspar has been observed at Mt. Somma by Scacchi.

BERZELINE, Neckar. Occurs in octahedrons and cubo-octahedrons, and in twins like f. 200; faces often uneven or rounded. Cleavage: cubic, tolerably perfect. Also massive. Colorless, gray, white, vitreous; H.=5. G.=2·727—2·428, Gmelin. B.B. fuses with difficulty to a blebby glass; with borax a clear glass. In muriatic acid soluble, and heated forms a jelly. Said to be near leucite in composition.

Occurs in peperino at Mt. Albano and Marino, near Rome.

NEPHELINE, *H.* Sommite, *P.* Nefelina, *Monticelli.* Cavolinite, *Mont.* Davyne, *Mont.* Beudanite, *Covelli.* Pseudo-nephelin. Elæolite. Fettstein, *W.* Pierre Grasse.

Hexagonal. Fig. 10, 120. Observed planes and angles, (Scacchi): *O* on $\frac{2}{5}$, 158° 54′; on $\frac{1}{2}$, 154° 15$\frac{1}{2}$′; on $\frac{2}{3}$, 147° 16′; on 1, 136° 2′; on 2, 117° 24′; on 4, 104° 32′; on 6, 99° 48′; besides also the form 42, and prisms, *I*, *i*2, $i\frac{3}{2}$. *O* : 42=120° 54′, *I* : $i\frac{3}{2}$=160° 53′. Cleavage: *I* distinct, *O* imperfect. Also massive, compact; also thin columnar.

H.=5·5—6. G.=2·5—2·64, Nepheline and Elæolite. Lustre vitreous—greasy; little opalescent in some varieties. Colorless, white or yellowish; also when massive, dark green, greenish or bluish-gray, brownish and brick-red. Transparent—opaque. Fracture subconchoidal.

Nepheline includes the crystallized varieties from Vesuvius; *Elæolite* the coarse massive varieties having a greasy lustre.

Composition.—$(\dot{N}a, \dot{K})^2\dddot{S}i+2\,\ddot{\bar{A}}l\,\dddot{S}i=(\dot{N}a, \dot{K}+\ddot{\bar{A}}l)\dddot{S}i^{\frac{4}{3}}$=(if $\dot{N}a : \dot{K}=5 : 1$) Silica 44·4, alumina 33·6, soda 16·9, potash 5·1=100.

Analyses: 1, Arfvedson, (Jahresb. ii, 97); 2, 3, 4, Scheerer, (Pogg. xlvi, 291, xlix, 359); 5, Gmelin, (Neph. im Dolerit, &c., Heidelberg, 1822); 6, Heidefreim, (J. f. pr. Chem. l, 500); 7, Monticelli and Covelli, (Prod. min. Vesuv. 375, and Pogg. xi, 470); 8, 9, 10, Scheerer, (Pogg. xlvi, 291, xlix, 359); 11, 12, Bromeis, (Pogg. xlviii, 577); 13, Smith and Brush, (Am. J. Sci., [2], xvi, 371):

I. *Nepheline.*

	$\dddot{S}i$	$\ddot{\bar{A}}l$	$\ddot{\bar{F}}e$	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	$\dot{H}$
1. Vesuvius,	44·11	33·73	——	——	20·46	——	0·62=98·92, Arfved.
2. "	44·03	33·28	0·65*	1·77	15·44	4·94	0·21=100·32, Scheer.
3. "	44·29	33·04	0·39*	1·82	14·93	4·72	0·21=99·40 "
4. Odenwald,	43·70	32·31	1·07	0·84	15·83	5·60	1·39=100·74 "
5. "	43·36	33·49	1·50	0·90	13·36	7·13	1·39=101·13, Gmelin.
6. Löbau,	43·50	32·33	1·42	3·55	14·13	5·03	0·32, $\dot{M}g$ 0·11=100·39, Heid.
7. *Davyne,*	42·91	33·28	1·25	2·02	——	7·43	——=96·89, M. & C.

* With $\ddot{\bar{M}}n$.

II. *Elæolite.*

		$\dddot{Si}$	$\bar{\ddot{Al}}$	$\bar{\ddot{Fe}}$	$\dot{Ca}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
8.	Fredericksv'n, *gn.*	45·31	32.63	0·45	0·33	15·95	5·45	0·60=100·72, Scheer.
9.	Brevig, *bn.*	44·59	32·14	0·86	0·28	15·67	5·10	2·05=100·69, “
10.	Miask, *white,*	44·30	33·25	0·82	0·32	16·02	5·82,	$\dot{Mg}$ 0·07=100·60, “
11.	“ “	42·51	33·73	*trace*	0·20	14·01	6·91,	“ 0·77=98·13, Brom.
12.	“ “	42·33	34·39	*trace*	0·47	16·26	5·95,	“ 0·45, $\dot{H}$ 0·92=100·77. Brom.
13.	Magnet Cove, Ark.,	44·46	30·97	2·09	0·66	15·61	5·91,	ign 0·95=100·65, S.& B.

Traces of muriatic acid, and also of sulphuric, were detected by Scheerer and Bromeis; and in one nepheline from Mt. Somma they found 0·22 of the former and 0·10 of the latter.

B.B. nepheline fuses with difficulty to a vesicular glass. Dissolves slowly with borax. With cobalt solution a grayish-blue color on the fused edge. Elæolite fuses easily. In acids easily gelatinize.

Nepheline occurs in crystals in the older lavas of Vesuvius, with mica, idocrase, &c.; also at Capo di Bove, near Rome, and in the clinkstone of Katzenbuckel, near Heidelberg. Elæolite comes from Brevig, Stavern, and Fredericksvärn, Norway, where it is found imbedded in zircon-syenite; also from Ilmengebirge in Siberia, along with white feldspar, brown hexagonal mica, zircon, pyrochlore, &c. The crystal measured by Scacchi was of the variety Sommite, or Davyne, occurring at Somma in a geode in limestone with sodalite.

Elæolite occurs massive and crystallized at Litchfield, Me., with cancrinite; in the Ozark Mts., Arkansas, with brookite and schorlomite.

The name nepheline is derived from νεφελη, *a cloud,* and alludes to the action in acids; and elæolite is from ελαιον, *oil,* in allusion to its greasy lustre.

Altered Forms.—Nepheline or Elæolite is liable to ready alteration, and usually produces a zeolite, as *natrolite,* (Bergmannite), or *Thomsonite.* The *Ozarkite* of Shepard, according to Smith and Brush, is Thomsonite, and its situation in cavities in elæolite shows that it is a product of alteration. The large amount of soda in nepheline compared with the silica, fits it especially for generating zeolites. The relation of Bergmannite to Elæolite was shown by Blum, (Pogg. lxxxvii, 315.)

Gieseckite is shown by Blum to be a pseudomorph after this species. It differs mainly in containing 4·88 per cent. of water. It occurs in six-sided greenish gray prisms of greasy lustre. Blum also considers *Leibenerite* a similar pseudomorph.

Elæolite has also been observed altered to Mica.

CANCRINITE, *G. Rose.*

Hexagonal. In six and twelve-sided prisms, sometimes with basal edges replaced; $O : \frac{1}{2} = 154° 7'$, $I : \frac{1}{2} = 115° 53'$, $\frac{1}{2} : \frac{1}{2} = 154° 47'$. Cleavage: *I* very perfect; *O* imperfect. Also thin columnar and massive.

H.=5·5—6. G.=2·42—2·62; 2·44, yellow, and 2·461, green, from Litchfield, Me., Whitney; 2·429, Vesuvius. Color white, gray, yellow, green, blue, reddish; streak uncolored. Lustre subvitreous, or a little pearly or greasy. Translucent.

Composition.—$\dot{Na}^2\dddot{Si} + 2\bar{\ddot{Al}}\dddot{Si} + (\dot{Na}, \dot{Ca})\ddot{C} + \dot{H} = (\dot{Na} + \bar{\ddot{Al}})\ \dddot{Si}^{\frac{3}{2}}\ [+\tfrac{1}{3}\dot{R}\ \ddot{C} + \tfrac{1}{2}\dot{H} =$ Silica 37·6, alumina 28·4, lime 3·9, soda 21·5, carbonic acid 6·1, water 2·5=100. Struve (anal. 15) gives the same. Rose found no water.

Analyses: 1, 2, G. Rose, (Pogg. xlvii, 779); 3, 4, J. D. Whitney, (Pogg. lxx, 431); 5, v. Struve, (Pogg. xc, 615):

	$\dddot{\mathrm{S}}\mathrm{i}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{K}}$	$\ddot{\mathrm{C}}$	$\dot{\mathrm{H}}$
1. Ural,	40·59	28·29	7·06	17·38	0·57	6·38	——=100·27, G. Rose.
2. "	40·26	28·34	6·34	17·66	0·82	6·38	——=99·70, "
3. Litchfield, *yellow*,	37·42	27·70	3·91	20·98	0·67	5·95	2·82, $\ddot{\bar{\mathrm{M}}}\mathrm{n}$, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·86=100.31, Whit.
4. " *greenish*,	37·20	27·59	5·26	20·46	0·50	5·92	3·28, $\ddot{\bar{\mathrm{M}}}\mathrm{n}$, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·27, W.
5. Turkinsk Mts.	38·33	28·55	4·24	20·37	——	($\ddot{\mathrm{C}}$ & $\dot{\mathrm{H}}$) 8·51=100, v. Str.	

Whitney found a trace of chlorine in his analyses. The red color of the Miask cancrinite is due to disseminated grains of specular iron, according to Kengott, who also found calcite in microscopic grains, and suggests that this may be the source of the carbonic acid of cancrinite.

B.B. loses color and fuses easily with intumescence to a white blebby glass. Effervesces with muriatic acid and forms a jelly on heating, but not before.

Cancrinite is found at Miask in the Urals; also of citron-yellow color in the Turkinsk Mts., 400 wersts west of Irkutsk, in a coarse granite with zircon, calcite and magnetite; and also in crystals and massive at Litchfield, Maine, with sodalite and zircon.

ANORTHITE, *Rose*, 1823. Amphodelite, *Nord.* Latrobite, *Brooke.* Indianite, *Bour.* Christianite, *Mont.* Biotina, *Mont.* Diploite, *Nord.* Linseite, *Komonen.* Thiorsauite, *Genth.*

Triclinic. *O* : iĭ=85° 48′, *O* : *I*=114° 22′, *O* : *I*′=110° 57′.
O : 2ĭ=133° 13′. *O* : ⅔ī=145° 12′. *O* : 42̆′=98° 37′.
O : 2ĭ′=137° 22′. *O* : 1=121° 50′. iĭ : *I*′=122° 2′.
O : 1ī (adj.)=128° 27′. *O* : 1′=125° 38′. iĭ : *I*=117° 28′.
O : 2ī (ov. 1ī)=98° 29′. *O* : 2=94° 53′. *I* : *I*′=120° 30′.
(Angles from Brooke and Miller).

O								
			−1					
2ĭ				−2ī				2ĭ′
						−42̆′		
iĭ	i3̆		*I*				i3̆′	iĭ
		42̆			*I*′	42̆′		
	33̆						33̆′	
2ĭ′			2	2ī				2ĭ
			1	1ī	1′			
				⅔ī				

Observed Planes.

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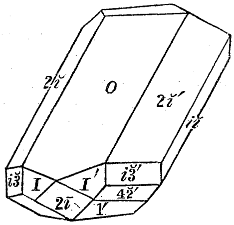

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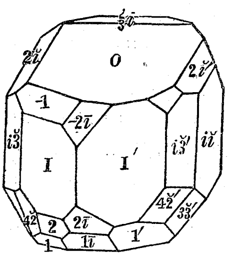

Cleavage parallel with *O* and iĭ perfect. Structure often granular, columnar, or coarse lamellar.

H.=6—7. G.=2·66—2·78; 2·762, (massive), Rose; 2·763, Amphodelite; 2·668, Indianite, Silliman. Lustre of cleavage planes inclining to pearly ; of other faces vitreous. Color white, grayish, reddish. Streak uncolored. Transparent—translucent. Fracture conchoidal. Brittle.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+3\ddot{\mathrm{Al}}\,\dddot{\mathrm{Si}}=(\dot{\mathrm{R}}+\ddot{\mathrm{Al}})\dddot{\mathrm{Si}}^{\overset{4}{3}}$=Silica 43·2, alumina 36·8, lime, 20·0.

Analyses: 1, G. Rose, (Gilb. Ann. lxxiii, 173); 2, 3, Abich, (Pogg. li, 519); 4, Reinwardt, (Pogg. l, 351); 5, Forchhammer, (Jahresb. xx, xxiii, 284); 6, Waltershausen, (Vulk. Gest., 22); 7, Erdmann, (Ofv. K. V. Ak. F. 1848, 67); 8, Nordenskiöld, (Pogg. xii, 174); 9, Svanberg, (Jahresb. 238); 10, Chenevix; 11, Laugier, (Mem. du Mus. d'hist. nat. vii, 341); 12, G. J. Brush, (Am. J. Sci. [2], viii); 13, 14, Hermann, (J. f. pr. Chem. xlvi, 387); 15, Damour, (Bull. G. Fr., [2], vii, 83); 16, Hermann, (J. f. pr. Ch. xlviii, 254); 17, 18, C. Gmelin, (Pogg. iii, 68):

		$\dddot{\mathrm{Si}}$	$\ddot{\mathrm{Al}}$	$\dddot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$
1.	Mt. Somma,	44·49	34·46	0·74	15·68	5·26	—	—=100·63, G. Rose.
2.	" "	44·12	35·12	0·70	19·02	0·56	0·25	0·27=100·04, Abich.
3.	" "	43·79	35·49	0·57	18·93	0·34	0·54	0·68=100·34, Abich.
4.	Java,	46·0	37·0	—	1·45	—	—	0·6 =98·1, Reinw.
5.	Iceland,	47·63	32·52	2·01	17·05	1·30	0·29	1·09=101·89, F.; G. 2·70.
6.	Hecla,	45·14	32·10	2·03	18·32	$\ddot{\mathrm{Mn}}$0·78[a]	0·22	1·06, ign. 0·31=99·96, W.
7.	*Anorthite*,	43·34	35·37	—	17·41	$\dot{\mathrm{Mg}}$0·35	0·52	0·89, ign. 0·39, $\dot{\mathrm{Fe}}$ 1·35, undec. 0·57=100·19, E.
8.	*Amphod.* Fin.	45·80	35·45	—	10·15	5·05	—	—, $\dot{\mathrm{Fe}}$ 1·70, $\dot{\mathrm{H}}$ 1·85, N.
9.	" Tunaberg,	44·55	35·91	0·07	15·02	4·08	—	—, ign. 0·6=100·23, S.
10.	*Indianite, red,*	42·00	34·00	3·20	15·00	—	—	3·35, $\dot{\mathrm{H}}$ 1·0=98·55, Ch.
11.	" *white,*	43·0	34·5	1·0	15·6	—	—	2·6, $\dot{\mathrm{H}}$ 1·0=97·7, Laug.
12.	" "	42·09	38·89	—	15·78	—	—	4·08=100·84, Brush.
13.	*Lepol.*, Lojo,	42·80	35·12	1·50	14·94	2·27	1·50	—, ign 1·56=99·69, H.
14.	" Orrijervi,	42·50	33·11	4·00	10·87	5·87	1·69	—, ign 1·50=99·54, H.
15.	Iceland,	45·97	33·28	1·12	17·21	—	—	1·85, augite 0·69=100·12, Delesse.
16.	*Linseite,*	42·22	27·55	6·98	—	8·85	3·00	2·53, $\dot{\mathrm{Fe}}$ 2·00, $\dot{\mathrm{H}}$ 7·00, H.
17.	*Latrobite,*	44·65	36·81	—	8·28	0·63	6·58,	$\ddot{\mathrm{Mn}}$ 3·16, $\dot{\mathrm{H}}$ 2·04=102·16.
18.	"	41·78	32·83	—	9·79	5·77[b]	6·58,	$\dot{\mathrm{H}}$ 2·04=98·78, Gmelin.

[a] With $\dot{\mathrm{Ca}}$ and $\dot{\mathrm{Ni}}$.

[b] With $\ddot{\mathrm{Mn}}$.

B.B. like albite, except that it forms with soda an enamel. Entirely decomposed by muriatic acid, but anorthite does not gelatinize. Indianite gelatinizes readily.

Amphodelite [fr. *αμφω, both*, and *οδελος, a spear*] is a reddish gray or dingy peach-blossom-red variety, occurring crystallized and massive, with the angle *O* : *iĭ*=85° 40′, and cleavage parallel to *O* and *iĭ*. *Indianite* has a granular texture somewhat like statuary marble, a glistening surface of fracture, and occurs massive. The grains cleave parallel to two planes inclined to one another 84° 45′, which is not far from the angle of anorthite, considering the difficulty in this case of obtaining perfectly accurate measurement.

Anorthite (*Biotine*) occurs at Mount Vesuvius, among the old lavas in the ravines of Monte Somma, associated with ice spar, augite, mica, and idocrase. Also on the island of Procida near the entrance to the bay of Naples; in the Faroe Islands, and Java.

Amphodelite occurs at Lojo, Finland, and at Tunaberg, Sweden. The *Lepolite* from Lojo and Orrijerfvi, is the same mineral; the crystals are sometimes two inches long; and *Linseite* is probably the same partly altered, containing a few per cent. of water. The Indianite is from the gangue of the corundum in the Carnatic, and is associated with garnet, kyanite, and hornblende. The specimen analyzed by G. J. Brush, was originally from the hands of Count Bournon, and came from the Indian locality. Genth's *Thiorsauite* from Iceland has been considered the same mineral that was analyzed by Forchhammer, (analysis 5); G.=2·688. H.=6. Color white to grayish. Genth obtained $\dddot{\mathrm{Si}}$ 48·36, $\ddot{\mathrm{Al}}$ 30·59, $\dddot{\mathrm{Fe}}$ 1·37, $\dot{\mathrm{Mg}}$ 0·97, $\dot{\mathrm{Mn}}$ *trace*, $\dot{\mathrm{Ca}}$ 17·16, $\dot{\mathrm{Na}}$ 1·13, $\dot{\mathrm{K}}$ 0·62=100·20. Walmstedt's "Scapolite" from Tunaberg is Anorthite, according to G. Rose, (Kryst. Chem. Min. 83).

A mineral from Bytown, U. C., analyzed by Tennant, has been referred to amphodelite. He obtained

$\dddot{\mathrm{Si}}$ 45·80, $\bar{\dddot{\mathrm{Al}}}$ 26·15, $\dot{\mathrm{Ca}}$ 16·25, $\dot{\mathrm{Mg}}$ 2·95, $\dot{\mathrm{Fe}}$ 4·70, Loss by ignition 2·00=97·85.

Rosite or *Rosellan*, (Svanberg, K. V. Ac. H., 1840, Pogg. liv, 268, and lvii, 170, and *Polyargite*, Svanberg), is stated by G. Rose, (Kryst. Chem. 89), to be altered anorthite.

Latrobite, Brooke, (Diploite, *Breit.*), is referred to anorthite by Hermann and others. It is pale rose-red and closely resembles the Amphodelite. It is from Amitok island, coast of Labrador, where it is found with feldspar, mica, and calcite.

ANDESINE, *Abich*, Berz. Jahresb. i, 167. Pseudoalbit.

Triclinic. Like albite in crystalline forms and twins; but distinct in cleavage, and surfaces of cleavage more uneven and edges less sharp. Also fine granular.

H.=6. G.=2·65—2·74; from the Andes, 2·7328: of Saccharite, 2·668; from the Vosges, 2·65—2·68; 2·668, Canada, Hunt. Color white, gray, greenish, yellowish, flesh-red. Lustre subvitreous, inclining to pearly.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+3\bar{\dddot{\mathrm{Al}}}\dddot{\mathrm{Si}}^2=(\dot{\mathrm{Ca}},\dot{\mathrm{Na}}+\bar{\dddot{\mathrm{Al}}})\dddot{\mathrm{Si}}^{\frac{8}{3}}$. Analyses: 1, Abich, (Pogg. li, 523); 2, 3, 4, Delesse, (Mem. Soc. d'Emulation du Doubs); 5, Schmidt, (Pogg. lxi, 385); 6, Waltershausen, (Vulk. Gest., 24); 7, 8, Rammelsberg, (5th Suppl., 48); 9, T. S. Hunt, (private communication):

	$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\bar{\dddot{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$
1. Andes,	59·60	24·18	1·58	5·77	1·08	1·08	6·53=99·92, Abich.
2. Vosges, *white*,	58·92	25·05	——	5·64	0·41	2·06	7·20, $\dot{\mathrm{H}}$ 1·27=99·55, D.
3. " *red*,	58·91	24·59	0·99	4·01	0·39	2·54	7·59, " 0·98=100, D.
4. Chagey,	59·95	24·13	1·05	5·65	0·74	0·81	5·39, " 2·28=100, D.
5. *Saccharite*,	58·93	23·50	1·27	5·67	0·56	0·05	7·42, $\dot{\mathrm{Ni}}$ 0·39, $\dot{\mathrm{H}}$ 2·21=100, S.
6. Iceland, *crystals*,	60·29	23·75	3·21	6·29	0·64	0·87	5·70=100·75, Walt.
7. Marmato,	60·26	25·01	*tr.*	6·87	0·14	0·84	7·74=100·86, Ramm.
8. "	58·32	26·52	*tr.*	8·18	0·11	2·36	5·27 ign0·60=101·36, R.
9. Canada,	59·80	25·39	0·60	7·78	0·11	1·00	5·14=99·82, Hunt.

Other analyses: Delesse, (Ann. d. M. [5], iii, 374, Vosges).

Andesine fuses in thin splinters before the blowpipe. Saccharite melts only on thin edges; with borax forms a clear glass. Imperfectly soluble in acids.

Andesine occurs in the Andes, at Marmato, in the rock called *Andesite*, a whitish syenite; also in the syenite of Alsace in the Vosges. G.=2·683, white of Servance; 2·651, red of Coravillers; and also in the porphyry near Chagey, Haute Saône; G.=2·736; at Vapnefiord, Iceland, in honey-yellow transparent crystals, (anal. 6, G.=2·65). Saccharite is a granular mineral, having traces of cleavage in one direction, occurring in veins in serpentine at the chrysoprase mines near Frankenstein, in Silesia. In North America, found at Chateau Richer, Canada, (anal. 9), forming with hypersthene and ilmenite a wide spread rock; color flesh-red; G.=2·668.

BARSOWITE, *G. Rose*, Pogg. xlviii, 567, 1839.

Massive of a granular texture, with a nearly perfect cleavage in one direction.

H.=5·5—6. G.=2·74—2·752. Lustre more or less pearly. Color snow-white, subtranslucent. Fracture granular or splintery.

Composition.—$\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}^2+3\bar{\dddot{\mathrm{Al}}}\dddot{\mathrm{Si}}=(\dot{\mathrm{Ca}}+\bar{\dddot{\mathrm{Al}}})\dddot{\mathrm{Si}}^{\frac{5}{4}}$=Silica 48·8, alumina 33·2, lime 18·0. Analyses by Varrentrapp, (Pogg. xlviii, 568):

	$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$
1.	49·01	33·85	15·46	1·55=99·87.
2.	49·05	33·78	15·30	1·42=98·56.
3.	48·07	34·08	15·10	1·65=98·90.

B.B. alone, fuses only on the edges to a vesicular glass. Melts slowly with borax to a clear colorless glass. The glass with salt of phosphorus is colorless with little of the salt, but with more, becomes opaline on cooling. Gelatinizes easily on heating with muriatic acid.

Occurs in boulders in the auriferous sand of Barsowskoi, as the gangue of the blue corundum, as Indianite is the gangue of the corundum of the Carnatic.

A feldspathic mineral forming with augite the orbicular diorite of Corsica afforded Delesse (Ann. Ch. Phys. xxiv) $\dddot{\mathrm{Si}}$ 48·62, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 34·66, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·66, $\dot{\mathrm{C}}\mathrm{a}$ 12·02, $\dot{\mathrm{M}}\mathrm{g}$ 0·33, $\dot{\mathrm{N}}\mathrm{a}$ 2·55, $\dot{\mathrm{K}}$ 1·06, $\dot{\mathrm{H}}$ 0·49=100·39.

BYTOWNITE, *Thomson*, Min. i, 372.

Massive, texture granular. Grains with one perfect cleavage and indications of another oblique to this. H.=6—6·5. G.=2·801, Thomson; 2·733, Hunt. Lustre vitreous, cleavage surface pearly. Color greenish-white. Translucent.

Analyses: 1, 2, Thomson, (loc. cit.); 3, T. S. Hunt, (Am. J. Sci. [2], xii, 213, from Phil. Mag. [4], i, 322):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{H}}$
1.	47·74	29·69	3·75	8·80	*trace*	7·60	2·00=99·58.
2.	47·40	29·60	3·4	9·32	0·40	7·60	1·96=99·68.
3.	47·40	30·45	$\dot{\mathrm{F}}\mathrm{e}$ 0·80	14·24	0·87	2·82	2·00, $\dot{\mathrm{K}}$ 0·38=98·96.

Thomson's analyses afford the oxygen ratio and formula of Barsowite, 1 : 3 : 5. Mr. Hunt's analysis gives the ratio 1 : 2·71 : 4·66, which corresponds to the same proportion of alumina to silica, and differs only in a small excess of protoxyds.

Occurs in large boulders, near Bytown, Canada West.

A dark bluish-green granular mineral or rock from Perth, Canada, which has been called Bytownite, is considered by Mr. Hunt as probably a mixture of bytownite and hornblende. It has a smoky-blue translucence in pieces a fourth of an inch thick.

LABRADORITE. Labrador Feldspar. Anhydrous Scolecite. Mauilite. Silicite, *Thomson.*

Triclinic. $O : \breve{i}i=86^\circ\ 32'$, $O : I=114^\circ 48'$, $ii : I=119^\circ\ 16'$. Twins like those of albite. Cleavage O perfect; $\breve{i}i$ distinct and usually striated; I indistinct. Also massive, with distinct cleavage. H.=6. G.=2·67—2·76. Lustre of O pearly, passing into vitreous; elsewhere vitreous or subresinous. Color gray, brown, or greenish; sometimes colorless and glassy; usually a change of colors may be observed, in which blue and green are predominant; yellow, red, and pearl-gray, are also apparent. Streak uncolored. Translucent—subtranslucent.

Composition.—$\dot{\mathrm{R}}\,\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{A}}}\mathrm{l}\,\dddot{\mathrm{Si}}=(\dot{\mathrm{R}}+\dddot{\bar{\mathrm{A}}}\mathrm{l})\,\dddot{\mathrm{Si}}^2$=(if $\dot{\mathrm{N}}\mathrm{a} : \dot{\mathrm{C}}\mathrm{a}=1 : 3$) Silica 53·1, alumina 30·1, lime 12·3, soda 4·5=100. Analyses: 1, Klaproth, (Beit. vi, 250); 2, 3, Lehunt, (Ed. N. Phil. J. 1832, July, 86); 4, Abich, (Ann. Ch. Phys. lx, 332); 5, Svanberg, (Jahresb. xxiii, 285); 6, Forchhammer, (J. f. pr. Chem. xxx, 385); 7, 8, Kersten, (Pogg. lxiii, 123); 9, A. Schlieper, (Am. J. Sci. [2], xi, 121); 10, Nordenskiöld, (Schweig. J. xxxi, 417); 11, Thomson, (Phil. Mag. 1843, 190); 12, 13, Delesse, (Ann. d. Mines, [4], xii, 251, 258); 14, 15, T. S. Hunt, (Am. S. Sci. [2], xi, 213, from Phil. Mag. [4], i, 322, and Logan's Rep. 1851); 16, 17, 18, Waltershausen, (Vulk. Gest. 1853, 24):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{M}}\mathrm{g}$
1. Labrador,	55·75	26·50	1·25	11·00	4·00	——	——, $\dot{\mathrm{H}}$ 0·5=99·00, Klap.
2. Campsie,	54·67	27·89	0·31	10·60	5·05	0·49	0·18=99·19, Lehunt.
3. Glasgow,	52·34	29·97	0·87	12·10	3·97	0·30	——=99·95, Lehunt.
4. Etna,	53·48	26·46	1·60	9·49	4·10	0·22	1·74, $\dot{\mathrm{H}}$ 0·42, $\dot{\mathrm{M}}\mathrm{n}$ 0·89=98·40, Ab.

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Mg}}$
5. Dalarne,	52·15	26·82	1·29	9·14	4·64	1·79	1·02, ign. 1·75=98·60, Sv.
6. Faroe,	52·52	30·03	1·72	12·58	4·51	—	0·19=101·55, F.
7. Egersund,	52·30	29·00	1·95	11·69	4·01	0·50	0·15=99·60, Karst.
8. "	52·45	29·85	1·00	11·70	3·90	0·60	0·16=99·66, Karst.
9. Maui, Pacific,	53·98	27·56	1·14	8·65	6·06	0·47	1·35=99·21, Schlieper.
10. *Scolexerose*,	54·13	29·23	—	15·45	—	—	—, $\dot{\mathrm{H}}$ 1·07=99·88, Nor.
11. *Silicite*,	54·8	28·4	—	12·4	—	—	—, $\dot{\mathrm{Fe}}$ 4·0, $\dot{\mathrm{H}}$ 0·6=100·2, Thomson.
12. Greece,	53·20	27·31	1·03	8·02	3·52	3·40	1·01, $\dot{\mathrm{H}}$2·51=100·63, D.
13. Tyrol,	53·23	27·73	1·50	8·28	7·38		0·93, " 0 95=100, Del.
14. Drummond, C.	54·70	29·80	0·36	11·42	2·44	0·33,	— $\dot{\mathrm{H}}$ 0·4=99·35, H.
15. Morin,	54·20	29·10	1·10	11·25	3·80		$\dot{\mathrm{Mg}}$ 0·15, ign. 0·4=100, H.
16. Etna, *Cryst.*	53·56	25·82	3·41	11·69	4·00	0·54	" 0·52, ign. 0·95=100·48, Waltershausen.
17. " "	55·83	25·31	3·64	10·49	3·52	0·83	" 0·74=100·35, Walt.
18. Labrador.	53·75	27·06	0·99	9·58	1·25	7·53	" 0·47, $\dot{\mathrm{H}}$ 0·62=101·25, Waltershausen.

No. 7, brown massive variety; 8, with blue opalescence; 9, glassy colorless crystals; 14, from a boulder.

G. of 6, 2·68; 7, 2·71; 8, 2·72; 11, 2·666; 14, 2·697; 15, 2·69; 16, 2·618; 17, 2·633; 18, 2·646. Other analyses: Delesse, (Ann. d. M. [4], xvi, 239, 324, 342, 512); Damour, (Bull. G. Soc. de Fr., [2], vii, 88); Metzger, (Leonh. Jahrb. f. Min., 1850, 683); Deville, (Et. Geol. 1848). See also Ramm., 5th Suppl., 155.

B.B. on charcoal, acts like feldspar, and fuses with a little less difficulty to a colorless glass. With oxyd of nickel and borax affords a blue pearl. When pulverized, entirely dissolved by heated muriatic acid, which does not attack either feldspar or albite.

Labradorite is a constituent of some lavas, as those of Etna and Vesuvius; of many porphyries, as the oriental verd antique of Greece, (analysis 12), and other varieties; of dolerite; certain hornblende rocks, granites, and syenites; of some porphyritic greenstones, as at Campsie, Scotland; of melaphyres, as in the Tyrol, (analysis 13). On the coast of Labrador, whence it was originally brought, it is associated with hornblende, hypersthene, and magnetic iron ore. It has been found in place at Mille Isles, Canada, also in Morin, Abercrombie and elsewhere. It occurs abundantly at Essex Co., N. Y. Large boulders are met with in the towns of Moriah, Newcomb, M'Intyre, Westport, and Lewis, N. Y.; also occasionally in Orange, Lewis, St. Lawrence, Warren, Scoharie, and Green counties. In Pennsylvania, at Mineral Hill, Chester Co., and opposite New Hope, Bucks Co.

The *Scolexerose* and *Anhydrous Scolecite* are from Pargas, Finland; the *Silicite* is from Antrim, Ireland. Scolexerose has been referred to scapolite.

Labradorite receives a fine polish, and owing to the chatoyant reflections, the specimens are often highly beautiful. It is sometimes used in jewelry.

Vosgite of Delesse (Ann. d. M. [4], xii, 284) appears to be a Labradorite rendered hydrous by partial alteration, as stated by Rammelsberg. Color whitish, with sometimes a shade of green or blue; lustre greasy or pearly. G.=2·771. Analysis by Delesse, (loc. cit.), $\dddot{\mathrm{Si}}$ 49·32, $\dddot{\bar{\mathrm{Al}}}$ 30·07, $\dddot{\bar{\mathrm{Fe}}}$ 0·70, $\dot{\mathrm{Mn}}$ 0·60, $\dot{\mathrm{Ca}}$ 4·25, $\dot{\mathrm{Mg}}$ 1·96, $\dot{\mathrm{Na}}$ 4·85, $\dot{\mathrm{K}}$ 4·45, $\dot{\mathrm{H}}$ 3·15=99·35. Delesse deduces the oxygen ratio 1 : 3 : 5, but by adding the water to the bases; excluding the water, it gives 0·96 : $3\frac{1}{3}$: 6. It constitutes the porphyry of Ternuay, in the Vosges.

OLIGOCLASE. Soda Spodumene. Natron-spodumene, *Berz.* Unionite, *Silliman, Jr.*

Triclinic. *I* : *I′* about 120°, $O : i\breve{\imath} = 93° \, 15'$, $O : I' = 115° \, 37'$. Cleavage : *O*, $i\breve{\imath}$ very distinct. Twins common.

O						
$i\breve{\imath}$	$i\breve{3}$	*I*		*I′*	$i\breve{3}'$	$i\breve{\imath}$
$2\breve{\imath}'$			$2\bar{\imath}$	2′		$2\breve{\imath}$
		1	$1\bar{\imath}$	1′		

Observed Planes.

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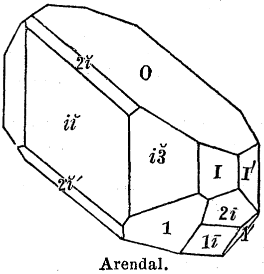


Arendal.

H.=6. G.=2·58—2·69. Lustre vitreous, vitreo-pearly or greasy. Color yellowish, grayish, reddish, greenish-white, white. Transparent, subtranslucent. Fracture conchoidal—uneven.

Composition.—$\dot{\mathrm{R}}\,\dddot{\mathrm{Si}}+\ddot{\bar{\mathrm{Al}}}\,\dddot{\mathrm{Si}}^2=(\dot{\mathrm{R}}+\ddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}^3$=Silica 62·3, alumina 23·5, soda 14·2=100. Analyses: 1, 2, Berzelius, (Jahresb. iv, 147, xix, 302); 3, Laurent, (Ann. Ch. Phys. lix, 108); 4, R. Hagen, (Pogg. xliv, 329); 5, Rosales, (Pogg. lv, 109); 6, Francis, (Pogg. lii, 470); 7, Chodnev, (Pogg. lxi, 390); 8, Wolff, (J. f. pr. Chem. xxxiv, 234); 9, Scheerer, (Pogg. lxiv, 153); 10, 11, Kersten, (J. f. pr. Ch. xxxvii, 173, Leonh. Jahrb. 1845, 653); 12, Deville, (Compt. Rend. xix, 46); 13, Forchhammer, (Skand. Nat. S. Stockholm, 1842); 14, L. Svanberg, (Œfv. K. V. Ann. Fœrh. iii, 111); 15, Rammelsberg, (Pogg. lvi, 617); 16, 17, 18, Delesse, (Ann. Ch. Ph. [3], xxiv, Bull. Geol. [2], vii, 310, Ann. d. M. [4], xix, 149); 19, Kerndt, (J. f. pr. Chem. xliii, 218); 20, Smith and Brush, (Am. J. Sci. [2], xv, 211, mean of 2 analyses); 21, Bodemann, (Pogg. lv, 110); 22, 23, Smith and Brush, (loc. cit., xvi, 44, each mean of 2 anal.); 24, Walterhausen, (Vulk. Gest., 26):

		$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\ddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$
1.	Danvikszoll,	63·70	23·95	0·50	2·05	0·65	8·11	1·20=100·16, Berz.
2.	Ytterby,	61·55	23·80	——	3·18	0·80	9·67	0·38=99·38, “
3.	Arriége,	62·6	24·6	0·01	3·0	0·2	8·9	——=99·4, Laurent.
4.	Arendal,	63·51	23·09	——	2·44	0·77	9·37	2·19=101·37, Hagen.
5.	Arendal, *yel.-w.*	62·70	23·80	——	4·60	0·02	8·00	1·05, $\dot{\mathrm{F}}$e 0·62=100·79 R.
6.	Ajatskaja,	61·06	19·68	4·11	2·16	1·05	7·55	3·91=99·52, Francis.
7.	Kimito, *red*,	63·80	21·31	——	0·47	——	12·04	1·98=99·60, C.
8.	Schlw. Holstein,	64·30	22·34	——	4·12	——	9·01	——=99·77, W.
9.	*Sunstone* fr. Tved.	61·30	23·77	0·36	4·78	——	8·50	1·29=100, Scheerer.
10.	Near Frieberg,	62·97	23·48	0·51	2·83	0·24	7·24	2·42=99·69, Kersten.
11.	Marienbad,	63·20	23·50	0·31	2·42	0·25	7·42	2·22=99·32, Kersten.
12.	Teneriffe,	62·97	22·29	——	2·06	0·54	8·45	3·69=100, Deville.
13.	*Hafnefjordite*,	61·22	23·32	2·40	8·82	0·36	2·56	*tra.*=98·68, Forch.
14.	“	59·66	23·28	1·18	5·17	0·36	5·61	1·75, ign. 1·02, und. 0·82 =98·85, Sv.
15.	Warmbrunn,	63·94*	23·71	*tra.*	2·52	*tra.*	7·66	2·17=100, Ramm.
16.	Mer-de-glace,	63·25	23·92	*tra.*	3·23	0·32	6·88	2·31, $\ddot{\bar{\mathrm{Mn}}}$ *tra.*=99·91, D.
17.	Quenast,	63·70	22·64	0·53	1·44	1·20	6·15	2·81, ign. 1·22=99·69, D.

* Loss.

	$\ddot{\mathrm{Si}}$	$\bar{\ddot{\mathrm{A}}}\mathrm{l}$	$\bar{\ddot{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$
18. Visembach,	63·88	22·27	0·51	3·45	*tra.*	6·66	1·21,ign.1·70=98·68,D.
19. Boden,	61·96	22·66	0·35	2·02	0·10	9·43	3·08=,Mn0·40=100,K
20. Unionville, Pa.,	64·27	21·21	*tra.*	0·81	0·58	10·94	1·36, ign.1·08=100·25, S. & B.
21. Schaitansk, Ural,	64·25	22·24	0·54	2·57	1·14	7·98	1·06=99·76, Bodemn.
22. Danbury, Ct.	63·76	22·56	*tra.*	3·09	*tra.*	9·72	0·55, ign. 0·26=99·94, S. & B.
23. Haddam, Ct.	64·26	21·90	——	2·15	*tra.*	9·99	0·50 ign. 0·29, S. & B.
24. Borodin, Finland,	63·20	18·41	0·20	0·11	0·87	0·52	14·41 "0·57=98·29, W.

G. of No. 7, 2·63; 8, 2·651; 9, 2·656; 10, 2·65; 11, 2·631; 12, 2·59; 14, 2·69; 19, 2·65. Other analyses: Lory, (Bull. Geol. Soc. de Fr. [2], vii, 452); Damour, etc. (Ramm. 5th Supp. 178); Deville, (Et. Geol. Teneriffe, 1848).

B.B. fuses more easily than orthoclase, and quietly to a glass, either clear or enamel-like. Not acted upon by acids.

Occurs in porphyry, granite, syenite, serpentine, and basalt; with quartz and mica it forms the granite at Kimito, containing columbite. At Teneriffe it occurs in trachyte.

Among its localities are Danvikszoll near Stockholm; at Arriège and Arendal, with calcite, crystals sometimes two or three inches long; at Schaitansk, Ural, greenish, in a gangue of quartz and mica and yellowish-white feldspar; at Clausthal in serpentine; at Lake Baikal; as *sunstone* at Christiana-fiord, Norway, the aventurine character of which is owing to minute particles of specular iron, according to Scheerer, (göthite according to Kengott).

In Iceland at Hafnefjord, (*Hafnefjordite*), Borodin, etc.

In the United States, at Unionville, Pa., (Unionite), with euphyllite and corundum, G.=2·61; also at Danbury, Ct., with othoclase and danburite; at Haddam, Ct., often transparent, with iolite and black tourmaline; at Mineral Hill, Delaware Co., Pa., called Moonstone.

Named from ολιγος, *little*, and κλαω, *to cleave.*

ALBITE, *D.* Cleavelandite, *Brooke.* Periklin, *Breit.* Tetartine. Kieselspath, *Haus.*

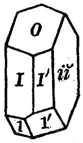
Triclinic. $O : i\breve{\imath}$=93° 36′, over $2\breve{\imath}$=86° 24′. (B. & M.)

$O : I$=115° 5′.
$O : I'$=110° 51′.
$O : 2\breve{\imath}$=133° 55′.
$O : 2\breve{\imath}'$=137° 26′.
$O : 1\bar{\imath}$(adj.)=127° 23′.
$O : 2\bar{\imath}$ (ov, $1\bar{\imath}$)=97° 37′.
$O : \frac{1}{2}$=150° 5′.
$i\breve{\imath} : i\breve{3}'$=149° 12′.
$I : I'$=122° 15′.
$i\breve{\imath} : i\breve{3}$=148° 30′.
$i\breve{\imath} : 1'$=120° 27′.
$i\breve{\imath} : 1$=112° 11′.
$I : 2\bar{\imath}$=134° 32′.
$I' : 2\bar{\imath}$=138° 34′.
$i\breve{\imath} : I$=117° 53′.
$i\breve{\imath} : I'$=119° 52′.
$1 : I$=122° 32′.
$1' : I'$=124° 53.′

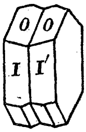
O						
$i\bar{\imath}$	$i\breve{3}$	I		I'	$i\breve{3}'$	$i\breve{\imath}$
$2\breve{\imath}'$			$2\bar{\imath}$			$2\breve{\imath}$
			$\frac{4}{3}\bar{\imath}$			
		1	$1\bar{\imath}$	$1'$		
		$\frac{1}{2}$		$\frac{1}{2}'$		

Observed Planes.

414



415



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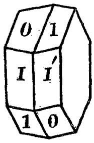

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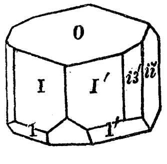

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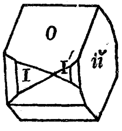
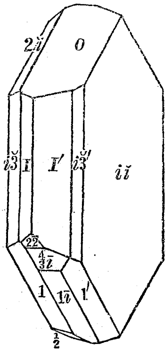


Cleavage: *O* very perfect; *iĭ* less so; *I′* imperfect. Twins: similar to f. 415 usually flattened parallel to *iĭ*; also similar, but with 1ī and *O* in same plane nearly, (f. 416); also parallel to *O*. Also lamellar and granular: the laminæ sometimes divergent; granular varieties occasionally quite fine, approaching to impalpable.

419



H.=6; some granular varieties 7. G.=2·59—2·65; 2·612, Finbo, Eggertz; 2·619, Broddbo; 2·641, variety Pericline; 2·626, Peristerite. Lustre pearly upon a cleavage face; vitreous in other directions. Color white; also occasionally bluish, gray, reddish, greenish, and green; sometimes having a bluish opalescence or play of colors on *O*. Streak uncolored. Transparent—subtranslucent. Fracture uneven. Brittle.

Composition.—$\dot{\mathrm{Na}}\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}^3=(\dot{\mathrm{Na}}+\dddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}^4$=Silica 68·7, alumina 19·5, soda 11·8=100.

Analyses: 1, G. Rose, (Gilb. Ann. lxxiii, 173); 2, Stromeyer, (Untersuch. 300); 3, Laurent, (Ann. Ch. Phys. lx); 4, Thaulow, (Pogg. xlii, 571); 5 Abich, (Berg. u. hüttenm. Zeitg. 1 Jahrg.); 6, Erdmann, (Jahresb. xxi, 192); 7, Abich, (Pogg. li, 526); 8, C. G. Gmelin, (Pogg. vii, 79); 9, Redtenbacher, (Pogg. lii, 468, mean of 3 anals.); 10, Brooks, (Pogg. lxi, 392); 11, Kersten, (Leonh. Jahrb. 1845, 648); 12, 13, Brush and Weld, (Am. J. Sci. [2], viii, 390); 14, T. S. Hunt, (Phil. Mag. [4], i, 322, and Am. J. Sci. [2], xii, 212); 15, Diday, (Cryst. from Melaphyre of Agay, Ann. d. M. [5], ii, 184, 193); 16, Rammelsberg, (Pogg. lxxix, 305):

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{Ca}}$
1.	Arendal,	68·46	19·30	0·28	—	9·12	0·68=97·84, G. Rose.
2.	Chesterfield,	70·68	19·80	0·11	—	9·06	0·24=99·88, Stromeyer.
3.	"	68·4	20·8	0·1	—	10·5	0·2=100, Laurent.
4.	St. Gothard, *cryst.*	69·00	19·43	—	—	11·47	0·20=100·10, Thaulow.
5.	Miask, *cryst.*	68·45	18·71	0·27	0·65	11·24	0·50, $\dot{\mathrm{M}}$g 0·18, $\dot{\mathrm{M}}$n *tr.*=100, A.
6.	Brevig,	69·11	19·34	0·62	0·65	10·98	*tr.*, $\dot{\mathrm{M}}$g, $\dot{\mathrm{M}}$n *tr.*=100·7, E.
7.	*Pericl.* Pantellaria,	68·23	18·30	1·01	2·53	7·99	1·26, $\dot{\mathrm{M}}$g 0·51=99·83, Ab.
8.	" "	67·94	18·93	$\dot{\mathrm{F}}$ 0·48	2·41	9·99	0·15, ign 0·36=100·26, G.
9.	Pennsylvania,	67·20	19·64	—	1·57	9·91	1·44, $\dot{\mathrm{M}}$g 0·31=100·07, R.
10.	St. Gothard, *white*,	67·39	19·24	—	6·77	6·23	0·31, $\dot{\mathrm{M}}$g 0·61=100·55, Bks.
11.	Marienbad,	68·70	17·92	0·72	1·18	11·01	0·24=99·77, Kersten.
12.	Lancaster Co., Pa.,	66·65	20·79	—	—	9·36	2·05, $\dot{\mathrm{M}}$g 0·52=99·42, B.
13.	Unionville, Pa.,	66·86	21·89	—	—	8·78	1·79, $\dot{\mathrm{M}}$g 0·48, $\dot{\mathrm{H}}$ 0·48=100·27, W.
14.	*Peristerite*,	66·80	21·80	0·30	0·58	7·00	2·52, $\dot{\mathrm{M}}$g 0·20, ign 0·6=99·80, Hunt.
15.	*Albite*, *cryst.*,	67·0	19·2	0·3	2·2	7·2	1·2, $\dot{\mathrm{M}}$g 1·8=98·9, Diday.
16.	*Hyposclerite*,	67·62	16·59	2·30	0·51	10·24	0·85, " 1·46=99·8, R.

In No. 5, G.=2·624; 11, G. 2·612; 12, G.=2·619; 15, G.=2·478; 16, G.=2·63 to 2·66.

B.B. like feldspar, but colors the flame distinctly yellow. Acted on by hot acids.

Albite often replaces feldspar as a constituent of granite; in other instances it is associated with feldspar, as in Pompey's pillar, and then may be generally distinguished by its superior whiteness. The albite granites are often repositories of several of the granite minerals, tourmalines of different colors, beryls, allanite,

&c. It is associated with pearl spar in the Tyrol, where it occurs in large transparent crystals; with epidote and garnet at Arendal; with eudialyte and hornblende in Greenland. It is frequently one of the constituents of syenite and greenstone.

In Massachusetts, U. S., at Chesterfield, with red and blue tourmalines in lamellar masses, (Cleavelandite), slightly bluish, and also fine granular, and rarely in small crystals. Contains the same minerals at Paris, Maine, and at Goshen, Mass., at Acworth and Alstead, N. H. At Haddam, Conn., accompanies chrysoberyl, beryl, columbite and black tourmalines. Fine transparent or translucent crystals at the Middletown feldspar quarry, (fig. 419; gave the author for *O* : *iì*, 92° 40′ and 87° 20′). At Granville, Washington Co., N.Y., white transparent crystals. At Monroe, Conn., a fine granular variety containing beryl. In Delaware Co., Pennsylvania, at Unionville, a granular variety is the matrix of the corundum, (see analyses 12 and 13), having the hardness of quartz, (7—7·25). It had been taken for Indianite. A similar variety equally hard is found with Idocrase at Sandford, Maine.

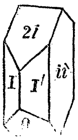
The name *Albite* is derived from *albus*, white, in allusion to its color, and was given the species by Gahn and Berzelius in 1814.

Hyposclerite of Breithaupt, analyzed by Hermann, (J. f. pr. Ch. xlvi, 396), with the resulting ratio for the protoxyds, peroxyds and silica 1 : 2 : 6, is shown by Rammelsberg to be probably albite mixed with augite. G.=2·6—2·66. From Arendal. Named from *υπο*, *under* or less, and *σκληρος*, *hard.*

ORTHOCLASE. Feldspar. Potash-Feldspar. Ice-spar. Felsite. Adularia. Murchisonite. Leelite. Amausite. Amazonstone. Sunadin. Moonstone. Napoleonite. Necronite. Pegmatolite. Mikroklin, *Breit.* Valencianite, *Breit.* Feldstein, *Haus.* Feldspath, *H.* Eispath, *W.* Erythrite, and Perthite of *Thomson.*

Monoclinic; (Diclinic?) $C=63°\ 53'$, $I : I=118°48'$, $O : 1\grave{i}=153°\ 28'$; $a : b : c=0{\cdot}844 : 1 : 1{\cdot}5183$.

420



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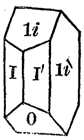

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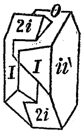

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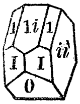

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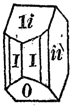

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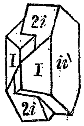
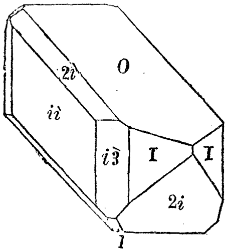


426

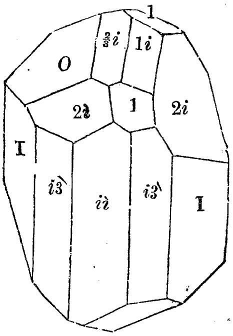


O				
	½			
⅔i				⅔ì
1i	1			
4/3i				
2i	2			2ì
			33̀	
		42̀		
				6ì
ii	I		i3̀	iì
		–42̀		
–2i				
	–1			

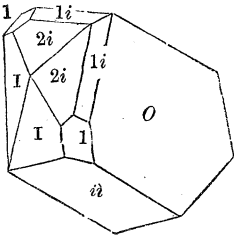
Observed Planes.

Cleavage: O perfect; $i\grave{i}$ less distinct; ii faint; also imperfect in the direction of one of the faces I. Twins: f. 424 and 425 face of composition, $i\grave{i}$; f. 428 parallel to plane $2\grave{i}$; also parallel to O and $\grave{i}_3$. Often massive, cleavable, or granular; sometimes coarse lamellar.

427



428



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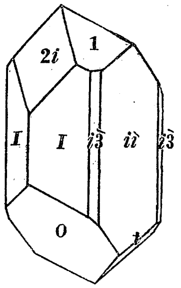

Loxoclase.

$O : \frac{2}{3}i = 145^\circ\ 47'$.
$O : 1i = 129^\circ\ 41'$.
$O : \frac{4}{3}i = 116^\circ\ 33'$.
$O : 2i = 99^\circ\ 38'$.
$O : -2i = 139^\circ$.
$O : i\grave{i} = 116^\circ\ 7'$.
$O : \frac{1}{2} = 150^\circ\ 52'$.
$O : 1 = 124^\circ\ 42'$.

$O : -1 = 146^\circ\ 30'$.
$O : 2 = 98^\circ\ 4'$.
$O : \grave{i}_3 = 77^\circ\ 31'$.
$O : \frac{2}{3}\grave{i} = 161^\circ\ 36'$.
$O : 2\grave{i} = 135^\circ\ 3'$.
$O : i\grave{i} = 90^\circ$
$O : I = 67^\circ\ 44'$.
$i\grave{i} : i\grave{i} = 90^\circ$.

$i\grave{i} : \grave{i}_3 = 150^\circ\ 35'$.
$i\grave{i} : \grave{4}_2 = 142^\circ\ 25'$.
$i\grave{i} : -\grave{4}_2 = 130^\circ\ 50'$.
$i\grave{i} : \grave{3}_3 = 146^\circ\ 40'$.
$I : 2i = 134^\circ\ 19'$.
$I : 1i = 110^\circ\ 40'$.
$1 : 1 = 126^\circ\ 14'$.
$-1 : -1 = 142^\circ\ 40'$.

H.=6. G.=2·4—2·62. Lustre vitreous, sometimes inclining to pearly upon the face of perfect cleavage. Color white; often gray, reddish-white, flesh-red, greenish-white, green; streak uncolored. Transparent—translucent. Fracture conchoidal to uneven.

Composition.—$\dot{K}\dddot{Si}+\dddot{\overline{Al}}\,\dddot{Si}^3=(\dot{K}+\dddot{\overline{Al}})\dddot{Si}^4$=Silica 64·8, alumina 18·4, potash 16·8 =100.

Analyses: 1, Val. Rose, (Scheerer's J. viii, 244); 2, G. Rose, (Pogg. xxviii, 143); 3, Schnedermann, (Stud. Götting. v. b. Freunde, v. Hft. 1); 4, Delesse, (Ann. Ch. Phys. [3], xxv); 5, 6, 7, Abich, (Pogg. li, 528, and Berg. und hüttenm. Zeitg. Jahrg. 19); 8, Domeyko, (Ann. d. Mines, [4], ix, 529); 9, Brongniart and Malaguti, (Ann. Mines, [4], ii, 465); 10, Kröner, (Pogg. lxvii, 421); 11, Kersten, (J. f. pr. Chem. xxxvii, 162); 12, Plattner, (Pogg. xlvi, 299); 13, Evreinoff, (Pogg. xlvii, 196); 14, T. S. Hunt, (Phil. Mag. [4], i, 322, and Am. J. Sci. [2], xii, 212); 15, 16, Gmelin, (Pogg. lxxxi, 313); 17, J. D. Whitney, (Am. J. Sci. [2], xv, 440); 18, Rammelsberg, (4th Suppl. 71); 19, F. A. Genth, (Keller and Tied., iii, 486); 20—23, Smith & Brush, (Am. J. Sci., [2], xvi, 42); 24, Plattner, (Pogg. lxvii, 419):

	$\dddot{Si}$	$\dddot{\overline{Al}}$	$\dddot{\overline{Fe}}$	$\dot{Ca}$	$\dot{K}$	$\dot{Na}$
1. Lomnitz,	66·75	17·50	1·75	1·25	12·00	——=98·25, V. Rose.
2. *Sanidin*, Vesuv.	65·52	19·15	——	0·60	14·74, with some $\dot{Na}$, G. Rose.	
3. *Glassy*, Dransfeld,	64·86	21·46	*trace*	*trace*	2·62	10·29=99·23, Schned.
4. Chamouni,	66·48	19·06	*trace*	0·63	10·52	2·30=98·99, Delesse.

		$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\bar{\dddot{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$
5.	*Adul.* St. Gothard,	65·69	17·97	——	1·34	13·99	1·01=100, Abich.
6.	Baveno, *green*,	65·72	18·57	——	0·34	14·02	1·25, $\dot{\mathrm{Mg}}$ 0·1=100, Ab.
7.	Siberia, *green*,	65·32	17·89	0·30	0·10	13·05	2·81, $\dot{\mathrm{Mg}}$ 0·09, $\bar{\ddot{\mathrm{Mn}}}$ 0·19, $\dot{\mathrm{Cu}}$ *trace*=99·75, Ab.
8.	Chili, *rose*,	65·37	20·47	——	2·60	6·30	4·00=98·74, Dom.
9.	*Moonstone*, Ceyl.	64·00	19·43	——	0·42	14·81	——, $\dot{\mathrm{Mg}}$ 0·2, $\dot{\mathrm{H}}$ & loss 1·14, B. & M.
10.	Marienberg,	66·43	17·03	0·49	1·03	13·96	0·91=99·85, Krön.
11.	Saxony,	65·52	17·61	0·80	0·94	12·98	1·70=99·55, Kersten.
12.	*Valencianite*,	66·82	17·58	0·09	——	14·80	——=99·29, Plattner.
13.	*Microcline*,	65·76	18·31	*trace*	1·20	14·06	——=99·33, Evreinoff.
14.	*Perthite*,	66·44	18·35	1·00	0·67	6·37	5·56, $\dot{\mathrm{Mg}}$ 0·24, ign 0·40 =99·03, H.
15.	*Orth.* Laurvig, *gnh.*	65·90	19·46	0·44	0·28	6·55	6·14, ign 0·12=98·89, G.
16.	" Freder'v'n, *blh.*	65·19	19·99	0·63	0·48	7·03	7·08, " 0·38=100·78, G.
17.	" L. Superior,	66·70	18·68		0·30	9·57	3·58, $\dot{\mathrm{H}}$ 0·70=99·53, W.
18.	" Auerberg,	66·26	16·98	0·31	0·43	14·42	0·20, $\dot{\mathrm{H}}$ 1·29, $\dot{\mathrm{Mg}}$ 0·11, =100, Ramm.
19.	" Davidson Co., N. C.,	65·30	20·20	*tr.*	0·05	14·35	0·79, $\dot{\mathrm{Mg}}$ *tr.*=100·69, Genth.
20.	*Chesterlite*,	64·76	17·60	0·50	0·65	14·18	1·75, $\dot{\mathrm{Mg}}$ 0·30, ign 0·65, =100·39, S. & B.
21.	"	65·17	17·70	0·50	0·56	13·86	1·64, $\dot{\mathrm{Mg}}$ 0·25, ign 0·65 =100·33, S. & B.
22.	*Loxoclase*,	65·40	19·48	1·25	2·26	2·76	7·23, $\dot{\mathrm{Mg}}$ 0·20, ign 0·76 =99·34, S. & B.
23.	"	66·31	18·23	0·67	1·09	4·35	7·81, $\dot{\mathrm{Mg}}$ 0·30, ign 0·20 =98·96, S. & B.
24.	"	63·50	20·29	0·67	3·22	3·03	8·76, $\dot{\mathrm{Mg}}$ *tr.* SiF$\dot{\mathrm{H}}$ 1·23 =100·7, Plattner.

G. of No. 5=2·5756; of 6, 2·55; of 7, 2·58; of 8, 2·596; of 10, 2·44; of 15, 16, 2·59; of 19, 2·547.

Analyses: Diday, (Ann. d. M. [5], ii, 181); Delesse, (ib., iii, 372, 388, 406); Dechen, (of *Sanidin*, Verh. nat. Ver. Rheinl. 1852, 336); Avdeeff and Moss, (Pogg. lii, 465); Moll, (Ramm. 4th Suppl., 69).

B.B. fuses with difficulty, and only on the edges, to a semi-transparent blebby glass. With borax forms slowly a transparent glass, and with soda a vesicular glass. Not acted on by the acids. With cobalt solution, becomes blue only on the fused edges.

Difference of color and lustre has given rise to distinct names for several varieties of this species.

Common Feldspar or Orthoclase [fr. ορθος, *straight* or rectangular, and κλαω, *to cleave*] includes the subtranslucent varieties, the common constituent of granite.

Loxoclase, Breit., has the composition of orthoclase as shown by Smith and Brush, and does not differ essentially in cleavage; the basal and clinodiagonal being much the most distinct; *I* : *I* about 120°; G.=2·6—2·62, Plattner.

Necronite [fr. νεκρος, *a corpse*] gives off a fetid odor when struck.

Adularia is a transparent or translucent variety, found in granitic rocks. The crystals are often large, and occur of great perfection in the high districts of Savoy; the name is derived from Adula, one of the highest peaks of St. Gothard. The *Valencianite* of Breithaupt is a variety of adularia; the name is from the Mexican mine Valenciana.

Moonstone is a variety of adularia, presenting, when polished, chatoyant or pearly reflections. *Sunstone* is a similar variety, containing minute scales of oxyd of iron, or Göthite, (Kengott), disseminated through it. The opalescence is seen in the direction of a plane replacing the edge *I* : *I* somewhat obliquely. But neither of these are exclusively common feldspar. A Siberian sunstone has been shown by Scheerer to be oligoclase; and the moonstone of Mineral Hill, Delaware Co., Pa., is of the same species.

Aventurine Feldspar is less pellucid, and has yellow and reddish internal reflections.

Glassy Feldspar is a transparent variety found in trachytic and volcanic rocks, having a perfect vitreous lustre. It has been called *Sanidin*, from σανις, a *board*, the crystals being tabular; and according to Naumann, it has $C=63° 55'$. $O : I=110°$, $O : I'=115°$. The name *Ice Spar* is sometimes given to a similar variety found in Vesuvian lavas; the term however includes pellucid varieties of other species of feldspar.

Other varieties are the *Murchisonite* of Levy, [named after Murchison, the Geologist], which is a yellowish-gray or flesh-red variety from Heavitree, near Exeter; *Amazon stone*, a verdigris-green variety colored by copper, from Lake Ilmen; the *Leelite* of Dr. Clarke, (the *Helleflinta* of the Swedes), which occurs at Gryphyttan in Sweden, with a peculiar waxy lustre, and deep flesh-red color; and the *Variolite*, a dark green variety, containing lighter globular particles, from river Drac in France.

Kaolin is a term applied to a clay resulting from the decomposition of feldspar. (See beyond.)

The *Microcline* [fr. μικρος, *little*, κλινω, to *incline*] of Breithaupt, is a variety of this species from Arendal, (Pogg. xlvii, 196). The *Erythrite* [fr. ερυθρος, *red*] of Thomson (Phil. Mag. xxii, 188, 1843) is a flesh-colored feldspar, containing three per cent. of magnesia, found in amygdaloid; G.=2·541. The *Perthite* of Thomson is from Perth, in Upper Canada.

Rhyacolite of Rose, (or Ryacolite), from Vesuvius, [named from ρυαξ, a *lava stream*], has the crystallization of feldspar, and resembles the glassy variety. G. Rose states (Kryst. Chem. Min. 88, 1852) that he suspects that in his analysis (Pogg. xxviii, 143) some nepheline may have been mixed with the feldspar, as they often occur together at the locality, and he therefore does not mention it as a distinct species in this recent work of his.

Feldspar in fine crystals is found at Carlsbad and Elnbogen in Bohemia, (twins, f. 424, 425). Ekatherinenburg in Siberia, Arendal in Norway, Baveno in Piedmont, Lomnitz in Silesia, Land's End, &c., are other localities. At the Mourne mountains in Ireland, fine specimens occur, associated with beryl and topaz. Glassy feldspar occurs in great abundance in the trachyte of the Drachenfels on the Rhine; also in the lavas which devastated the island of Ischia, near Naples, in 1302. Ice spar is found principally at Vesuvius; it may be obtained in profusion in the valley called Fossa Grande.

Fine crystallized feldspar occurs in New York, in St. Lawrence Co., at Rossie, two miles north of Oxbow; the crystals are white or bluish-white, and sometimes an inch across; also eight miles from Potsdam, on the road to Pierremont, where crystals a foot through are said to have been found; and near DeLong's mills in the town of Hammond, with apatite and zircon, where the *Loxoclase* is obtained; in Lewis Co., feldspar occurs both crystallized and massive in white limestone near Natural Bridge, with scapolite and sphene; in Orange Co., crystals near West Point; more abundant and interesting forms are found at Rocky Hill, in Warwick, with tourmaline and zircon; and at Amity and Edenville. In Saratoga Co., N. Y., at the Greenfield chrysoberyl locality, white translucent crystals, usually coated with silvery mica. In Connecticut at the gneiss quarries of Haddam and the feldspar quarries of Middletown, crystals a foot long, and six or eight inches thick; near Bradleysville, in the western part of Litchfield, crystals 2–3 inches long, abundant. In Massachusetts at South Royalston and Barre, in crystals often large; also at Three Rivers, in Palmer. The Acworth beryl locality, the tourmaline locality of Paris, Maine, are other localities of crystallized feldspar. In Pennsylvania, in crystals at Leiperville, Mineral Hill, and Chester, (chesterlite), Delaware Co.; a sunstone in Kennett Township; fine crystals of green feldspar occur on the island, Mt. Dessert, Me. Washington Mine, Davidson Co., N. C., in white and yellowish crystals, (anal. 19).

Massive feldspar is abundant at the above mentioned localities, besides many others. An aventurine variety, with bright coppery reflections in spots, occurs at Leiperville, Pennsylvania. Adularia occurs at the Falls of the Yantic, near Norwich, Conn., at Brimfield, Mass., with iolite, and at Parsonfield, Me.; and sunstone at Lyme, Conn. (Some of these may be oligoclase). Kaolin occurs at Andover, Mass., and abundantly in New Milford, Kent, and Cornwall, Conn., and in the counties of Essex and Warren, New York; also in New Garden, Chester Co., Pa., abundant. Necronite is found at Roger's Rock, Essex Co., and at Thomson's quarry, near 196th street, New York.

Chesterlite (anal. 20, 21) is shown by Smith and Brush to have the constitution of Orthoclase. It occurs in crystals sometimes $1\frac{1}{4}$ inches broad, implanted often on dolomite. Faces not polished; $I : I'=121°—127°$. $O : ii=90°$ as shown by twins; $O : I$ and $O : I'$ unequal, (as also $2i$ on I and $2i$ on I'), but not constant, and the difference may be an irregularity. Cleavage parallel to O and ii, perfect. Twins common parallel to O : also a peculiar twin, in general form rectangular, made by composition parallel both to O and ii, the latter composition shown by the meeting of striæ along the middle of O, and the former by a similar meeting on ii; but it is singular that in the two specimens observed by the author (from the cabinet of Joel Baily) this meeting of striæ is seen on only one of the planes O, and one ii; on the other plane O the striæ extend across, parallel to the intersection of O with one of the planes I, a fact that indicates a diclinic rather than a monoclinic form. The crystals normally would have 4 planes I at one extremity; but the specimens are partly broken and only two are present on one side, one *above* the other.

Feldspar enters into the composition of a great number of rocks.

Granite consists of feldspar, quartz, and mica, crystallized promiscuously together. The feldspar constitutes ordinarily about 40 per cent., but varies very widely; while the quartz is usually 30 to 40 per cent. Ordinary granite contains about 72·3 silica, 15·3 alumina, 7·4 of alkalies, 5·0 of lime, magnesia, and oxyd of iron,—a composition near that of petrosilex. *Pegmatite* is graphic granite.

Gneiss has the same ingredients as granite, but with traces of lamination.

Mica slate is similar in constitution, with a distinctly foliated structure.

Beresite is a fine grained granite, containing pyrites, from near Beresof, in the Ural.

Syenite consists of feldspar, hornblende, and quartz, and otherwise resembles granite. These rocks pass into one another by insensible gradations. *Protogine* is a talc granite.

Dolerine is a gneissoid rock in the Alps consisting of talc and feldspar.

Granulite, *Eurite*, or *Leptynite*, (Weissstein), is a granular compound of feldspar and quartz, with sometimes garnet.

The *Hornfels* of the Germans is a massive compound of quartz and feldspar breaking with a smooth flinty fracture. The *Cornubianite* is similar.

Pyroxenite consists of feldspar and lamellar pyroxene.

Pyromeride is a granitoid rock containing spherules thickly disseminated. Similar spherules sometimes occur in porphyry, trachyte, eurite, diorite, and occasionally granite. Delesse has shown that rocks containing these spherules have an excess of silica. The spherules are feldspathic, but contain mixed quartz which is most abundant in the exterior coats or at the centre.

Miascite, a granular slaty rock consisting of orthoclase, mica, and elæolite, with sometimes quartz, albite, and hornblende.

Porphyry consists of a compact feldspathic base, (*cornite* or *porphyrite*), with crystals of feldspar, (often orthoclase or oligoclase); it may be green with blotches of paler green or white, or red with white blotches or specks, besides other shades of color; the blotches of a polished surface are the feldspar crystals. When distinct feldspar crystals are scattered through granite it is called *porphyritic* granite. The feldspar of porphyry is often also the species labradorite, as is the case in the ancient verd antique porphyry of Greece, quarried from rounded hills on the plains of Helosin, Laconia. In the porphyry of Ternuay in the Vosges it is the species vosgite. It is often *quartzose* or globuliferous.

Clinkstone or *phonolite* is a compact feldspathic rock of grayish colors and smooth fracture, clinking under the hammer when struck somewhat like a metal. G.=2·5—2·6.

Trachyte is a rock of similar constitution and color with clinkstone, but having a rough surface of fracture. *Domite* is a grayish earthy variety from Puy-de Dome.

Pumice (Bimsstein, *German*) is a porous feldspathic scoria from volcanoes; the pores are fine and linear and often barely visible without a glass. G.=2·2—2·4.

Trap or *greenstone* is a dark and heavy blackish-green or brownish rock, consisting of feldspar and hornblende; it usually has a crystalline texture, but is sometimes compact. When albite replaces orthoclase the rock is called *diorite.*

Basalt or dolerite is a similar rock, consisting of feldspar (often labradorite) and augite, either subcrystalline or not at all so, and often containing distinct crystals of augite or feldspar or both, and still more frequently chrysolite in bottle-glass colored grains, with also grains of magnetic iron. It passes into lavas, which often have the same constitution and are of the same origin. *Anamesite* is a very fine granular rock of similar constitution, in which the labradorite predominates. *Wacke* is an earthy variety, or a rock consisting of basaltic earth or sand.*

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* In the analysis of basalt, it is subjected to the action of nitric or muriatic acid, and thus separated into a soluble and insoluble portion. The basalt of Wickenstein, thus examined by Löwe, with muriatic acid, afforded him 55·58 per cent. of insoluble product, and 44·42 of soluble, the latter consisting of 39·81 of zeolite or zeolitic minerals, and 4·61 of magnetic iron. The basalt from Stolpen, according to Sinding, consists of 57·736 per cent. soluble in muriatic acid, and 42·264 insoluble. On analysis, the soluble and insoluble portions afforded,

	From Wickenstein.—*Löwe.*		From Stolpen.—*Sinding.*	
	Zeolitic.	Insoluble.	Soluble.	Insoluble.
Silica,	39·13	47·98	39·920	52·62
Alumina,	29·00	9·10	21·266	11·93
Lime,	10·52	14·41	7·857	15·49
Soda,	13·92	——	5·279	——
Potash,	1·43	——	2·795	——
Protoxyd of iron,	——	16·51	Oxyd, 16·800	Peroxyd, 10·63
Magnesia,	——	12·97	4·379	8·26
Water,	7·93	——	2·490	——
	100·93	100·97	100·786	98·93

The zeolite of the Wickenstein basalt is stated by Löwe to be near Thomsonite in composition. According to Girard, who analyzed the same basalt with somewhat different results, it is a mixture of mesolite and nepheline. The rest of the basalt, excluding the magnetic iron, is augite, and, according to Girard, the whole consists of mesotype 22·686, nepheline 22·686, magnetic iron 6·370, augite 48·256.

The Stolpen basalt is inferred from the analysis, to consist of zeolite 74·837, olivine 12·630, magnetic iron 13·318. The zeolite is supposed to be a mixture of several zeolitic minerals; it approaches, in composition, mesole, brevicite, and sodalite.

A *Dolerite* from Iceland, analyzed by Auerbach, gave labradorite 38·18 per cent. and augite 61·82. Girard shows that the only difference between the so-called dolerite and the basalt of Meissner is that the latter contains zeolites.

Composition of Phonolite, from Marienberg near Aussig, by Meyer, and from Whisterschan near Teplitz, by Redtenbacher of Vienna.

	The phonolite as a whole.		Soluble part.	
	Marienberg.	Whisterschan.	Marienberg.	Whisterschan.
Silica,	56·652	54·090	43·244	41·220
Alumina,	16·941	24·087	21·000	29·238
Perox. of iron,	3·905	Protoxyd, 1·248	Peroxyd, 7·816	Protoxyd, 2·497
Perox. of mang.	——	0·319	——	0·638
Lime,	1·946	0·687	2·986	1·034
Potash,	9·519	4·244	0·035	3·557
Soda,	2·665	9·216	7·112	12·108
Magnesia,	1·697	1·379	——	1·261
Oxyd of copper,	——	0·012	——	0·025
Water,	4·993	3·279	13·325	6·558
	98·318, M.	98·561, R.	95·518, M.	98·136, R.

The Marienberg phonolite is supposed to contain, besides feldspar, natrolite and

Petrosilex (Adinole, *Beudant*) is compact impure feldspar, like the base of porphyry. It differs from jasper, which it often resembles, in being fusible before the blowpipe. G.=2·606—2·66. A greenish-gray specimen from Brittany afforded Berthier, Silica 75·4, alumina 15·5, potash 3·8, magnesia 1·4, oxyd of iron 1·2. The results are varying; as the species is rather a rock than a pure mineral. Thomson's *Leelite*, which falls here, consists of Silica 81·91, alumina 6·55, potassa 8·88, protoxyd of iron 6·42.

Obsidian or volcanic glass is sometimes an impure feldspar in a glassy state; and in other cases it is a mixture of feldspar and augite with chrysolite and much iron, or of augite and chrysolite or labradorite, &c., the materials varying with the lavas of a volcano; for any lava will become glassy, and thus make obsidian, by rapid cooling. G.=2·25—2·8.

Pitchstone has the lustre of pitch rather than glass; *pearlstone* has a pearly lustre, and is sometimes in spherules, (spherulite), or consists of spheroidal concretions. G.=2·3—2·4. The spherules of pyromeride, porphyry, etc., are quite similar. The siliceous character of these spherules is mentioned on page 246; see also Delesse on Globuliferous Rocks, Trans. Geol. Soc. France, 1853, and Am. Jour. Sci. [2], xvii, 168.

Krablite, Forchhammer, or Baulite, appears to be a siliceous feldspathic mineral, related to these concretions. It forms the basis of the trachyte, obsidian and pitchstone of Iceland. According to von Waltershausen, it occurs also in triclinic crystals; and he deduces the oxygen ratio 1 : 3 : 24=$(\dot{\mathrm{R}}+\ddot{\mathrm{Al}})\dddot{\mathrm{Si}}^8$. B.B. fuses only in thin splinters; in acids insoluble. H.=6. G.=2·656, Forch., 2·572, Walt.

The following are analyses of pumice, obsidian, spherulite, krablite, etc.: 1, Berthier, (Ann. d. Mines, [3], v, 543); 2, Vauquelin, (N. allg. J. d. Chem. v, 230); 3, 4, Erdmann, (J. f. techn. Chem. xv, 32); 5, Thomson; 6, Trommsdorf, (N. J. d. Pharm. iii, 301); 7, Erdmann, (loc. cit.); 8, Ficinus, (Schw. J. xxix, 136); 9, Erdmann, (loc. cit.); 10, Klaproth, (Beit. ii, 62, iii, 262); 11, Berthier, (Ann. d. Mines, vii); 12, 13, B. Silliman, Jr., (Dana's Geol. Rep. p. 200); 14, Waltershausen, (Vulk. Gest. p. 211); 15, Delesse, (Bull. Geol. Fr. [2], ix 175); 16, Forchhammer, (Skand. Nat. Samm. i. Stockholm); 17, Genth, (Ann. Ch. u. Pharm. lxvi, 271):

	$\dddot{\mathrm{Si}}$	$\ddot{\mathrm{Al}}$	$\ddot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$
1. *Obsidian*, Pasco,	69·46	2·60	2·60	7·54	2·60	5·08	7·12, $\dot{\mathrm{H}}$3·00=100, Berth.
2. " Mexico,	78·	10·	2·	1·	——	——	——$\dot{\mathrm{Mn}}$ 1·6=98·6, Vauq.
3. " Telkiban.	74·80	12·40	2·03	1·96	0·90	——	6·40, $\dot{\mathrm{Mn}}$ 1·31=99·80, E.
4. *Pitchstone*, Meis.	75·60	11·60	1·20	1·35	6·69	2·77	$\dot{\mathrm{H}}$ 4·73=103·95, E.
5. " Arran	63·50	12·74	$\dot{\mathrm{F}}$3·80	4·46	——	6·22	——, ign. 8·0=98·71, Th.
6. " *bk.* Dresdn.	74·00	17·00	$\ddot{\mathrm{F}}$2·75	1·50	——	——	——, $\dot{\mathrm{Li}}$ 3·00,=98·25, Tr.
7. *Pearlstone*, Hun.	72·87	12·05	1·75	1·30	1·10	6·13	$\dot{\mathrm{H}}$ 3·0=98·20, Erd.
8. " "	79·12	12·00	2·45	——	1·10	3·58	$\dot{\mathrm{H}}$ 1·76=100·01, F.
9. *Spherulite*, "	77·20	12·47	2·27	3·34	0·73	4·27	=100·28, Erdmann.
10. *Pumice*, Lipari,	77·50	17·50	1·75	——	——	3·00	=99·75, Klaproth.
11. " "	70·00	16·00	0·50	2·50	——	——	6·50, H 3·00=98·50, B.
12. *Pélé's Hair*,	51·19	——	——	——	18·16	——	——, $\dot{\mathrm{F}}$e 30·26=99·61, S.
Hawaii, *volc. glass*,	39·74	10·55	——	2·74	2·40	21·62	——, $\dot{\mathrm{F}}$e 22·29, $\dot{\mathrm{H}}$ 0·33=99·67, Silliman, Jr.
14. *Sideromelane*,	49·25	15·18	20·23	9·61	2·10	2·51	1·12=100, Waltersh.
15. *Spher. in pyrom.*	88·09	6·03	0·58	0·28	1·65	2·53	$\dot{\mathrm{H}}$ 0·84=100, Del.
16. *Krablite*, Iceland	74·83	13·49	4·40	1·98	0·17	5·56	*tra.*=100·43, F. G.=2·389.
17. " "	80·23	12·08	——	0·95	——	2·26	4·92=100·44, Genth.

Other analyses of obsidian, Deville, (Bull. Geol. [2], viii, 427); of pumice, ib.; also Schäffer, (J. f. pr. Chem. liv, 16):

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apophyllite, some anhydrous silicate, (nepheline?) that gelatinizes with acids. Phonolite from Abstrode, analyzed by C. Gmelin, according to him, consists of mesotype, or some allied mineral, and a feldspar containing both soda and feldspar; but the proportions vary much in different phonolites, and some are but slightly attacked by acids. See further, Ramm. Handw. 76, etc., and Suppl. i to v.

Sideromelane is an amorphous ferruginous labradorite; formula $\dot{R}\,\dddot{\mathrm{Si}}+\dddot{\bar{R}}\,\dddot{\mathrm{Si}}$. Pélé's Hair (anal. 12) has the composition of an augite, (Rammelsberg).

ALTERED FORMS.—Feldspar may be altered through infiltrating waters carrying more or less carbonic acid in solution, (Forchhammer, Fournet, Bischof); also through the action of waters rendered acid by the decompositio nof pyrites, (Mitscherlich); also by ordinary waters holding traces of alkaline and other ingredients in solution, (Bischof).

The presence of pyrites, or a mineral containing protoxyd of iron, as some mica, garnet, &c., is often the first occasion of the change. The decomposition of the mineral with the attendant oxydation of the iron distributes ferruginous waters through the rock, (or sulphate of iron, from the altered sulphuret), and thus by a disaggregating or decomposing action, prepares the way for other agencies.

When the infiltrating waters contain traces of carbonic acid, the feldspar acted on first loses its lime, if a lime feldspar, by a combination of the lime with this acid; next, its alkalies are carried off as carbonates, if the supply of carbonic acid continues, or otherwise as silicates in solution. The change thus going on, ends in forming *Kaolin* or some other hydrous silicate. The carbonate of soda or potash, or the silicate of these bases, set free, may go to the formation of other minerals—the production of pseudomorphic or metamorphic changes—and the supplying fresh and marine waters with their saline ingredients.

Kaolin is generally a simple hydrous silicate of alumina, expressed by the formula $\dddot{\bar{A}}\mathrm{l}\,\dddot{\mathrm{Si}}+2\dot{\mathrm{H}}$=Silica 40·0, alumina 44·5, water 15·5; occasionally it corresponds to $\dddot{\bar{A}}\mathrm{l}\dddot{\mathrm{Si}}\tfrac{4}{3}+2\dot{\mathrm{H}}$. Orthoclase in changing to the former loses $1\dot{\mathrm{K}}+3\dddot{\mathrm{Si}}$; or to the latter, $1\dot{\mathrm{K}}+\tfrac{8}{3}\dddot{\mathrm{Si}}$. Part of the silica set free may go off with more or less of the potash, or may form opal, quartz, siliceous sinter. The alumina also is often in part removed. The same explanation is readily applied to the change in albite or other feldspars.

When the change is not carried on to the exclusion of the protoxyd bases, certain zeolites may result, especially as Bischof states, when labradorite is the feldspar undergoing alteration, which species he describes as giving origin to the species mesolite. Massive nepheline or elæolite is a still more common source of zeolites.

When the waters contain traces of a magnesian salt—a bicarbonate or silicate—the magnesia may replace the lime or soda, and so lead to a steatitic change, or to a talc when the alumina is excluded; and when augite or hornblende is present, it may give origin to chlorite.

The action of sulphurous acid from volcanic fumaroles produces often a complete destruction of the feldspar and other minerals present, giving rise to deposits or incrustations of silica, in some of its various forms, and also Halloysite, etc.

Steatite, Talc, Chlorite, Kaolin, Lithomarge, occur as pseudomorphs after orthoclase or albite; and Tin ore and Calcite also replace these feldspars by some process of solution and substitution. Labradorite more rarely forms kaolin.

Orthoclase is also described as occurring altered to Albite. This has been mentioned as an example of *paramorphism*, the two species being dimorphous. But as these feldspars occur together in the same rock, and must have been formed under very similar circumstances, we can hardly suppose that either is liable to a change like that of a dimorphous compound to the form of the other.

The following are analyses of *Kaolin*. No. 1 to 28 are by Brongniart and Malaguti, who carefully separated the free silica and undecomposed feldspar. Their results are here reduced to 44·5 as constant for the alumina, this being the amount in the Kaolin of the formula, $\dddot{\bar{A}}\mathrm{l}\,\dddot{\mathrm{Si}}+2\,\dot{\mathrm{H}}$. G.=2·21—2·26. Analyses *a*, *b*, are from analyses by Ebelmen and Salvetat, (Ann. Ch. Phys. xxxi, 257). Analyses 1 to 17 and 21 give quite closely the theoretical formulas $\dddot{\bar{A}}\mathrm{l}\,\dddot{\mathrm{Si}}+2\dot{\mathrm{H}}$; 19, 20, have one quarter more of silica; 22, one half more; 26 and *b*, twice more.

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{A}}\mathrm{l}$	$\dot{\mathrm{H}}$	$\dddot{\mathrm{Si}} : \dddot{\bar{A}}\mathrm{l}$
1. Limoges,	40·	44·5	15·5	1·0 : 1
2. Clos de Madame, Allier,	46·0	"	16·	1·15 : 1
3. Chabrol, Puy-de-Dome,	37·2	"	15·9	0·93 : 1
4. Plympton, Devonshire,	40·9	"	15·3	1·02 : 1
5. Piedmont,	36·5	"	15·5	0·91 : 1
6. Diendorf, Passau,	36·9	"	16·5	0·92 : 1
7. Rama, Passau,	43·8	"	15·4	1·09 : 1
8. Auerbach, Passau,	38·3	"	15·9	0·96 : 1

	$\dddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dot{\text{H}}$	$\dddot{\text{Si}} : \dddot{\text{Al}}$
9. Seilitz, near Meissen,	41·2	44·5	15·7	1·03 : 1
10. Aue, near Schneeberg,	44·6	"	14·5	1·11 : 1
11. Morl, near Hall,	42·9	"	14·8	1·07 : 1
12. Munschoff, Carlsbad,	45·7	"	14·9	1·14 : 1
13. Bornholm, Scandinavia,	40·0	"	15 8	1·0 : 1
14. Oporto, Portugal,	37·4	"	14·8	0·93 : 1
15. Newcastle, Delaware,	35·3	"	15·5	0·86 : 1
16. Galicia,	43·8	"	15·2	1·09 : 1
17. Near Cherbourg,	51·5	"	15·6	1·29 : 1
18. Kaschna, near Meissen,	49·1	"	17·4	1·23 : 1
19. Zetlitz, Carlsbad,	41·1	"	16·0	1·03 : 1
20. Elba,	60·7	"	15·8	1·52 : 1
21. Wilmington, Delaware,	26·1	"	15·4	0·65 : 1
22. Cornwall,	83·8	"	16·1	2·09 : 1
23. Schletta, near Meissen,	82·	"	15·5	2·05 : 1
24. Hungary,	75·5	"	15·2	1·89 : 1
a. China,	73·4	"	14·4	1·81 : 1
b. "	80·7	"	12·0	2·01 : 1

Ebelmen and Salvetat found in the last 1 : 1 per cent. of potash, 2 of peroxyd of iron, and 2·7 of soda.

The following are other analyses in which the free silica and undecomposed mineral was not separated. Analyses *c* to *l* reduced to the same standard as the above, give 13 to 16·5 for the water. *c* to *g* are by Brongniart and Malaguti; *h, i,* R. D. Thomson and Richardson, (Thom. Min. i, 244); *k*, Rammelsberg, (3d Supp. 117); *l,* Dumenil (Chem. Anal. i, 1825, p. 35); *m*, Rammelsberg, (Pogg. lxii, 152); *n* Glocker, (J. f. pr. Chem. xxxv, 39); *o*, W. S. Clarke, (Ann. Ch. Pharm. lxxx, 122):

	$\dddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dot{\text{H}}$	$\dot{\text{Ca}}$,$\dot{\text{Mg}}$,$\dot{\text{K}}$	$\dot{\text{Ca}}$,$\dot{\text{Mg}}$,$\dot{\text{Na}}$	
c. Newcastle,	29·73	25·59	8·94	——	——	Residue not argillac. 34·99
d. Wilmington,	32·69	35·01	12·12	1·14	0·72	" 22·81
e. Limoges,	42·07	34·65	12·17	1·33	——	" 9·76
f. Devonshire,	44·26	36·81	12·74	1·55	——	" 4·30
g. China,	23·72	9·80	2·62	$\dot{\text{K}}$ 3·08	$\dddot{\text{Fe}}$0·43	" 68·18
h. *Tuesite,*	44·30	40·40	13·50	$\dot{\text{Ca}}$0·75	$\dot{\text{Mg}}$0·50=99·45, Thomson.	
i. "	43·80	40·10	14·21	" 0·64	" 0·55 $\dot{\text{Fe}}$0·94=100·23, R.	
k. Schlackenwald,	43·46	41·48	13·49	" 1·20	$\dot{\text{Na}}$ 0·37=100, Ramm.	
l. Clausthal,	43·00	40·25	15·50	" 0·47	$\dddot{\text{Fe}}$ 0·48=99·70, Dumenil.	
m. Zorge,	49·75	29·88	5·48	" 0·43	$\dot{\text{Mg}}$1·47, $\dot{\text{K}}$6·35 $\dddot{\text{Fe}}$6·61=99·97, R.	
n. *Smelite,*	50·0	32·0	13·0	$\dot{\text{Na}}$2·1	$\dddot{\text{Fe}}$2·0=99·1, Glocker.	
o. Schneckenstein,	46·75	39·58	$\dot{\text{Mg}}$ 0·93	$\dot{\text{H}}$13·42=100·68, W. S. Clark.	G.=2·6.	

No. *m* contains still considerable potash, and was but partially decomposed.

The *Smelite* is from a trachytic porphyry near Telkibanya, Hungary; it is rather tough; H.=2·5. G.=2·168; grayish-white, bluish. Named from *σμηλη*, *soap.*

The Schneckenstein Kaolin often surrounds the crystals of topaz. Appears under the microscope to consist in part of rhombic scales. B.B. becomes brownish but does not melt. Formula deduced $\dddot{\text{Al}}^3\dddot{\text{Si}}^4+6\dot{\text{H}}$.

Many localities of Kaolin are already given in the above table. The name is a corruption of the Chinese *Kauling*, meaning *high-ridge*, the name of a hill near Jauchau Fu, where this mineral is obtained. The *petuntze* (peh-tun-tsz) of the Chinese, with which the Kaolin is mixed in China, for the manufacture of porcelain, is a quartzose feldspathic rock, consisting largely of quartz.

The name *Lithomarge* (Steinmark) is often applied to a Kaolin material; the color may be white, yellow, or red, the latter color due to oxyd of iron. A variety from Rochlitz analyzed by Klaproth (Beit. vi, 285) is red, and is called *Carnat* by Breithaupt. Analyses *h* to *l* have been referred to Lithomarge.

Myelin of Breithaupt (Talksteinmark) is from Rochlitz, and is of a yellowish or reddish color. Kersten obtained in an analysis $\dddot{\text{Si}}$ 37·62, $\dddot{\text{Al}}$ 60·50, $\dot{\text{Mg}}$ 0·82, $\dddot{\text{Mn}}$0·63, $\dddot{\text{Fe}}$ *trace*=99·57.

Melopsite of Breithaupt is a yellowish or greenish white Lithomarge from Neudeck in Bohemia. H.=2—3. G.=2·5—2·6. Feel greasy; adheres a little to the tongue.

Pholerite does not differ much from Kaolin in composition, but occurs in soft nacreous scales of a white color. G.=2·35—2·57. Infusible. Formula given $\dddot{\bar{\mathrm{Al}}}\,\dddot{\mathrm{Si}}+2\dot{\mathrm{H}}$. Analyses 1, 2, 3, Guillemin, (Ann. d. M. xi, 489); 4, 5, J. L. Smith, (Am. J. Sci. [2], xi, 58):

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{H}}$
1.	Fins,	41·65	43·35	15·00=100, Guillemin.
2.	"	42·93	42·07	15·00=100, "
3.	R. de Gier,	40·75	43·89	15·36=100, "
4.	Naxos,	44·41	41·20	13·14, $\dot{\mathrm{C}}\mathrm{a}$ 1·21=99·96, Smith.
5.	Schemnitz,	42·45	42·81	12·92, $\dot{\mathrm{C}}\mathrm{a}$ $\dot{\mathrm{M}}\mathrm{g}$ *tr.*=98·18, "

From Fins in the Dept. of Allier, and Rive de Gier, Dep. de la Loire, in France, filling fissures in nodules of iron ore in the coal formation. Also from Cache-Après, at Mons in Belgium; with emery and margarite at Naxos, and with diaspore at Schemnitz.

Halloysite. With a higher percentage of water (mostly about 24) the aluminous material is called *Halloysite,* Berthier, *Lenzinite,* John, etc. The composition corresponds mostly either to $\dddot{\bar{\mathrm{Al}}}\,\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$ or $\dddot{\bar{\mathrm{Al}}}\,\dddot{\mathrm{Si}}^{\frac{4}{3}}+4\,\dot{\mathrm{H}}$; the last=Silica 41·5, alumina 34·4, water 24·1.

Halloysite has a waxy lustre, a shining streak, white or bluish shade of color, and is subtranslucent, or becomes so in water; also adheres to the tongue. G.=1·8—2·1.

Analyses: 1, 2, Berthier, (Ann. Chim. Phys. xxxii, 332, Ann. des Mines, [3], ix, 500); 3, Boussingault, (ib. v, 554); 4, 5, Dufrénoy, (ib. iii, 393); 6, Oswald, (J. f. pr. Chem. xii, 173); 7, Monheim, (Verh. d. Nat. Ver. d. preuss. Rheinl. v. 41 in Ramm. 4th Suppl. 221); 8, Sauvage (Ann. M. [4], x, 77); 9, ib. (ib. [3], xx, 204); 10, Salvetat, (Ann. Ch. Phys. [3], xxxi, 102):

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{H}}$
1.	Anglar,	44·94	39·06	16·00=100, Berthier.
2.	Housscha,	46·7	36·9	16·0=99·15, Dufrénoy.
3.	New Granada,	45·0	40·2	14·8=100, Boussingault.
4.	La Vouth,	40·66	33·66	24·83=99·15, Dufréuoy.
5.	Thiviers,	43·10	32·45	22·30, $\dot{\mathrm{M}}\mathrm{g}$ 1·70=99·55, Dufrénoy.
6.	Upper Silesia,	40·25	35·00	24·25, $\dot{\mathrm{M}}\mathrm{g}$ 0·25=99·55, Oswald.
7.	Altenberg,	40·31	33·23	23·69, $\dot{\mathrm{Z}}\mathrm{n}$ 1·23=98·46, M.
8.	Milo,	44·7	32·9	17·9, $\dot{\mathrm{M}}\mathrm{g}$ and Alk, 14·5=100, Sauvage.
9.	Ecogne,	42·	34·	24·0=100, Sauvage.
10.	Condè, *Smectite,*	43·0	32·5	21·7, $\dot{\mathrm{F}}\mathrm{e}$ 1·02, $\dot{\mathrm{M}}\mathrm{g}$ 0·3, $\dot{\mathrm{K}}$, $\dot{\mathrm{N}}\mathrm{a}$ 0·4, $\dddot{\mathrm{Si}}$ *gel.* 1·5=[101·62, Sal.
11.	*Lenzinite,* Eifel,	37·5	37·5	25·0=100, John.
12.	" Chanteloube,	36·36	36·00	21·50, $\dddot{\bar{\mathrm{Fe}}}$ 1·95, $\dot{\mathrm{M}}\mathrm{g}$ 0·18, $\dot{\mathrm{K}}$ $\dot{\mathrm{N}}\mathrm{a}$ 0·50, $\dddot{\mathrm{Si}}$ *gel.* 2·0, quartz 1·64=100·13, Sal.

The *Halloysite* of Housscha is derived from graphic granite; that of Milo is from a pumiceous tufa, and it contained 29·3 per cent. of quartz. The mineral from Condè, near Houdan, France, is called *Smectite* by Salvetat, and he gives the formula $\dddot{\bar{\mathrm{Al}}}^{2}\,\dddot{\mathrm{Si}}^{3}+7\frac{1}{2}\dot{\mathrm{H}}$; *it is greenish,* and in certain states of humidity appears transparent and almost gelatinous. For his *Lenzinite,* Salvetat writes the formula $\dddot{\bar{\mathrm{Al}}}\,\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$; the mineral is from the pegmatite of La Vilate, near Chanteloube, (Haute Vienne); it is clear brown, tender, not plastic. B.B. becomes reddish, but does not fuse; decomposed by heated sulphuric acid; at 100° C, the water is reduced to 16·5 per cent.

Samoite is related to the above, but contains more water. Moreover it is much harder than the other aluminous silicates that are here described as results of alteration. It forms stalactites three or four inches broad, and half as long, in a cavern in lava, island of Upolu of the Navigator group. The structure is lamellar; color whitish; lustre a little pearly. H.=4—4·5. G.=1·7—1·9. Analysis by Silliman, Jr. (Dana's Geol. Rep. Exp. Exp.):

$$\dddot{\mathrm{Si}}\ 31{\cdot}25,\quad \dddot{\bar{\mathrm{Al}}}\ 37{\cdot}21,\quad \dot{\mathrm{H}}\ 30{\cdot}45,\quad \dot{\mathrm{M}}\mathrm{g}\ 4{\cdot}06,\quad \dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}\ 0{\cdot}01,\quad \dot{\mathrm{N}}\mathrm{a}\ 0{\cdot}06=99{\cdot}04.$$

corresponding to $\dddot{\bar{\mathrm{Al}}}\,\dddot{\mathrm{Si}}+5\dot{\mathrm{H}}$. In another analysis he obtained $\dddot{\mathrm{Si}}$ 35·19, $\dddot{\bar{\mathrm{Al}}}$ 31·95, $\dot{\mathrm{H}}$ 30·80, etc.

Bole.—The material so-called is closely related to Halloysite in its appearance, and prominently in its large per centage of water; but it is more varying in character. It is subtranslucent to opaque, has a shining streak, a brown, yellowish or reddish color, a greasy feel, and adheres to the tongue. Some varieties contain considerable oxyd of iron, from the decomposition of other minerals associated with the feldspar. *Rock soap*, (Bergseife), *Bolus* of Sinope, and *Ochran* of Orawitza, are of similar character. The following are analyses:

1, 2, Löwig, (Leonh. Oryk.); 3, Wackenroder, (Kast. Arch. xi, 466); 4, Zellner, (Leonh. N. Jahrb., 1835, 467); 5, Rammelsberg, (Pogg. xlvii, 180); 6, 7, Salvetat, (Ann. Ch. Phys. [3], xxxi, 102); 8, Smith & Brush, (Am. J. Sci. [2], xv, 211); 9, Bucholz, (Gehlen's, N. J., iii, 597); 10, Berthier, (Ann. d. M. [3], xi, 479); 11, Klaproth, (Beit. iv, 345); 12, Kersten, (Schw. J. lxvi, 31):

		$\dddot{\mathrm{Si}}$	$\dddot{\cancel{\mathrm{Al}}}$	$\dddot{\cancel{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
1.	Ettingshausen,	42·00	24·04	10·03	0·52	0·43	24·03=101·05, Löwig.
2.	C. de Prudelles,	41·05	25·03	8·09	0·45	0·50	24·02=99·14, Löwig.
3.	Säsebühl,	41·9	20·9	12·2	——	——	24·9 =99·9, Wackenroder.
4.	Striegau,	42·00	20·12	8·53	2·81	2·01	24·00, $\dot{\mathrm{K}}$ 0·5=99·97, Zellner.
5.	Stolpen,	45·92	22·15	*trace*	3·90	*trace*	24·86=97·83, Ramm.
6.	Thiviers,	47·55	22·60	1·05	1·66	0·30	26·20, $\dot{\mathrm{K}}$ $\dot{\mathrm{Na}}$ 0·1, $\dddot{\mathrm{Si}}$ gel. 1·04, qtz. 1·04=99·46, S.
7.	——?	45·44	24·00	1·35	0·83	0·09	26·70, $\dot{\mathrm{Na}}$ 0·93=99·35, Salvetat.
8.	Unionville, Pa.,	44·50	25·00	——	——	7·75	22·39 $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$ $\dot{\mathrm{Mn}}$ *tr.*=99·64, Smith.
9.	*Bergseife*, Thu.	44·0	26·5	8·0	0·5	——	20·5=99·5, Bucholz.
10.	" Plomb.,	44·0	22·0	——	——	2·0	25·0, Sand 6·0=99·0, Berth.
11.	*Bolus*, Sinope,	32·0	26·5	21·0	$\dot{\mathrm{H}}$ 17·0	NaCl 1·5=98·0, Klaproth.	
12.	*Ochran*, Oraw.,	31·3	43·0	1·2	" 21·0 and trace of $\dddot{\mathrm{B}}$=96·5, Kersten.		

The first two analyses give the formula $\dddot{\cancel{\mathrm{R}}}^2\dddot{\mathrm{Si}}^3+9\dot{\mathrm{H}}$, and 7 to 10 nearly $\dddot{\cancel{\mathrm{Al}}}\dddot{\mathrm{Si}}^2+6\dot{\mathrm{H}}$. The Unionville mineral occurs with euphyllite; H.=2·25; G.=2·2; yellowish-white; brittle; crumbles to pieces in water.

The Thiviers mineral which Salvetat calls Halloysite, has a rose-red color and is unctuous to the feel. No. 7 is similar. He writes for the formula of these $\dddot{\cancel{\mathrm{R}}}\dddot{\mathrm{Si}}^2+7\dot{\mathrm{H}}$.

Clays are mostly derived from the decomposition of feldspathic rocks. Common clay consists ordinarily of about 1 part of alumina to 2 of silica, besides water; and often there are other ingredients present, as carbonate of lime, oxyd of iron, and some magnesian compounds; and when iron is present it burns red. Acids attack the clay but slightly, showing that the water present is not to any great amount in chemical combination forming hydrous silicates of alumina; and thus they differ from the Halloysites and related compounds.

Catlinite of Jackson, (Am. J. Sci. xxxv, 388), is a variety of reddish clay stone, from the Coteau de Prairies, west of the Mississippi; and *Pipestone*, (pfeifenstein) is also a variety of clay slate or argillite. A variety from Northern Oregon, of a grayish color, has been analyzed by Thomson, (Min. i, 287).

Such clays or clay-slates have often been altered through infiltrating waters and heat. Of this nature are *Agalmatolite*, *Dysyntribite* of Shepard, and *Parophite* of Hunt. The alteration they have undergone has been dependent not properly upon a kaolinising process, but on the *action and addition of alkalies*, through the infiltration of solutions containing alkaline silicates or carbonates, which ingredients the decomposition of feldspar produces on a large scale.

Agalmatolite (Figure stone, Bildstein, Pagodite, Lardite, Fun Shih or Powder stone of the Chinese) occurs massive, with a greasy feel and is rather soft. H.=2—3. G.=2·8—2·9. Colors white, greenish, grayish, brownish, sometimes mottled. Found in China, Saxony, at Nagyag, and Schemnitz. B.B. fuses only on the thinnest edges.

Dysyntribite of Shepard, (Am. J. Sci. [2], xii, 209), is massive or slaty and tough, and looks somewhat like serpentine; H.=3—3·5. G.=2·76—2·81. Color mottled, usually greenish, sometimes mottled with red. The composition varies widely, as Smith and Brush have shown. It is from Diana and other places in St. Lawrence Co., Northern New York. B.B. fuses in thin fragments.

Parophite of Hunt, (Logan's Rep. Canada, 1852, 95, Am. J. Sci. [2], xvii, 127), has the same serpentine aspect, and to this its name alludes; it is massive or slaty;

greenish, yellowish, grayish or reddish in color; H.=2·5—3, cutting like massive talc. G.=2·7—2·784. It is identical with some agalmatolite. Mr. Hunt regards it as an altered clay slate. It is from Canada.

Analyses; 1, Vauquelin, (Ann. de Ch. xlix, 88); 2, Klaproth, (Beit. v, 19); 3, Thomson, (Min. i, 343); 4, Karafiat, (Pogg. lxxviii, 575); 5, 6, T. S. Hunt, (loc. cit.); 7, 8, 9, Smith and Brush, (Am. J, Sci. [2], xvi, 50).

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1.	*Agalmatolite,*	56·	29·	1·	2·	—	7·	5·=100, Vauquelin.
2.	"	54·50	34·0	0·75	—	—	6·25	4·=99·50, Klaproth.
3.	"	49·82	29·60	1·50	6·00	—	6·80	5·5=99·21, Thomson.
4.	"	49·50	27·45	$\dot{\mathrm{F}}$e1·03	5·56	0·72	10·20	5·10, $\dot{\mathrm{Mn}}$ *tr.*=99·56, Karafiat.
5,	*Parophite,*	48·50	27·50	" 5·67	1·30	2·24	5·30	7·00, $\dot{\mathrm{Na}}$ 1·91=99·42, Hunt.
6.	"	48·42	27·60	" 4·50	2·80	1·80	5·02	6·88, " 2·78=99·80, Hunt.
7.	*Dysyntribite,*	44·80	34·90	$\dddot{\bar{\mathrm{Fe}}}$3·01	0·66	0·42	6·87	5·38, $\dot{\mathrm{Na}}$ 3·60 $\dot{\mathrm{Mn}}$0·30=99·94, Smith & Brush.
8.	"	46·70	31·01	3·69	*tr.*	0·50	11·68	5·30, " *tr.* =98·88, S. & B.
9.	"	44·94	25·05	3·33	8·44	6·86	5·80	6·15, " *tr.* =100·13, S. & B.

The analyses by Hunt agree rather closely with 3 and 4 by Thomson and Karafiat. Karafiat's agalmatolite is in part the gangue of the Diaspore of Schemnitz; it is slightly greenish and somewhat greasy in lustre. H.=2·5—3. G.=2·735.

Walmstedt and Lychnell have analyzed other so-called Agalmatolites from China which contain no alkali; Walmstedt obtained (Ofv. K. V. Ak. Förh., 1848, 111) Silica 65·96, $\dddot{\bar{\mathrm{Al}}}$ 28·58, $\dddot{\bar{\mathrm{Fe}}}$ 0·09, $\dot{\mathrm{Ca}}$ 0·18, $\dot{\mathrm{H}}$ 5·16=100·12. Some specimens called agalmatolite are steatite.

PETALITE. Castor, *Breit.*

Monoclinic? Massive, with three cleavages in one zone, affording the angles 117°, 142° and 101°; the cleavages inclined at 142°, the most perfect.

H.=6—6·5. G.=2·42, Arfvedson; 2·45, Dr. Clarke; 2·426, C. G. Gmelin. Lustre vitreous and glistening; pearly on the faces of perfect cleavage. Color white or gray, with occasionally a reddish or greenish tinge. Streak white. Translucent. Fracture imperfectly conchoidal.

Composition.—$(\dot{\mathrm{L}}\mathrm{i}, \dot{\mathrm{N}}\mathrm{a})^3\dddot{\mathrm{Si}}^4+4\dddot{\bar{\mathrm{Al}}}\,\dddot{\mathrm{Si}}^4=(\tfrac{1}{5}\dot{\mathrm{R}}^3+\tfrac{4}{5}\dddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}^4$=(if $\dot{\mathrm{N}}\mathrm{a} : \dot{\mathrm{L}}\mathrm{i}=1 : 6$) Silica 77·9, alumina 17·7, lithia 3·1, soda 1·3=100.

Analyses: 1, Arfvedson, (Schw. J. xxii, 93); 2, Gmelin, (Gilb. Ann. lxii, 399); 3, 4, R. Hagen, (Pogg. xlviii, 361); 5, Rammelsberg, (Pogg. lxxxv, 553); 6, Waltershausen, (Vulk. Gest. 296); 7, 8, Smith & Brush, (Am. J. Sci. [2], xvi, 373); 9, Plattner, (Ann. Ch. Pharm. lxix, 443).

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{L}}\mathrm{i}$	$\dot{\mathrm{N}}\mathrm{a}$
1.	Utö,	79·212	17·225	5·761	——=102·198, Arfvedson.
2.	"	74·17	17·41	5·16	$\dot{\mathrm{C}}\mathrm{a}$ 0·32, ign. 2·17=99·23, Gmelin.
3.	"	77·812	17·194	2·692	2·302=100, R. Hagen.
4.	"	77·067	18·000	2·660	2·273=100, "
5.	"	77·79	18·58	3·30	1·19=100, Rammelsberg.
6.	" *reddish,*	76·74	18·66	2·69	——, $\dddot{\bar{\mathrm{Fe}}}$0·08, $\dot{\mathrm{M}}\mathrm{n}$1·0, $\dot{\mathrm{M}}\mathrm{g}$1·0, $\dot{\mathrm{H}}$0·97=99·95, W.
7.	Bolton, Ms.	77·95	16·63	3·74	0·48, $\dddot{\bar{\mathrm{Fe}}}$ 0·62, $\dot{\mathrm{K}}$, $\dot{\mathrm{C}}\mathrm{a}$, *tr.*, $\dot{\mathrm{M}}\mathrm{g}$ 0·21, ign. 0·60=100·23, Smith & Brush.
8.	"	77·90	15·85	3·52	0·53, " 0·51 " *tr.*, $\dot{\mathrm{M}}\mathrm{g}$0·26, ign. 0·70, S. & B.
9.	*Castor,*	78·01	18·86	2·76	(with *tr.* $\dot{\mathrm{K}}$, $\dot{\mathrm{N}}\mathrm{a}$)=100·24, Plattner. G.=2·392.

The protoxyds in Castor are less than in Petalite, according to the analyses: but it is hardly possible that it can be a distinct species. Its cleavages are like those of Petalite, according to Rose.

Gently heated, it emits a blue phosphorescent light. B.B. on charcoal becomes glassy, subtransparent, and white, and melts only the edges; gives the reaction of lithia. With borax, it forms a clear, colorless glass. Not acted on by acids.

Petalite occurs at the iron mine of Utö, accompanying lepidolite, tourmaline, spodumene, and quartz; near York on the north coast of Lake Ontario; at Bolton, Mass., with scapolite; on Elba (Castor) in attached crystals.

Lithia was first discovered in this mineral by Arfvedson. The name *petalite* is from *πεταλον, a leaf.*

ZYGADITE, [fr. *ζυγαδην, in pairs*] Breithaupt, Ann. d. Ph. u. Chem. lxix, 429. Plattner in a qualitative analysis found silica, alumina, and lithia, without water. Form thin tabular rhombic prisms; only seen in twins, and like albite. G.=2·511. Lustre like glass. Color red and yellowish-white. Feebly transparent. Occurs with quartz and stilbite at Andreasberg in the Hartz.

Appendix.

CYCLOPITE, *von Waltershausen.*

Triclinic; in small crystals resembling those of Anorthite and Labradorite.

H.=6. Lustre vitreous. Color white. Transparent.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+2\ddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}=(\frac{1}{3}\dot{\mathrm{R}}^3+\frac{2}{3}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$, or same as for Meionite. Analysis by Waltershausen, (Vulk. Gest., 292):

$\dddot{\mathrm{Si}}$ 41·45, $\ddot{\bar{\mathrm{Al}}}$ 29·83, $\ddot{\bar{\mathrm{Fe}}}$ 2·20, $\dot{\mathrm{Ca}}$ 20·83, $\dot{\mathrm{Mg}}$ 0·66, $\dot{\mathrm{Na}}$ 2·32, $\dot{\mathrm{K}}$ 1·72, $\dot{\mathrm{H}}$ 1·91=100·92.

In dolerite of the Cyclopean Islands near Catania.

SAUSSURITE. Jade tenace, Feldspath tenace, *H.* Lemanit. Magerer Nephrit.

Probably oblique. Cleavage in two directions parallel to the lateral faces of a rhombic prism of 124° nearly. Composition often granular, impalpable; strongly coherent.

H.=5·5—6. G.=3·256, Piedmont; 3·642, Pays de Vaud. Lustre pearly, inclining to vitreous upon the faces of cleavage; also resinous in some specimens, particularly the massive. Color white, passing into greenish-white, mountain-green or ash-gray. Streak white. Fracture uneven, splintery. Subtranslucent. Extremely tough.

Composition.—$(\frac{1}{3}\dot{\mathrm{R}}^3+\frac{2}{3}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}$? Analyses: 1, Klaproth, (Beit. iv, 278); 2, Saussure, (J. d. Mines, xix, 205); 3, 4, Boulanger, (Ann. d. Mines, [3], viii, 159):

		$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\ddot{\bar{\mathrm{Fe}}}$	$\ddot{\bar{\mathrm{Mn}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Mg}}$
1.	Lake Geneva,	49·00	24·00	6·50	—	10·50	5·50	—	3·75=99·25, Klap.
2.	" "	44·00	30·00	12·50	0·05	4·00	6·00	0·25	—=96·80, Saus.
3.	Mt. Genèvre,	44·6	30·4	—	—	15·5	7·5	—	2·5=100·5, Boul.
4.	Corsica,	43·6	32·0	—	—	21·0	—	1·6	2·4=100·6, "

B.B. fuses with great difficulty to a greenish-gray glass. Not acted on by acids.

Saussurite occurs in regions of crystalline rocks, and with hornblende and augite constitutes the rocks called gabbro and euphotide. It was first found on the borders of the lake of Geneva, by Saussure, Senior, whose name it bears. It also occurs at Monte Rosa and its vicinity, in Corsica, in Greenland, at Madras, and elsewhere, as a constituent of the above rocks. This species has been considered an impure Labradorite.

WEISSIGITE, G. Jenzsch, N. Jahrb., 1853, 396.

Monoclinic. Crystals very small and indistinct. Cleavage unequal in two directions, parallel to the vertical axis, and meeting at 118°; also in the direction of a hemidome inclined 106° to the brachydiagonal. Sometimes in twins. Also massive.

H.=6·5. G.=2·538—2·546. Lustre vitreous. Color white to pale rose-red. Streak white.

Composition.—Contains silica, alumina, soda, lithia, and no water, and near petalite. B.B. fuses easily on the edges to a white somewhat blebby enamel and tinges the outer flame weak red and yellow at the point; the red color more distinct, on platinum, but less so than with petalite. With borax a colorless glass; with salt of phosphorus, a silica skeleton.

Occurs in the cavities of a porphyritic amgydaloid, with chalcedony and quartz, near Weissig; also as a pseudomorph after a zeolite.

POLLUX, *Breit.*, *Plattner*, Ann. d. Ch. u. Pharm. lxix, 439, 445.

Massive. Like quartz in appearance; traces of cleavage.

H.=6—6·5. G.=2·880. Colorless and transparent, with a vitreous splendent lustre. Fracture conchoidal. Refraction biaxial.

Composition.—Analysis by Plattner, (loc. cit.):

$\dddot{\mathrm{Si}}$ 46·200, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 16·394, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·862, $\dot{\mathrm{K}}$ 16·506, $\dot{\mathrm{N}}\mathrm{a}$ (and $\dot{\mathrm{L}}\mathrm{i}$ *trace*) 10·470, $\dot{\bar{\mathrm{H}}}$ 2·321=92·753.

The quantity analyzed was too small for a satisfactory result.

B.B. fuses to an enamel-like blebby glass, and tinges the flame orange. Dissolves easily with borax and forms a colorless glass. Glass with salt of phosphorus uncolored when cold. Decomposed completely in the acids.

Associated with castor at the island of Elba.

ISOPYRE, *Turner*. Ed. New Phil. J. iii, 263.

In compact masses, with cleavage.

H.=6—6·5. G.=2·9—3. Lustre vitreous. Streak light greenish-gray. Color grayish or velvet-black, occasionally spotted red, like Heliotrope. Opaque—subtranslucent. Fracture flat conchoidal. Brittle. Acts slightly on the magnetic needle.

Composition.—$(\dot{\mathrm{C}}\mathrm{a}+(\dddot{\bar{\mathrm{A}}}\mathrm{l}, \dddot{\bar{\mathrm{F}}}\mathrm{e}))\dddot{\mathrm{Si}}^2$ or essentially same as for Labradorite. Analysis by Turner, (loc. cit.):

$\dddot{\mathrm{Si}}$ 47·09, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 13·91, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 20·07, $\dot{\mathrm{C}}\mathrm{a}$ 15·43, $\dot{\mathrm{C}}\mathrm{u}$ 1·94=98·44.

Part of the iron is supposed to be protoxyd, judging from the color of the mineral.

B.B. fuses easily to a magnetic bead. On platinum colors the flame green. A silica skeleton, with salt of phosphorus. With the acids decomposed with difficulty and imperfectly.

From St. Just, near Penzance, in a quartzose granite with tourmaline and tin ore, in pieces two inches in diameter. Also in breccia, on the Calton Hill, Edinburgh, with limonite.

SILICATE OF YTTRIA, Damour, L'Institut, 1853, 78.

H.=5—6; scratches glass. G.=4·391. Color brown. Probably a silicate of yttria. B.B. whitens, but infusible. Not soluble in salt of phosphorus. Sulphuric acid heated to 300°C decomposes it, leaving a siliceous residue.

From the Diamond sands of Bahia, Brazil.

POLYCHROILITE, P. C. Weibye.

Hexagonal? In 6-sided prisms of about 120°, with flat summits. Also massive, and reniform.

H.=3—3·5. Lustre greasy. Color blue, green, brown, red, rarely white. Fracture splintery—subconchoidal to even.

Analysis by Dahl, (v. Leonh. 1846, 288). $\dddot{\mathrm{Si}}$ 52, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 37, $\dot{\mathrm{M}}\mathrm{g}$ 7, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 3, $\dot{\mathrm{C}}\mathrm{a}$, $\dot{\bar{\mathrm{H}}}$; Scheerer found less alumina and 6 per cent. of water.

Found in gneiss at Krageröe, Norway.

VII. ANDALUSITE SECTION.

Oxygen of the bases exceeding in amount that of the silica.

1. GEHLENITE GROUP.—Dimetric.

Gehlenite,	$(\frac{1}{4}\dot{R}^3+\frac{3}{4}\dddot{\bar{R}})\dddot{Si}^{\frac{2}{3}}$.

2. ANDALUSITE GROUP.—Trimetric.

Andalusite,	$\dddot{\bar{Al}}\,\dddot{Si}^{\frac{2}{3}}$; also $\dddot{Si}^{\frac{3}{4}}$.
Topaz,	$\dddot{\bar{Al}}\,\dddot{Si}^{\frac{2}{3}}$ (F in place of some O).
Staurotide,	$(\dddot{\bar{Al}}, \dddot{\bar{Fe}})\dddot{Si}^{\frac{1}{2}}$.
? Lievrite,	$(\frac{3}{5}\dot{R}^3+\frac{2}{5}\dddot{\bar{R}})\dddot{Si}^{\frac{4}{5}}$.

3. KYANITE GROUP.—Triclinic.

Kyanite,	$\dddot{\bar{Al}}\,\dddot{Si}^{\frac{2}{3}}$.
Sillimanite,	$\dddot{\bar{Al}}\,\dddot{Si}^{\frac{2}{3}}$; also $\dddot{Si}^{\frac{3}{4}}, \dddot{Si}^{\frac{5}{6}}, \dddot{Si}$?

4. EUCLASE GROUP.—Monoclinic.

Euclase,	$(\dddot{\bar{Be}}, \dddot{\bar{Al}})\dddot{Si}^{\frac{3}{4}}$.
Sphene,	$(\dot{Ca}+\ddot{Ti})\dddot{Si}^{\frac{2}{3}}=\dddot{\bar{R}}\,\dddot{Si}^{\frac{2}{3}}$.

5. TOURMALINE GROUP.—Hexagonal.

Tourmaline,	$(\dot{R}^3, \dddot{\bar{R}}, \dddot{B})\dddot{Si}^{\frac{3}{4}}$.

[Euclase and sphene are homœomorphous, and probably dimorphous with Tourmaline. (See Am. J. Sci., [2], xvi, 96, xvii, 216). Through andalusite, kyanite and sphene, the compound $\dddot{\bar{R}}\,\dddot{Si}^{\frac{2}{3}}$ is trimorphous; and including gehlenite, it is tetramorphous. Datholite, although hydrous, is related to sphene and euclase both in form and formula.]

GEHLENITE, *Fuchs.* Stylobite.

Dimetric. Usual in short square prisms, sometimes tabular. Cleavage: basal, imperfect; lateral in traces.

H.=5·5—6. G.=2·9—3·067. Lustre resinous, inclining to vitreous. Color different shades of grayish green to liver-brown; none bright. Faintly subtranslucent—opaque. Fracture uneven—splintery. Streak white—grayish-white.

Composition.—$3\dot{R}^3\dddot{Si}+\ddot{\bar{R}}^3\dddot{Si}=(\frac{3}{4}\dot{R}^3+\frac{1}{4}\ddot{\bar{R}})\dddot{Si}^{\frac{2}{3}}$=(if $\ddot{\bar{A}}l : \ddot{\bar{F}}e=5 : 1$) Silica 30·8, alumina 19·6, peroxyd of iron 6·8, lime 42·8. Analyses: 1, Fuchs, (Schw. xv, 277); 2, Thomson, (Min. i, 281); 3, Kobell, (Kastn. Archiv. iv, 313); 4, Damour, (Ann. Ch. Phys. [3], x, 66); 5, 6, Kühn, (Ann. Ch. u. Pharm. lix, 371); 7, Rammelsberg, (3d Supp. 47):

	$\dddot{Si}$	$\ddot{\bar{A}}l$	$\ddot{\bar{F}}e$	$\dot{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$
1. Fassa,	29·64	24·80	6·56		35·30	—	3·30=99·60, Fuchs.
2. "	29·13	25·05	—	4·35	37·38	—	4·54=100·45, Thomson.
3. "	31·0	21·4	—	4·4	37·4	3·4	2·0=99·6. Kobell.
4. "	31·60	19·80	5·97		38·11	2·20	1·53, $\dot{N}a$ 0·33=99·54, Damour.
5. "	30·47	17·79	7·30	—	36·97	2·99	3·62=99·14, Kühn.
6. "	29·53	19·00	—	7·25	36·55	1·41	5·55=99·28. "
7. "	29·78	22·02	3·22	1·73	37·90	3·88	$\dot{H}$ & loss 1·28, $\dot{M}n$ 0·19=100, R.

Rammelsberg has cleared up the discrepancies in the analyses, by discovering that the mineral contains both *peroxyd* and *protoxyd* of iron.

B.B. thin splinters fuse with difficulty to a gray glass. With borax fuses slowly to a vitreous globule colored by iron. Gelatinizes with muriatic acid.

Gehlenite is found mostly at Mount Monzoni, in the Fassa Valley, in isolated or aggregated crystals, invested by calcareous spar. Named by Fuchs after his colleague, Gehlen.

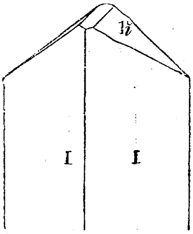
In the first of the above formulas, (the one usually adopted), the protoxyd and peroxyd silicates have the widely unlike ratios 1 : 1 and 3 : 1, the latter very improbable in any case. The second formula is not thus objectionable.

Altered Forms.—Gehlenite occurs altered to Steatite.

ANDALUSITE. Feldspath Apyre, *H.* Macle, *H.* Chiastolite. Hohlspath. Crucite. Stanzait.

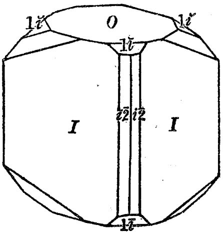
Trimetric. *I* : *I*=90° 44′, *O* : 1ī=144° 33′; *a* : *b* : *c*=0·712 : 1 : 1·013. *O* : *I*=90° 0′, *O* : 1ĭ=144° 55′, $\bar{i}_2 : \bar{i}_2$=127° 28′. Cleavage: *I* distinct. Also massive, indistinctly columnar and granular.

430



Westford, Mass.

431



H.=7·5. G.=3·1—3·2. Lustre vitreous, often weak. Color flesh-red, pearl-gray; sometimes showing trichroism, green in one direction, and hyacinth-red in another transverse. Streak white. Subtranslucent—nearly opaque. Fracture uneven. Tough.

The variety chiastolite varies in hardness from 3 to 7·5, owing to impurities, which are arranged in part symmetrically about the edges and axis, so as to give a tesselated appearance, as shown in the following figures, from a memoir by Dr. C. T. Jackson, (Jour. Bost. Soc. Nat. Hist. i, 55). Figs. *a* and *b* are from opposite extremities of the same crystal; so also *c* and *d*, and *e* and *f*. *h* appears to be a twin crystal.

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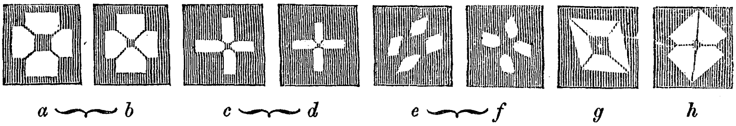


Composition.—$\dddot{\bar{\mathrm{A}}}\mathrm{l}\,\dddot{\mathrm{Si}}^{\frac{2}{3}}$=Silica 37·0, alumina 63·0. Perhaps in part $\dddot{\bar{\mathrm{A}}}\mathrm{l}\,\dddot{\mathrm{Si}}^{\frac{3}{4}}$=Silica 40·3, alumina 59·7. Analyses: 1, Bucholz, (v. Moll's Ephemer. iv, 190); 2, Thomson, (Min. i, 332); 3, Kersten, (J. f. pr. Chem. xxxvii, 162); 4, Svanberg, (Jahresb. xxiii, 279); 5, Bunsen, (Pogg. xlvii, 186); 6, A. Erdmann, (Jahresb. xxiv, 311); 7, Bunsen, 8, Jackson, (Bost. J. Nat. Hist. i, 55); 9, Renou, (Expl. Sci. de l'Algerie, Paris, 1848, 58); 10, Hubert, (Jahrb. k. k. g. Reichs. i, 350):

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$
1.	Herzogau,	36·5	60·5	4·0=101·0, Bucholz.
2.	Tyrol,	35·30	60·20	——, $\dot{\mathrm{F}}\mathrm{e}$ 1·32, $\dot{\mathrm{M}}\mathrm{g}$ 1·0, $\dot{\mathrm{H}}$ 2·03=99·86, Thomson.
3.	Munzig,	37·51	60·01	1·49, $\dot{\mathrm{C}}\mathrm{a}$ 0·48, $\dot{\mathrm{M}}\mathrm{g}$ 0·46=99·95, Kersten. G.=3·152.
4.	Fahlun,	37·65	59·87	1·87, $\dot{\mathrm{C}}\mathrm{a}$ 0·58, $\dot{\mathrm{M}}\mathrm{g}$ 0·38=100·35, Svanberg.
5.	Lysens, Tyrol	40·17	58·62	——, $\dddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·51, $\dot{\mathrm{C}}\mathrm{a}$ 0·28=99·58, Bunsen.
6.	" "	39·99	58·60	0·72, $\dddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·83=100·14, Erdm. G.=3·154.
7.	*Chiast.* Lanc.	39·09	58·56	——, $\dddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·53, $\dot{\mathrm{C}}\mathrm{a}$ 0·21, ign. 0·99=99·38, Bunsen.
8.	" "	33·0	61·0	4·0, $\dot{\mathrm{H}}$ 1·5=99·5, Jackson.
9.	" Algeria,	36·6	61·9	——, 98·5, Renou; *I* : *I*=93° 30′. G.=3·1.
10.	*Andal.* Tyrol,	39·24	59·49	0·63, $\dot{\mathrm{M}}\mathrm{g}$ 0·25, $\dot{\mathrm{C}}\mathrm{a}$ 0·51=100·12, Hubert.

B.B. alone infusible. When pulverized and mixed with borax, it fuses with extreme difficulty to a transparent colorless glass. With soda it swells up without melting.

Andalusite occurs in crystalline schists, especially mica and clay slate. It was first observed in the province of Andalusia, in Spain. Occurs in the Lisens valley, in the Tyrol, in large crystallizations; at Bräunsdorf and Penig in Saxony; Goldenstein, in Moravia; in Bavaria; in Siberia; at Killiney Bay, Ireland, in mica slate; and near Balahulish, Argyleshire. Chiastolite at Jago di Compostella in Spain, Barèges in the Pyrenees, Bayreuth, and Cumberland in England.

At Westford, Mass., abundant both crystalline and massive, sometimes rose-colored. Litchfield and Washington, Conn., fine crystals; also Mt. Abraham, Bangor, and Searsmont, Me. In Pennsylvania, near Leiperville, in large crystals; also at Marple; at lake St. Francis, Canada East, in flesh-red translucent crystals in a mica schist of Silurian age, the larger crystals sometimes chiastolite. Chiastolite is abundant in the towns of Lancaster and Sterling, Mass.; and at the former place occasionally in quartz, presenting all the essential characters of andalusite, (anal. 7, 8). Andalusite occurs also near Bellows Falls, Vermont; at the White Mountain Notch, N. H.; at Camden in Maine, and Charleston, N. H.

ALTERED FORMS.—Andalusite occurs altered to Kyanite. Hubert's analysis above, was of the interior of an Andalusite crystal, the exterior of which was changed in structure to Kyanite. The exterior afforded $\dddot{\mathrm{Si}}$ 36·67, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 60·00, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 1·33, $\dot{\mathrm{C}}\mathrm{a}$ 0·93=98·93. The analysis of the Andalusite affords the second formula above, while that of the Kyanite affords the first, which is that of all Kyanite. It is also found changed to talc, steatite and mica.

TOPAZ. Fluosilicate of Alumina, *Thom.* Physalite, Pyrophysalite, *Hisinger.* Pycnite. Schorlartiger Beril, *W.* Stangenstein. Alumine Fluatée Siliceuse, *H.*

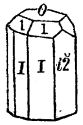
Trimetric. $I : I = 124° \; 19' : O : 1\bar{i} = 138° \; 3'$; $a : b : c = 0{\cdot}8987 : 1 : 1{\cdot}8932$.

$O : \frac{2}{3}\bar{i} = 149° \; 5'$.
$O : \frac{3}{4}\bar{i}$ (unobs.) $= 145° \; 59'$.
$O : 2\bar{i} = 119° \; 5'$.
$O : \frac{1}{2} = 153° \; 4'$.
$O : \frac{2}{3} = 145° \; 53'$.
$O : 1 = 134° \; 32'$.
$O : 2 = 116° \; 12'$.
$O : \frac{4}{3}\breve{2} = 128° \; 56'$.
$O : \frac{6}{5}\breve{3} = 146° \; 3'$.
$O : \frac{3}{2}\breve{i}$ (unobs.) $= 144° \; 34'$.
$O : \frac{8}{3}\breve{4} = 125° \; 33'$.
$O : \frac{4}{3}\breve{i} = 147° \; 41'$.
$O : 2\breve{i} = 136° \; 29'$.
$O : 4\breve{i} = 117° \; 47'$.
$i\breve{2} : i\breve{2}$ (adj.) $= 93° \; 8'$.
$I : i\breve{2} = 161° \; 16\frac{1}{2}'$.
$I : i\breve{\tfrac{3}{2}} = 169° \; 27\frac{1}{2}'$.
$I : i\breve{3} = 150° \; 6\frac{1}{2}'$.
$1 : 1$ (mac.) $= 141° \; 7'$.
$\frac{2}{3} : \frac{2}{3}$ " $= 149° \; 38'$.
$\frac{1}{2} : \frac{1}{2}$ " $= 155° \; 37'$.
$2 : 2$ " $= 130 \; 27'$.

O						
	$\frac{1}{2}$					
$\frac{2}{3}\bar{i}$	$\frac{2}{3}$					
	1					
				$\frac{6}{5}\breve{3}$		
			$\frac{4}{3}\breve{2}$			$\frac{4}{3}\breve{i}$
$\frac{3}{2}\bar{i}$	$\frac{3}{2}$		$\frac{3}{2}\breve{2}$			
$2\bar{i}$	2					$2\breve{i}$
					$\frac{8}{3}\breve{4}$	
			$4\breve{2}$			$4\breve{i}$
						$8\breve{i}$
	I	$i\breve{\tfrac{3}{2}}$	$i\breve{2}$	$i\breve{3}$	$i\breve{4}$	$i\breve{i}$

Observed planes.

433



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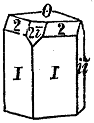

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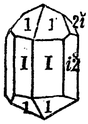

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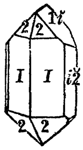

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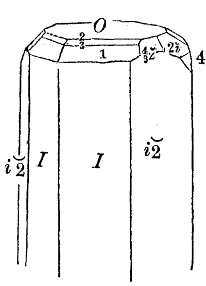

Schneckenstein.

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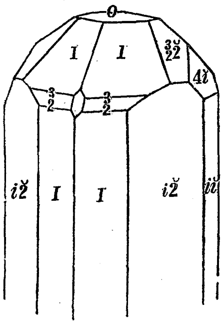

Trumbull, Ct.

Crystals usually hemihedral, the extremities being unlike. Cleavage: basal, highly perfect. Also granular—coarse or fine.

H.=8. G.=3·4—3·65. Lustre vitreous. Color yellow, white, green, blue; pale. Streak uncolored. Transparent—subtranslucent. Fracture subconchoidal, uneven. Pyroelectric.

Composition.—$\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}^{\frac{2}{3}}$ with one-seventh of the oxygen replaced by fluorine, Rammelsberg.

Analyses: 1—3, Berzelius, (Schweig J. xvi, 423, Afhand. iv, 236); 4, 5, Forchhammer, (J. f. pr. Ch. xxix, 195, xxx, 400); 6, Berzelius, (Schw. J. xvi); 7, Bucholz, (ib. i, 385); 8, Forchhammer, (J. f. pr. Chem. xxix, xxx):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	F
1. Auerbach, Saxony,	34·24	57·45	14·99, Berzelius.
2. Brazil, *yellow*,	34·01	58·38	15·06, "
3. Finbo, *pyrophysalite*,	34·36	57·74	15·02, "
4. Monroe, Ct.,	35·39	55·96	17·35, Forchhammer.
5. Finbo, *pyrophysalite*,	35·66	55·16	17·79, "
6. *Pycnite*, Altenberg,	38·43	51·00	17·09, Berzelius.
7. " "	35·0	48·0	16·5, $\dot{\mathrm{C}}\mathrm{a}$ 0·5, Bucholz.
8. " "	39·04	51·25	18·48, Forchhammer.

B.B. infusible alone on charcoal, but when strongly heated becomes covered with small blisters, which crack as soon as formed. Some varieties take a wine-yellow or pink tinge when heated. With borax forms slowly a diaphanous glass.

Pycnite is a massive subcolumnar variety; G. Rose has observed the prism 93° 15′—93° 20′, proving its identity with topaz. The formula $\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}$ with one-seventh of the oxygen replaced by fluorine, is proposed by Rammelsberg.

Physalite or *pyrophysalite* of Hisinger is a coarse, nearly opaque variety, found in yellowish-white crystals of considerable dimensions; it intumesces when heated, and hence its name from φυσαω, to blow. Minute crystals of three or four different kinds, and two or three kinds of fluids have been detected by Sir David Brewster in crystals of topaz.

Topaz occurs in gneiss or granite, with tourmaline, mica, and beryl, occasionally with apatite, fluor spar, and tin; also in talcose rock, as in Brazil, with euclase, &c., or in mica slate. With quartz, tourmaline, and lithomarge, it forms the topaz rock of Werner. Specimens of quartz crystal from Brazil, penetrated by topaz, are not uncommon.

Fine topazes come from the Urals and Altai mountains, Miask in Siberia, and from Kamschatka, of green and blue colors; Villa Rica in Brazil of deep yellow color, either in veins or nests in lithomarge, or in loose crystals or pebbles; sky-blue crystals in Cairngorm, Aberdeenshire; Jameson mentions one which weighed 19 oz.; the tin mines of Schlackenwald, Zinnwald, and Ehrenfriedersdorf, smaller crystals also at Schneckenstein and Altenberg; the Mourne mountains, small limpid crystals with beryl, albite, and mica, in drusy cavities in granite. Physalite occurs in crystals of great size, at Fossum, Norway; Finbo, Sweden, in a granite quarry, and at Broddbo in a boulder; one crystal from this last locality, at Stockholm, weighed eighty pounds.

Pycnite is from Altenberg, Schlackenwald, Zinnwald, and Kongsberg.

Topaz occurs in the United States at Trumbull, with fluor and diaspore, at Middletown, Conn., and Crowder's Mountain, N. C. At Trumbull the crystals are abundant, but are seldom transparent, except those of small size; these are usually white, or with a tinge of green or yellow. The large coarse crystals are sometimes six or seven inches in diameter.

A variety of topaz from Brazil, when heated, assumes a pink or red hue, resembling the Balas ruby. The finest crystals are brought from Minas Novas in Brazil. From their peculiar limpidity, topaz pebbles are sometimes denominated *gouttes d'eau.* The coarse varieties of topaz may be employed as a substitute for emery. The name topaz, is from τοπαξιος, an island in the Red Sea.

ALTERED FORMS.—Topaz is found altered both to Steatite and Kaolin or Lithomarge. It is possible that pycnite has lost part of its alumina by a process of change, and hence the excess of silica.

STAUROTIDE, *Haüy.* Staurolite. Grenatite. Staurolith, *W.*

Trimetric. $I:I$=129° 20′, $O:1\bar{i}$=124° 38′; $a:b:c$=1·4478 : 1 : 2·11233. $O:\frac{3}{2}\breve{i}$ (plane of composition, f. 440)=134° 12′; $O\ \frac{3}{2}\breve{\frac{3}{2}}$ (plane of composition, f. 441)=119° 23′, $I:\breve{i}\breve{i}$=115° 20′. Cleavage: $\breve{i}\breve{i}$ distinct, but interrupted; I in traces. Crystals thick, often cruciform, surface often rough. Massive varieties have not been observed.

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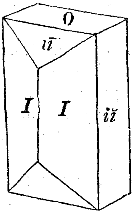

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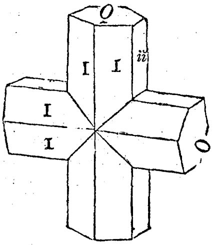

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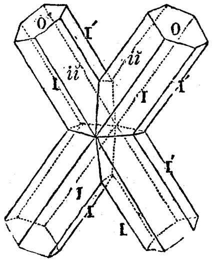

H.=7—7·5. G.=3·5—3·75. Subvitreous, inclining to resinous. Color dark reddish-brown—brownish-black. Streak uncolored, grayish. Translucent—nearly or quite opaque. Fracture conchoidal.

Composition.—$(\ddot{\bar{\mathrm{Al}}}, \ddot{\bar{\mathrm{Fe}}})\dddot{\mathrm{Si}}^{\frac{1}{2}}$=(if $\ddot{\bar{\mathrm{Al}}}:\ddot{\bar{\mathrm{Fe}}}$=2 : 1) Silica 29·3, alumina 53·5, peroxyd of iron 17·2. But the crystals from Airolo in St. Gothard and Polewskoi in the Ural and Brittany, if correctly analyzed, are irreconcilable with this formula; the first affording $\ddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}^{\frac{2}{3}}$, and the second $\ddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}^{\frac{4}{5}}$.

Analyses: 1–4, Jacobson, (Pogg. lxii, 419); 5, Marignac, (Ann. Ch. Phys. [3], xiv, 49); 6–11, Jacobson, (Pogg. lxviii, 414):

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\ddot{\bar{\mathrm{Fe}}}$	$\ddot{\bar{\mathrm{Mn}}}$	$\dot{\mathrm{Mg}}$	
1. St. Gothard,	30·31	46·80	18·08	—	2·16 $\dot{\mathrm{C}}$a 0·13=97·48, Jac.	G.=3797 in pieces, 3·744 pulveriz.
2. “	30·91	48·68	15·37	—	1·33, $\dot{\mathrm{M}}$n1·19=97·48, Jac.	
3. “	29·72	54·72	15·69	—	1·85=101·98, Jac.	
4. “	29·13	52·01	17·58	—	1·28=100, Jac.	
5. “	28·47	53·34	17·41	0·31	0·72=100·25, Marig.	
6. Airolo,	33·45	47·23	16·51	—	1·99=99·18, Jac. G.=3·66—3·73.	
7. “	32·99	47·92	16·65	—	1·66=99·22, Jac.	
8. Brittany,	39·19	44·87	15·09	—	0·32, $\dot{\mathrm{M}}$n 0·37=99·64, Jac. G.=3·528.	
9. “	40·35	44·22	15·77	—	—, $\dot{\mathrm{M}}$n 0·10=100·44, Jac.	
10. Polewskoi, Ural	38·68	47·43	15·06	—	2·44=103·61, Jac. G.=3·549—3·588.	
11. “ “	38·33	45·97	14·60	—	2·47=101·37, Jac. “ “	

B.B. alone darkens, but infusible; with borax forms with difficulty a dark green glass.

Occurs imbedded in mica slate and gneiss, at St. Gothard, in Switzerland; at the Greiner mountain, Tyrol, in simple crystals associated with kyanite and sometimes appearing as a continuation of its crystals, parallel with them. Angle of prism in a crystal from Cheronice, Switzerland, according to Kengott 128° 42′. Large twin crystals occur in Brittany; also at Oporto and St. Jago de Compostella, &c.

Staurotide is very abundant throughout the mica slate of New England. At Franconia, Vt., large brownish-red opaque crystals, often compound; also brownish black. At Windham, Me., near the bridge, the mica slate is filled with large crystals; also at Mt. Abraham, Hartwell, and Winthrop, Me. In New Hampshire, at Lisbon, abundant in mica slate, and on the shores of Mink Pond, loose in the soil; at Grantham, two miles from Meriden, of a gray color. In Vermont, at Cabot. At Chesterfield, Mass., in fine crystals; also at Bolton, Vernon, Stafford, and Tolland, Conn. Small crystals at the Foss ore bed in Dover, Duchess Co., N. Y.; also three and a half miles from New York city, on the Hudson,. Reddish-brown crystals abundant on the Wissahiccon, eight miles from Philadelphia.

If we make I the plane $i\breve{\tfrac{3}{2}}$, then the faces of composition have simple expressions, being $1\breve{i}$ and 1; $I : I = 109° 14'$, $O : 1\bar{i} = 124° 38'$, $O : 1\breve{i} = 134° 12'$. The only difference between this form and the above is that the longer lateral axis is one third shorter. If we halve *a* and *c* the axes are nearly identical with those of andalusite.

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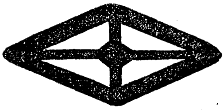

Dr. C. T. Jackson has described a variety of staurotide in tesselated crystals like chiastolite, from Charlestown, N. H., as represented in the accompanying figure. He states that the staurotide macles pass by insensible shades into andalusite macles, where the mica slate passes into argillaceous slate.

Staurotide and Staurolite are derived from σταυρος, *a cross.*

Altered Forms.—Staurotide crystals occur altered to steatite.

LIEVRITE, *W.* Yenit. Ilvait.

Trimetric. $I : I = 111° 12'$, $O : 1\bar{i} = 146° 20'$; $a : b : c : = 0{\cdot}6643 : 1 : 1{\cdot}46$.
$O : 3\bar{i} = 116° 35'$. $O : 2\breve{i} = 137° 37'$. $1\bar{i} : 1\bar{i} = 112° 40'$.
$O : 1 = 141° 5'$. $1 : 1$ (mac.) $= 138° 26'$. $i\breve{2} : i\breve{2}$ (brach.) $= 107° 44'$.
$O : \tfrac{1}{2}\breve{i} = 167° 9'$, $1 : 1$ (brach.) $= 117° 34'$. $I : i\breve{2} = 160° 32'$.

Lateral faces usually striated longitudinally. Cleavage: parallel to the longer diagonal, indistinct. Also columnar or compact massive.

O						
						$\tfrac{1}{2}\breve{i}$
$1\bar{i}$		1				
	$2\bar{2}$					$2\breve{i}$
$3\bar{i}$						
$i\bar{i}$	$i\bar{2}$	I	$i\breve{2}$	$i\breve{3}$	$i\breve{4}$	ii

Observed Planes.

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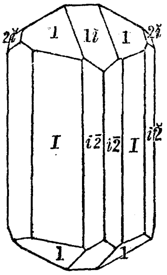

H. = 5·5—6. G. = 3·8—4·2; 3·994, Haidinger; 3·9796, Stromeyer; 3·825—4·061, Lelievre. Lustre submetallic. Streak black, inclining to green or brown. Color iron-black, or dark grayish-black. Opaque. Fracture uneven. Brittle.

Composition.—$3(\mathrm{Fe}, \dot{\mathrm{C}}\mathrm{a})^3\dddot{\mathrm{S}}\mathrm{i}+\ddot{\bar{\mathrm{F}}}\mathrm{e}^2\dddot{\mathrm{S}}\mathrm{i}=(\frac{3}{5}\dot{\mathrm{R}}^3+\frac{2}{5}\ddot{\bar{\mathrm{R}}})\dddot{\mathrm{S}}\mathrm{i}^{\frac{4}{5}}$=(if $\dot{\mathrm{F}}\mathrm{e} : \dot{\mathrm{C}}\mathrm{a}=3 : 1$) Silica 28·2, peroxyd of iron 25·0, protoxyd of iron 33·7, lime 13·1. Analyses: 1, Stromeyer, (Unters. 372); 2, same corrected by Kobell, (Schw. J. lxii, 166); 3, Rammelsberg, (Pogg. l, 157, 340):

	$\dddot{\mathrm{S}}\mathrm{i}$	$\ddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	$\ddot{\bar{\mathrm{M}}}\mathrm{n}$	$\dot{\mathrm{H}}$
1. Elba,	29·28	——	52·54	13·78	0·61	1·59	1·27=99·07, Stromeyer.
2. "	29·28	23·00	31·90	13·78	0·61	1·59	1·27=101·43, Kobell.
3. "	27·83	[24·58]	[30·73]	12·44	——	$\dot{\mathrm{M}}\mathrm{n}$ 1·51	——, Rammelsberg.

In two other trials Rammelsberg found $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 22·80, 21·29, and $\dot{\mathrm{F}}\mathrm{e}$ 33·07, 34·20. B.B. on charcoal fuses easily to a black globule, vitreous in the external flame; in the interior flame dull, and provided the globule has not been heated to redness, attractable by the magnet. With borax and carbonate of soda, it fuses to an iron glass. It is soluble in muriatic acid, forming a jelly.

The mineral was first discovered on the Rio la Marina, on Elba, by M. Lelievre, in 1802, where it occurs in large solitary crystals, and aggregated crystallizations in compact augite. Also found at Fossum in Norway, in Siberia, near Andreasberg in the Hartz; near Predazzo, Tyrol, in granite; at Schneeberg in Saxony, at Skeen, in Norway.

At Cumberland, R. I., slender black or brownish-black crystals traverse quartz, associated with magnetic iron and hornblende; also at Milk Row quarry, Somerville, Mass.

Named *Lievrite* after its discoverer; *Ilvaite* from the name of the island (Elba) on which it was found; *Yenite* or Jenite, by the French in commemoration of the battle of Jena, in 1806.

A boulder from near Bytown, Canada, analyzed by T. S. Hunt, gave (Logan's Rep., 1853) $\dddot{\mathrm{S}}\mathrm{i}$ 27·80—28·20, $\dot{\mathrm{F}}\mathrm{e}$ 56·52, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 10·80, $\dot{\mathrm{C}}\mathrm{a}$ 0·64, $\dot{\mathrm{M}}\mathrm{g}$ 2·59, ign. 1·20=99·55; near Lievrite. It is black, submetallic and magnetic, with two oblique cleavages. H.=5·5. G.=4·15–·4·16. In powder gelatinizes with acids. Possibly a furnace slag?

Wehrlite of Kobell is probably Lievrite. It is massive granular. H.=6—6·5. G.=3·90. Analysis by Wehrle, $\dddot{\mathrm{S}}\mathrm{i}$ 34·60, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 42·38, $\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·28, $\ddot{\bar{\mathrm{A}}}\mathrm{l}$ 0·12, $\dot{\mathrm{F}}\mathrm{e}$ 15·78, $\dot{\mathrm{C}}\mathrm{a}$ 5·84, $\dot{\mathrm{H}}$ 1·00=100. B.B. fuses with difficulty on the edges. Imperfectly soluble in muriatic acid. From Szurraskö, Hungary.

If $\overset{\smile}{i\tfrac{3}{2}}$ be taken as I in Lievrite, the form approaches that of Andalusite, affording $I : I$=91° 32′, $O : 1\bar{\imath}$=145° 37′, $O : 1\breve{\imath}$=146° 20′, $1\breve{\imath} : 1\breve{\imath}$=112° 40′, $1\bar{\imath} : 1\bar{\imath}$=111° 14′.

KYANITE. Cyanite. Disthene, *H.* Sappare. Rhœtizite. Monrolite, *Silliman.*

Triclinic. Observed planes a triclinic prism (O, $i\bar{\imath}$, $i\breve{\imath}$), with one plane (I') on the acute lateral edge and two (I and $i\bar{2}$) on the obtuse lateral edge. Crystals usually bladed.

$O : i\breve{\imath}$=93° 15′. $O : I'$=96° 42′. $i\bar{\imath} : I$=145° 41′.
$O : i\bar{\imath}$=100° 50′. $i\bar{\imath} : i\breve{\imath}$=106° 16′. $i\bar{\imath} : I'$=131° 23′.
$O : I$=98° 58′. $I : I'$=97° 4′. $i\bar{\imath} : i\bar{2}$=159° 15′.

Cleavage: perfect parallel with the smoother lateral plane; basal imperfect. Twins: of two kinds, with face of composition $i\bar{\imath}$, and planes $i\breve{\imath}$ meeting at an angle; in one kind the planes O coincident, in the other forming a reëntering angle. Also coarse bladed columnar; also subfibrous.

H.=6—7·25. G.=3·559, white kyanite; 3·675, blue transparent; 3·661, Tyrol, Erdmann. Lustre vitreous—pearly. Color blue, white, blue with white margins; also gray, green, black. Streak uncolored. Translucent—transparent.

Kyanite is generally in bladed crystallizations, though occasionally in short prisms; and these prisms or blades are bounded by the planes *iī* and *iĭ*, with cleavage parallel to the larger face. The prevalent color is pale blue, which is often deeper along the middle of the prisms. The crystals may often be easily scratched on the lateral surface while they are very hard on the extremities.

Composition.—$\ddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}^{\frac{2}{3}}$=Silica 37·0, alumina 63·0.

Analyses: 1–3, Arfvedson, (K. V. Ac. H. 1821, i, 148, and Schw. J. xxxiv, 203); 4, Rosales, (Pogg. lviii, 160); 5, Marignac, (Ann. Ch. Phys. xiv, 49); 6, 7, A. Erdmann, (Jahresb. xxiv, 311); 8, Jacobson, (Pogg. lxviii, 416); 9, 10, 11, Smith and Brush, (Am. J. Sci. [2], xvi, 49, 371):

		$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\ddot{\bar{\mathrm{Fe}}}$	
1.	Röraas, Norway,	36·4	63·8	——	=100·2, Arfvedson.
2.	St. Gothard,	34·33	64·89	——	=99·22, “
3.	“	36·9	64·7	——	=101·6, “
4.	“	36·67	63·11	1·19	=100·97, Rosales.
5.	“	36·60	62·66	0·84	=100·60, Marignac. G.=3·6.
6.	Röraas,	34·40	61·86	0·52,	$\dot{\mathrm{Cu}}$ 0·19=96·97, Erd. G.=3·124.
7.	Tyrol,	37·36	62·09	0·71	=100·16, Erd. G.=3·661.
8.	Greiner, Tyrol,	37·30	62·60	1·08	=100·98, Jacobson. G.=3·678.
9.	Monroe, N. Y.,	37·20	59·02	2·08,	ign. 1·03=99·33, Smith and Brush.
10.	“	37·03	61·90		“ 0·85=99·78, “ “
11.	Lincoln Co., N.C.,	37·60	60·40	1·60	“ ——=99·60, “ “

B.B. unaltered. With borax slowly fuses to a transparent colorless glass. With cobalt solution, a dark blue.

This species occurs principally in gneiss and mica slate. Transparent crystals occur at St. Gothard in Switzerland; at Greiner and Pfitsch (Rhœtizite or white variety) in the Tyrol; also in Styria, Carinthia, Bohemia; at Pontivy, France; Villa Rica, South America.

In Massachusetts, at Chesterfield, it occurs with garnet in mica slate; Worthington and Blanford in good specimens. In Connecticut, at Litchfield and Washington in large rolled masses with corundum and massive apatite; at Oxford, near Humphreysville, in mica slate. In Vermont, at Thetford and Salisbury; in New York at Monroe, Orange Co., (Monrolite). In Pennsylvania, in fine specimens near Philadelphia, on the Schuylkill road near the Darby bridge; near the Schuylkill on the Ridge road, back of Robin Hood Tavern; at Leiperville; at East and West Branford and Darby, Chester Co.; at Morris's Ferry, Delaware Co. In Maryland eighteen miles north of Baltimore, at Scott's mill; in Delaware, near Wilmington. In Virginia at Willis's Mt., Buckingham Co., and two miles north of Chancellorville, Spotsylvania Co. In North Carolina, on the road to Cooper's gap in Rutherford Co., near Crowder's Mtn. In short crystals at Bellows Falls, Vt., in gneiss, at Westfield, and Lancaster, Mass., and at Jaffrey on the Monadnock Mt., N. H. A black variety associated with rutile occurs in North Carolina.

Kyanite, when blue and transparent, and in sufficiently large pieces, is employed as a gem, and somewhat resembles sapphire. The name is from κυανος, *blue.* The name *sappare* arose from a mistake by Saussure in reading a label of this mineral on which it was called sapphire. Disthene is from δις, *twice*, or of two kinds, and σθενος, *strong*, alluding to its unequal hardness and electric properties in two different directions.

Bamlite, Erdmann, (J. f. pr. Ch. xxxi, 165), from Bamle, Norway, has the structure and appearance of some Kyanite, occurring in columnar somewhat plumose forms, silky in lustre, with one perfect cleavage. H.=5—7. G.=2·984. Greenish-white or bluish green. The analysis by Erdmann (loc. cit.) gave $\dddot{\mathrm{Si}}$ 56·90, $\ddot{\bar{\mathrm{Al}}}$ 40·73, $\ddot{\bar{\mathrm{Fe}}}$ 1·04, $\dot{\mathrm{Ca}}$ 1·04, F *trace*=99·71. There is an excess of silica. But according to recent observations by Mr. L. Sæmann, there are minute prisms of quartz among the fibres of the Bamlite, which fully account for this excess.

Xenolite of Nordenskiöld resembles kyanite as well as bucholzite; and the analysis differs no more from the accepted formula than some that have been made of each of these species. Komonen obtained (Act. Soc. Sci. Fenn., i, 372, Pogg. lvi, 643) Silica 47·44, alumina 52·54=$\dddot{\text{Al}}\ \dddot{\text{Si}}$. H.=5. G.=3·58. From Peterhoff, Finland.

Altered Forms.—*Wœrthite* appears to be an altered or hydrous kyanite, which it resembles. H.=7·25; white and translucent. Hess obtained (Pogg. xxi, 73) $\dddot{\text{Si}}$ 40·58, $\dddot{\text{Al}}$ 53·50, $\dot{\text{Mg}}$ 1·00, $\dot{\text{H}}$ 4·63=99·71. B.B. infusible. From near St. Petersburg.

Hydrobucholzite of Thomson is probably of similar origin. Thomson obtained (Min. i, 237) $\dddot{\text{Si}}$ 41·35, $\dddot{\text{Al}}$ 49·55, $\dot{\text{H}}$ 4·85, gypsum 3·12=98·87. Probably from Sardinia.

Kyanite has also been observed altered to talc and steatite.

SILLIMANITE, *Bowen*. Bucholzite, *Brandes*. Fibrolite, *Bournon*.

Triclinic. $I : I'$=98°, but varying to 110°, and larger when the faces are much striated; $O : I'$=105°, $O : m$=133° 30′, $I' : m$=120° 30′, $O : a$=130°, D., (but only approximations, as the terminal planes were rough and uneven.) Cleavage: perfect, parallel with the longer diagonal, affording a brilliant surface. Also compact or loose fibrous; and columnar massive.

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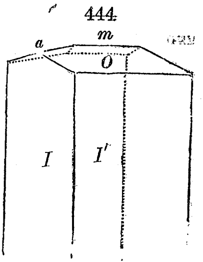

H.= 6—7·25. G. = 3·238, from Norwich, Dana, 3·232. ib., Brush; 3·259, Yorktown, Norton; 3·239, bucholzite of Chester, Del., Erdmann. Lustre vitreous, approaching subadamantine. Color hair-brown, grayish. Streak uncolored. Translucent—transparent.

Bucholzite and *fibrolite* are generally fibrous massive, sometimes approaching distinct prisms, like those of sillimanite; the lustre approaches adamantine as in sillimanite. The colors are grayish, whitish and pale brown.

Composition.—$\dddot{\text{Al}}\ \dddot{\text{Si}}^{\frac{2}{3}}$, like Kyanite=Silica 37·0, alumina 63·0. Bucholzite and fibrolite of Bournon afford the same, according to Silliman, Jr. Most analyses of bucholzite give $\dddot{\text{Al}}\ \dddot{\text{Si}}$=Silica 46·9, alumina 53·1. Erdmann's (No. 9) corresponds to $\dddot{\text{Al}}\ \dddot{\text{Si}}^{\frac{3}{4}}$. Bowen's and Hayes's analyses of Sillimanite afford $\dddot{\text{Al}}\ \dddot{\text{Si}}^{\frac{5}{6}}$=Silica 42·3, alumina 57·7.

I, Sillimanite.—1, Bowen, (Am. J. Sci. viii, 113); 2, Hayes, (Alger's Min. p. 601); 3, Connel, (Jameson's J. xxxi, 232); 4, Norton, (2d edit. of this work, 378); 5, Staaf, (Jahresb. xxv, 348); 6, Silliman, Jr., (Am. J. Sci. [2], viii, 386. II, Bucholzite.—7, Brandes, (J. de Pharm. xci, 237); 8, Thomson, (Ann. Lyc. N. York, iii, and Min. i, 235); 9, A. Erdmann, (K. V. Ac. H. 1842, 19); 10, B. Silliman, Jr., (Am. J. Sci. [2], viii, 386). III, Fibrolite.—11, 12, B. Silliman, Jr., (Am. J. Sci. [2], 8, 388); 13, Chenevix:

	$\dddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dddot{\text{Fe}}$
1. Chest. Ct., *Sillimanite*,	42·66	56·111	1·999, $\dot{\text{H}}$ 0·510=99·286, Bowen.
2. " "	42·60	54·90	1·10, $\dot{\text{Ca}}$ 0·31, $\dot{\text{Mg}}$ 0·4=99·31, Hayes.
3. " "	36·75	58·94	0·9=96·68, Connell.
4. Fairfield, N.Y. "	37·700	62·750	2·287=102·739, Norton.*
5. Chester, Ct., "	37·362	58·622	2·174, $\dot{\text{Mg}}$ 0·398, $\dot{\text{H}}$ 0·428=98·984, Staaf.

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* Prof. Norton states that in his analysis the excess of alumina was probably owing to the presence of aluminate of potassa, which remained with the alumina after separating the peroxyd of iron by caustic potassa; subtracting this excess, the analysis corresponds to those by Silliman.

		$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\bar{\dddot{\mathrm{Fe}}}$
6.	Chest. Ct., *Sillimanite*,	37·653	62·411	——=100·064, Silliman.
7.	Tyrol, *Bucholzite*,	46·0	50·0	2·5, $\dot{\mathrm{K}}$ 1·5=100, Brandes.
8.	Chester, Pa., "	46·40	52·92	*trace*=99·32, Thomson.
9.	" "	40·08	58·88	0·74=99·67, Erdmann=$\bar{\dddot{\mathrm{Al}}}^4 \dddot{\mathrm{Si}}^3$.
10.	" "	35·96	64·43	—— $\dot{\mathrm{Mg}}$ 0·52=100·910, Silliman.
11.	Carnatic,* *Fibrolite*,	36·309	62·415	—— $\dot{\mathrm{Mg}}$ 0·702=99·426, Silliman.
12.	Brandywine Sp. "	36·159	63·525	——=99·684, Silliman.
13.	Carnatic, "	38·00	58·25	0·75=97·00, Chenevix.

B.B. alone unaltered. With borax slowly fuses to a transparent colorless glass; with cobalt solution, a dark blue.

Occurs in slender prisms often flattened and striated, thickly traversing quartz in a vein of gneiss at Chester, Conn., near Saybrook; also at the falls of the Yantic, near Norwich, Conn., associated with minute zircons and monazite. Prisms half an inch in diameter are occasionally met with. It also occurs in the town of Yorktown, Westchester Co., N. Y., about ten miles northeast of Sing Sing, near the road leading from Pine's Bridge to Yorktown Post Office, associated with monazite, tremolite, and magnetic iron; the crystals are distinct and often run through the iron ore.

Bucholzite was originally obtained from Fassa in the Tyrol. A similar variety occurs at Chester, Pennsylvania, in the Delaware, near the Queensbury forge; at Concord and Birmingham, Chester Co.; at Brandywine Springs, Delaware; in Monroe, Orange Co., N. Y.; at Humphreysville, Conn.; Worcester, Mass.; in Aston and Leiperville, Pa., approaching the Sillimanite.

Sillimanite was named after Prof. Silliman; and bucholzite after Bucholz.

NOTE.—In the last edition of this work, the author placed together Kyanite and Sillimanite. The angles *I*: *I'* are approximately alike, and if polished prisms of the latter mineral could be found, they might prove to be much nearer. The terminal planes observed are so rough that were other points of identity made out, we should not rely upon them as evidence of a real difference. But the two minerals, as G. Rose states, (Kryst. Chem. p. 80), differ strikingly in appearance, and widely in *specific gravity;* and they have not been found associated together, although both occur in the same class of rocks. We therefore adopt the view of Rose, and make them for the present distinct species.

SAPPHIRINE, *Stromeyer*

Trimetric? Shows colors with polarized light, hence not monometric. Occurs granular massive.

H.=7—8. G.=3·42—3·48. Lustre vitreous. Color pale blue or green. Translucent.

Composition.—Contains 3 $\dot{\mathrm{Mg}}$, 4 $\bar{\dddot{\mathrm{Al}}}$, 1 $\dddot{\mathrm{Si}}$, which, if a portion of the alumina equal to the silica (or 1$\bar{\dddot{\mathrm{Al}}}$) acts as acid, becomes $\dot{\mathrm{Mg}}^3 (\dddot{\mathrm{Si}}, \bar{\dddot{\mathrm{Al}}})^{\frac{1}{2}} + 3\, \bar{\dddot{\mathrm{Al}}}(\dddot{\mathrm{Si}}, \bar{\dddot{\mathrm{Al}}})^{\frac{1}{2}} = (\tfrac{1}{4}\dot{\mathrm{Mg}}^3 + \tfrac{3}{4}\bar{\dddot{\mathrm{Al}}})(\dddot{\mathrm{Si}}, \bar{\dddot{\mathrm{Al}}})^{\frac{1}{2}}$=Silica 14·8, alumina 65·7, magnesia 19·5. Some relation in composition to clintonite and chloritoid.

Analyses: 1, Stromeyer, (Untersuch. i, 391); 2, 3, Damour, (Bull. Soc. Geol. d. Fr. 1849, 317):

	$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Fe}}$	
1.	14·51	63·11	16·85	0·38	3·92	ign. 0·49=99·78, Stromeyer.
2.	14·88	63·31	19·06	——	2·09	=99·34, Damour.
3.	14·84	63·20	19·50	——	1·90	=99·44, "

B.B. alone and with borax infusible, unaltered. Associated with mica and anthophyllite at Fiskenaes, in Greenland. The name alludes to the sapphire color.

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* One of Bournon's own specimens, received by Col. Gibbs (from whom the Yale Cabinet was obtained) from Count Bournon himself.

EUCLASE, *H.* Euklas, *W.*

Monoclinic. C=71° 7′; *I* : *I*=115° 0′, *O* : 1i=162° 30′; *a* : *b* : *c*=0·49492 : 1 : 1·4852. Angles, (Schabus, Denks. K. Ak. Wien, vi, 57):

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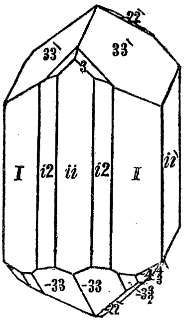

O : ii=108° 53′. 1 : 1=151° 43′.
O : 1i=158° 10′. -1 : -1=143° 42′.
ii : 1i=130° 52′. -33 : -33 (front)=156° 14′.
ii : *I*=147° 30′. $3\grave{3}$: $3\grave{3}$ (front)=105° 49½′.
ii : i2=162° 20′. $-3\grave{3}$: $-3\grave{3}$ (front)=90° 56′.
i2 : i2=144° 40′. $-2\grave{2}$: $2\grave{2}$ (front)=133° 29′.
iì : -33=101° 53′. 3 : 3(front)=130° 16′.
iì : $-3\frac{3}{2}$=112° 50′. 2ì : 2ì(top)=115° 32′.
iì : $-4\frac{4}{3}$=130° 17½′. iì : $3\grave{3}$ =127° 5′.

Cleavage: iì highly perfect; *O* and ii much less distinct.

H.=7·5. G.=3·036, Mallet; 3·098, Haidinger. Lustre vitreous. Color pale mountain-green, passing into blue and white. Streak uncolored. Transparent; occasionally subtransparent. Fracture conchoidal. Very brittle.

O												
$-\frac{1}{2}i$												$\frac{1}{2}\grave{\imath}$
						-1						
										$-2\grave{2}$		2ì
												$\frac{5}{2}\grave{\imath}$
	$-3\frac{9}{2}$	-33		$-3\frac{3}{2}$								
												$\frac{13}{4}\grave{\imath}$
								$-4\grave{\frac{4}{3}}$				4ì
ii		i3	i2	$i\frac{3}{2}$	$i\frac{4}{3}$	*I*			$\grave{\imath}\frac{3}{2}$			iì
						3	$3\grave{\frac{9}{7}}$				$3\grave{3}$	
1i						1						

Observed Planes. Add $i\frac{10}{9}$, $i\frac{12}{7}$, i8, i18, i32, Schabus.

Composition.—$(\frac{1}{2}\dddot{\bar{\text{B}}}\text{e}+\frac{1}{2}\dddot{\bar{\text{A}}}\text{l})\dddot{\text{S}}\text{i}^{\frac{3}{4}}$, G. Rose=Silica 43·2, alumina 32·6, glucina 24·2 =100. Analyses: 1, Berzelius, (Schw. J. xxvii, 73); 2, Mallet, (Phil. Mag. [4], v, 127):

	$\dddot{\text{S}}\text{i}$	$\dddot{\bar{\text{A}}}\text{l}$	$\dddot{\bar{\text{F}}}\text{e}$	$\dddot{\bar{\text{B}}}\text{e}$	$\ddot{\text{S}}\text{n}$
1.	43·22	30·56	2·22	21·78	0·70=98·48, Berz.
2.	44·18	31·87	1·31	21·43	0·35=99·14, Mallet.

B.B. strongly heated intumesces and becomes white, throws out points, and melts to a white enamel, if the temperature is still further increased. Dissolves with borax with effervescence to a clear glass. A silica skeleton with salt of phosphor us. Becomes electric by friction, and when once excited, retains this property for several hours. Not acted on by acids.

Occurs in Brazil, in the mining district of Villa Rica, in chlorite slate resting on sandstone. The crystallization of this species is elaborately detailed by Schabus in the Transactions of the Royal Academy of Vienna, vol. vi.

Euclase receives a high polish, but is useless as an ornamental stone on account of its brittleness. Named by Haüy from εὖ, *easily*, and κλάω, *to break*.

SPHENE. Titanite. Menakerz. Menachine Ore, *Wern.* Titane Silico-calcaire, *H.* Lederite, *Shepard.* Greenovite, *Duf.* Spinthère. Pictite, *Saus.* Arpidelite.

Monoclinic. $C=60° 27'$; $I : I=113° 28'$, $O : 1\grave{i}=159° 34'$; $a : b : c=0{\cdot}5678 : 1 : 1{\cdot}326$.*

$O(y) : ii(P)=119° 33'$.
$O(y) : 1i(x)=158° 55'$.
$O(y) : 4i(s)=123° 52'$.
$O(y) : I(r)=114° 21'$.
$O(y) : 1(z)=154° 13'$.
$O(y) : 2(n)=141° 36'$.
$O(y) : -1(l)=139° 20'$.
$O(y) : -2(t)=109° 37'$.
$1(z) : 1(z)=149° 38'$.
$2(n) : 2(n)=136° 4'$.

$-1(l) : -1(l)=133° 48'$.
$-2(t) : -2(t)=110° 54'$.
$22(e) : 22(e)=157° 12'$.
$12(w) : 12(w)=164° 32'$.
$I(r) : I(r)=113° 28'$.
$6\grave{3}\ (u) : ii(b)=140° 26'$.
$-3\grave{3}\ (m) : -3\grave{3}\ (m)=76° 1'$.
$-3\grave{3}\ (m) : ii(b)=141° 59'$.
$ii(P) : i3(o)=167° 40'$.
$ii(P) : ii(b)=90°$.

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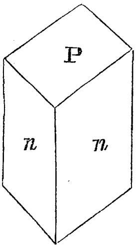

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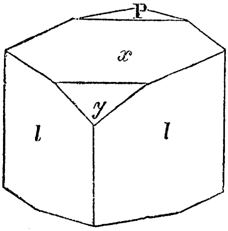

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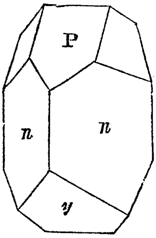

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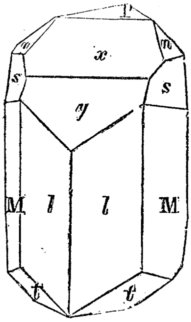

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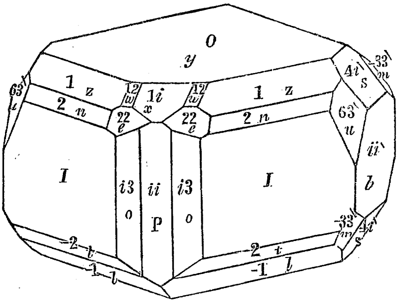

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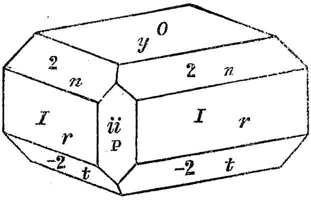

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* Authors generally take *P* as the base of the fundamental prism, *y* as the plane replacing the front angle, and *l* as the lateral prismatic planes. Above, in figures

Cleavage: sometimes distinct parallel with *I*; orthodiagonal less so; parallel with -1, also very imperfect, and not easily obtained. Sometimes massive, compact, and rarely lamellar.

H.=5—5·5. G.=3·4—3·56. Lustre adamantine—resinous. Color brown, gray, yellow, green, and black. Streak white, slightly reddish in greenovite. Transparent—opaque. Brittle.

Composition.—The analyses afford $3\dot{\mathrm{C}}\mathrm{a}$, $2\dddot{\mathrm{S}}\mathrm{i}$, $3\ddot{\mathrm{T}}\mathrm{i}$=Silica 30·45, titanic acid 41·33, lime 28·22=100, (which have been written $2\dot{\mathrm{C}}\mathrm{a}\,\dddot{\mathrm{S}}\mathrm{i}+\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{T}}\mathrm{i}^3$.) The oxygen of the $\dot{\mathrm{C}}\mathrm{a}$ and $\ddot{\mathrm{T}}\mathrm{i}$ is to that of the Silica as 3 : 2=1 : $\frac{2}{3}$, and this leads to the formula $(\dot{\mathrm{C}}\mathrm{a}+\ddot{\mathrm{T}}\mathrm{i})\,\dddot{\mathrm{S}}\mathrm{i}^{\frac{2}{3}}$ or $\dddot{\bar{\mathrm{R}}}\,\dddot{\mathrm{S}}\mathrm{i}^{\frac{2}{3}}$, (since $\dot{\mathrm{C}}\mathrm{a}+\ddot{\mathrm{T}}\mathrm{i}=\mathrm{RO}+\mathrm{RO}^2=\mathrm{R}^2\mathrm{O}^3$); so that sphene is a silicate of a peroxyd ($\dddot{\bar{\mathrm{T}}}\mathrm{i}$) in which part of the $\dddot{\bar{\mathrm{T}}}\mathrm{i}$ is replaced by $\dot{\mathrm{C}}\mathrm{a}$. It is probable that there is the same kind of replacement by a protoxyd in much ilmenite, and also in Keilhauite, etc., and that there are properly no silico-titanates. The formula accords with the relation in form to Euclase.

Analyses: 1, Fuchs, (Ann. d. Ch. u. Pharm. xlvi, 319); 2, H. Rose, (Pogg. lxii, 253); 3, 4, Rosales and Brooks, (ib); 5, Marignac, (Ann. Ch. Phys. [3], xiv, 47); 6, Delesse, (Ann. d. Mines, [4], vi, 325): 7, T. S. Hunt, (Am. J. Sci. [2], xv, 442):

	$\dddot{\mathrm{S}}\mathrm{i}$	$\ddot{\mathrm{T}}\mathrm{i}$	$\dot{\mathrm{C}}\mathrm{a}$
1. Schwarzenstein, *yw.*	32·52	43·21	24·18=99·91, Fuchs; G.=3·44.
2. Zillerthal, *ywh. green,*	32·29	41·58	26·61, $\dot{\mathrm{F}}\mathrm{e}$ 0·96=101·44, Rose; G.=3·535.
3. Arendal, *brown,*	31·20	40·92	22·25, $\dot{\mathrm{F}}\mathrm{e}$ 5·06=99·43, Rosales.
4. Passau,	30·63	42·56	25·00, $\dot{\mathrm{F}}\mathrm{e}$ 3·93=102·12, Brooks.
5. Piedmont, *Greenovite,*	32·26	38·57	27·65, $\dot{\mathrm{F}}\mathrm{e}$ 0·76, $\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·76=100, Marignac.
6. " "	30·4	42·0	24·3, $\dot{\mathrm{M}}\mathrm{n}$ 3·6=100·3, Delesse.
7. Grenville, *Lederite,*	31·83	40·00	28·31, ign. 0·40=100·54, Hunt. G.=3·5.

B.B. the yellow varieties are not altered in color; the others become yellow; they slightly intumesce, and fuse on the edges to a dark enamel. With borax they afford a clear yellowish-green glass. Imperfectly soluble in heated muriatic acid; and if the solution be concentrated along with tin, it becomes of a fine violet color.

This species was formerly divided into *titanite* and *sphene;* the former included the brown or black variety, the latter the lighter colored and translucent.

Greenovite, from St. Marcel in Piedmont, was shown to be identical in crystallization with sphene by Breithaupt (Pogg. lviii, 257) and Descloizeaux, (Ann. Ch. Phys. [3], xx, 84).

Sphene occurs in imbedded crystals, in gneiss, granite, mica slate, and granular limestone; also in syenite, beds of iron ore, and volcanic rocks. Found with pyroxene, in beds of iron ore, at Arendal in Norway; in granite in Greenland; in complicated compound crystals of a pale green color and transparent, at Graubinden in the Grisons, associated with feldspar and chlorite; in mica slate at St. Gothard; also at Mont Blanc, and elsewhere, in the Alps. Small crystals occur in syenite at Strontian in Argyleshire, and Criffel in Galloway. Occasionally it is found among volcanic rocks, as at Lake Laach, and Andernach on the Rhine.

Occurs in Canada at Grenville, Elmsley, Burgess and Grand Calumet Island, in amber-colored crystals; in the trap of Montreal, Yemaska, Monnoir, and Brome Mts. In Maine in fine crystals at Sanford, also at Thurston! In Massachusetts, good crystals in gneiss, in the east part of Lee; at Bolton with pyroxene and scapolite in limestone; at Pelham. In Connecticut, at Trumbull. In New Jersey, at Franklin, of a honey-yellow color. In Pennsylvania, Buck's Co., three miles west

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450, 451, *y* is made the base, and *r* the prismatic planes, a course recommended not only by the simplicity it gives to the view of the crystallization, but also by the fact that *y* is a common plane of composition in twins, and *r* is the direction of most distinct cleavage; moreover the analogy with Euclase is thus brought out. In Euclase $I:I$=115°, $O:1i$=158° 10′, 1 : 1=151° 43′, and the same angles in Sphene are 113° 28′, 158° 55′, 149° 38′.

Fig. 450 represents an ideal crystal containing all known planes; it has both the old and new lettering.

of Attleboro', associated with tabular spar and graphite. In New York, at Rogers Rock on Lake George, abundant in small brown crystals, along with graphite and pyroxene; at Gouverneur, in black crystals in granular limestone with scapolite; in Diana near Natural Bridge, Lewis Co., in dark brown crystals, among which is the variety lederite (f. 451), in which cleavage is distinct parallel to *I*; the crystals are sometimes nearly three inches square; at Rossie, St. Lawrence Co., in pale red and brown crystals with apatite, pargasite, and feldspar; in Macomb near Pleasant Lake; in Orange Co., in large crystals abundant in limestone, near Duck-cedar pond, in the town of Monroe; near Edenville, in light brown crystals, sometimes nearly two inches across, in limestone; five miles south of Warwick, in large grayish-brown crystals, with zircon, hornblende, and iron ore; also in small crystals a mile south of Amity; in Westchester Co., near Peekskill, in an aggregate of feldspar, quartz, and hornblende; also near West Farms, in small reddish-brown prisms.

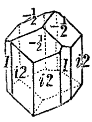
The name *sphene* alludes to the form of the crystal, and is from σφην, *a wedge.*

Ligurite, (from a talcose rock in the Appenines), according to Dufrénoy, has the angles and characters of sphene.

TOURMALINE, *W.* Schörl. Rubellite. Indicolite. Aphrizite. Aphrite, *W.* Turmalin. Tourmaline Apyre, *H.* Zeuxite, *Thomson.*

Rhombohedral. $R : R = 103°$, $O : R = 134° \ 3'$; $a = 0{\cdot}89526$. Observed planes: rhombohedrons, $\frac{1}{4}$, $1(R)$, $\frac{5}{4}, \frac{7}{4}, \frac{5}{2}, 5, \frac{11}{2}$?, $-2, -\frac{5}{4}, -\frac{7}{8}, -\frac{1}{2}, -\frac{1}{8}$; Scalenohedrons, $\frac{1}{2}^2, \frac{1}{2}^3, \frac{1}{2}^5, 1^{\frac{4}{3}}, 1^2, \frac{1}{4}^3, \frac{3}{5}^3$, (the last replacing angle between $-\frac{1}{2}, \frac{1}{4}$, and $\frac{1}{4}^3$); prisms, $I, i2, i\frac{7}{5}, i\frac{5}{4}$. Forms usually unlike at the opposite extremities and prisms often triangular. The annexed figures, and also 253, 254. Cleavage R, $-\frac{1}{2}$, and $i2$, difficult. Sometimes massive compact; also columnar, coarse or fine, parallel or divergent.

452



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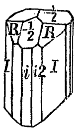

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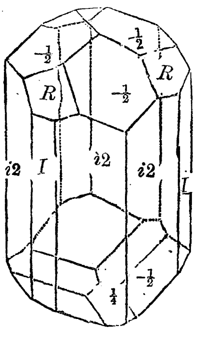

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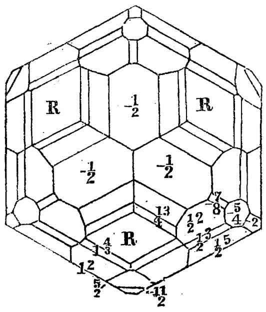

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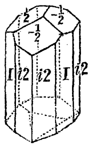

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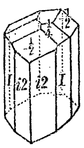


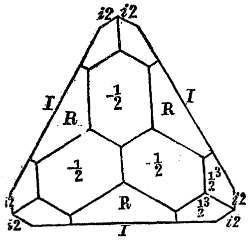
$O : \frac{1}{4} = 165° \ 31'$.
$O : \frac{1}{2} = 152° \ 40'$.
$O : \frac{5}{4} = 129° \ 21'$.
$O : 2 = 115° \ 49'$.
$O : \frac{5}{2} = 111° \ 9'$.
$O : \frac{11}{2} = 99° \ 58'$.

$\frac{1}{4} : \frac{1}{4} = 154° \ 59'$.
$\frac{1}{2} : \frac{1}{2} = 133° \ 8'$.
$i2 : \frac{1}{2} = 113° \ 26'$.
$i2 : R = 128° \ 30'$.
$i2 : \frac{1}{2}^5 = 155° \ 14'$.
$i2 : \frac{1}{2}^3 = 142° \ 26'$.

$i2 : \frac{1}{2}^2 = 130° \ 55'$.
$i2 : 1^{\frac{4}{3}} = 136° \ 41'$.
$i2 : 1^2 = 147° \ 51.'$
$i2 : i\frac{5}{4} = 160° \ 54'$.
$i2 : i\frac{7}{5} = 166° \ 6'$.
$i2 : I = 150°$.

H.=7—7·5. G.=2·94—3·3; 3·021. Lustre vitreous. Color black, brown, blue, green, red, and rarely white or colorless; some specimens red internally, and green externally; and others red at one extremity, and green, blue, or black, at the other. Exhibits dichroism. Streak uncolored. Transparent—opaque; unlike in transparency across the prism and in the line of the axis. Fracture subconchoidal—uneven. Brittle. Pyroelectric.

458



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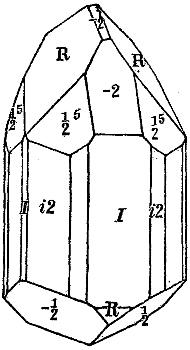

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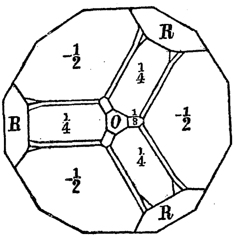

Composition.—($\dot{R}^3$, $\bar{R}$, $\dddot{B}$)$\dddot{Si}^{\frac{3}{4}}$, the oxygen ratio between the Silica and all the other ingredients being 3 : 4, as ascertained by Rammelsberg. The oxygen ratio for the protoxyds, peroxyds, and boracic acid ($\dot{R} : \bar{R} : \dddot{B}$) varies greatly; group I, affording mostly 4 : 12 : 4; II, 4 : 15 : 5; III, 4 : 21 : 6, 4 : 24 : 7, etc.; IV, 4 : 40 : 12, 4 : 36 : 11, etc.; V, 4 : 48 : 13, 4 : 56 : 12, etc. The special formula for group I is, $\dot{R}^3\dddot{Si}^{\frac{3}{4}}+3\bar{R}\dddot{Si}^{\frac{3}{4}}+\dddot{B}\dddot{Si}^{\frac{3}{4}}$ or $(\frac{1}{5}\dot{R}^3+\frac{3}{5}\bar{R}+\frac{1}{5}\dddot{B})\dddot{Si}^{\frac{3}{4}}$; for analysis 23 in group V, $\dot{R}^3\dddot{Si}^{\frac{3}{4}}+14\bar{R}\dddot{Si}^{\frac{3}{4}}+3\dddot{B}\dddot{Si}^{\frac{3}{4}}$ or $(\frac{1}{18}\dot{R}^3+\frac{14}{18}\bar{R}+\frac{3}{18}\dddot{B})\dddot{Si}^{\frac{3}{4}}$, and these (excluding analysis 26) are the extreme variations.

For analyses see next page.

BB. I, fuse rather easily to a white blebby glass or slag; II, fuse with a strong heat to a blebby slag or enamel, either white, greenish or brownish; III, fuse with difficulty, or in some, only on the edges to a brownish, brownish-red, gray, or black slag; IV, fuse on the edges, and often with great difficulty, to a yellowish, grayish, bluish or whitish slag or enamel, and some are infusible; V, infusible, but becoming white or paler, sometimes, as the Paris (Me.) rubellite, affording a fine enamel on the edges.

Blue tourmalines have been termed *indicolite*, from their indigo-blue color; the colorless, *achroite;* red tourmalines, *rubellite;* and to the black, the name *schorl* was formerly applied. The green color is due to iron; the red has been attributed to oxyd of manganese,

Tourmaline is usually found in granite, gneiss or mica slate. It also occurs in dolomite or granular limestone, and in sandstone near dykes of igneous rocks.

Large black tourmalines occur in Greenland, at Hörlberg, near Bodenmais, in Bavaria; at Käringbricka in Sweden; near Bovey in Devonshire. Small brilliant crystals in decomposed feldspar, at Andreasberg in the Hartz, are the variety *Aphrizite.* Rubellite and green tourmaline occur near Ekatherinenburg in Siberia; pink crystals are found at Elba. Pale yellowish brownish crystals in talc, at Windisch Kappell, in Carinthia; green at Airolo, Switzerland; white specimens (*Achroite*) come from St. Gothard, Siberia and Elba. The Grand Duke's collection at Florence contains a specimen 11 inches square, on which there are 4 erect green tourmalines and 1 prostrate, 2, 4, and 2¼ inches long and ¾ to 1 inch thick. Black tourmalines occur with the emery of Naxos. Other localities are mentioned beyond.

I. *Magnesia Tourmaline.*—G.=3—3·07 ; mean 3·05.

	G	$\ddot{\mathrm{Si}}$	$\ddot{\mathrm{B}}$	$\ddot{\overline{\mathrm{Al}}}$	$\ddot{\overline{\mathrm{Mn}}}$	$\ddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\overset{\cdot\cdot}{\overline{\mathrm{P}}}$	F
1. *Brown,* Gouverneur,	3·049	38·85	8·25	31·32	—	1·27	—	14·89	1·60	1·28	0·26	—	2·28=100.
2. " W. Kappel, Carinthia,	3·035	38·08	9·39	34·21	—	1·43	—	11·22	0·61	2·37	0·47	0·12	2·10=100.
3. *Greenish, reddish,* Eibenstock,	3·034	37·83	8·88	30·86	—	4·85	—	11·62	0·88	2·27	0·30	—	2·51=100.
4. *Brown,* Orford, N. H.,	3·068	38·33	9·86	33·15	—	3·07	0·12	10·89	0·77	1·52		0·24	2·50=100·45.
5. " Monroe, Ct.,	3·068	39·01	9·04	31·18	—	3·44	0·98	9·90	1·81	1·82	0·44	—	2·38=100.
6. *Black,* Zillerthal,	3·054	37·94	8·58	33·64	—	2·79	0·37	10·46	0·98	2·13	0·37	0·24	2·50=100.

II. *Iron-magnesia Tourmaline.*—G.=3·05—3·2; mean 3·11.

	G	$\ddot{\mathrm{Si}}$	$\ddot{\mathrm{B}}$	$\ddot{\overline{\mathrm{Al}}}$	$\ddot{\overline{\mathrm{Mn}}}$	$\ddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\overset{\cdot\cdot}{\overline{\mathrm{P}}}$	F
7. *Black,* Geenland,	3·072	37·70	7·36	34·53	—	4·63	0·25	9·51	1·25	2·00	0·43	0·11	2·23=100.
8. " Texas, Pa.,	3·043	38·45	8·48	34·56	$\dot{\mathrm{M}}$n 0·09	3·31	—	9·11	0·71	2·00	0·73	0·20	2·36=100.
9. *Brownish black,* St. Gothard,	3·055	38·00	8·99	32·28	—	6·36	1·51	7·27	1·31	1·43	0·28	0·24	2·33=100.
10. *Black,* Haddam, Ct.,[a]	3·136	37·50	7·94	30·87	—	8·31	1·06	8·60	1·61	1·60	0·73	*tr.*	1·78=100.
11 " " "[b]	3·132	36·55	4·87	32·46	—	11·08	0·50	8·51	1·80	2·28		—	1·95=100.
12. " Unity, Me.,	3·192	36·29	6·94	30·44	—	13·08	2·38	6·32	1·02	1·94		—	1·59=100.

[a] Gneiss Quarries. [b] Chrysoberyl locality.

III. *Iron Tourmaline; Black.*—G.=3·13—3·25; mean 3·19.

	G	$\ddot{\mathrm{Si}}$	$\ddot{\mathrm{B}}$	$\ddot{\overline{\mathrm{Al}}}$	$\ddot{\overline{\mathrm{Mn}}}$	$\ddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\overset{\cdot\cdot}{\overline{\mathrm{P}}}$	F
13. Bovey Tracey,	3·205	37·00	7·66	33·09	—	9·33	6·19	2·58	0·50	1·39	0·65	0·12	1·49=100.
14. Alabaschka Ural,	3·227	37·54	8·00	34·40	—	7·61	8·60	1·76	0·86	1·02	0·47	—	1·54=100.
15. Sonnenberg, Hartz,	3·243	36·51	7·62	32·92	$\dot{\mathrm{M}}$n 0·11	8·13	9·51	0·78	0·72	1·36	0·58	0·12	1·64=100.
16. Krummau, Bohemia,	3·135	38·43	8·06	34·25	—	9·98	1·44	3·84	0·44	1·36	0·30	—	1·90=100.

IV. *Iron-Manganese-Lithia Tourmaline.*—G.=2·94—3·11; mean 3·083.

	G	$\ddot{\mathrm{Si}}$	$\ddot{\mathrm{B}}$	$\ddot{\overline{\mathrm{Al}}}$	$\ddot{\overline{\mathrm{Mn}}}$	$\ddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Li}}$	F
17 *Bluish-black,* Sarapulsk, Ural,	3·162	38·30	6·32	36·17	3·71	6·35	3·84	0·53	0·27	2·37	0·33	—	1·75 $\overset{\cdot\cdot}{\overline{\mathrm{P}}}$ 0·06.
18. *Black,* Elba,	2·942	36·71	6·49	36·00	6·14	7·14	—	2·30	0·80	2·04	0·38	—	2·00=100.
19. *Green,* "	3·112	38·19	7·10	39·16	4·74	3·14	—	1·00	0·84	2·40	0·34	0·74	2·35=100.
20. " Paris, Me.,	3·069	38·47	7·51	40·93	1·78	3·08	—	1·21	0·88	2·36	0·36	1·47	2·00=100.
21. " Brazil,	3·107	38·55	7·21	38·40	0·81	5·13	2·00	0·73	1·14	2·37	0·37	1·20	2·09=100.
22. " Chesterfield, Mass.,	3·108	40·26	7·79	38·00	0·90	2·61	3·80	0·80	0·81	2·09	0·64	0·20	2·10=100.

V. *Lithia-tourmaline.* G.=3—3·1; mean 3·041.

	G.	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{B}}}$	$\ddot{\bar{\mathrm{Al}}}$	$\ddot{\bar{\mathrm{Mn}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Li}}$	$\dddot{\bar{\mathrm{P}}}$	F
23. *Red*, Elba,	3·022	39·27	7·87	44·41	0·64	0·78	—	2·00	1·30	1·22	0·10	2·41=100.
24. " Paris, Me.,	3·019	38·33	9·00	43·15	1·12	1·02	—	2·60	0·68	1·17	0·27	2·58=99·92.
25. " Schaitansk, Ural,	3·082	38·38	7·41	43·97	2·60	1·60	0·62	1·97	0·21	0·48	0·27	2·47=100.
26. " Rozena, Moravia,	2·998	41·16	8·56	41·83	0·97	0·61	—	1·37	2·17	0·41	0·22	2·70=100.

The above analyses, 1 to 26, are by Rammelsberg, (Pogg. lxxx, 449, and lxxxi, 1.)

Loss *by ignition*, in analysis

1, 3·19	9, 3·25	17, 2·44
2, 2·93	10, 2·49	19, 3·28
3, 3·50	11, 2·72	21, 2·92
4, 3·49	12, 2·22	22, 2·94
5, 3·32	13, 2·09	23, 3·37
6, 3·54	14, 2·15	24, 3·61
7, 3·11	15, 2·31	25, 3·45
8, 3·30	16, 2·66	26, 3·76

Earlier Analyses; Section II, 27—30, Gmelin, (Schw. J., xxxi, 299, xxxviii, 514, Pogg. ix, 172); Section III, 31, Hermann, (J. f. pr. Ch. xxxv, 232); Section IV, 32, 33, Gmelin, (loc. cit.); 34, Hermann, (loc. cit.); Section V, 35, 36, Gmelin, (loc. cit.); 37, 38, Hermann, (loc. cit.)

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{B}}}$	$\ddot{\bar{\mathrm{Al}}}$	$\ddot{\bar{\mathrm{Mn}}}$	$\ddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	
27. *Brown*, St. Gothard,	37·81	4·18	31·61	1·11	7·77		5·99	0·98	—	1·20,	ign. 0·24=90·89, Gmelin.
28. *Black*, Greenland,	38·79	3·63	37·19	*tr.*	5·81		5·86	—	3·13	0·22,	" 1·86=96·48, Gmelin.
29. " Karingbricka,	37·65	3·83	33·46	—	9·38		10·98	0·25	2·53		" 0·03=98·11, Gmelin.
30. " Bovey,	35·20	4·11	35·50	0·43	17·86		0·70	0·55	2·09	——	=96·44, Gmelin.
31. *Brown*, Mursinsk,	37·80	9·90	30·56	$\dot{\mathrm{M}}$ 2·50	0·50	12·07	1·42	—	2·09	—,	$\ddot{\mathrm{C}}$ 1·66 $\dot{\mathrm{Li}}$ 0·50=100, Hermann.
32. *Green*, Brazil,	39·16	4·59	40·00	$\ddot{\bar{\mathrm{M}}}$ 2·14	5·96		—	—	—	3·59,	ign 1·58=97·02, Gmelin.
33. " Chesterfield,	38·80	3·88	39·61	" 2·88	7·43		—	—	4·95	—,	" 0·78=98·33, Gmelin.
34. " Totsch. Gora,	40·54	11·78	31·77	$\dot{\mathrm{M}}$ 0·90	—	3·65	6·44	—	—	—,	$\dot{\mathrm{Li}}$ 2·09, $\ddot{\mathrm{C}}$ 166, $\ddot{\mathrm{Cr}}$ 1·17=100.
35. *Red*, Rozena,	42·13	5·74	36·43	6·32	—	—	—	1·20	—	2·41,	" 2·04, ign. 1·31=97·58, Gmelin.
36. " Perm,	39·37	4·18	44·00	5·02	—	—	—	—	—	1·29,	" 2·52, " 1·58=97·56, Gmelin.
37. *Achroite*, Elba,	42·89	5·34	44·09	$\dot{\mathrm{M}}$ 0·27	—	—	0·45	—	3·12	—,	" 2·19, $\ddot{\mathrm{C}}$ 1·66=100, Herm.
38. *Red*, Sarapulsk,	39·70	6·65	40·29	" 2·30	—	—	0·16	—	7·88	—,	" 3·02=100, Hermann.

In the United States, magnificent red and green tourmalines have been found at Paris, Maine, some crystals over an inch in diameter, transparent, ruby-red within, surrounded by green, or red at one extremity and green at the other; blue and pink varieties commonly imbedded in lepidolite, still to be found. Red and green, at Chesterfield, Mass., in a granite vein with albite, uranite, and pyrochlore; the crystals small and curved, nearly opaque, and fragile; green crystals often with distinct prisms of red color inside, especially when in smoky quartz; blue also at this locality. At Goshen, Mass., similar varieties occur, and the blue is met with in greater perfection. At Norwich, New Baintree, and Carlisle, Mass., good black crystals; also Alstead, Grafton, Sullivan, Acworth, and Saddleback Mt., N. H., and Streaked Mountain, Me.; Brattleboro', Vt.; large brownish black crystals abundant in steatite at Orford, N. H. Green and black crystals with beryl and feldspar at Albany, Me. Perfect dark brown crystals in mica-slate near Lane's Mine, Monroe, Conn.; sometimes two inches in length and breadth. At Haddam, Conn., interesting black crystals in mica slate with anthophyllite, also in granite with iolite, and also at the gneiss quarries, on the east side of the river. Near Gouverneur, N. Y., light and dark brown crystals, often highly modified, with apatite and scapolite in granular limestone, (f. 253, 254, p. 174); at Canton; in simple prisms in the same rock near Port Henry, Essex Co.; at Schroon, with chondrodite and scapolite; fine brown crystals at Crown Point, one mile south of village. Black crystals at the chrysoberyl locality near Saratoga, N. Y.; also at Alexandria, Jefferson Co.; at Kingsbridge, N. Y., brown, yellowish or reddish-brown crystals in dolomite; gray or bluish-gray and green in three-sided prisms occur near Edenville; short black crystals in the same vicinity, and at Rocky Hill, sometimes 5 inches in diameter; a mile southwest of Amity, yellow and cinnamon colored crystals with spinel in calc spar; also near the same village a clove-brown variety with hornblende and rutile in granular limestone. At Franklin, Hamburgh, and Newton, N. J., black and brown crystals in limestone, with spinel. Good crystals in Pennsylvania at Newlin, Chester Co.; at London Grove and near Unionville, of a light yellow or brownish yellow, (f. 458), in limestone, and rarely *white;* at Parksburg; Aston; at Chester, fine black; Lieperville, Delaware Co., black; Marple, Lancaster Co., of a green color in talc; opposite New Hope, Buck's Co.; in New Garden township, Chester Co., in limestone, light brown to yellow and sometimes transparent. Near New Hope on the Delaware, large black crystals, in which the prismatic faces are sometimes almost obsolete. Also in Cheowee valley, South Carolina; Habersham Co., Georgia. In Canada, superb greenish-yellow crystals, 1 inch through, in limestone at G. Calumet, Id.; amber colored at Fitzroy, C. W.; transparent brown (f. 457) at Hunterstown, C. E., with idocrase and garnet; black at Bathurst and Elmsley, C. W., and St. Jerome, C. E.

Figure 459 represents a crystal from northern New York; and 460 as well as 457 crystals from Canada, both of these last furnished the author for examination by T. S. Hunt.

A *green* Tourmaline gave Brooke and Miller, from whom the above angles are cited, $O : R = 134° 2' 24''$; a *red,* 133° 48′; a *black* from Modum, 133° 47′ 12″; a *light brown,* 133° 56′; a *white* afforded Brooke, 134° 7′. A *green* gave Kupffer 134° 3′, a *black* 134° 6′, a *red* 133° 58′.

ALTERED FORMS.—Tourmaline occurs altered to Mica, Chlorite, Steatite. The mica is lepidolite, a species which is related in composition to some tourmaline and is a frequent associate of the red and green varieties. It appears to take place through the addition of alkalies. Some rubellites and green tourmalines at Chesterfield are hollow, evidently from decomposition and removal of the interior; and in the cavities are occasionally observed small crystals of yellow uranite, (Teschemacher).

II. *Hydrous Silicates.*

A. MAGNESIAN HYDROUS SILICATES.

B. NON-MAGNESIAN HYDROUS SILICATES.

A. MAGNESIAN HYDROUS SILICATES.

I. TALC SECTION. Oxygen ratio for the bases and silica (water excluded) 1 : 3 to 1 : $2\frac{1}{4}$.

II. SERPENTINE SECTION. Oxygen ratio (ib.) 1 : 2 to 1 : $1\frac{1}{4}$.

III. CHLORITE SECTION. Oxygen ratio (ib.) 1 : 1 to 1 : $\frac{1}{2}$.

[The Hydrous Magnesian Silicates have so many common characters and relations, that they are conveniently and naturally kept apart from the other hydrous species. With them are naturally associated certain ferruginous species, containing protoxyd of iron in place of magnesia.

The ratios characterizing the above sections have rather wide limits, such being adopted as were necessary, in order to distribute the species into natural groups. When the proper relation of water to the rest of the compound is in each case fully established, these limits may perhaps be more precisely defined.

In the Chlorite section there are but three or four species which have the ratio 1 : 1; in general, the oxygen of the bases in the species of this section much exceeds that of the silica, as in the Andalusite Section of the Anhydrous Silicates. Euphyllite has the ratio 1 : 1, Chlorite has the ratio 1 : $\frac{3}{4}$, Ripidolite the ratio 1 : $\frac{2}{3}$, Chloritoid 1 : $\frac{2}{3}$ to 1 : $\frac{1}{2}$, etc.]

I. TALC SECTION.

	Oxygen ratios.			Formulas.		Oxygen ratios.			Formulas.
	$\dot{R}$	$\dddot{Si}$	$\dot{H}$			$\dot{R}$	$\dddot{Si}$	$\dot{H}$	
TALC,	1	$2\frac{1}{2}$	$\frac{1}{3}$	$\dot{Mg}^6\dddot{Si}^5+2\dot{H}$.	SPADAITE,	1 :	$2\frac{2}{5}$:	$\frac{4}{5}$	$4\dot{Mg}\dddot{Si}+\dot{Mg}\dot{H}^4$
MEERSCHAUM,	1	3	1?	$\dot{Mg}\,\dddot{Si}+\dot{H}$?	?CHLOROPHÆITE,	1 :	3 :	6?	$\dot{Fe}\,\dddot{Si}+6\dot{H}$?
NEOLITE,	1	3	$\frac{1}{3}$	$\dot{R}\,\dddot{Si}+\frac{1}{3}\dot{H}$.	?CROCIDOLITE,	1 :	$2\frac{1}{2}$:	$\frac{1}{3}$	$\dot{R}^6\dddot{Si}^5+2\dot{H}$.

TALC. Soapstone. Steatite. Speckstein. Lapis ollaris.

Trimetric? *I* : *I*=120°. Occurs rarely in rectangular prisms and hexagonal plates. Cleavage: basal, eminent. Usually massive and thin foliated; sometimes in globular and stellated groups; also granular, massive to impalpable.

H.—1—1·5. G.—2·565—2·8. Lustre pearly. Color apple-green to white, or silvery-white; also greenish-gray and dark green;

sometimes bright green, perpendicular to cleavage surface, and brown and less translucent at right angles to this direction. Streak usually white; of dark-green varieties, lighter than the color. Subtransparent—subtranslucent. Sectile in a high degree. Thin laminæ flexible, but not elastic. Feel greasy.

VARIETIES.—*Foliated Talc.*—Purest crystalline talc, consisting of easily separated folia, having a greasy feel, and presenting light-green, greenish-white, and white colors. G.=2·55—2·78.

Soapstone or *Steatite*, (*Speckstein* of the Germans).—Coarse gray and grayish-green massive varieties, generally granular. Also of fine texture, and grayish-green to white, occasionally yellowish or reddish; sometimes lamellar, but usually compact. Very greasy to the feel, or like soap. G.=2·65—2·8 The Briançon variety is milky-white with a pearly lustre. *Pot stone* or *Lapis ollaris* includes the coarser granular specimens of dark color, and more or less impure. Some *Agalmatolite* is of this nature.

Indurated Talc.—An impure slaty talc, with a nearly compact texture, and superior hardness to common talc.

Talcose Slate.—A dark slaty rock, having a somewhat greasy feel, consisting largely of talc, mixed intimately with more or less feldspar and quartz.

Composition.—$\dot{M}g^6\,\dddot{S}i^5+2\dot{H}$=Silica 62·14, magnesia 32·92, water 4·94=100. The more recent analyses give 4 to 5 per cent. of water. Analyses: 1, 2, Kobell, (Kastn. Arch. xii, 29); 3, 4, Delesse, (Rev. Scientif. etc.); 5, Marignac, (Bib. Univ. de Gen. 1844); 6, 7, Scheerer, (Pogg. lxxxiv, 321, Am. J. Sci. xiv); 8, Tengström, (Jahresb. iv, 156); 9, 10, 11, Lychnell (Pogg. xxxviii); 12–17, Scheerer and Richter, (loc. cit. where are also other anal.); 18, Kersten, (J. f. pr. Ch. xxxvii, 164):

		$\dddot{S}i$	$\dot{M}g$	$\dot{F}e$	$\dot{H}$	$\dddot{\bar{A}}l$
1.	*Fol. Talc*, Greiner,	62·8	32·4	1·6	2·3	1·0=100·1, Kobell.
2.	" Katherinen.,	62·8	31·92	1·10	——	0·60, $\dot{C}a$ 1·92=98·34, Kob.
3.	" Zillerthal,	63·0	33·6	*tr.*	3·4	——=100, Delesse.
4.	" R. Island,	61·75	31·68	1·70	3·83	——=98·96, Delesse.
5.	" Chamouni,	62·58	35·40	1·98	0·04	——=100, Marignac.
6.	" Tyrol,	62·38	31·19	1·42	4·73	——$\dot{N}i$ 0·20=99·92, Sch.; G. 2·69.
7.	" Röraas,	61·98	30·41	1·59	5·04	0·04=99·06, Sch.; G. 2·78.
8.	*Steatite*, Abo,	63·95	28·25	——	2·71	0·78, ign. 3·94 $\ddot{\bar{F}}e$ 0·6=100·23, T.
9.	" Sala,	63·13	34·30	2·27	——	——=99·70, Lychnell.
10.	" Mt. Caunegou,	66·70	30·23	2·41	——	——=99·34, Lychnell.
11.	" Scotland,	64·53	27·70	6·85	——	——=99·08, Lychnell.
12.	" Wunsiedel,	62·03	31·44	1·88	4·96	——=100·31, Scheerer.
13.	" Parma,	62·18	30·46	2·53	4·97	*tr.* =100·14, Richter.
14.	" *Pseudomorph*,	62·07	31·13	1·69	4·83	0·39=100·11, Scheerer.
15.	*Indur'd*, Gloggnitz,	62·47	32·08	0·47	4·78	0·13=99·93, Scheerer; G. 2·78.
16.	*Sparry*, Piedmont,	61·96	31·02	1·47	4·92	——=99·37, Scheerer; G.=2·79.
17.	*Agalmat.* China,	62·30	31·32	1·62	4·89	0·06=100·19, Scheerer.
18.	*Lardite*, Voigtsberg,	66·02	31·94	0·81	0·2	——$\dot{N}a$, $\dot{K}$ *tr.* 0·75=99·72, Kers.

Stromeyer found 0·4 $\dot{N}i$ in the talc of Röraas, and 0·43 $\dot{N}i$ in that of Sell.

A steatite from Göpfersgrün in which Klaproth found but 59·5 per cent. of silica, has been called *Hydrosteatite*.

B.B. talc loses color, not fusing, or rarely with difficulty on the edges. With borax it intumesces, and forms a clear glass, sometimes colored with iron. Not attacked by the acids.

This species is very generally diffused, and in some of its varieties especially common talc, potstone, and steatite, forms extensive beds in regions of crystalline rocks, which often contain rhomb spar, dolomite, (var. bitter spar), magnetic iron, and actinolite.

Apple-green talc occurs in the island of Unst, one of the Shetland isles; also in the Greiner mountain in Saltzburg, and in the Vallais, etc. Other foreign localities of *potstone* are, the Vallais and Grisons, and Wald, in Styria.

Extensive beds of steatite occur in various part of the New England States, also in New Jersey, Pennsylvania, &c. A bed at Smithfield, R. I., affords a delicate green columnar variety of talc, and a crystalline limestone in the same region, a white granular variety. At Bridgewater, Vt., handsome green talc occurs, intermingled with a transparent massive dolomite; also at Dexter, Me.; Lockwood, Newton, and Sparta, N. J.; near Amity, N. Y.; on Staten Island, both common and indurated, near the quarantine; and four miles distant it occurs in detached masses made up of folia, of a snow-white color, (Beck); at Cooptown, Md., of green, blue, and rose colors; in South Mountain, ten miles south of Carlisle, Penn.; in Texas, Nottingham, and Unionville, Penn.

Steatite occurs in Vermont at Athens or Grafton, Westfield, Marlboro, and Newfane; in New Hampshire at Francestown, Pelham, Orford, Keene, and Richmond; in Massachusetts at Middlefield, Windsor, Blanford, Andover, and Chester; at Potton, Canada East, with green talc and magnesite.

Slabs of steatite are extensively employed as fire stones in furnaces and stoves. It may be turned in a lathe, or formed into tubes by boring. When ground, it is used for diminishing friction. It is also employed in the manufacture of some kinds of porcelain. Venetian talc is used for removing oil stains from woollen cloth, etc.

Hampshirite is a name applied by Hermann, to the steatite of steatitic pseudomorphs described and analyzed by Dewey, (Am. J. Sci., iv, 274, v, 249, vi, 334, 1822, 1823), who obtained $\dddot{\text{Si}}$ 50·60, $\dddot{\bar{\text{A}}}\text{l}$ 0·15, $\dot{\text{Mg}}$ 28·83, $\dot{\text{Fe}}$ 2·59, $\dot{\text{Mn}}$ 1·10, $\dot{\text{H}}$ 15·00. But the constituents of pseudomorphs are seldom pure species, and without thorough investigation afford no sufficient ground for instituting a new species. These have mostly the form of quartz.

MEERSCHAUM. Magnesite. Sepiolite, *Glocker*.

Compact, with a smooth feel, fine earthy texture.

H.=2—2·5; impressible by the nail. Color grayish-white, white, or with a faint yellowish or reddish tinge. Opaque.

Composition.—$\dot{\text{Mg}}\,\dddot{\text{Si}}+\dot{\text{H}}$?=Silica 60·9, magnesia 26·1, water 12·0. Analyses: 1, Lychnell, (K. V. Ac. H., 1826, 175); 2–6, Scheerer and Richter, (Pogg. lxxxiv, 321); 7, Damour, (Ann. Chem. Ph. [3], vii, 316):

	$\dddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$	
1. Asia Minor,	60·87	27·80	11·29,	$\dddot{\bar{\text{F}}}\text{e}$ and $\dddot{\bar{\text{A}}}\text{l}$ 0·09=100·05, Lychnell.
2. Turkey,	61·17	28·43	9·83,	$\dot{\text{Fe}}$ 0·06, $\ddot{\text{C}}$ 0·67=100·16, Scheerer.
3. "	61·49	28·13	9·82,	$\dot{\text{Fe}}$ 0·12, $\ddot{\text{C}}$ 0·67, $\dot{\text{Ca}}$ 0·60=100·83, Richter.
4. Greeee,	61·30	28·39	9·74,	$\dot{\text{Fe}}$ 0·08, $\ddot{\text{C}}$ 0·56=100·07, Scheerer.
5. ———?	58·20	27·73	9·64,	$\dot{\text{Ca}}$ 1·53, $\ddot{\text{C}}$ 2·73=99·83, Richter.
6. ———?	60·45	28·19	9·57,	$\dot{\text{Fe}}$ 0·09, $\ddot{\text{C}}$ 1·74, $\dddot{\bar{\text{A}}}\text{l}$ 0·11=100·15, Scheerer.
7. Morocco,	55·00	28·00	10·35,	$\dddot{\bar{\text{F}}}\text{e}$ 1·40, $\dddot{\bar{\text{A}}}\text{l}$ 1·20, $\dot{\text{Ca}}$ 1·01, $\dot{\text{K}}$ 0·52, sand 1·50 =98·98, Damour.

19 to 20 per cent. of water were found by Berthier in Meerschaum from Madrid and Coulommiers, (Ann. des M. vii, 313); and by Kobell in that of Greece, (J. f. pr. Chem. xxviii, 482), as follows:

1. Spain,	$\dddot{\text{Si}}$ 53·8	$\dot{\text{Mg}}$ 23·8	$\dot{\text{H}}$ 20·0	$\dddot{\bar{\text{A}}}\text{l}$ 1·2=98·8, Berthier.
2. Coulommiers,	54·0	24·0	20·0	1·4=99·4, "
3. Greece,	48·0	20·06	19·6	*trace*, $\dddot{\bar{\text{F}}}\text{e}$ 12·40=100·06, Kobell.

Döbereiner also found 2 atoms of water (instead of 1) in the meerschaum of Asia Minor. Klaproth (Beit. ii, 172) found in the same 5 per cent. of carbonic acid, which proceeded from intermixed carbonate of magnesia.

Yields water in a matrass, blackens, and gives a burnt smell. B.B. on charcoal burns white and fuses on the thinnest edges. Dissolves readily in borax to a transparent glass. A lilac color with cobalt solution.

The word *Meerschaum* is German for *froth of the sea*, in allusion to its apparent lightness and whitish color.

Occurs in Asia Minor, in masses in stratified earthy or alluvial deposits at the plains of Eskihi-sher, where, according to Dr. J. Lawrence Smith, it has proceeded from the decomposition of carbonate of magnesia, which is imbedded in serpentine in the surrounding mountains. He observes that more or less carbonate of magnesia is often found in the meerschaum, (Am. J. Sci. [2], vii, 286); also found in Greece, at Hrubschitz in Moravia, and in Morocco.

NEOLITE, *Scheerer*, Ann. d. Ph. u. Chem. lxxi, 285.

In silky fibres stellately grouped; also massive.

H.=1—2. G.=2·77, (perfectly dried.) Color green. Lustre silky or earthy.

Composition.—Nearly ($\dot{\text{Fe}}$, $\dot{\text{Mg}}$) $\dddot{\text{Si}}+\frac{1}{3}\dot{\text{H}}$. Analyses: 1, 2, 3, Scheerer, (Pogg. lxxxiv, 321); 4, Richter, (ibid.):

	$\dddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{Ca}}$	$\dot{\text{H}}$
1. Arendal,	52·28	7·33	31·24	3·79	0·89	0·28	4·04=99·85.
2. "	47·35	10·27	24·73	7·92	2·64	—	6·28=99·19.
3. Eisenach,	51·35	9·02	30·19	0·79	—	1·93	6·50=99·78.
4. "	51·44	8·79	31·11	$\dddot{\text{Fe}}$0·88	—	2·00	6·50=100·72.

Neolite is a recent formation produced in mines at Arendal and Eisenach, through the agency of infiltrating waters that have passed over rocks containing magnesia; and hence the name, from *νεος*, *new*, and λιθος. It is considered a massive talc by Scheerer.

SPADAITE, *Kobell*, (J. f. pr. Chem. xxx, 467).

Massive, with an imperfectly conchoidal fracture.

H.=2·5. Lustre pearly. Color reddish, approaching flesh-red.

Composition.—$\dot{\text{Mg}}^5\dddot{\text{Si}}^4+4\dot{\text{H}}$ or $4\dot{\text{Mg}}\dddot{\text{Si}}+\dot{\text{Mg}}\dot{\text{H}}^4$. Analysis by Kobell:

$\dddot{\text{Si}}$ 56·00, $\dot{\text{Mg}}$ 30·67, $\dot{\text{Fe}}$ 0·66, $\dddot{\text{Al}}$ 0·66 $\dot{\text{H}}$ 11·34=99·33.

Yields much water in a matrass and becomes gray. B.B. melts to a glassy enamel. Dissolves in concentrated muriatic acid, the silica easily gelatinizing. From Capo di Bove, forming a conglomerate with Wollastonite. Named after Sign. Medici Spada.

CHLOROPHÆITE, *Macculloch.*

Foliated or granular massive, imbedded. Cleavage in two directions.

H.=1·5—2. G.=2·02. Lustre subresinous, rather dull. Color dark-green, olive-green, often changing to black.

Composition.—$\dot{\text{Fe}}\dddot{\text{Si}}+6\dot{\text{H}}$?=Silica 33·5, protoxyd of iron 26·6, water 39·9=100.

Analysis by Forchhammer, (J. f. pr. Chem. xxx, 399);

From Faroe, $\dddot{\text{Si}}$ 32·85, $\dot{\text{Fe}}$ 22·08, $\dot{\text{Mg}}$ 3·44, $\dot{\text{H}}$ 41·63=100,

the iron being corrected, (Rammelsberg), for the true atomic weight.

B.B. fuses to a black glass. From amygdaloid at Scuir More in Rum; also from the Faroe islands, Fife, and near Newcastle. Named from χλωρος, *green*, and φαιος, *brown.*

CROCIDOLITE. Krokidolite, *Hausmann.* Blue Asbestos. Blaueisenstein, *Klap.*

Fibrous, asbestus-like; fibres long but delicate and easily separable. Also massive.

H.=4. G.=3·2—3·265. Color and streak lavender-blue or leek-green. Opaque. Fibres somewhat elastic.

Composition.—$\dot{R}^6\dddot{Si}^5+2\dot{H}$=Silica 51·1, protoxyd of iron 35·8, soda 6·9, magnesia 2·3, water 3·9=100. But the iron may not be all protoxyd. It is possibly an altered augite.

	$\dddot{Si}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{Na}$	$\dot{H}$
1. *Asbestiform,*	50·81	33·88	0·17	2·32	0·02	7·03	5·58=98·81.
2. *Plumose,*	51·64	34·38	0·02	2·64	0·05	7·11	4·01=99·85.

B.B. heated to redness melts easily to a black shining, opaque, and somewhat frothy glass, which is attractable by the magnet. Single fibres readily fuse in the flame of a spirit lamp. With borax forms a green transparent bead, which, by adding saltpetre, changes to brown.

Occurs in Africa, in the Grigna county, beyond the Great Orange river, seven hundred miles up from the Cape of Good Hope. Stavern in Norway is stated as another locality; but the mineral it affords does not precisely resemble the African variety.

Named from κροκις, *woof,* in allusion to its wood-like fibrous structure.

II. SERPENTINE SECTION.

	$\dot{R}$ $\dddot{Si}$ $\dot{H}$	*Formulas.*
PICROPHYLL,	$1:2:\frac{2}{3}$	$\dot{R}^3\dddot{Si}^2+2\dot{H}$.
? KEROLITE,	$1:2:\frac{3}{2}$	$\dot{R}^3\dddot{Si}^2+4\frac{1}{2}\dot{H}$.
MONRADITE,	$1:2:\frac{1}{4}$	$\dot{R}^3\dddot{Si}^2+\frac{3}{4}\dot{H}$.
APHRODITE,	$1:2:\frac{3}{4}$	$\dot{Mg}^3\dddot{Si}^2+2\frac{1}{4}\dot{H}$.
PICROSMINE,	$1:2:\frac{1}{2}$	$\dot{Mg}^3\dddot{Si}^2+1\frac{1}{2}\dot{H}$.
ANTIGORITE,	$1:1\frac{1}{2}:\frac{1}{4}$	$\dot{R}^3\dddot{Si}^2+\dot{Mg}\dot{H}$.
SAPONITE,		? $\dot{R}^3\dddot{Si}^2+\frac{1}{2}\ddot{Al}\dddot{Si}+Aq$.
SERPENTINE,	$1:1\frac{1}{3}:\frac{2}{3}$	$\dot{Mg}^3\dddot{Si}^2+1\frac{1}{2}\dot{Mg}\dot{H}^2$.
DEWEYLITE,	$1:1\frac{1}{2}:1\frac{1}{2}$	$\dot{Mg}\dddot{Si}+\dot{Mg}\dot{H}^3$.
HYDROPHITE,	$1:1\frac{1}{2}:1\frac{1}{2}$	? $\dot{R}\dddot{Si}+\dot{Mg}\dot{H}^3$.

Related to the above species are the magnesian compounds, which have resulted from the alteration of augite, viz.: Rensselaerite, Pyrallolite, Schiller Spar, Green Earth, Hydrosilicite, (see p. 165); and perhaps to the same origin should also be attributed some of the above species having (the water excluded) the augite formula $\dot{R}^3\dddot{Si}^2$.

PICROPHYLL, *Svanberg*, Pogg. l, 662.

Massive and foliated fibrous. Color deep greenish-gray. H.=2·5. G.=2·75.

Composition.—$(\dot{\mathrm{Mg}}, \dot{\mathrm{Fe}})^3\dddot{\mathrm{Si}}^2+2\dot{\mathrm{H}}$. Analysis by Svanberg:

$\dddot{\mathrm{Si}}$ 49·80, $\dot{\mathrm{Mg}}$ 30·10, $\dot{\mathrm{Fe}}$ 6·86, $\dot{\mathrm{Mn}}$ *trace*, $\dot{\mathrm{Ca}}$ 0·78, $\dddot{\mathrm{Al}}$ 1·11, $\dot{\mathrm{H}}$ 9·83=98·48.

Yields water in a matrass. B.B. like Picrosmine.

From Sala, Sweden. The name is from *πικρος*, *bitter*, and *φυλλον*, *leaf.* May be altered augite.

KEROLITE, *Breithaupt*.

Massive, reniform, compact or lamellar.

H.=2—2·5. G.=2—2·4. Vitreous or resinous. White or green. Streak uncolored. Transparent—translucent. Feel greasy. Fracture conchoidal. Does not adhere to the tongue.

Composition.—$\dot{\mathrm{Mg}}^3\dddot{\mathrm{Si}}^2+4\tfrac{1}{2}\dot{\mathrm{H}}$. Analyses: 1, 2, Kühn, (Ann. d. Ch. u. Ph. lix, 368); 3, Melling, (Ramm. First Sup. p. 79):

	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$	$\dot{\mathrm{Fe}}$	$\dddot{\mathrm{Al}}$	
1. Silesia,	47·34	29·84	21·04	——	——	=98·22, Kühn.
2. Zöblitz,	46·96	31·26	21·22	——	——	=99·44, "
3. "	47·128	36·128	11·500	2·922	2·570	=100·248, Melling.

Pfaff found 37·95 silica, and 12·18 alumina, with 18·02 magnesia, and 31·00 water, in a Silesian specimen; and Delesse in one from Zöblitz, Silica 53·5, magnesia 28·6, alumina and peroxyd of iron 0·9, water 16·4=99·4. Maak obtained from his analysis of a Frankenstein specimen, the formula $\dot{\mathrm{Mg}}^3\ \dddot{\mathrm{Si}}^2+\dddot{\mathrm{Al}}\ \dddot{\mathrm{Si}}+15\dot{\mathrm{H}}$=Silica 36·8, alumina 12·2, magnesia 19, water 32. B.B. blackens but does not fuse.

From Zöblitz in Saxony and Frankenstein in Silesia, associated with serpentine. Two or three minerals or mixtures are indicated by the analyses. The name Kerolite is from *κηρος*, *wax*, and *λιθος*.

Dermatin, *Breithaupt.* Massive, reniform or in crusts on serpentine, of a resinous lustre and green color. Feel greasy; odor when moistened, argillaceous.

Composition, according to Ficinus, (Min. Ges. zu Dresden, ii, 215):

	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Fe}}$	$\dddot{\mathrm{Mn}}$	$\dot{\mathrm{H}}, \ddot{\mathrm{C}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$
1.	35·80	23·70	11·33	2·25	25·20	0·42	0·83	0·50=100·03.
2.	40·17	19·33	14·00	1·17	22·00	0·83	0·83	1·33, $\dddot{\mathrm{S}}$ 0·43=100·10.

Formula $(\dot{\mathrm{Mg}}, \dot{\mathrm{Fe}})^3\dddot{\mathrm{Si}}^2+6\dot{\mathrm{H}}$? B.B. blackens and cracks.

From Waldheim in Saxony. The name is from *δερμα*, *skin*, alluding to its occurrence as an incrustation.

MONRADITE, *Erdmann*, K. V. Ac. H. 1842, p. 103.

Massive, granular; also foliated, with one distinct and another imperfect cleavage, inclined 130°.

H. nearly 6. G.=3·2673. Color pale yellowish, verging on red. Lustre vitreous.

Composition.—$(\dot{\mathrm{Mg}}, \dot{\mathrm{Fe}})^3\dddot{\mathrm{Si}}^2+\tfrac{3}{4}\dot{\mathrm{H}}$. Analysis by Erdmann:

$\dddot{\mathrm{Si}}$ 56·17, $\dot{\mathrm{Mg}}$ 31·63, $\dot{\mathrm{Fe}}$ 8·56, $\dot{\mathrm{H}}$ 4·04=100·40.

Yields water when heated. B.B. infusible alone; with borax affords a glass colored by iron, and with salt of phosphorus a silica skeleton.

From Bergen in Norway. Named after M. Monrad.

APHRODITE. *Berlin*, K. V. Ac. H. 1840.

Soft and earthy like Meerschaum. G.=2·21.

Composition.—$\dot{M}g^3\dddot{S}i^2+2\frac{1}{4}\dot{\bar{H}}$. Berlin obtained Silica 51·55, magnesia 33·72, protoxyd of manganese 1·62, protoxyd of iron 0·59, alumina 0·20, water 12·32. From Longbanshytta, Sweden. The name is from αφρος, *foam.*

Delesse has analyzed another species, containing Silica 53·5, magnesia 28·6, alumina with trace of peroxyd of iron 0·9, water 16·4=nearly $\dot{M}g^3\dddot{S}i^2+3\dot{\bar{H}}$. Occurs in serpentine, of a white or yellowish color, with a waxy lustre and somewhat translucent. G.=2·335.

Quincite.—The *Quincite* of Berthier is in light carmine red particles disseminated through a limestone deposit.

Composition.—Silica 54, magnesia 19, protoxyd of iron 8, water 17=98. From near the village of Quincey, France. Strong concentrated acids dissolve the magnesia and iron, and leave the silica in a gelatinous state.

PICROSMINE. Pikrosmin, *Haidinger.*

Trimetric. $I:I=126°\ 52'$, $\bar{i}i:I=153°\ 26'$, $\breve{i}i:1\breve{i}=121°\ 6'$, $1\breve{i}:1\breve{i}$ (over $\breve{i}i$)$=62°\ 11'$, adjacent 117° 49′. Cleavage: $\breve{i}i$ perfect; $\bar{i}i$ less so; traces parallel with $1\breve{i}$. Also fine columnar and granular.

H.=2·5—3. G.=2·596—2·68. Lustre of cleavage face pearly, elsewhere vitreous. Color greenish-white: also dark green, gray. Streak white. Subtranslucent—opaque. Odor bitter argillaceous when moistened.

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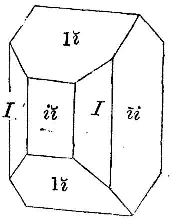

Composition.—$\dot{M}g^3\dddot{S}i^2+1\frac{1}{2}\dot{\bar{H}}$=Silica 55·2, magnesia 36·6, water 8·2. Analysis by Magnus, (Pogg. vi, 53):

$\dddot{S}i$ 54·886, $\dot{M}g$ 34·348, $\dddot{\bar{A}}l$ 0·793, $\dddot{\bar{F}}e$ 1·399, $\dot{M}n$ 0·420, $\dot{\bar{H}}$ 7·301=98·147.

Some ammonia was given off with the water. Yields water in a matrass, blackens, and has a burnt smell. B.B. on charcoal whitens without fusing. With borax slowly dissolves to a transparent glass; affords a glass with little soda, and an infusible slag if the soda be increased. A pale and indistinct red with cobalt solution.

Associated with magnetic iron ore near Presnitz in Bohemia. The fibrous variety resembles asbestus. The name is from πικρος, *bitter*, and οσμη, *odor.*

ANTIGORITE, *Schweizer*, Pogg. Ann. xlix, 595.

Trimetric. In foliated masses, laminæ easily separating.

H.=2·5. G.=2·622. Brownish-green in reflected light and leek-green in transmitted, with uncolored streak. Transparent in thin laminæ. Feel smooth, but not greasy.

Composition.—$\dot{R}^3\dddot{S}i^2+\dot{M}g\dot{\bar{H}}$, Schw. Analyses by Schweizer, (loc. cit.):

	$\dddot{S}i$	$\dot{M}g$	$\dot{F}e$	$\dddot{\bar{A}}l$	$\dot{\bar{H}}$
1.	46·22	34·39	13·05	2·08	3·70=99·44.
2.	46·18	35·19	12·68	1·89	3·70=99·64.

In a matrass yields water. B.B. fuses on thin edges to a yellowish-brown enamel. With borax forms easily a glass colored by iron. Decomposed with some difficulty by concentrated muriatic acid, affording a greenish solution.

From the Antigorio valley to the north of Domo d'Ossola, Piedmont; also reported from Mount Albrun between Oberwallis and Piedmont, where masses 5 inches long and over 2 thick are said to have been obtained.

SAPONITE. Steatite. Soapstone. Seifenstein. Pierre de Savon, *H.*

Massive. Soft, almost like butter, but brittle on drying. Lustre greasy. G.=2·26. Color white, yellowish, bluish, reddish. Does not adhere to the tongue.

Composition.—$2\dot{M}g^3\dddot{S}i^2+\ddot{\bar{A}}l\dddot{S}i+10\dot{H}$ (or $6\dot{H}$). Analyses: 1, Klaproth, (Beit. ii, 180, v, 22); 2, Svanberg, (K. V. Ac. H., 1840, and Pogg. lvii, 165); 3, 4, Smith and Brush, (Am. J. Sci. [2], xvi, 368); 5, Svanberg, (Pogg. liv, 267, lvii, 165):

	$\dddot{S}i$	$\ddot{\bar{A}}l$	$\ddot{\bar{F}}e$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	$\dot{H}$
1. Cornwall,	45·00	9·25	1·00	24·75	—	0·75	18·00=98·75, Klaproth.
2. "	46·8	8·0	0·4	33·3	—	—	11·0, $\dot{C}a$ 0·7=100·2, Svanberg.
3. *Thalite,*	45·60	4·87	2·09	24·10	0·45		20·66, $\dot{C}a$ 1·07=98·84, S. & B.
4. "	48·89	7·23	2·46	24·17	0·81		15·66=99·22, S. & B.
5. *Piotine,*	50·89	9·40	2·06	26·52	—	—	10·50, $\dot{C}a$ 0·78=100·15, Svan.

B.B. gives out water and blackens; thin splinters fuse with difficulty on the edges. Wholly soluble in sulphuric acid.

Occurs at Lizard's Point, Cornwall; in the geodes of datholite at Roaring Brook, near New Haven, Ct.; in the trap of the north shore of Lake Superior, (Thalite of Owen, J. Acad. Nat. Sci. Philad. 1852); at Svärdsjö in Dalarne. Saponite is from *sapo, soap;* and Piotine, from *πιοτης, fat.*

A Saponite-like mineral from Morocco, afforded Damour the composition of Meerschaum.

SERPENTINE, *Linn.*, *Werner.* Marmolite of *Nuttal,* Silliman's Journal, iv, 18. Οφιτης, Ophitis, *Vetruvius.* Picrolite, *Hausmann.* Baltimorite, *Thom.* Kypholite, *Breit.* Chrysotil, and Schillernder Asbest, *Kobell.* Metaxite, (in part).

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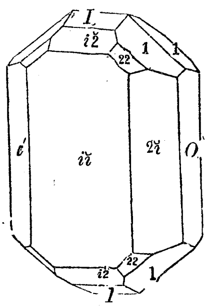

Supposed to be Trimetric: but the crystals, like the annexed, are probably pseudomorphs of Chrysolite. Usually massive, granular to impalpable; also fibrous and foliated.

H.=3—4, rarely 5. G.=2·507—2·591; some fibrous varieties 2·2—2·3. Lustre resinous—greasy; low degrees of intensity. Color leek-green and blackish-green; occasionally, oil and siskin-green; none bright; sometimes nearly white. On exposure, becoming yellowish-gray. Streak white, slightly shining. Translucent—opaque. Fracture conchoidal or splintery. Sectile.

VARIETIES. *Precious* or *Noble Serpentine.*—Translucent and massive, with a rich oil-green color, of pale or dark shades.

Common Serpentine.—Opaque or nearly so, and often of dark shades of green. Constitutes extensive beds.

Picrolite, Hausmann.—A fibrous variety of a dark green color, somewhat resembling asbestus. *Baltimorite* is an allied variety, and so also *Chrysotile* and

Metaxite, (in part). Chrysotile is fine asbestiform, of olive oil, yellowish or brownish color, and metallic or silky lustre. G.=2·219. It is the so-called asbestus or amianthus occurring in serpentine. Metaxite of Delesse does not differ in composition from Chrysotile.

Marmolite.—A thin foliated variety; folia brittle, separable. G.=2·41. Of a pale green color, sometimes nearly white. A lamellar variety in which the laminæ are not separable, is sometimes misnamed *Kerolite.*

Retinalite has a resinous appearance, honey yellow to oil green color, and is translucent. H.=3·5. G.=2·47—2·53. *Bowenite* resembles nephrite and has a hardness of 5.

Composition.—$\dot{\mathrm{M}}\mathrm{g}^3\dddot{\mathrm{S}}\mathrm{i}^2+1\frac{1}{2}\dot{\mathrm{M}}\mathrm{g}\dot{\mathrm{H}}^2=\dot{\mathrm{M}}\mathrm{g}^9\dddot{\mathrm{S}}\mathrm{i}^4\dot{\mathrm{H}}^6$=Silica 43·64, magnesia 43·35, water 13·01. Analyses: 1, Hartwall, (Jahresb. ix, 204); 2, Hisinger, (Afhand. iv, 341); 3, Mosander, (K. V. Ac. H. 1825, 227); 4, 5, 6, Lychnell, (ib. 1826, 175); 7, Scheerer, (Pogg. Ann. lxviii, 328); 8, 9, Jordan and Marchand, (J. f. pr. Chem. xxxii, 499); 10, Hermann, (ib. xlvi, 227); 11, Ivanoff, (Ann. Mines Russ. for 1841, 333); 12, Garrett, (this Min. 3d edit., 692); 13, Lychnell, (loc. cit.); 14, Shepard, (Min. p. 292); 15, Vanuxem, (J. Ac. Sci. Phil. iii); 16, Beck, (Min. N. Y., 280); 17, Hermann, (J. f. pr. Ch. xlvi, 230); 18, Stromeyer, (Unters. 365); 19, Schaffgotsch, (Rose, Reise n. d. Ural, i, 245); 20, Rammelsberg, (3d Suppl. 107); 21, Kobell, (J. f. pr. Chem. ii, 297); 22, Thomson, (Phil. Mag. xxii, 193); 23, Delesse, (Thése An. 24); 24, Kühn, (Ann. Ch. u. Pharm. lix, 369); 25, G. J. Brush, (communicated to the author); 26–28, Hunt, (Logan's Rep. 1851, 41, and Am. J. Sci. [2], xii, 213); 29–31, Smith and Brush, (ibid., xv, 213); 32, Kersten, (J. f. pr. Ch. xxxvii, 167):

I. *Massive Serpentine.*

	$\dddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{H}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$
1. Snarum, *crystallized,*	42·97	41·66	—	12·02	0·87, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 2·48=100, Hartwall.
2. Fahlun,	43·07	40·37	1·17	12·45	0·25, $\dot{\mathrm{C}}\mathrm{a}$ 0·50=97·81, Hisinger.
3. Wermland,	42·34	44·20	0·18	12·38	—, $\ddot{\mathrm{C}}$ 0·89=99·97, Mosander.
4. Fahlun,	41·95	40·64	2·22	11·68	0·37, $\ddot{\mathrm{C}}$ and bitumen 3·42, L.
5. Sjögrube,	41·58	42·41	2·17	11·29	*trace,* “ “ 2·38=99·33, L.
6. Massachusetts,	43·20	40·09	5·24	11·42	—=99·95, Lychnell.
7. Snarum,	40·71	41·48	2·43	12·61	2·39=99·62, Scheerer.
8. Fahlun, G.=2·53,	40·32	41·76	3.33	13·54	—=98·95, Jordan.
9. “	40·52	42·05	3·01	13·85	0·21, Coaly subst. 0·3=99·94, M.
10. L. Auschkal, *crystals,*	40·21	35·09	9·13	13·75	1·82=100, Hermann, G.=2·57.

II. *Foliated varieties—including Marmolite.*

11. Urals, G.=2·55,	40·80	40·50	2·2	12·02	3·02, $\dot{\mathrm{C}}\mathrm{a}$ 0·42, $\dot{\mathrm{M}}\mathrm{n}$ 0·2=99·16, I.
12. Hoboken,	42·32	42·23	1·28	13·80	0·66=100·29, Garrett.
13. “	41·67	41·25	—	13·80	—, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 1·64, $\ddot{\mathrm{C}}$* 1·37=99·73.
14. Blandford,	40·00	41·40	2·70	15·67	—, $\dot{\mathrm{C}}\mathrm{a}$ 0·93=100·70, Shep.
15. Bare Hills, Md.,	42·69	40·00	1·16	16·11	—, $\ddot{\mathrm{C}}$ 0·87=99·96, Vanuxem.
16. Westchester Co., N. Y.,	40·50	38·00	—	21·00	—=99·50, Beck.
17. Finland,	40·00	42·40	1·80	15·80	—=100, Hermann.

* With bitumen.

III. *Fibrous varieties, (including Chrysotile, Metaxite in part, Baltimorite.)*

18. Wermland, *Picrolite,*	41·66	37·16	4·05	14·72	—, $\dddot{\bar{\mathrm{M}}}\mathrm{n}$ 2·25=99·84, Strom.
19. Gornoschit,	43·73	37·72	6·11	11·63	0·81=100, Schaffgotsch.
20. Texas, Pa. G.=2·557,	43·79	41·03	2·05	12·47	—=99·34, Rammelsberg.
21. Reichenstein, *Chrysotile,*	43·50	40·00	2·08	13·80	0·40=99·78, Kobell,
22. Bare Hills, *Baltimorite,*	40·95	34·74	10·05	12·60	1·50=99·80, Thomson.
23. Reichenstein, *Metaxite,*	42·1	41·9	3·0	13·06	0·4=100, Delesse.
24. “ “	44·48	40·60	2·34	12·35	—=99·77, Kühn.
25. N. Haven, Ct., *Chrysotile,*	44·05	39·24	2·53	13·49	—=99·31, Brush. G.=2·49

IV. *Retinalite—Williamsite—Bowenite.*

		$\dddot{Si}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{H}$	$\ddot{\bar{Al}}$
26.	*Retinalite*, Grenville,	39·34	43·02	$\ddot{\bar{Fe}}$ 1·80	15·09	——=99·25, Hunt. G.=2·494.
27.	" "	40·10	41·65	" 1·90	15·00	——=99·55, "
28.	" G. Calumet, I.	41·20	43·52	" 0·80	15·40	——=100·92, " G.=2·370.
29.	*Williamsite*,	41·60	41·11	3·24	12·70	*trace*, $\dot{Ni}$ 0·50=99·15, S. & B.
30.	"	42·60	41·90	1·62	12·70	" " 0·40=99·22, S. & B.
31.	*Bowenite*,	42·29	42·29	1·21	12·96	" $\dot{Ca}$ 1·90=99·65*, S. & B.
32.	*Pseud.* after Garnet,	41·50	40·34	4·10	12·87,	$\ddot{\bar{Mn}}$ 0·5, $\dot{Na}$ 0·42, $\ddot{C}_3\dot{Ca}$, Bit., *tr.* =99·73, Kersten.

* Mean of three analyses.

A *Serpentine* from Vermont afforded Dr. Jackson, (Am. J. Sci. xxxviii, 198), $\dddot{Si}$ 45·80, $\dot{Mg}$ 33·41, $\dot{H}$ 7·70, Magnetic iron 2·00, Oxyd of Chromium 2·00. Lychnell detected 2·24 per cent. of protoxyd of cerium in one serpentine.

The *Meerschaum* of Taberg and Sala, Sweden, is a soft earthy serpentine.

The *Marmolite*, according to Hermann, differs in containing more water as well as in its foliated structure, and gives the formula $\dot{Mg}^3\dddot{Si}^2+2\dot{Mg}\dot{H}^3=\dot{Mg}^6\dddot{Si}^2\dot{H}^4$.

Delesse found for *Chrysotile* from the Vosges the composition of serpentine, (Ann. d. M. [4], xviii, 309). The pseudomorphs, anal. 32, were from Schwarzenburg, in Saxony.

As serpentine is mostly a rock, the analyses must be expected to disagree, and every portion of alumina or water present, cannot in all cases be assumed to be an essential constituent.

Serpentine yields water in a matrass. B.B. on charcoal, fuses on the edges with difficulty. Dissolves readily in borax; with effervescence in salt of phosphorus. Gives usually an iron reaction. Soluble in muriatic and sulphuric acids.

Serpentine often constitutes mountain masses. Mixed with carbonate of lime, it forms *verd antique marble*, which occurs often in extensive beds. Chromic iron is often disseminated through it, giving it a mottled appearance, somewhat similar to the skin of a snake, whence the name *serpentine* or *ophite*. It is very commonly a result of pseudomorphic (or metamorphic) changes. Hornblende, augite, chrysolite, garnet, spinel, mica, and many other minerals, have thus been altered. Delesse says, that the Serpentine of Odern sometimes so graduates into feldspar as to appear to have been formed at the expense of that mineral. Rose has found that some of the supposed crystals of serpentine are actually part chrysolite, the change not having been complete.

Crystals of serpentine occur in the Fassa valley, Tyrol; near Miask at Lake Auschkal, Barsovka, Katharinenberg, and elsewhere; in Norway at Snarum, (crystals). Fine precious serpentines come from Fahlun and Gulsjo in Sweden, the Isle of Man, the neighborhood of Portsoy in Aberdeenshire, Corsica, Siberia, and Saxony; in crystals at Lake Auschkal, in Miask, Borsovka, etc. Common serpentine occurs at Lizard's Point in Cornwall, and many other places.

In the United States, precious serpentine of a light-green color occurs at Phillipstown, in the Highlands, N. Y.; also at Port Henry, Essex Co.; at Antwerp, Jefferson Co., in crystals; at Syracuse, east of Major Burnet's, interesting varieties; in Gouverneur, St. Lawrence Co., in crystals, and also in Rossie, two miles north of Somerville; at Johnsburg in Warren Co.; Davenport's Neck, Westchester Co., affording fine cabinet specimens; in Cornwall, Monroe, and Warwick, Orange Co., sometimes in large crystals at Warwick; and from Richmond to New Brighton, Richmond County. In Massachusetts, fine at Newburyport; at Blanford with Schiller spar, and the marmolite variety; also at Westfield, Middlefield, Lynnfield, Newburyport, and elsewhere. In Maine, at Deer Isle. In Vermont, at New Fane, &c. In Rhode Island, at Newport. In Connecticut, near New Haven, at the verd antique quarries. In New Jersey, at Hoboken, with brucite, magnesite, &c., and the marmolite variety; also at Frankfort and Bryan; at Montville, Morris Co., silky fibrous, (chrysotile), and similar at New Haven, Ct. In Maryland, at Cooptown, Harford Co., with diallage; also in the north part of Cecil Co. In Pennsylvania, massive, fibrous and foliated, of various colors, purple, brown, green, and gray, at Texas, Lancaster Co.; also at Nottingham and West Goshen, Chester Co.; and Mineral Hill, Delaware Co. Westchester, Chester Co., Pa., affords the serpentine called *Williamsite*, by Shepard, (Am. J. Sci. [2], vi, 249). *Bowenite* is from Smithfield, Rhode Island. Serpentine also occurs in Canada, (see for analysis by T. S. Hunt, Am. J. Sci. [2], xv, 436, from Logan's Geol. Report, 1851, 1852); a greenish-white subtranslucent variety, is the gangue of chromic iron at Ham; it afforded T. S. Hunt, $\ddot{\mathrm{Si}}$ 43·4, $\dot{\mathrm{Mg}}$ 40·0, $\dddot{\mathrm{Al}}$ and $\dddot{\mathrm{Fe}}$ 3·6, $\dot{\mathrm{H}}$ 13·0.

Serpentine admits of a high polish, and may be turned in a lathe, and is sometimes employed as a material for ornaments, vases, boxes, &c. At Zöblitz in Saxony, Bayreuth, and in Franconia, several hundred persons are employed in this manufacture. Verd antique marble is clouded with green of various shades, and is a beautiful material for table and ornamental in-door work. Exposed to the weather it wears uneven, owing to its unequal hardness, and soon loses its polished surface. Serpentine may be used for the manufacture of epsom salt.

A "*picrolite*" from Silesia afforded Dr. List (Ann. d. Ch. u. Pharm., lxiv, 20) $\ddot{\mathrm{Si}}$ 44·606, $\dot{\mathrm{Mg}}$ 39·748, $\dot{\mathrm{Fe}}$ 2·631, $\dot{\mathrm{H}}$ 2·576=99·561. It is remarkable for the small percentage of water.

A so-called *Baltimorite*, from Baltimore, analyzed by von Hauer, (Jahrb. Geol. Reichs. 1853), is a different mineral from that of Thomson, and probably a mixture. He obtained $\ddot{\mathrm{Si}}$ 27·15, $\dddot{\mathrm{Al}}$ 18·54, $\dot{\mathrm{Ca}}$ 15·08, $\dot{\mathrm{Mg}}$ 26·00, $\dot{\mathrm{H}}$ 13·23=100. See further, p. 293.

Retinalite of Thomson is shown by Hunt to be nothing but serpentine, his specimens having been authentic. The name is from *ρετινη*, *resin.*

VILLARSITE. Villarsite of Dufrénoy, according to G. Rose, is pseudomorphic after chrysolite, like serpentine. *I* : *I* as given, is 119° 59′; in rhombic octahedrons of 139° 45′. Named after M. Villars.

METAXITE, *Breithaupt*, *Plattner*. The metaxite of Schwarzenberg, is a fibrous mineral of a weak pearly lustre and greenish white color. H.=2—2·5. G.=2·52.

Composition.—According to analyses by Plattner, (Prob. Löth. 2d ed.):

	$\ddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$	$\dddot{\mathrm{Al}}$
1. *Metaxite*	40·0	32·8	12·6	10·7, $\dot{\mathrm{Fe}}$ 2·3, $\dot{\mathrm{Ca}}$ 1·1=99·5, Plattner.
2. "	43·60	34·24	12·67	6·10, $\dddot{\mathrm{Fe}}$ 2·8=99·41, Plattner.

Named from *μεταξα*, *silk.*

XYLOTILE, *Glocker*. (Bergholz, of Sterzing.) Delicately fibrous. Soft. G.=2·4—2·56. Glimmering. Wood-brown, light or dark, also green. Streak somewhat shining. Opaque.

Composition.—Thaulow obtained (Pogg. xli, 635) $\ddot{\mathrm{Si}}$ 55·58, $\dddot{\mathrm{Fe}}$ 19·44, $\dot{\mathrm{Mg}}$ 15·50, $\dot{\mathrm{Ca}}$ 0·10, $\dddot{\mathrm{Al}}$ 0·04, $\dot{\mathrm{H}}$ 10·27=09·93. Von Hauer in recent analyses finds (Sitz. Wien. Akad., xi, 388):

	$\ddot{\mathrm{Si}}$	$\dddot{\mathrm{Fe}}$	$\dddot{\mathrm{Al}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{H}}$
1.	44·31	21·88	*trace*	8·90	2·27	21·57
2.	45·53	21·76	*trace*	11·08	*trace*	22·01
3.	47·96	18·12	*trace*	12·37	*trace*	21·64

Kengott considers it as probably altered Chrysotile. The composition is not constant.

Xylite of Hermann is near Xylotile in its constitution as well as its brown color and asbestiform structure. Hermann obtained (J. f. pr. Ch. xxxiv, 180) $\ddot{\mathrm{Si}}$ 44·06, $\dddot{\mathrm{Fe}}$ 37·84, $\dot{\mathrm{Ca}}$ 6·58, $\dot{\mathrm{Mg}}$ 5·42, $\dot{\mathrm{Cu}}$ 1·36, $\dot{\mathrm{H}}$ 4·70=99·96. H.=3. G.=2·935.

DEWEYLITE, *Emmons*, Man. Min. and Geol. 1826. Gymnite, *Thomson*.

Amorphous, and having some resemblance to Gum Arabic.

H.=2—3·5. G.=2·246, Middlefield, Shepard; 2·19—2·31, Bare Hills, Tyson; 2·216, ib. Thomson; 1·936—2·155, Tyrol, Oellacher. Lustre greasy. Color whitish, yellowish, wine-yellow, greenish, reddish. Translucent. Brittle and often much cracked.

Composition.—$\dot{\mathrm{Mg}}^2\ddot{\mathrm{Si}}+3\dot{\mathrm{H}}$, Kobell, or $\dot{\mathrm{Mg}}\ddot{\mathrm{Si}}+\dot{\mathrm{Mg}}\dot{\mathrm{H}}^3$=Silica 40·3, magnesia 35·6, water 24·1. Analyses: 1, Shepard, (Am. J. Sci., xviii, 31, 1830, analysis imperfect);

2, Brush, (communicated to the author); 3, Thomson, (Phil. Mag. 1843, 191); 4, Oellacher, (Zeits. geol. Ges., iii, 222); 5, Kobell, (Münch. gel. Anz., 1851, xxxiii, 1):

	$\dddot{Si}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{H}$	$\overset{...}{\overline{Al}}$	$\overset{...}{\overline{Fe}}$	
1. Middlefield,	40·	40·	——	20·	——	——	=100, Shepard.
2. Texas, Pa.,	43·15	35·95	——	20·25	*tr.*	——	=99·35, Brush.
3. Bare Hills, Md.,	40·16	36·00	0·80	21·60	*tr.*	1·16	=99·72, Thomson.
4. Tyrol,	40·40	35·85	——	22·60	——	0·38,	Apatite 0·78=100, O.
5. “	41·50	38·30	——	20·50	——	——	100·30, Kobell.

B.B. decrepitates, becomes opaque, and fuses with great difficulty on the edges; in powder with borax, a colorless transparent glass.

Occurs with serpentine at the localities above-mentioned. Named after Prof. Chester Dewey. The gymnite of Thomson named from *γυμνος*, *naked*, in allusion to the locality at Bare Hills, Md., is the same species.

Thomson found in another mineral from the United States labelled Deweylite (G. =2·0964), $\dddot{Si}$ 50·70, $\dot{Mg}$ 23·65, $\dot{H}$ 20·60, $\overset{...}{\overline{Al}}$ 3·55, $\dot{Fe}$ 1·70, (Am. J. Sci. xxxi, 173); and in another allied mineral, $\dddot{Si}$ 41·42, $\dot{Mg}$ 23·53, $\dot{Na}$ 6·25, $\dot{H}$ 19·86, $\overset{...}{\overline{Al}}$ 4·47, $\overset{...}{\overline{Ce}}$ 3·57, $\dot{Fe}$ *tr.*

HYDROPHITE, *Svanberg*, K. V. Ac. H. 1839, Pogg. li, 535. Jenkinsite, *Shepard*, Am. J. Sci. [2], xiii, 392. Eisengymnite.

Massive; sometimes fibrous.

H.=3·5. G =2·4—2·65. Lustre feeble, subvitreous. Color mountain-green to blackish-green. Streak paler. Translucent to opaque.

Composition.—$\dot{R}^2 \dddot{Si}+3\dot{H}$ or $(\dot{Mg}, \dot{Fe})\dddot{Si}+\dot{Mg}\ \dot{H}^3$? Analyses: 1, L. Svanberg, (loc. cit.); 2, 3, Smith and Brush, (Am. J. Sci. [2], xvi, 369):

	$\dddot{Si}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Mg}$	$\overset{...}{\overline{Al}}$	$\dddot{V}$	$\dot{H}$	
1. *Hydrophite*, of Taberg,	36·193	22·729	1·660	21·082	2·895	0·115	16·080	=100.754, Svanberg.
2. *Jenkinsite*,	38·97	19·30	4·36	22·87	0·53		$\dot{H}$13·36	=99·39, S. and B.
3. “	37·42	20·60	4·05	22·75	0·98		“ 13·48	=99·28, S. and B.

Smith and Brush find the oxygen ratio for the protoxyds, silica and water 3 : 4 : 2⅛, and they mention the nearness to both Hydrophite and Serpentine.

B.B. blackens and becomes magnetic, and finally fuses to a black globule.

Hydrophite occurs at Taberg in Smaoland; also (Jenkinsite) at O'Neil's mine in Orange Co., N. Y., as a fibrous incrustation on magnetite. The name is from *υδωρ*, *water.*

Nickel-gymnite, Genth, (Keller and Tied. Nordamer. Monatsb., iii, 487). An amorphous reniform or stalactitic mineral from Texas, Lancaster Co., Pa. H.=3—4. G.=2·409. Lustre resinous. Color pale apple green, or yellowish. Streak greenish white. Opaque to translucent. Heated in a tube, yields water and blackens. B.B. the reaction of oxyd of nickel and silica. Soluble in muriatic acid, silica separating but not gelatinizing. Composition: $\dddot{Si}$ 35·36, $\dot{Ni}$ 30·64, $\dot{Fe}$ 0·24, $\dot{Mg}$ 14·60, $\dot{Ca}$ 0·26, $\dot{H}$=19·09, corresponding to $(\dot{Ni}, \dot{Mg})^2 \dddot{Si}+3\dot{H}$. In other trials, 24·78 and 36·41 per cent. of oxyd of nickel were obtained.

Appendix.

OTTRELITE, *Haüy*. Phyllite, *Thomson*.

In small shining scales or plates, disseminated through the gangue; structure micaceous.

G.=4·4, Ottrelite. Scratches glass with difficulty. Color blackish-gray, greenish-gray, black. Streak pale green.

Composition.—$(\dot{Fe}, \dot{Mn})^3 \dddot{Si}^2 + 2\dddot{\bar{Al}}\dddot{Si} + 3\dot{H}$, Ottrelite. Analyses: 1, Damour, (Ann. des Mines, [2], ii, 357); 2, Thomson, (Ann. Lyc. Nat. Hist. N. Y. iii):

	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{K}$	$\dot{H}$
2. *Ottrelite,*	43·34	24·63	16·72	8·18	—	5·66=98·53, Damour.
1. *Phyllite,*	38·40	23·68	$\dddot{\bar{Fe}}$ 17·52	8·96	6·80	4·80=100·16, Thomson.

B.B. fuses with difficulty to a black magnetic globule.

Notwithstanding the discrepancies in the analyses here given, there can be little doubt of the identity of Phyllite and Ottrelite. The latter occurs near Ottrez, on the borders of Luxembourg, disseminated in argillaceous schist. The former is found in a similar rock over a large extent of country about Sterling, Goshen, Chesterfield, Plainfield, &c. The scales are oblong, often nearly eliptical, and one-eighth to one-quarter of an inch long, and half this in breadth. It is so abundant that the rock is consequently designated by Prof. Hitchcock, in his Geology of Massachusetts, (4to. 1841, p. 594), "spangled mica slate."

GROPPITE, *Svanberg*, Ofv. K. V. Ac. Förh. iii, 14.

Crystalline, with one distinct cleavage affording a broad cleavage surface, and two others less distinct.

H.=2·5. G.=2·73. Thin splinters translucent. Color rose-red to brownish-red. Streak paler. Fracture splintery.

Composition.—$\dot{R}^3\dddot{Si}^2 + 2\dddot{\bar{Al}}\dddot{Si} + 3\dot{H}$, Svanberg; $\dot{R}^2\dddot{Si} + \dddot{\bar{R}}\dddot{Si} + 2\dot{H}$, Ramm. Analysis by Svanberg:

$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\dot{Na}$	$\dot{H}$
45·01	22·55	3·06	4·55	12·28	5·23	0·22	7·11, undissolved 0·13=100·13.

In a matrass yields water. B.B. whitens, and on thin edges shows only incipient fusion. Dissolves with borax, with intumescence. A glass with little soda, and a slag if the quantity is increased. Svanberg's formula is the same as for Ottrelite.

From a limestone at Gropptorp in Sweden. May it be altered Pargasite? This is suggested to the author by L. Sæmann.

STILPNOMELANE, *Glocker*.

Foliated, radiated, and also compact.

H.=3—4. G.=3—3·4. Lustre of cleavage surface between vitreous and pearly. Color black, greenish-black. Streak greenish.

Composition.—$\dddot{\bar{\text{R}}}^2\dddot{\text{Si}}^3+3\dot{\text{H}}$, from Siegert's analysis. Analyses: 1, Rammelsberg, (Pogg. xliii, 127); 2, Siegert, (Ramm. 5th Suppl., 230):

$\dddot{\text{Si}}$	$\dot{\text{Fe}}$	$\dddot{\bar{\text{A}}}\text{l}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{K}}$	$\dot{\text{H}}$
46·17	35·82	5·88	2·67	——	0·75	8·72=100, Ramm.
42·07	$\dddot{\bar{\text{F}}}\text{e}$ 41·98	4·92	0·94	1·67	——	8·47=100·05, Siegert.

In a matrass yields water. B.B. fuses with some difficulty to a black shining globule; with the fluxes gives an iron reaction. Dissolves imperfectly in the acids.

Occurs at Obergrund, with calc spar and quartz, sometimes intermixed with pyrites and magnetic iron ore. Probably mixed with chlorite, according to Rammelsberg. Named from στιλπνος, *shining*, and μελας, *black*.

This species requires more investigation, and the same is true of the following.

EPICHLORITE. The Epichlorite of *Rammelsberg*, (Pogg. Ann. lxxvii, 437, 1849), is a fibrous or columnar mineral from Radauthal, between schiller spar and chlorite. H.=2—2·5. G.=2·76. Color dull leek-green. Streak white to greenish. Lustre greasy. In thin columns translucent and of a bottle-green color.

Composition.—$3\dot{\text{R}}^3\dddot{\text{Si}}+\dddot{\bar{\text{R}}}^2\dddot{\text{Si}}^3+9\dot{\text{H}}$, Rammelsberg. Analysis: $\dddot{\text{Si}}$ 40·88, $\dddot{\bar{\text{A}}}\text{l}$ 10·96, $\dddot{\bar{\text{F}}}\text{e}$ 8·72, $\dot{\text{Fe}}$ 8·96, $\dot{\text{Mg}}$ 20·00, $\dot{\text{Ca}}$ 0·68, $\dot{\text{H}}$ 10·18=100·38. B.B. fuses only in thin fibres with difficulty. With the fluxes reaction of silica and iron.

GLAUCONITE.—The *Green Grains* of the green sand formation of Gay Head, contain, according to Dr. S. L. Dana, (Hitchcock's Geol. of Mass., p. 93); of New Jersey, according to H. D. Rogers, (Geol. Rep. New Jersey, pp. 204 and 207); and W. Fisher, (Am. Jour. Sci., [2], ix, 83); of Germany, according to Berthier:

	$\dddot{\text{Si}}$	$\dddot{\bar{\text{A}}}\text{l}$	$\dot{\text{Fe}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{K}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$
1. Gay Head, Mass.	56·70	13·32	20·10	1·18	1·62	——	——	——=99·92, D.
2. Cauley's Pits, Woodstown, N. J.,	48·45	6·30	24·31	——	*trace*	12·01	——	8·40=99·47, R.
3. Sculltown, N. J.,	51·50	6·40	24·30	*trace*	——	9·96	——	7·70=99·86, R.
4. Poke Hill, Burlingt. Co., N.J.	50·75	6·50	22·14	——	——	12·96	——	7·50=99·85, R.
5. S. E. of Phil. in N. J.,	53·26	3·85	24·15	1·10	1·73	5·36	1·60	10·12=101·12, Fisher.
6. Germany,	46·1	5·5	19·6	3·8	——	5·3	——	8·9, quartz, 11·5, Berth.

Van der Marck found in the Green Sand of Büderich near Werl in Westphalia, 25·9 per cent. soluble in muriatic acid (*a*), 33·1 insoluble ib. (*b*), and 41·0 of quartz. Analysis afforded him, (Rammelsberg, 5th Suppl. 126),

a. $\dot{\text{Ca}}\ddot{\text{C}}$ 19·7, $\dot{\text{Mg}}\ddot{\text{C}}$ 0·4, $\dot{\text{Ca}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$ 2·6, $\dddot{\bar{\text{F}}}\text{e}$ 0·9, $\dddot{\bar{\text{A}}}\text{l}$ 1·6, F *trace*=25·2.
b. $\dddot{\text{Si}}$ 19·3, $\dddot{\bar{\text{A}}}\text{l}$ 3·3, $\dot{\text{Fe}}$ 6·2, $\dot{\text{Mg}}$ 1·1, $\dot{\text{K}}$ 1·1, $\dot{\text{H}}$ 2·1=33·1.

When first dug the grains are very soft, and the mass is sometimes adhesive, but on exposure they nearly equal gypsum in hardness.

KIRWANITE. Fibrous; fibres diverging from a centre. H.=2. G.=2·941. Color dark olive-green. Opaque.

Composition.—According to R. D. Thomson, Silica 40·5, protoxyd of iron 23·91, lime 19·78, alumina 11·41, water 4·35=99·95, whence Rammelsberg deduces the formula of $3\dot{\text{R}}^2\dddot{\text{Si}}+\dddot{\bar{\text{A}}}\text{l}\dddot{\text{Si}}+2\dot{\text{H}}$. Blackens before the blowpipe and partially fuses. With soda or borax forms a dark brown glass. Occurs in basalt on the northeast coast of Ireland. (*Thomson*, Min. i, 379).

MELANOLITE of Wurtz, (this Min. 3d edit., p. 679), has a chlorite like aspect. It is black and opaque with a striated surface and somewhat columnar structure; streak dark olive green. H.=2. G.=2·69.

H. Wurtz obtained $\dddot{\text{Si}}$ 30·86, $\dddot{\bar{\text{A}}}\text{l}$ 3·92, $\dddot{\bar{\text{F}}}\text{e}$ 20·25, $\dot{\text{Fe}}$ 21·97, $\dot{\text{Na}}$ 1·62, $\dot{\text{H}}$ 8·94, $\dot{\text{Ca}}\ddot{\text{C}}$ 12·77=100·33. It affords the oxygen ratio for the protoxyds, peroxyds, silica and water, 2 : 3 : 6 : 3; but it is probably not of constant composition. Rammelsberg observes that it is near Hisingerite.

From Milk Row Quarry, near Charlestown, Massachusetts, incrusting the sides of a fissure.

III. CHLORITE SECTION.

1. *General Formula*—$(\dot{R}^3, \ddot{\bar{R}})\dddot{Si}+Aq.$

	$\dot{R}$: $\ddot{\bar{R}}$: $\dddot{Si}$: $\dot{H}$		
HISINGERITE,	1 : 2 : 3 : 3	$\dot{Fe}^3\dddot{Si}+2\ddot{\bar{Fe}}\dddot{Si}+9\dot{H}.$	$=(\frac{1}{3}\dot{Fe}^3+\frac{2}{3}\ddot{\bar{Fe}})\dddot{Si}+3\dot{H}.$
THURINGITE,	2 : 3 : 3 : 2	$\dot{Fe}^3\dddot{Si}+\ddot{\bar{R}}(\dddot{Si}, \ddot{Al})+3\dot{H}.$	$=(\dot{Fe}^3, \ddot{Al})(\dddot{Si}, \ddot{Al})+1\frac{1}{2}\dot{H}.$
EUPHYLLITE,	1 : 8 : 9 : 2	$\dot{R}^3\dddot{Si}+8\ddot{\bar{R}}\dddot{Si}+6\dot{H}.$	$=(\frac{1}{9}\dot{R}^3+\frac{8}{9}\ddot{\bar{R}})\dddot{Si}+\frac{2}{3}\dot{H}.$
PYROSCLERITE(A)	4 : 2 : 6 : 4	$2\dot{R}^3\dddot{Si}+\ddot{Al}\dddot{Si}+6\dot{H}.$	$=(\frac{2}{3}\dot{R}^3+\frac{1}{3}\ddot{Al})\dddot{Si}+2\dot{H}.$

2. *General Formula*—$(\dot{R}^3, \ddot{\bar{R}})\dddot{Si}^{\frac{3}{4}}+Aq.$

PYROSCLERITE(B)	6 : 4 : $7\frac{1}{2}$: 5	$3\dot{R}^3\dddot{Si}^{\frac{3}{4}}+2\ddot{\bar{R}}\dddot{Si}^{\frac{3}{4}}+7\frac{1}{2}\dot{H}.$	$=(\frac{3}{5}\dot{R}^3+\frac{2}{5}\ddot{\bar{R}})\dddot{Si}^{\frac{3}{4}}+1\frac{1}{2}\dot{H}.$
CLINOCHLORE, CHLORITE,	5 : 3 : 6 : 4	$5\dot{R}^3\dddot{Si}^{\frac{3}{4}}+3\ddot{\bar{R}}\dddot{Si}^{\frac{3}{4}}+12\dot{H}.$	$=(\frac{5}{8}\dot{R}^3+\frac{3}{8}\ddot{\bar{R}})\dddot{Si}^{\frac{3}{4}}+1\frac{1}{2}\dot{H}.$
DELESSITE,	2 : 2 : 3 : 2	$\dot{R}^3\dddot{Si}^{\frac{3}{4}}+\ddot{\bar{R}}\dddot{Si}^{\frac{3}{4}}+3\dot{H}.$	$=(\frac{1}{2}\dot{R}^3+\frac{1}{2}\ddot{\bar{R}})\dddot{Si}^{\frac{3}{4}}+1\frac{1}{2}\dot{H}.$

3. *General Formula*—$(\dot{R}^3, \ddot{\bar{R}})\dddot{Si}^{\frac{2}{3}}+Aq.$

RIPIDOLITE,	3 : 3 : 4 : 3	$\dot{R}^3\dddot{Si}^{\frac{2}{3}}+\ddot{Al}\dddot{Si}^{\frac{2}{3}}+3\dot{H}.$	$=(\frac{1}{2}\dot{R}^3+\frac{1}{2}\ddot{Al})\dddot{Si}^{\frac{2}{3}}+1\frac{1}{2}\dot{H}.$
APHROSIDERITE,	3 : 3 : 4 : 2	$\dot{Fe}^3\dddot{Si}^{\frac{2}{3}}+\ddot{Al}\dddot{Si}^{\frac{2}{3}}+2\dot{H}.$	$=(\frac{1}{2}\dot{Fe}^3+\frac{1}{2}\ddot{Al})\dddot{Si}^{\frac{2}{3}}+\dot{H}.$
CLINTONITE,	3 : 5 : 2 : 1	$\dot{R}^3(\dddot{Si}, \ddot{Al})^{\frac{2}{3}}+\ddot{\bar{R}}(\dddot{Si}, \ddot{Al})^{\frac{2}{3}}+\dot{H}$	$=(\frac{1}{2}\dot{R}^3+\frac{1}{2}\ddot{Al})(\dddot{Si}, \ddot{Al})^{\frac{2}{3}}+\frac{1}{2}\dot{H}.$
CHLORITOID (A)	1 : 2 : 2 : 1	$\dot{R}^3\dddot{Si}^{\frac{2}{3}}+2\ddot{Al}\dddot{Si}^{\frac{2}{3}}+3\dot{H}.$	$=(\frac{1}{3}\dot{R}^3+\frac{2}{3}\ddot{Al})\dddot{Si}^{\frac{2}{3}}+\dot{H}.$

4. *General Formula*—$(\dot{R}^3, \ddot{\bar{R}})\dddot{Si}^{\frac{1}{2}}+Aq.$

CHLORITOID (B)	1 : 3 : 2 : 1	$\dot{R}^3\dddot{Si}^{\frac{1}{2}}+3\ddot{Al}\dddot{Si}^{\frac{1}{2}}+3\dot{H}.$	$=(\frac{1}{4}\dot{R}^3+\frac{3}{4}\ddot{Al})\dddot{Si}^{\frac{1}{2}}+\frac{3}{4}\dot{H}.$
CHRONSTEDTITE,	1 : 1 : 1 : 1	$\dot{R}^3\dddot{Si}^{\frac{1}{2}}+\ddot{\bar{R}}\dddot{Si}^{\frac{1}{2}}+3\dot{H}.$	$=(\frac{1}{2}\dot{R}^3+\frac{1}{2}\ddot{Al})\dddot{Si}^{\frac{1}{2}}+1\frac{1}{2}\dot{H}.$
SIDEROSCHISOLITE,	0 : 2 : 1 : 1		$\dot{Fe}^3\dddot{Si}^{\frac{1}{2}}+1\frac{1}{2}\dot{H}.$
MARGARITE,	1 : 6 : 4 : 1	$(\dot{R}^3, \dot{H}^3)\dddot{Si}^{\frac{1}{2}}+3\ddot{Al}\dddot{Si}^{\frac{1}{2}}.$	$=(\frac{1}{4}(\dot{R}^3, \dot{H}^3)+\frac{3}{4}\ddot{Al})\dddot{Si}^{\frac{1}{2}}.$

[The parallelism of the Andalusite and Chlorite sections of Silicates has been alluded to. In the former there are the formulas $\ddot{\bar{R}}\dddot{Si}^{\frac{1}{2}}, \ddot{\bar{R}}\dddot{Si}^{\frac{2}{3}}, \ddot{\bar{R}}\dddot{Si}^{\frac{3}{4}}$ or $(\dot{R}^3, \ddot{\bar{R}})\dddot{Si}^{\frac{3}{4}}$, and they afford a key to the formulas of the latter section, for the same oxygen ratios are repeated with only the addition of water, as is illustrated in the above table.

Margarodite is a hydrous mica, and may belong near the species of this section, if not a mere alteration of common mica, without a subsequent reconstruction into a distinct form. In most of the species, following Pyrosclerite (A), if the oxygen of the water be added to that of the bases, the ratio between this sum and that of the silica is 2 : 1.]

HISINGERITE, *Berz.* Thraulite, *Kob.* Gillingite, *Herm.*

Imperfectly crystallized. Cleavage: distinct in one direction. Soft. G.=3·045. Color black. Streak greenish-gray or brownish-yellow. Opaque. Cross fracture earthy. Sectile.

Composition.—$\dot{\mathrm{Fe}}^3\dddot{\mathrm{Si}}+2\dddot{\bar{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{Si}}+6\dot{\mathrm{H}}$, (Riddarhyttan, Rammelsberg)=Silica 29·7, peroxyd of iron 34·9, protoxyd of iron 23·6, water 11·8=100. $\dot{\mathrm{Fe}}^3\dddot{\mathrm{Si}}+2\dddot{\bar{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{Si}}+9\dot{\mathrm{H}}$, (Gillinge, R.)=Silica 28·0, peroxyd of iron 33·0, protoxyd of iron 22·3, water 16·7=100. For the Orijervfi mineral possibly $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+\frac{1}{3}\dddot{\bar{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$. All these formulas come under the general formula $(\dot{\mathrm{Fe}}^3,\dddot{\bar{\mathrm{F}}}\mathrm{e})\dddot{\mathrm{Si}}+\mathrm{Aq}$.

Analyses: 1, Berzelius, (Pogg. xiii, 505); 2, 3, Rammelsberg, (Pogg. lxxv, 398); 4, Hermann, (J. f. pr. Chem. xlvi, 238); 5, Kobell, (Pogg. xiv, 467):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{H}}$
1. Gillinge,	27·50	51·50	——	11·75, $\dddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·77, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 5·50=97·02, B.
2. Riddarhyttan,	33·07	34·78	17·59	11·54, $\dot{\mathrm{C}}\mathrm{a}$ 2·56, $\dot{\mathrm{M}}\mathrm{g}$ 0·46=100, R.
3. Gillinge,	32·18	30·10	8·63	19·37, $\dot{\mathrm{C}}\mathrm{a}$ 5·50, $\dot{\mathrm{M}}\mathrm{g}$ 4·22=100, R.
4. Orijervfi,	29·51	10·74	37·49	13·00, $\dot{\mathrm{M}}\mathrm{g}$ 7·78=98·52, Hermann.
5. Bodenmais, *Thraulite*,	31·28	43·42	5·70	19·12=99·52, Kobell.

B.B. fuses to a black magnetic slag. In acids easily decomposed. Occurs in calc spar at the iron mine of Gillinge and at the other localities mentioned.

Hermann names the Gillinge and Orijervfi (Finland) mineral *Gillingite.*

THURINGITE, *Breit.* Owenite, *F. A. Genth,* Am. J. Sci. [2], xvi, 167.

Massive. An aggregate of minute scales. Cleavage: distinct in one direction.

H.=2—2·5. G.=3·197, Genth; 3·186, Smith; 3·151—3·157, Thuringite. Lustre pearly. Color olive-green. Streak paler. Fracture subconchoidal. Very tough. Feel of powder greasy. Odor argillaceous.

Composition.—$\dot{\mathrm{Fe}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{R}}}(\dddot{\mathrm{Si}},\dddot{\bar{\mathrm{A}}}\mathrm{l})+3\dot{\mathrm{H}}$, if one third of the alumina replaces silica. Analyses: 1, 3, Smith, (private communication); 2, P. Keyser, under the direction of F. A. Genth, (loc. cit., mean of results):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{M}}\mathrm{n}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1. *Thuringite,*	22·05	17·66	16·40	30·78	0·89	——	——		0·14	11·44=99·36, Smith.
2. *Owenite,*	23·21	13·89	15·59	34·58	*tra.*	1·26	0·36	0·41	0·08	10·59=99·97, Genth.
3. "	23·58	14·33	16·85	33·20	——	1·52	——	0·46	——	10·45=100·39, Smith.

B.B. fuses easily to an iron-black globule; with borax, an iron reaction, and with soda evidence of a trace of manganese. Soluble easily in dilute muriatic acid.

Thuringite is from near Saalfeld in Thuringia. Found in the metamorphic rocks on the Potomac near Harper's Ferry. *Owenite* was named after the Geologist, Dr. D. D. Owen.

Smith's recent analysis of the Thuringite shows that it is identical with Genth's Owenite, and the latter name has therefore to yield to the earlier one.

Rammelsberg obtained in his analysis of Thuringite, (Pogg. lxviii, 515), $\dddot{\mathrm{Si}}$ 22·41, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 21·94, $\dot{\mathrm{Fe}}$ 42·60, $\dot{\mathrm{M}}\mathrm{g}$ 1·16, $\dot{\mathrm{H}}$ 11·89=100.

EUPHYLLITE, *Silliman, Jr.* Am. J. Sci. [2], viii, 382.

Structure as in mica, but laminæ not as easily separable. Biaxial; angle between the optical axes 71½°, Silliman.

H.=3·5—4·5. G.=2·963—3·008, Silliman. Lustre of cleavage surface bright pearly, inclining to adamantine. Color white to colorless; sides faint grayish sea-green or whitish. Transparent to translucent; at times opaque or nearly so. Laminæ rather brittle.

Composition.—$\dot{\bar{R}}^3\dddot{Si}+8\ddot{\bar{Al}}\dddot{Si}+6\dot{H}=(\frac{1}{9}\dot{R}^3+\frac{8}{9}\ddot{\bar{R}})\dddot{Si}+\frac{2}{3}\dot{H}$=(if $\dot{Ca}:\dot{K}:\dot{Na}$=3 : 4 ; 11), Silica 41·8, alumina 42·2, lime 1·4, potash 3·2, soda 5·8, water 5·5. Analyses: Smith and Brush, (Am. J. Sci. [2], xi, 209):

	$\dddot{Si}$	$\ddot{\bar{Al}}$	$\ddot{\bar{Fe}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\dot{Na}$	$\dot{H}$	
1. Unionville,	40·29	43·00	1·30	1·01	0·62	3·94	5·16	5·00=100·32,	S. & B.
2. "	39·64	42·40	1·60	1·00	0·70	3·94	5·16	5·08= 99·52,	"
3. "	40·21	41·50	1·50	1·88	0·78	3·25	4·26	5·91= 99·29,	"
4. "	40·96	41·40	1·30	1·11	0·70	3·25	4·26	6·23= 99·21,	"

In a matrass yields water. B.B. exfoliates, emits a strong light, and in the forceps fuses on the edges. Gives traces of fluorine, but none of lithia.

Occurs associated with tourmaline and corundum at Unionville, Delaware Co., Pennsylvania. The impression of the crystals of tourmaline on the lateral surface of the euphyllite leaves a very smooth hard looking surface. Also in the same vicinity in aggregated laminæ, or scales, or compact masses.

Smith and Brush deduce the oxygen ratio 1 : 9 : 9 : 2, and give the formula $\dot{R}\dddot{Si}+\ddot{\bar{R}}^3\dddot{Si}^2+2\dot{H}$. 1 : 8 : 9 : 2 corresponds better with the analyses, giving the above formula.

Dr. Smith refers here with a query, a mica found by him with the emery of Asia Minor, which afforded him the following results, (Am. J. Sci. [2], xv, 62):

	$\dddot{Si}$	$\ddot{\bar{Al}}$	$\ddot{\bar{Fe}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Mn}$	$\dot{K}, \dot{Na}$	$\dot{H}$
1. Gumuchdagh,	42·80	40·61	1·30	3·01	*tra.*	*tra.*	*undet.*	5·62
2. Kulah,	43·62	38·10	3·50	0·52	0·25	*tra.*	7·83	5·51
3. "	42·71	37·52	2·32	1·41	*tra.*	*tra.*	*undet.*	5·95
4. Nicaria,	42·60	37·45	1·70	0·68	*tra.*	*tra.*	9·76	5·20

They afford the mean oxygen ratio, excluding the water, 1 : 10 : 12.

PYROSCLERITE, *Kobell.* Chonikrite, *Kobell.* Kæmmercrite, *Nord.* Rhodophyllite, *Genth.* Vermiculite, *Webb.* Tabergite, *Rose.* Rhodochrome, *Rose.*

Hexagonal? $O:r$=95° 31′, $O:m$=93° 58′, $O:n$ (another plane in same series) 109° 4′, Kohscharov. Cleavage: basal perfect. Occurs foliated and massive; also fibrous.

H.=2·5—3. G.=2·6—2·74. Lustre weak, pearly. Color green, apple-green, grayish, reddish. Translucent. Fracture uneven and splintery.

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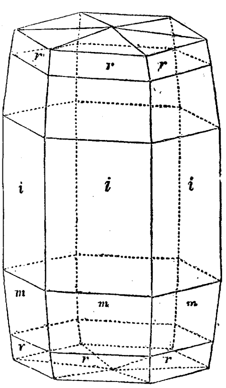


Composition.—$3\dot{R}^3\dddot{Si}^{\frac{3}{4}}+2\ddot{\bar{Al}}\dddot{Si}^{\frac{3}{4}}+7\frac{1}{2}\dot{H}=(\frac{3}{5}\dot{R}^3+\frac{2}{5}\ddot{\bar{Al}})\dddot{Si}^{\frac{3}{4}}+1\frac{1}{2}\dot{H}$=Silica 32·6, alumina 19·8, magnesia 34·6, water 13·0=100. In part, the same with $\dddot{Si}^{\frac{4}{5}}$ or $\dddot{Si}^{\frac{5}{6}}$; in part $2\dot{R}^3\dddot{Si}+\ddot{\bar{Al}}\dddot{Si}+6\dot{H}=(\frac{2}{3}\dot{R}^3+\frac{1}{3}\ddot{\bar{Al}})\dddot{Si}+2\dot{H}$=Silica 37·6, alumina 14·2, magnesia 33·2, water 14·9; and the same with $1\frac{1}{2}\dot{H}$, for Tabergite.

Analyses: 1 Kobell, (J. f. pr. Ch. ii, 51); 2, Lychnell, (K. V. Ac. H., 1826); 3, Kobell, (loc. cit.); 4, Svanberg, (K. V. Ac. H., 1839, 155); 5, Hartwall, (Jahresb. xxiii, 266); 6, T. H. Garrett, (Am. J. Sci. [2], xv, 332); 7, Genth, (Proc. Acad. Nat. Sci. Philad. 1852, 121, mean of two analyses); 8, Hermann, (J. f. pr. Chem. liii, 1); 9, 10, Smith and Brush, (Am. J. Sci. [2], xvi, 47); 11, 12, Hermann, (loc. cit.); 13, Crossley, (this Min. 3d edit., 291); 14, T. S. Hunt, (Phil. Mag. [4], ii, 65):

	$\dddot{\text{Si}}$	$\ddot{\text{Al}}$	$\ddot{\text{Cr}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\dot{\text{H}}$
1. *Pyrosclerite,*	37·03	13.50	1·43	31·62	—	3·52	11·00=98·10, Kobell.
2. “	35·28	13·73	—	35·35	—	1·79	7·33, $\ddot{\text{C}}$ & Bit. 6·28=99·76, L.
3. *Chonikrite,*	35·69	17·12	—	22·50	12·60	1·46	9·00=98·37, Kobell.
4. *Tabergite,*	35·76	13·03	—	29·27	—	6·34	11·76, $\dot{\text{Mn}}$1·64, $\dot{\text{K}}$2·07, Mg F, 1·1=100·98, Sv.
5. *Kæmmererite,*	37·0	14·2	1.0	31·5	1·5	1·5	13·0=99·7, Hartwall.
6. “	37·66	11·82	3·60	24·97	4·11	2·50	13·58, $\dot{\text{Ni}}$ 0·67=98·92, Gar.
7. “	33·20	11·11	6·85	35·54	*trace*	$\ddot{\text{Fe}}$1·43	12·95, $\dot{\text{Li}}$, $\dot{\text{Na}}$0·28, $\dot{\text{K}}$0·1, G.
8. “	31·82	15·10	0·90	35·24	—	“ 4·06	12·75, $\dot{\text{Ni}}$ 0·25=100·12, Her.
9. “	33·26	10·69	4·78	35·93	—	“ 1·96	12·64, $\dot{\text{K}}$, $\dot{\text{Na}}$ 0·35=99·61, Smith & Brush.
10. “	33·30	10·50	4·67	36·08	—	“ 1·60	13·25, $\dot{\text{K}}$, $\dot{\text{Na}}$ 0·35=99·75, Smith & Brush.
11. “	30·58	15·94	4·99	33·45	—	$\dot{\text{Fe}}$3·32	12·05=100·33, Hermann.
12. *Rhodochrome,*	34·64	10·50	5·50	35·47	—	$\ddot{\text{Fe}}$2·00	12·03=100·14, Hermann.
13. *Vermiculite,*	35·74	16·42	—	27·44	—	$\dot{\text{Fe}}$10·02	10·30=99·92, Crossley.
14. *Loganite,*	32·49	13·18	—	35·77	0·95	$\ddot{\text{Fe}}$2·14	16·92 ($\ddot{\text{C}}$ included)=101·45.

1, From Elba; 2, Aker, Sudermanland; 3, Elba; 4, Taberg; 5, Siberia; 6 to 10, Texas, Pa.; 11, 12, L. Itkul; 13, Milbury, Massachusetts.

Nos. 6 to 10 are of similar character; 7 is rhodophyllite of Genth; 8 is chrome-chlorite of Hermann. The varieties severally in a matrass yield water; and B.B. fuse with difficulty to a grayish glass; with borax form a chrome-green pearl. Wholly decomposed by concentrated sulphuric acid.

The oxyd of chromium varies in amount with the color, the paler varieties containing but little. Smith and Brush attribute the nickel to mixed sulphuret of nickel. The Aker mineral (anal. 2) resembles serpentine in appearance.

Chonikrite occurs massive, of a white color, glistening lustre and weak translucence; found with *pyrosclerite*, at Elba. B.B. fuses with intumescence to a grayish glass; soluble in muriatic acid, without gelatinizing.

Vermiculite has a granular scaly structure and greasy feel, and looks like steatite. The scales when heated (to 500° or 600° F) open out into worm-like threads made up of separated laminæ of cleavage; and sometimes, as Dr. C. T. Jackson states, swelling to nearly a hundred times the original length; and if confined in a glass tube this expansion is so powerful as to break it with an explosion, and scatter the glass to a distance. G.=2·756. In the forceps a scale fuses readily to a yellowish-green glass; with soda an opaque brown bead; with borax or salt of phosphorus easily a glass, yellow while hot and colorless when cold, or with the latter flux becoming somewhat milky-white on cooling. Decomposed by muriatic and sulphuric acids. In a matrass yields water which is somewhat alkaline. Crossley's analysis was made on the scales carefully separated from the mealy magnesian base with which it is associated. His formula is that of pyrosclerite.

Tabergite, called by Werner blue talc of Taberg in Wermland, is considered a distinct species by G. Rose, as it has but little resemblance to pyrosclerite.

Kæmmererite occurs in hexagonal prisms, of a reddish-violet color like lepidolite. Cleavage basal, perfect. Sometimes plumose massive. H.=1·5—2. G.=2·76, Siberia; 2·617—2·62, Texas. Lustre pearly. Translucent. Sectile and flexible. Feel greasy. Found with chromic iron at Bissersk, Siberia; also at Texas, Lancaster Co., Pennsylvania, with chromic iron in serpentine; the crystals are hexagonal or rhombic prisms, sometimes with the basal edges replaced; also crystallized at Haroldswick in Unst, Shetlands.

Rhodochrome has a greenish black color, but is peach-blossom-red in thin splinters. It occurs massive with a fine scaly structure, and a splintery fracture. H.=2·5—3. G.=2·668; 2·65, Hermann. B.B. strongly heated fuses on the edges to a yellow enamel. Affords a chrome-green glass with borax. Dissolves with difficulty in muriatic acid. From the island Tino, Greece, and from Bissersk and Kyschtimsk in the Ural.

Loganite, T. S. Hunt, from Calumet Island, on the Ottawa, Canada, has a weak subresinous lustre, pale or dark brownish color, and grayish streak; H.=3. G.=2·6—2·64; sometimes in crystals wth rounded angles, which appear to be pseudomorphs; one gave the angle 124°, near that of hornblende. Associated with serpentine, phlogopite, pyrites and apatite in crystalline limestone.

Hermann has found in blue *Baltimorite*, from Bare Hills, near Baltimore, Md., 33·26 per cent. of silica, 7·23 alumina, 4·34 chromic acid, with 2·89 $\dot{F}e$, 38·56 $\dot{M}g$, 12·44 $\dot{H}$, 1·30 $\ddot{C}$; while Thomson, who instituted the species, obtained 40·95 of silica and 1·50 of alumina. Hermann's mineral may be impure pyrosclerite.

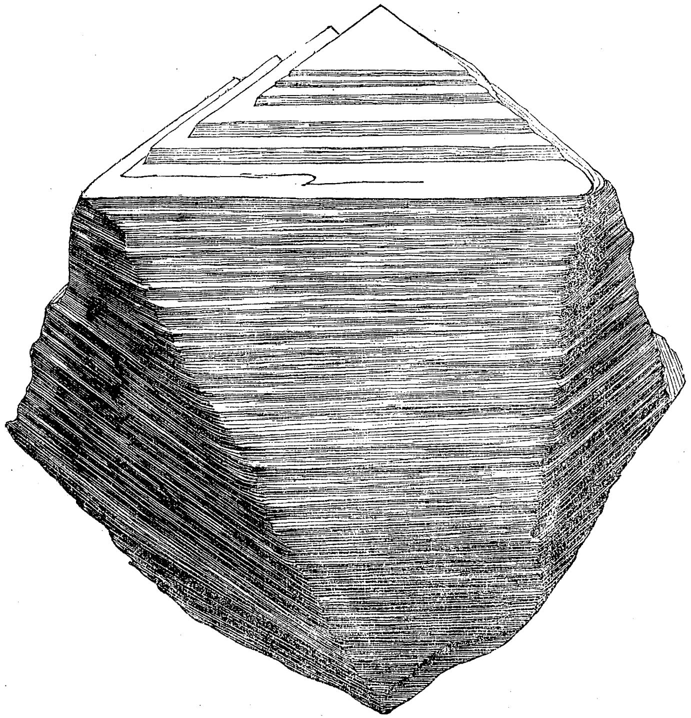
Delesse has analyzed a *Serpentine-like* mineral, remotely related to pyrosclerite, from the granular limestone of the Vosges, (Ann. des M. [4], xx, 155). It is soft, with a greasy or waxy lustre, grayish, bluish, and emerald-green color. G.=2·622. Analysis, in which the magnesia was determined by the loss, afforded $\dddot{S}i$ 38·39, $\ddot{\bar{A}}l$ 26·54, $\ddot{\bar{C}}r$ *trace*, $\dot{F}e$ 0·59, $\dot{M}n$ *trace*, $\dot{C}a$ 0·67, $\dot{M}g$ (by diff.) 22·16 $\dot{H}$ 11·65=100.

The name *pyrosclerite* is from πυρ, *fire*, σκληρος, *hard*, (refractory); chonikrite, from χωνεια, *fusion*, κριτος, *test*, alluding to its differing from some allied minerals in its fusibility; *Kæmmererite*, after M. Kæmmerer; *Rhodochrome*, from ροδος, *rose*, χρωμα, *color*; *Vermiculite*, from vermiculus, a *little worm*, alluding to the blowpipe action.

CLINOCHLORE, *W. P. Blake*, Am. J. Sci. [2], xii, 339.

Trimetric and hemihedral; structure micaceous, and crystalline planes often equilateral triangles. Optically biaxial; apparent an-

464—Natural size.



gle between the axes 84° 30′, (or 80° to 86°); plane of the axes, perpendicular to cleavage surface, but the two unequally inclined to this surface, one at about 54°, the other 30°. In large crystals and plates. Often compounded, the crystals giving a second pair of optical axes, making 60°, with the other. Crystals have usually a rhombohedral aspect, as in f. 464.

H.=2—2·25. G.=2·714, but probably too low, as the specimens could not be obtained wholly free from air, (Blake). Lustre somewhat pearly. Color olive-green. Transparent, unless in thick plates. Somewhat elastic.

Composition.—$5\dot{R}^3\dddot{Si}^{\frac{3}{4}}+3\bar{\dddot{Al}}\dddot{Si}^{\frac{3}{4}}+12\dot{\bar{H}}=(\frac{5}{8}\dot{R}^3+\frac{3}{8}\bar{\dddot{R}})\dddot{Si}^{\frac{3}{4}}+1\frac{1}{2}\dot{\bar{H}}$=Silica 32·6, alumina 18·5, magnesia 36·0, water 12·9=100. Perhaps $\dot{R}^3:\bar{\dddot{R}}=7:4$, instead of 5 : 3, which gives Silica 32·6, alumina 17·9, magnesia 36·6, water 12·9=100, corresponding closely with von Kobell's analysis.

Analyses: 1, 2, W. J. Craw, (Am. J. Sci. [2], xiii, 222); 3, Kobell, (Gel. Anzeig. No. 43 Ap. 10, 1854):

	$\dddot{Si}$	$\bar{\dddot{Al}}$	$\bar{\dddot{Fe}}$	$\bar{\dddot{Cr}}$	$\dot{Mg}$	$\dot{\bar{H}}$
1. Chester Co., Pa.,	31·34	17·47	3·85	1·69	33·44	12·60=100·39, Craw.
2. " "	31·78	22·71			33·64	12·60=100·73, Craw.
3. Bavaria,	33·49	15·37	2·30	0·55	32·94	11·50, $\dot{Fe}$ 4·25=100·40, K.

B.B. like chlorite; shows traces of fusion on the edges. Abundant with serpentine in large crystals and plates at Westchester, Chester Co., Pa.; at Unionville, Pa.; at Leugast, Bavaria.

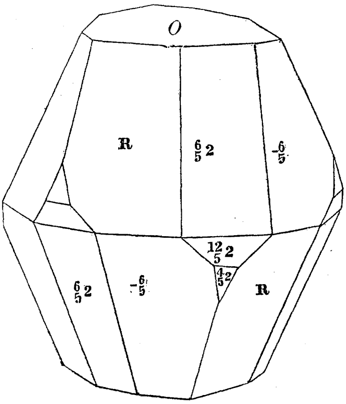
A line between the apparent optical axes is a perpendicular to one side of the triangular plates of the mineral.

HELMINTH, (*G. H. Otto Volger*, Entw. Min. 142). A chlorite occurring in feldspar and quartz, and resembling f. 467, but the prisms trimetric or monoclinic. *I*: *I* nearly 120°; the rhombic prisms with the acute edges truncated by a striated plane unlike *I*. *O* : *I* nearly 90°. No analysis is given; and it may be clinochlore.

CHLORITE, *Werner*. Leuchtenbergite, *Komonen*. Ripidolite, *Kobell*.

Rhombohedral. $R:R=75°\ 22\frac{1}{2}'$, $O:R=113°\ 58'$; $a:1·948$.

465



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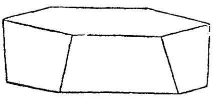
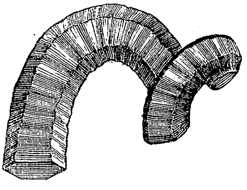


Pennine.

467



$O:2=102°\ 32'$, $2:2=64°\ 34'$, $\frac{6}{5}:\frac{6}{5}=71°\ 24'$, $\frac{12}{5}:\frac{12}{5}=63°\ 14\frac{1}{2}'$, (Pennine). Usually massive granular, also foliated.

Cleavage basal, highly perfect. Crystals often tabular, crested. H.=2—2·5; sometimes 3 on lateral edges. G.=2·65—2·85; 2·673, Ala, Piedmont. Lustre vitreous when pearly. Color dull emerald-green, seen in the direction of the axis, and yellowish or hyacinth-red, at right angles with it: sometimes silver-white. Massive varieties olive-green. Transparent—subtranslucent. Laminæ not elastic.

Composition.—$5\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^{\frac{3}{4}}+3\ddot{\bar{\mathrm{Al}}}\,\dddot{\mathrm{Si}}^{\frac{3}{4}}+12\dot{\mathrm{H}}=(\frac{5}{8}\dot{\mathrm{R}}^3+\frac{3}{8}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}^{\frac{3}{4}}+1\frac{1}{2}\dot{\mathrm{H}}$=Silica 32·6, alumina 18·5, magnesia 36·0, water 12·9=100. Analyses: 1, Varrentrapp, (Pogg. xlviii, 185); 2, 3, 4, Kobell, (J. f. pr. Ch. xvi, 470); 5, Brüel, (Pogg. xlviii); 6, Delesse, (Ann. Ch. Phys. [3], ix. 396); 7, 8, Marignac, (Ann. Ch. Ph. [3]. x, 430); 9, 10, Hermann, (J. f. pr. Ch. xl, 13); 11, Schweizer, (Pogg. l, 526); 12, 13, 14, Marignac, (Ann. Ch. Ph. [3], x, 428):

		$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{H}}$
1.	Achmatowsk,	30·38	16·97	33·97	4·37	——	12·63=98·31, Varrentrapp.
2.	"	31·25	18·72	32·08	5·10	——	12·63=99·78, Kobell.
3.	"	31·14	17·14	34·40	3·85	0·53	12·20, insol. 0·85=100·11, K.
4.	Schwarzenstein,	32·68	14·57	33·11	5·97	0·28	12·10, insol. 1·02=99·73, K.
5.	Zillerthal,	31·47	16·67	32·56	5·97	0·01	12·42=99·11, Brüel.
6.	Pyrenees, G.=2·615,	32·1	18·5	36·7	0·6	——	12·1=100, Delesse.
7.	Ala, G.=2·673,	30·01	19·11	33·15	$\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 4·81	——	12·52=99·60, Marignac.
8.	Slatoust,	30·27	19·89	33·13	" 4·42	——	12·54=100·25, Marignac.
9.	" (*white*),	30·80	17·27	37·07	" 1·37	——	12·30=98·82, Hermann.
10.	*Leuchtenbergite*,	32·35	18·00	32·29	" 4·37	——	12·50=99·51, Hermann.
11.	Zermath, *Pennine*,	33·07	9·69	32·34	$\dot{\mathrm{F}}$ 11·36	——	12·58=99·08, Schweizer.
12.	" "	33·36	13·24	34·21	$\ddot{\bar{\mathrm{F}}}$ 5·93	——	12·80, $\ddot{\mathrm{Cr}}$ 0·20=99·74, M.
13.	" "	33·40	13·41	34·57	" 5·73	——	12·74, " 0·15=100, M.
14.	Binnen, "	33·95	13·46	33·71	" 6·12	——	12·52, " 0·24=100, M.

Other analyses: A. McDonnell, (Proc. R. Irish Ac. v, 307); Delesse, (Ann. d. M. [4], xviii, 309, loc. Col de Pertuis).

Yields water in a matrass. B.B. on charcoal fuses to a globule, at least on the edges; glass with borax colored with iron. Not dissolved with soda. Thin leaves are soluble in concentrated sulphuric acid.

Chlorite forms extensive beds in Plutonic regions, and is the characterizing ingredient of chlorite slate. Often occurs in quartz crystals, in vermiform crystallizations, and f. 467 is an enlarged view of a part of a specimen from New Hampshire, described by Professor Hubbard. Octahedral crystals of magnetic iron, and hornblende, are the most common minerals in chlorite and chlorite slate.

Chlorite occurs at the above-mentioned localities and in various parts of the Eastern United States. The name is from *χλωρος, green.* Kokscharov, in a paper on the crystallization of chlorite, mentions numerous planes, and their angles. But the micaceous minerals vary so much by distortion that the angles are seldom trustworthy. (Verh. Min. Ges. St. Petersb., 1850–51, and Am. J. Sci., [2], xv, 437). Fig. 465 is from Kokscharov's paper.

Leuchtenbergite is from near Slatoust, in the Ural. Breithaupt considers it an altered chlorite; Komonen found but 8·62 per cent. of water. Kengott regards it as a distinct species.

The *Pihlite* of Sefstrom from Fahlun, is a doubtful species between talc and mica. The *Talc Zographique* of Haüy is a *green earth.*

A *Chlorite-like* mineral from Pressburg, Hungary, analyzed by von Hauer and described by Kengott, (Sitzb. xi, 609, 1853), is a hydrous biotite, affording the oxygen ratio for the protoxyds, peroxyds, silica and water, 1 : 1 : 2 : 1 and formula $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$ or $(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}+1\frac{1}{2}\dot{\mathrm{H}}$. Von Hauer obtained (loc. cit.) $\dddot{\mathrm{Si}}$ 38·13, $\ddot{\bar{\mathrm{Al}}}$ 21·60, $\dot{\mathrm{Fe}}$ 19·92, $\dot{\mathrm{Mn}}$ 2·61, $\dot{\mathrm{Mg}}$ (loss) 13·76, $\dot{\mathrm{H}}$ 3·98.

DELESSITE, *Naumann*. Chlorite Ferrugineuse, *Delesse*. Eisenchlorit.

Massive, with a short fibrous or scaly feathery texture.

H.=2·5. G.=2·89. Color olive-green to blackish-green.

Composition.—$\dot{\text{R}}^3\dddot{\text{Si}}^{\frac{3}{4}}+\ddot{\overline{\text{R}}}\,\dddot{\text{Si}}^{\frac{3}{4}}+3\dot{\text{H}}=(\frac{1}{2}\dot{\text{R}}^3+\frac{1}{2}\ddot{\overline{\text{R}}})\,\dddot{\text{Si}}^{\frac{3}{4}}+1\frac{1}{2}\,\dot{\text{H}}$. Analysis by Delesse, (Ann. des M. [4], xvi, 520):

$\dddot{\text{Si}}$ 29·45 $\ddot{\overline{\text{Al}}}$ 18·25 $\ddot{\overline{\text{Fe}}}$ 8·17 $\dot{\text{Fe}}$ 15·12 $\dot{\text{Mg}}$ 15·32 $\dot{\text{Ca}}$ 0·45 $\dot{\text{H}}$ 12·57=99·33.

In a matrass yields water and becomes brown. B.B. fuses with difficulty on the edges. Easily soluble in acids, affording a deposit of silica.

Occurs in the amygdaloidal porphyry of Oberstein and Zwickau.

The *Grengesite* of Hisinger from Grengesberg in Dalecarlia is referred here. G. =3·1. Color dark green. According to Hisinger, it contains $\dddot{\text{Si}}$ 27·01, $\ddot{\overline{\text{Al}}}$ 14·31, $\ddot{\overline{\text{Mn}}}$ 2·18, $\dot{\text{Fe}}$ 25·63, $\dot{\text{Mg}}$ 14·31, $\dot{\text{H}}$ 12·53.

RIPIDOLITE, *G. Rose*. Chlorite, *in part*.

Hexagonal. Cleavage: basal, eminent. Crystals from Tyrol in double pyramids, pyramidal edges 132° 40′, basal 106° 50′, Descloizeaux.

H.=1—2. G.=2·78—2·96. Translucent—nearly transparent. Lustre pearly. Color green, olive-green; across the axis, by transmitted light, red. Streak uncolored or greenish. Laminæ flexible, not elastic.

Composition.—$\dot{\text{R}}^3\dddot{\text{Si}}^{\frac{2}{3}}+\ddot{\overline{\text{Al}}}\,\dddot{\text{Si}}^{\frac{2}{3}}+3\dot{\text{H}}=(\frac{1}{2}\dot{\text{R}}^3+\frac{1}{2}\ddot{\overline{\text{Al}}})\dddot{\text{Si}}^{\frac{2}{3}}+1\frac{1}{2}\dot{\text{H}}$=(if $\dot{\text{Mg}}:\dot{\text{Fe}}=1:1$) Silica 27·2, alumina 23·1, magnesia 13·5, protoxyd of iron 24·2, water 12·1=100.

Analyses: 1, Varrentrapp; 2, 3, 4, Kobell, (J. f. pr. Ch. xvi); 5, 6, Marignac, (Ann. Ch. Phys. xiv, [3], 59); 7, Hermann; 8, J. L. Smith, (Am. J. Sci., [2], xi, 65):

		$\dddot{\text{Si}}$	$\ddot{\overline{\text{Al}}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{H}}$
1.	St. Gothard,	25·37	18·50	17·09	28·79	——	8·96=98·70, Varr.
2.	Zillerthal, G.=2·78,	26·51	21·81	22·83	15·00	——	12·00=98·15, Kobell.
3.	" G.=2·88,	27·32	20·69	24·89	15·23	0·47	12·00=100·60, "
4.	Rauris, G.=2·9,	26·06	18·47	14·69	26·87	0·62	10·45, gan. 2·24=99·40, K.
5.	Dauphiny,	26·88	17·52	13·84	29.76	——	11·33=99·33, Marignac.
6.	"	27·14	19·19	16·78	24·76	——	11·50=99·37, "
7.	Miask,	25·60	22·21	30·96	$\ddot{\overline{\text{Fe}}}$ 5·00	——	13·43, 2·25 undec., H.
8.	Gumuch-dagh,	27·20	18·62	17·64	$\dot{\text{Fe}}$23·21	——	10·61=98·28, Smith.

Analyses 2, 3, are of the *Lophoite* of Breithaupt; *R* : *O*=105° 14′. Analyses 4 is of his *Ogcoite.*

B.B. like chlorite. Rammelsberg makes the St. Gothard ripidolite (anal. 1) to contain 16·89 $\dot{\text{Fe}}$ and 13·22 $\ddot{\overline{\text{Fe}}}$, and finds reason for changing other analyses correspondingly.

Ripidolite occurs at the localities above-mentioned, and also in Scotland; at Gumuch-dagh, in Asia Minor, with Emery, etc. The name *ripidolite* is from ριπις, *a fan.*

The "*chlorite*" *of Traversella* has all the characters of a hexagonal chlorite, occurring in rather large hexagonal plates regularly grouped. But Marignac considers it a mixture of talc and chlorite. His analyses obtained, (Ann. Ch. Phys. [3], xiv, 60):

$\dddot{\text{Si}}$	$\ddot{\overline{\text{Al}}}$	$\dot{\text{Fe}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$
38·45	11·75	12·82	28·19	8·49=99·70.
39·81	12·56	11·10	28·41	7·79=99·67.
41·34	11·42	10·09	29·67	7·66=100·18.

It has the greasy feel of talc.

APHROSIDERITE, Sandberger, (Ueb. Geol. Nassau). A ferruginous ripidolite, differing from the above in containing protoxyd of iron replacing the magnesia, and having less water. Occurs fine scaly granular.

Composition.—According to Sandberger, $\dddot{\mathrm{Si}}$ 26·45, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 21·25, $\dot{\mathrm{Fe}}$ 44·24, $\dot{\mathrm{Mg}}$ 1·06, $\dot{\mathrm{H}}$ 7·74=100·74=$(\frac{1}{2}\dot{\mathrm{Fe}}^3+\frac{1}{2}\dddot{\bar{\mathrm{A}}}\mathrm{l})\dddot{\mathrm{Si}}^{\frac{2}{3}}+\dot{\mathrm{H}}$. From Weilburg.

METACHLORITE, List. Foliated columnar, like chlorite, vitreous to pearly in lustre, dull leek green color. H.=2·5. Composition according to K. List:

$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
23·77	16·43	40·36	3·10	0·74	1·37	0·08	13·75=99·60.

Whence the oxygen ratio for $\dot{\mathrm{R}}$, $\dddot{\bar{\mathrm{R}}}$, $\dddot{\mathrm{Si}}$, $\dot{\mathrm{H}}$, is 10·65 : 7·67 : 12·59 : 12·22, which gives for the oxygen of the bases and silica the ratio 18·32 : 12·59=3 : 2, as in Aphrosiderite; the formula is therefore $4\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^{\frac{2}{3}}+3\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}^{\frac{2}{3}}+14\dot{\mathrm{H}}=(\frac{4}{7}\dot{\mathrm{R}}^3+\frac{3}{7}\dddot{\bar{\mathrm{R}}})\,\dddot{\mathrm{Si}}^{\frac{2}{3}}+2\dot{\mathrm{H}}$.

B.B. fuses on the edges to a dark enamel. Gelatinizes in the cold with muriatic acid.

CLINTONITE, *Mather.* Seybertite, *Clemson.* Holmesite, *Thomson.* Chrysophane, *Breit.* Xanthophyllite, *Rose.* Brandisite, *Liebener.*

Usually in tabular crystals, or foliated massive; sometimes lamellar radiate. Structure thin foliated, or micaceous parallel to the base.

H.=4—5. G.=3—3·1. Lustre pearly submetallic. Color reddish-brown, yellowish, copper-red. Streak uncolored, or slightly yellowish or grayish. Folia brittle.

Composition.—Meitzendorff's analyses give the oxygen ratio for $\dot{\mathrm{R}}$, $\dddot{\bar{\mathrm{R}}}$, $\dddot{\mathrm{Si}}$, $\dot{\mathrm{H}}$, 3 : 5 : 2 : 1=$3\dot{\mathrm{H}}^3$, $5\dddot{\bar{\mathrm{A}}}\mathrm{l}$, $2\dddot{\mathrm{Si}}$, $3\dot{\mathrm{H}}$, whence, if $2\dddot{\bar{\mathrm{A}}}\mathrm{l}$ replace silica, we have the formula $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^{\frac{2}{3}}+\dddot{\bar{\mathrm{A}}}\mathrm{l}\,(\dddot{\mathrm{Si}},\dddot{\bar{\mathrm{A}}}\mathrm{l})^{\frac{2}{3}}+\dot{\mathrm{H}}=(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\dddot{\bar{\mathrm{A}}}\mathrm{l})(\dddot{\mathrm{Si}},\dddot{\bar{\mathrm{A}}}\mathrm{l})^{\frac{2}{3}}+\frac{1}{2}\dot{\mathrm{H}}$.

Analyses: 1, Clemson, (Am. J. Sci. xxiv, 171); 2, Richardson, (*Holmesite*), (Rec. Gen. Sci. May, 1836); 3, 4, 5, Meitzendorf in Rose's labratory, (*Xanthophyllite*), (Pogg. lviii, 165); 6, Kobell, (the *Disterrite*), (J. f. pr. Chem. xli, 154):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{H}}$
1. Amity, *Clint.*	17·0	37·6	24·3	10·7	5·0	3·6=98·2, Clemson.
2. “ “	19·35	44·75	9·05	11·45	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 4·80	4·55, $\dot{\mathrm{Mn}}$ 1·35, $\ddot{\bar{\mathrm{Z}}}\mathrm{r}$ 2·05, HF 0·9 =98·25, R.
3. Slatoust, *Xant.*	16·55	43·73	19·04	13·12	$\dot{\mathrm{Fe}}$ 2·62	ign. 4·33, $\dot{\mathrm{Na}}$ 0·67=100·06, Meit.
4. “ “	16·41	43·17	19·47	14·50	2·23	“ 4·45, $\dot{\mathrm{Na}}$ 0·62=100·85, M.
5. “ “	16·20	44·96	19·43	12·15	2·73	“ 4·33, $\dot{\mathrm{Na}}$ 0·55=100·35, M.
6. Fassa, *Dister.*	20·00	43·22	25·01	4·00	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 3·60	$\dot{\mathrm{H}}$ 3·60, $\dot{\mathrm{K}}$ 0·57=100, Kobell.

B.B. infusible alone, but whitens; with borax or soda forms a transparent pearl. In powder acted on by concentrated acids.

Occurs at Amity, N. Y., in limestone beds connected with serpentine, along with hornblende, spinel, pyroxene, and graphite. Also (the *Xanthophyllite*) in the Schischimskian mountains, near Slatoust, in implanted globules about an inch and a half through, consisting within of the mineral; and in columnar and lamellar individuals, which sometimes contain within thin tabular crystals of a hexagonal form, secondary apparently to a rhombic prism. Also (the *Disterrite*, called also *Brandisite*) in the valley of Fassa, Tyrol, in hexagonal prisms. H. of base 5, of sides 6—6·5. G.=3·042—3·051.

The clintonite was discovered over twenty years since, and thus named by Messrs. Fitch, Mather, and Horton, in honor of the Hon. De Witt Clinton. It was subsequently analyzed by Clemson and named *Seybertite.* Dr. Thomson's *Holmesite* was based on the same mineral. Breithaupt makes the crystallization monoclinic, and gives the angle between the lateral planes 94°.

CHLORITOID. Chloritspath, *Fiedler.* Barytophyllit, *Breit.* Masonite, *C. T. Jackson.*

Coarsely foliated, massive, folia often curved or bent, and brittle; sometimes also a transverse cleavage.

H.=5·5—6. G.—3·557, chloritoid; 3·450, masonite; 3·52, Hermann, (anal. 6). Color dark gray, greenish-gray, greenish-black. Streak uncolored, or slightly greenish. Lustre weak, pearly.

Composition.—$\dot{R}^3\dddot{S}i^{\frac{2}{3}}+2\ddot{\bar{A}}l\dddot{S}i^{\frac{2}{3}}+3\dot{H}=(\frac{1}{3}\dot{R}^3+\frac{2}{3}\ddot{\bar{A}}l)\dddot{S}i^{\frac{2}{3}}+\dot{H}$=Silica 27·6, alumina 31·3, protoxyd of iron 32·9, water 8·2=100. Whitney obtained *one third* less water.

Also for the chloritoid of Asia Minor and Bregratten, $\dot{R}^3\dddot{S}i^{\frac{1}{2}}+3\ddot{\bar{A}}l\dddot{S}i^{\frac{1}{3}}+3\dot{H}=(\frac{1}{4}\dot{R}^3+\frac{3}{4}\ddot{\bar{R}})\dddot{S}i+\frac{3}{4}\dot{H}$=Silica 24·0, alumina 40·5, protoxyd of iron 28·4, water 7·1. The Bregratten mineral contains one third less water, ($\frac{1}{2}\dot{H}$ in the last formula).

Analyses: 1, Bonsdorff, (G. Rose, Reise n. d. Ural, i, 252); 2, J. D. Whitney, (Proc. Bost. S. N. Hist. 1849, 100); Delesse, (Ann. Ch. Phys. [3], ix, 385); 4, Kobell, (J. f. pr. Ch. lviii, 40); 5, J. L. Smith, (Am. J. Sci. [2], xi, 64); 6, Hermann, (J. f. pr. Ch. liii, 13); 7, Kobell, (Gel. Anz. Ap. 1854):

	$\dddot{S}i$	$\ddot{\bar{A}}l$	$\dot{F}e$	$\dot{M}g$	$\dot{H}$
1. *Chloritoid,*	27·48	35·57	27·05	4·29	6·95, $\dot{M}n$ 0·30=101·64, Bonsd.
2. *Masonite,*	28·27	32·16	33·72	0·13	5·00=99·28, Whitney.
3. *Sismondine,*	24·1	43·2	23·8	——	7·6, $\ddot{T}i$ *tr.*=98·7, Delesse.
4. "	25·75	37·50	21·00	6·20	7·80, *undec.* 0·5=98·75, Kobell.
5. Asia Minor,	23·91	39·52	28·05	——	7·08=98·56, Smith.
6. Katharinenburg,	24·54	30·72	17·30	3·75	6·38, $\ddot{\bar{F}}e$ 17·28=99·97, Hermann.
7. Bregratten,	26·19	38·30	21·11	3·30	5·50, " 6·00=100·40, Kobell.

In a matrass yields water. B.B. infusible, but becomes darker and magnetic. Wholly dissolved by sulphuric acid. The masonite fuses with difficulty to a dark green enamel.

Occurs at Koroibrod near Katharinenburg in the Ural, associated with mica and kyanite; at Bregratten in the Tyrol. The masonite occurs in compact argillite, near Natic village, Rhode Island.

A related mineral found on the Corundum of North Carolina has been called *Corundophilite* by Shepard, (Am. J. Sci. [2], xii, 211). Shepard mentions some angles which are nearly those of common mica. It is dark green, lamellar, brittle. No analyses given except one with 20 per cent. loss.

The *Sismondine* of *Delesse* occurs at St. Marcel, in chlorite slate, and resembles chloritoid, agreeing in composition, according to von Kobell, with the Bregratten mineral; color dark grayish or blackish green; structure foliated; G.=3·565; H.=5·5.

B.B. nearly infusible and forms a blackish glass; after heating, magnetic. Yields water; with borax dissolves and affords the reaction of iron; not dissolved in strong muriatic acid, but attacked by sulphuric after long heating.

CHLORITE SPAR.—A mineral from the Ural, referred to chloritoid and resembling it, afforded Erdmann (J. f. pr. Chem. vi, 89) no water. He obtained $\dddot{S}i$ 24·90, $\ddot{\bar{A}}l$ 46·20, $\dot{F}e$ 28·89, which is equivalent to $\dddot{S}i^2\ddot{\bar{A}}l^3\dot{F}e^3$, or $\dot{F}e^3\ddot{\bar{A}}l+2\ddot{\bar{A}}l\dddot{S}i$.

CRONSTEDTITE, *Steinmann*. Chloromelan, *Naumann*.

Rhombohedral. Occurs in hexagonal prisms, tapering towards the summit, or adhering laterally; also in diverging groups, reniform and amorphous. Cleavage: basal, highly perfect.

H.=2·5. G.=3·348. Lustre brilliantly vitreous. Color brownish-black. Streak dark leek-green. Opaque. Not brittle. Thin laminæ elastic.

Composition.—$\dot{R}^3\dddot{Si}^{\frac{1}{2}}+\ddot{\bar{F}}e\dddot{Si}^{\frac{1}{2}}+3\dot{H}=(\frac{1}{2}\dot{R}^3+\frac{1}{2}\ddot{\bar{R}})\dddot{Si}^{\frac{1}{2}}+1\frac{1}{2}\dot{H}$. Analyses: 1, Steinmann, (Schw. J. xxxii, 69); 2, same, as corrected by Kobell, (Schw. J. lxii, 196):

	$\dddot{Si}$	$\dot{F}e$	$\dot{M}g$	$\dot{M}n$	$\dot{H}$
1.	22·452	58·852	2·885	5·078	10·700=99·968, Steinmann.
2.	22·452	27·112	2·885	5·078	10·700, $\ddot{\bar{F}}e$ 35·350=103·577, Kobell.

B.B. froths and fuses on the edges, yielding, according to Kobell, a magnetic gray globule. With borax gives the reaction of iron and manganese. In powder gelatinizes in concentrated muriatic acid.

Accompanies hydrate of iron and calc spar, in veins containing silver ores, at Przibram in Bohemia. It occurs also at Wheal Maudlin in Cornwall, in diverging groups. Named after the Swedish mineralogist and chemist, Cronstedt.

SIDEROCHISOLITE, *Wernekink*, Pogg. i, 387.

Hexagonal or rhombohedral. Observed planes *O*, *I*, 1. Crystals minute and often hemispherically grouped. Cleavage: basal, perfect. Massive.

H.=2·5. G.=3—3·4. Lustre splendent. Color pure velvet-black when crystallized, dark greenish-gray. Streak leek-green, greenish-gray. Opaque.

Composition.—$\dot{F}e^3\dddot{Si}^{\frac{1}{2}}+\frac{1}{2}H$. Analysis by Wernekink, (on three grains of the mineral, loc. cit.):

$\dddot{Si}$ 16·3, $\dot{F}e$ $\ddot{\bar{F}}e$ 75·5, $\ddot{\bar{A}}l$ 4·1, $\dot{H}$ 7·3=103·2, Wernekink.

B.B. fuses easily to an iron-black magnetic globule, according to Wernekink; infusible, Berzelius. Gelatinizes in muriatic acid.

Crystallized specimens occur in cavities of magnetic pyrites and sparry iron ore, at Conghonas do Campo in Brazil. Named from *σιδηρος*, *iron*, and *σχιστος*, *cleavable*, *λιθος*, *stone*.

Chamoisite, as analyzed by Berthier, (Ann. d. Mines, v, 393), has nearly the above composition, his result giving

$\dddot{Si}$ 14·3, $\dot{F}e$ 60·5, $\ddot{\bar{A}}l$ 7·8, $\dot{H}$ 17·4=100, with 15 per cent. of carbonate of lime.

It is considered a mixture of magnetic iron and a hydrous silicate of alumina. It occurs in beds of small extent in a limestone mountain abounding in ammonites at Chamoisin in the Valais. It has a black earthy appearance, and becomes red before the blowpipe.

MARGARITE, *Fuchs.* Perlglimmer, *L.* Emerylite, *Smith.* Corundellite and Clingmanite, *Silliman.*

Trimetric; hemihedral, with a monoclinic aspect, like Muscovite. $I : I = 119° — 120°$, $O : r = 152° — 153°$, $O : t = 144° — 145°$, $O : s = 129° — 134°$, $O : i\check{i} = 90°$. Lateral planes horizontally striated. Cleavage: basal, eminent. Usually in intersecting or aggregated laminæ, sometimes compact massive, with a somewhat scaly structure.

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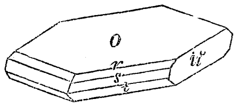

H.=3·5—4·5. G.=3·032—2·99, the latter for Margarite, Hermann; 2·995 Emerylite, Silliman, Jr. Lustre of base pearly, laterally vitreous. Color grayish, reddish-white, yellowish. Translucent—subtranslucent. Laminæ rather brittle.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+3\ddot{\mathrm{Al}}^2\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$=Silica 30·1, alumina 51·2, lime 11·6, soda 2·6, water 4·5. Or, making the water basic, $(\dot{\mathrm{R}}^3, \dot{\mathrm{H}}^3)\dddot{\mathrm{Si}}^{\frac{1}{2}}+3\ddot{\mathrm{Al}}\dddot{\mathrm{Si}}^{\frac{1}{2}}$.

Analyses: 1–9, J. L. Smith, (Am. J. Sci. [2], xi, 59, and xv, 208); 10–13, W. J. Craw, (ib. viii, 379); 14, B. Silliman, Jr., (this Min. 3d edit., 362); 15, W. J. Craw, (ibid.); 16, C. Hartshorne in Laboratory of J. C. Booth, (ibid. 362); 17, Hermann, (J. f. pr. Chem. liii, 1); 18, 19, J. L. Smith and G. J. Brush, (Am. J. Sci. [2], xv, 209):

		$\dddot{\mathrm{Si}}$	$\ddot{\mathrm{Al}}$	$\ddot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
1.	Gumuch-dagh,	29·66	50·88	1·78	13·56	0·50	1·50	3·41, J. L. Smith.
2.	Island of Nicaria,	30·22	49·67	1·33	11·57	*trace*	2·31	5·12, J. L. Smith.
3.	" "	29·87	48·48	1·63	10·84	*trace*	2·86	4·32, J. L. Smith.
4.	Island of Naxos,	30·02	49·52	1·65	10·82	0·48	1·25	5·55, J. L. Smith.
5.	" "	28·90	48·53	0·87	11·92	undet.	undet.	5·08, J. L. Smith.
6.	" "	0·10	50·08	undet.	10·80	"	"	4·52, J. L. Smith.
7.	Gumuch-dagh,	30·90	48·21	2·81	9·53	"	"	4·61, J. L. Smith.
8.	" "	31·93	48·80	1·50	9·41	"	2·31	3·62, $\ddot{\mathrm{Mn}}$ *trace*, J. L. Smith.
9.	Siberia,	28·50	51·02	1·78	12·05	"	undet.	5·04, J. L. Smith.
10.	Village Green, Pa.,	32·31	49·24	—	10·66	0·30	2·21	5·27, W. J. Craw.
11.	"	31·06	51·20	—	9·24	0·28	2·97	5·27, W. J. Craw.
12.	"	31·26	51·60	—	10·15	0·50	1·22	4·27, W. J. Craw.
13.	"	30·18	51·40	—	10·87	0·72	2·77	4·52, W. J. Craw.
14.	Buncombe Co., N. C.,	29·17	48·40	—	9·87	1·24	6·15	3·99, HF2·03, S.Jr.
15.	Unionville. Pa.,	29·99	50·57	—	11·31	0·62	2·47	5·14, W. J. Craw.
16.	"	32·15	54·28	*trace*	11·36	0·05	undet.	0·50, Hartshorne.
17.	*Margarite*,	32·46	49·18	1·34	7·42	3·21	1·76[a]	4·93=100·30,Her.
18.	"	28·47	50·24	1·65	11·50	0·70	1·87[b]	5·00=99·26, S.
19.	"	28·64	51·66		12·25	0·68	2·01[b]	4·76=100·0, "

[a] 0·05 of this is $\dot{\mathrm{K}}$. [b] trace of $\dot{\mathrm{K}}$.

The specimens of Margarite analyzed by Smith and Brush, were from Sterzing, the original locality, and leave no doubt of the identity, as observed by Smith. The early analyses of Margarite were wide from the truth. *Corundellite* and *Clingmanite* were based on an incorrect determination of the silica in the analyses.

Margarite occurs in chlorite at Sterzing in the Tyrol; at the different localities of emery in Asia Minor, and the Grecian Archipelago, as discovered by Dr. Smith; with corundum at Village Green, Delaware Co., Pa.; at Unionville, Chester Co., Pa., (Corundellite); at the corundum locality in Buncombe Co., North Carolina, (Clingmanite); with the corundum of Katherinenburg, Urals. It occurs massive in Pennsylvania. Also found at Greinerberg, Zillerthal, with chlorite.

Diphanite of Nordenskiöld (Bull. Acad. St. Petersburg, v, 17) is near Margarite. It occurs in hexagonal prisms with perfect basal cleavage. H.=5—5·5. G.=3·04—3·97. Color white to bluish. Formula $2\dot{\mathrm{R}}^2\dddot{\mathrm{Si}}+3\dddot{\overline{\mathrm{Al}}}^2\dddot{\mathrm{Si}}+4\dot{\mathrm{H}}$. Analysis by Jeveinoff: $\dddot{\mathrm{Si}}$ 34·02, $\dddot{\overline{\mathrm{Al}}}$ 43·33, $\dot{\mathrm{Ca}}$ 13·11, $\dot{\mathrm{Fe}}$ 3·02, $\dot{\mathrm{Mn}}$ 1·05, $\dot{\mathrm{H}}$ 5·34=99·87. B.B. becomes opaque and fuses with intumescence in the inner flame to an enamel. With little soda, a blebby glass. From the emerald mines of the Ural with chrysoberyl and phenacite.

EPHESITE, *J. L. Smith*, Am. J. Sci. [2], xi, 59.

Lamellar, and resembles white kyanite. Cleavage difficult. Scratches glass easily. G.=3·15—3·20. Color pearly-white.

Composition.—Analyses by Smith, (loc. cit.):

	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Na}}$ and a little $\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1.	31·54	57·89	1.89	1·34	4·41	3·12=100·19.
2.	30·04	56·45	2·11	1·00	4·41	3·09=97·07.

The oxygen ratio deduced for the protoxyds, peroxyds, silica and water, is 1 : 15 : 9 : 2. From the emery locality of Gumuch-dagh near Ephesus, on specimens of magnetite.

Probably related to Margarite, near which it is placed by Dr. Smith.

NON-MAGNESIAN HYDROUS SILICATES.

1. *Oxygen ratio of bases and silica* 1 : 1 *to* 1 : 3*; of protoxyds and peroxyds*, 1 : 1 *to* 1 : 2½, *rarely to* 1 : 3.

I. PYROPHYLLITE SECTION. Oxygen ratio between bases and silica, 1 : 3 to 1 : 2½.

Pyrophyllite,	$\dddot{\overline{\mathrm{Al}}}\,\dddot{\mathrm{Si}}^3+1\frac{1}{2}\dot{\mathrm{H}}$.
Anthosiderite,	$\dddot{\overline{\mathrm{Fe}}}\,\dddot{\mathrm{Si}}^3+\dot{\mathrm{H}}$.

II. PECTOLITE SECTION. Oxygen ratio between bases and silica augitoid, or 1 : 2, varying to 1 : 2¼.

APOPHYLLITE GROUP, II.	Apophyllite,	?$(\dot{\mathrm{Ca}}, \dot{\mathrm{Na}}, \dot{\mathrm{H}})^3\dddot{\mathrm{Si}}^2+\dot{\mathrm{H}}$.
LAUMONTITE GROUP, IV.	Pectolite,	$(\dot{\mathrm{Ca}}, \dot{\mathrm{Na}})^4\dddot{\mathrm{Si}}^3+\dot{\mathrm{H}}$.
	Okenite,	?$(\dot{\mathrm{Ca}}, \dot{\mathrm{H}})^3\dddot{\mathrm{Si}}^2+1\frac{1}{2}\dot{\mathrm{H}}$.
	Laumontite,	$(\frac{1}{4}\dot{\mathrm{Ca}}^3+\frac{3}{4}\dddot{\overline{\mathrm{Al}}})\dddot{\mathrm{Si}}^2+3\dot{\mathrm{H}}=(\dot{\mathrm{R}}^3, \dddot{\overline{\mathrm{R}}})\dddot{\mathrm{Si}}^2+3\dot{\mathrm{H}}$.
	?Catapleiite,	$(\frac{1}{3}\dot{\mathrm{R}}^3+\frac{2}{3}\ddot{\mathrm{Zr}})\dddot{\mathrm{Si}}^2+2\dot{\mathrm{H}}$.
DIOPTASE GROUP, VI.	Dioptase,	$\dot{\mathrm{Cu}}^3\dddot{\mathrm{Si}}^2+3\dot{\mathrm{H}}$.
	[Chrysocolla,	$\dot{\mathrm{Cu}}^3\dddot{\mathrm{Si}}^2+6\dot{\mathrm{H}}$.
	Pyrosmalite,	$(\dot{\mathrm{Fe}}, \dot{\mathrm{Mn}})^3\dddot{\mathrm{Si}}^2+\frac{1}{4}(\mathrm{Fe}^2\mathrm{Cl}^3+\dddot{\overline{\mathrm{Fe}}}\dot{\mathrm{H}}^6)$.

III. CALAMINE SECTION. Oxygen ratio between bases and silica, 1 : 1.

TRITOMITE GROUP, I.	TRITOMITE,	$\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}+2\dot{\mathrm{H}}$.
THORITE GROUP.	THORITE,	$\dot{\mathrm{Th}}^3\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$.
	CERITE,	$(\dot{\mathrm{Ce}}, \dot{\mathrm{La}})^3\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$.
CALAMINE GROUP, III.	CALAMINE,	$\dot{\mathrm{Zn}}^3\dddot{\mathrm{Si}}+1\frac{1}{2}\dot{\mathrm{H}}$(or $2\dot{\mathrm{H}}$).
	PREHNITE,	$(\frac{1}{2}(\dot{\mathrm{R}}, \dot{\mathrm{H}})^3+\frac{1}{2}\dddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}$.

Appendix. CHLORASTROLITE, SAVITE, SCHNEIDERITE, CARPHOLITE.

2. *Oxygen ratio of protoxyds and peroxyds*, 1 : 3.

IV. ZEOLITE SECTION.—[For enumeration of species see beyond.]

3. *Oxygen ratio of bases and silica*, 1 *to less than* 1.

V. DATHOLITE SECTION.

[Among the Non-magnesian Hydrous Silicates, a large group—the Zeolite Section—corresponds with the Feldspar Section of Anhydrous Silicates, in having the oxygen of the protoxyds and peroxyds as 1 : 3; and to some extent there are analogies in crystallization as well as formula. Thus Analcime is related to Leucite, and Ittnerite to Sodalite, both in form and formula; while Heulandite and Orthoclase are each monoclinic, with a like oxygen ratio, 1 : 3 : 12. Still these analogies are not to be too closely pressed. Gismondine is regarded as more nearly related to the Scapolite Group; and Chabazite, excluding the water, has the oxygen ratio of Beryl, and Eudialyte, as well as of Pyrosmalite and Dioptase, besides being related in angles.

Another section, including Datholite, corresponds with the Andalusite Section of Anhydrous Silicates, the oxygen of the silica being less than that of the bases; another section (II) has the augite ratio; another (III) the garnet ratio.

In view of these and other considerations, the above prominent subdivisions are adopted.

The ratios on which the divisions are based, are, as with the magnesian species, for the most part independent of the water present in the compound. Thus in the Pectolite Section, excluding the water, Pectolite has an augite ratio (Frankenheim) as well as augite form. The same is true of Laumontite. So also Dioptase and Pyrosmalite have the form and ratio of the *Beryl* Group. Again, in the Calamine Section, Calamine and Prehnite are homœomorphous with one another, besides being each pyro-electric: and as written above, they have analogous formulas, (ratio 1 : 1), if the water of Calamine is excluded and that of Prehnite is basic.

On the other hand, if part of the water in *Apophyllite* be regarded as acting as a protoxyd base, the formula may be $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+2\dot{\mathrm{H}}$. The ratio of ingredients afforded by the analyses is $10\dddot{\mathrm{Si}}$, $8\dot{\mathrm{Ca}}$, $1\dot{\mathrm{K}}$, $16\dot{\mathrm{H}}$; and if $6\dot{\mathrm{H}}$ out of the

$16\dot{\mathrm{H}}$ be added to the bases, we have $15\dot{\mathrm{R}}+10\dddot{\mathrm{Si}}+10\dot{\mathrm{H}}=5\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+10\dot{\mathrm{H}}=\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+2\mathrm{H}$, which last is probably the true formula of the species, and seems to require that Apophyllite should be arranged in the Pectolite Section, where we place it provisionally.

In *Okenite* the ratio of the oxygen of the bases and silica is 1 : 4, a ratio unknown in the Anhydrous Silicates, except in Petalite. The prismatic angle 122° 19′ is so near that of Hornblende that we may suspect an approximation in form under the Monoclinic System. If $3\dot{\mathrm{H}}$ be considered as acting as a base, the formula is then of the Augite type, (ratio 1 : 2); and on this ground the species is placed near Pectolite. Rose recognizes the ratio 1 : 2 for the silicate of lime in his formula of Okenite, $\dot{\mathrm{C}}\mathrm{a}^3\ddot{\mathrm{Si}}^2+2\dot{\mathrm{H}}^3\ddot{\mathrm{Si}}$.

Pyrophyllite has the ratio and probably the form of Talc, although different in containing no protoxyds; it pertains to a section parallel with that of Talc in the Magnesian Series.

A considerable group of so-called species, related to Kaolin or Halloysite, might be here added. They are the direct result of the decomposition or alteration of other species, and have already been mentioned under the species from which they are derived. They are as follows:

Under *Pyroxene*, Cimolite, (p. 165), Palagonite, (p. 166). Under *Feldspar*, Kaolin, (p. 249), Tuesite, Smelite, Lithomarge, Myelin, Melopsite, (p. 250), Pholerite, Halloysite, Smectite, Lenzinite, Samoite, (p. 251), Bole, Ochran, Collyrite, Pipestone, Agalmatolite, (p. 252).]

I. PYROPHYLLITE SECTION.

PYROPHYLLITE, *Hermann*.

Foliated like talc; often radiated lamellar.

H.=1. G.=2·7—2·8; 2·785, Berlin. Lustre pearly, inclined to greasy. Color white, apple-green, grayish and brownish-green, ochre-yellow. Subtransparent—subtranslucent. Thin laminæ flexible.

Composition.—$\ddot{\overline{\mathrm{Al}}}\dddot{\mathrm{Si}}^3+1\frac{1}{2}\dot{\mathrm{H}}$=Silica 67·7, alumina 25·6, water 6·7; or $\ddot{\overline{\mathrm{Al}}}^2\dddot{\mathrm{Si}}^5+2\dot{\mathrm{H}}$= Silica 65·2, alumina 29·6, water 5·2. Analyses: 1, Hermann, (Pogg. xv, 592); 2, Rammelsberg, (lxviii, 513); 3, 4, Sjögren, (Öfv. K. V. Ac. Förh., 1848, 110):

	$\dddot{\mathrm{Si}}$	$\ddot{\overline{\mathrm{Al}}}$	$\ddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{H}}$
1. Siberia,	59·79	29·46	1·80	4·00	5·62, silver *trace*=100·67, Herm.
2. Spaa,	66·14	25·87	—	1·49	5·59, $\dot{\mathrm{C}}\mathrm{a}$ 0·39=99·48, Ramm.
3. Westana, Sw.	67·77	25·17	0·82	0·26	5·82, $\dot{\mathrm{C}}\mathrm{a}$ 0·66, $\dot{\mathrm{M}}\mathrm{n}$ 0·50=101·00, Sj.
4. " "	65·61	26·09	0·70	0·09	7·08, $\dot{\mathrm{C}}\mathrm{a}$ 0·69, $\dot{\mathrm{M}}\mathrm{n}$ 0·09=100·35, Ber.

From Hermann's analysis comes the formula $\dot{\mathrm{M}}\mathrm{g}^3\dddot{\mathrm{Si}}^2+9\ddot{\overline{\mathrm{Al}}}\,\dddot{\mathrm{Si}}^2+9\dot{\mathrm{H}}$.

B.B. alone swells up and spreads out into fan-like shapes, and increases to twenty times its former bulk. Infusible. With soda it forms a clear yellow glass. With cobalt solution it assumes a fine blue color. Partially soluble in sulphuric acid.

Pyrophyllite occurs in the Uralian mountains, between Pyschminsk and Beresof; at Westana, Sweden, etc. It was considered a radiated talc. Also found in Cottonstone Mountain, Montgomery Co., N. C., in white stellate aggregations.

ANTHOSIDERITE, *Hausmann.*

In tufts of a fibrous structure, and sometimes collected into feathery flowers. Resembles Cacoxene.

H.=6·5. G.=3·6. Color ochre-yellow and yellowish-brown, somewhat grayish. Opaque or slightly subtranslucent. Gives sparks with a steel. Tough.

Composition.—$\dddot{\bar{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{Si}}^3+\dot{\mathrm{H}}$=Silica 60·4, peroxyd of iron 35·6, water 4·0=100. Analysis by Schnedermann, (Pogg. lii, 292): $\dddot{\mathrm{Si}}$ 60·08, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 34·99, $\dot{\mathrm{H}}$ 3·59=98·66.

B.B. becomes reddish-brown, then black, and fuses with difficulty to a black magnetic slag. Dissolves in muriatic acid.

From the province Minas Geraes, in Brazil, where it is associated with magnetic iron. Named from *ανθος*, *flower*, and *σιδηρος*, *iron.*

II. PECTOLITE SECTION.

APOPHYLLITE. Pyramidal Zeolite, *J.* Tesselite, *Brewster.* Oxhaverite, *Brewster.* Ichthyophthalmite. Albin, *Wern.* Mesotype Epointée, *H.*

Dimetric. $O : 1i$=128° 38′; a=1·2515. Observed planes: O, ii, $i2$, $i3$, 1, $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{2}i$, $\frac{1}{5}i$. O:1=119° 30′, $O : \frac{1}{2}i$=147° 58′, 1 : 1 (pyr.) =104° 2′, (bas.)=121°, $ii : i3$=161° 34′, $ii : i2$=153° 26′. Crystals sometimes nearly cylindrical or barrel-shape. Cleavage: O highly perfect; I less so. Also massive and lamellar.

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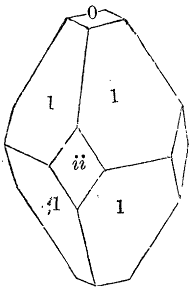

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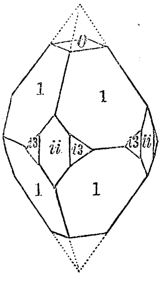

H.=4·5—5. G.=2·335, Haidinger, a variety from Iceland; 2·359, Thomson; 1·961, from Radauthal, R. Lustre of O pearly; of the other faces vitreous. Color white, or grayish; occasionally with a shade of green, yellow, or red. Streak white. Transparent—opaque. Fracture uneven. Brittle.

Composition.—$(\dot{\mathrm{R}})^3\,\dddot{\mathrm{Si}}^2+2\dot{\mathrm{H}}$, (in which $\dot{\mathrm{R}}^3=\dot{\mathrm{C}}\mathrm{a}$, $\dot{\mathrm{K}}$, $\dot{\mathrm{H}}$, in the proportions 8 : 1 : 6) =Silica 52·7, lime 26·0, potash 4·4, water 16·7, (see page 302.) There is also a variable proportion of fluorine in the mineral, but its relation to the compound is not clearly made out. Analyses: 1, 2, Berzelius, (Afhand. vi, 181); 3, 4, 5, Rammelsberg, (2d Supp. 16, and 3d Supp. 18); 6, C. T. Jackson, (this Min. 3d edit., p. 249); 7, E. L. Reakirt, (Am. J. Sci., [2], xvi, 84); 8, J. L. Smith, (private communication):

	$\ddot{\mathrm{Si}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$	HF
1. Utö,	52·13	24·71	5·27	16·20	0·82 (=4·82 Ca fluosil)=99·13, B.
2. Faroe, *Tesselite*,	52·38	24·98	5·37	16·20	0·64 (=3·53 Ca fluosil)=99·57, B.
3. Andreasberg,	51·33	25·86	4·90	und.	F 1·28, Ramm.
4. "	50·20	24·52	und.	und.	F 1·09, Ramm.
5. Radauthal, G.=1·961,	52·44	24·61	4·75	16·73	Ca fluosil. 1·43 (=0·46 F.) R.
6. Michigan, G. 2·305,	52·70	23·35	4·95	16·00	Ca F 1·85=98·85, Jackson.
7. Nova Scotia,	52·60	24·88	5·14	16·67	F 1·71=101, Reakirt.
8. L. Superior, G.=2·37,	52·08	25·30	4·93	15·92	0·96=99·19, Smith.

Yields much water in a matrass, and in an open tube some fluorine. B.B. exfoliates, and ultimately fuses to a white vesicular glass; in an open tube usually some hydrofluoric acid. Melts easily with borax, and the saturated solution becomes milk-white on flaming. In nitric acid in powder it separates into flakes and becomes imperfectly gelatinous and subtransparent.

The *tesselite* of Brewster, from Faroe, has a cubical form, and on optical examination, exhibits a tesselated structure. *Oxhaverite* is a pale green variety from the Oxhaver springs, near Husavick in Iceland, where it occurs on calcified wood; it is generally indistinctly crystallized and translucent. *Albin*, of Werner, is a white, opaque variety, found at Aussig in Bohemia, associated with natrolite.

Greenland, Iceland, the Faroe Islands, Poonah and Ahmednuggar in Hindostan, afford fine specimens of apophyllite, coating cavities in amygdaloid, and associated with chalcedony, stilbite, chabazite, &c. At Andreasberg, in silver veins, traversing gray-wacke slate; in the Bannat, associated with Wollastonite; in Fifeshire, with magnetic iron; at Utö in Sweden; at Puy de la Piquette in Auvergne, in a tertiary limestone, near intruded basaltic rocks; at Dalecarlia, Sweden; in the Tyrol, near Frombach; Orawicza, Hungary; near Nertschinsk, Siberia; in New Holland; the Valencian Mines, Mexico.

In America it has been found at Peter's Point and Partridge Island, in the Basin of Mines, Nova Scotia, both massive and crystallized, presenting white, reddish, and greenish colors, and associated with laumonite, thomsonite, and other minerals of trap rocks. Good crystals occur in greenstone at Bergen Hill, N. J., associated with analcime, pectolite, stilbite, datholite, &c. It is also found at Gin Cove, near Perry, Maine, with prehnite and analcime in amygdaloid; at the Cliff Mine, Lake Superior region, (f. 470.)

Apophyllite was so named in allusion to its tendency to exfoliate under the blowpipe, from απο and φυλλον, *a leaf.* Its whitish pearly aspect resembling the eye of a fish after boiling gave rise to the name *Ichthyophthalmite,* from ιχθυς, *fish,* and οφθαλμος, *eye.*

Xylochlore, *Waltershausen,* Vulk. Gest. 297. Dimetric and pyramidal, like apophyllite. Angle of pyramid about 96°. Cleavage basal, perfect, H.=6. G.=2·2904. Color olive green. *Composition.*—Analysis by Waltershausen, (mean of two analyses, loc. cit.), $\ddot{\mathrm{Si}}$ 52·07, $\dddot{\mathrm{Al}}$ 1·54, $\dot{\mathrm{Ca}}$ 20·57, $\dot{\mathrm{Mg}}$ 0·33, $\dot{\mathrm{Fe}}$ 3·40, $\dot{\mathrm{Na}}$ 0·55, $\dot{\mathrm{K}}$ 3·77, $\dot{\mathrm{H}}$ and $\ddot{\mathrm{C}}$ 17·14=99·37.

The mineral contains some carbonate of lime intermixed. From Iceland. The crystals are 1 to 1½ millimeters long. Closely resembles apophyllite, and may be that species.

Gyrolite.—The *Gyrolite* (or Gurolite) of Anderson, (Phil. Mag. [4], i, 101), from Skye, is very near Apophyllite. It occurs in spherical concretions having a lamellar radiate structure, white and pearly; H.=3—4; like Apophyllite before the blowpipe and with acids. Analysis afforded $\ddot{\mathrm{Si}}$ 50·70, $\dddot{\mathrm{Al}}$ 1·48, $\dot{\mathrm{Ca}}$ 33·24, $\dot{\mathrm{Mg}}$ 0·18, $\dot{\mathrm{H}}$ 14·18=99·78; giving approximately $\dot{\mathrm{Ca}}\ddot{\mathrm{Si}}+1\frac{1}{2}\dot{\mathrm{H}}$, (or more nearly $1\frac{1}{3}\dot{\mathrm{H}}$).

PECTOLITE. Pektolith, *Kobell*, Kastner's Archiv., xiii, 385, xiv, 341. Osmelite, *Breit.* Wollastonite, *Thom.*

Monoclinic, and near Wollastonite in angle, (Greg and Lettsom). Cleavage: orthodiagonal, perfect. Twins parallel to *ii* common. In aggregated acicular crystals, or fibrous massive, radiated or stellar.

H.=5. G.=2·68—2·74. Lustre of the surface of fracture silky or subvitreous. Color whitish or grayish. Subtranslucent to opaque. Tough like dysclasite.

Composition.—$(\dot{\mathrm{Ca}}, \dot{\mathrm{Na}})^4\dddot{\mathrm{Si}}^3+\dot{\mathrm{H}}$=Silica 52·5, alumina 36·1, soda 8·0, water 3·4; same with half more water, Scott's analysis. Analyses: 1, Kobell, (Kastner's Arch. xiii, 385); 2, Hayes, (2d edit. of this Min. p. 336); 3–4, J. D. Whitney, (Jour. Bost. Soc. N. H. 1849, p. 36, and Amer. J. Sci. [2], vii, 434); 5, J. S. Kendall, (ib.); 6, G. J. Dickinson, (ib.); 7, A. J. Scott, (Jameson's J. liii, 277):

	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$	
1. M. Baldo,	51·3	33·77	8·26	1·57	3·89,	$\dddot{\bar{\mathrm{Al}}}$, $\dddot{\bar{\mathrm{Fe}}}$ 0·9=99·69, K.
2. Bergen,	55·96	35·12	6·75	0·60	0·16,	$\dddot{\bar{\mathrm{Al}}}$, $\dot{\mathrm{Mg}}$ 0·08, $\dot{\mathrm{Mn}}$ 0·64=99·31, H.
3. I. Royal,	53·45	31·21	7·37	*trace*	2·72,	$\dddot{\bar{\mathrm{Al}}}$ 4·94=99·69, W.
4. "	55·66	32·86	7·31	——	2·72,	$\dddot{\bar{\mathrm{Al}}}$ 1·45=100, W.
5. "	54·00	32·10	8·89	*trace*	2·96,	$\dddot{\bar{\mathrm{Al}}}$ 1·90=99·85, K.
6. "	55·00	32·53	9·72	——	2·75,	$\dddot{\bar{\mathrm{Al}}}$ 1·10=101·10, D.
7. I. Skye,	52·00	32·85	7·67	$\dot{\mathrm{Mg}}$0·39	5·06,	$\dddot{\bar{\mathrm{Al}}}$ 1·82=99·80, Scott.

An analysis by M. Adam, (Millon, &c., Annuaire de Chemie, 1848, 166), places the osmelite of Breithaupt with pectolite; but a very different result is obtained by Riegel. B.B. fuses easily to a white enamel. With little borax a silica skeleton remains; with more, a transparent glass. After heating gelatinizes perfectly with muriatic acid.

Occurs at Mount Baldo, and Mount Monzoni in the Tyrol, and at Storr on the Isle of Skye; also at Bergen Hill (called stellite) in amygdaloid, and at Isle Royal, Lake Superior; and Ratho Quarry, near Edinburg. The *Wollastonite* of Thomson from Kilsyth, Scotland, is referred here by J. D. Whitney.

The stellite of Thomson, (Min. i, 313), from Kilsyth, Scotland, afforded him $\dddot{\mathrm{Si}}$ 48·47, $\dddot{\bar{\mathrm{Al}}}$ 5·30, $\dot{\mathrm{Ca}}$ 30·96, $\dot{\mathrm{Fe}}$ 3·53, $\dot{\mathrm{Mg}}$ 5·58, $\dot{\mathrm{H}}$ 6·11=99·95. It is white, radiated, silky. H.=3—3·5. G.=2·612.

OKENITE, *Kobell.* Dysclasite, *Connel.*

Trimetric? $I : I$=122° 19′, Breit. Usually massive and fibrous; also imperfectly fibrous or composed of a congeries of minute crystals.

H.=4·5—5. G.=2·362 of dysclasite, Connel; 2·28 of okenite, Kobell. Lustre sub-pearly. Color white, with a shade of yellow or blue; often yellow by reflected light, and blue by transmitted. Frequently opalescent. Subtransparent—subtranslucent. Very tough.

Composition.—$(\frac{1}{2}\dot{\mathrm{Ca}}^3+\frac{1}{2}\dot{\mathrm{H}}^3)\dddot{\mathrm{Si}}^2+1\frac{1}{2}\dot{\mathrm{H}}=\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}^4+6\dot{\mathrm{H}}$=Silica 56·8, lime 26·3, water 16·9. Analyses: 1, 2, Kobell, (Kastner's Arch. xiv, 333); 3, Connel, (Edinb. Phil. Jour. xvi, 198); 4, Würth, (Pogg. lv, 113):

	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{H}}$	
1. Greenland,	55·64	26·59	17·00	$\dddot{\bar{\mathrm{Al}}}$ and $\dddot{\bar{\mathrm{Fe}}}$ 0·53, $\dot{\mathrm{K}}$ *trace*=99·76, Kobell.
2. "	56·99	26·35	16·65=99·99, Kobell.	
3. Faroe,	57·69	26·83	14·71	$\dot{\mathrm{Mn}}$ 0·22, $\dddot{\bar{\mathrm{Fe}}}$ 0·32, $\dot{\mathrm{K}}$ 0·23, $\dot{\mathrm{Na}}$ 0·44=100·44, C.
4. Iceland,	54·88	26·15	17·94	$\dddot{\bar{\mathrm{Al}}}$ 0·46, $\dot{\mathrm{Na}}$ 1·02=100·45, Würth.

In a matrass yields water. B.B. alone becomes opaque and white, and fuses to a glass. Effervesces with soda, and fuses to a subtransparent glass, which is milk-white on cooling; with borax forms a transparent colorless glass. Gelatinizes readily in muriatic acid.

Found at the Faroe Islands, and in Iceland; in amygdaloid in Greenland.

LAUMONTITE, *Hauy*. Lomonite, *W.* Laumonite. Efflorescing Zeolite.

Monoclinic. *C.*=68° 40′, *I* : *I*=86° 16′, *O* : 1*i*=151° 9′; *a* : *b* : *c*=0·516 : 1 : 0·8727. In form related to augite. Observed planes, *O*, *I*, *ii*, 1, –1, –2*i*.

O : 1=148° 22′. 1 : 1=133° 26′. *ii* : –1=120° 17′.
O : *I*=104° 20′. –1 : –1=119° 26′. *ii* : –2*i*=125° 41′.
O : *ii*=101° 20′. *ii* : 1=113° 17′. *O* : –2*i*=122° 59′.

Cleavage: *ii* perfect; also *I*. Also columnar, radiating, or divergent.

H.=3·5—4. G.=2·29—2·36. Vitreous, inclining to pearly upon the faces of cleavage. White, passing into yellow or gray, sometimes red; streak uncolored. Transparent—translucent; becomes opaque and usually pulverulent on exposure. Fracture scarcely observable, uneven. Not very brittle.

Composition.—$\dot{C}a^3\dddot{S}i^2+3\bar{\dddot{A}}l\dddot{S}i^2+12\dot{H}$, Gerhardt=$(\frac{1}{4}\ddot{C}a^3+\frac{3}{4}\bar{\dddot{A}}l)\dddot{S}i^2+3\dot{H}$=Silica 51·1, alumina 21·8, lime 11·9, water 15·2=100.

Analyses: 1, 2, Dufrénoy, (Ann. d. Mines, [3], viii, 503); 3, Connel, (Edinb. Jour. 1829, 282); 4, 5, Babo and Delffs, (Pogg. Ann. lix, 339); 6, Malaguti and Durocher, (Ann. d. Mines, [4], ix, 325); 7, N. J. Berlin, (Pogg. lxxviii, 415); 8, Scott, (Jameson's J., Oct. 1852, liii, 284):

	$\dddot{S}i$	$\bar{\dddot{A}}l$	$\dot{C}a$	$\dot{H}$
1. Phipsburg, Me.,	51·98	21·12	11·71	15·05=99·86, Dufrénoy.
2. Cormayeur,	50·38	21·43	11·14	16·15=99·10, Dufrénoy.
3. Skye,	52·04	21·14	10·62	14·92=98·72, Connel.
4.	52·30	22·30	12·00	14·2=100·8, Babo.
5.	51·17	21·23	12·43	15·17 (loss)=100, Delffs.
6. Huelgoet, G.=2·290,	52·47	22·56	9·41	15·56=100, M. and D.
7. *Red*, Upsala,	51·61	19·06	12·53	14·02, $\bar{\ddot{F}}e$ 2·96=100·18, Berlin.
8. I. Storr,	53·05	22·94	9·67	14·64=100·30, Scott.

B.B. intumesces and fuses to a frothy mass. With borax forms a transparent globule. Gelatinizes with nitric or muriatic acid, but not affected by sulphuric acid, unless heated.

Laumontite occurs in the cavities of amygdaloid, also in porphyry and syenite, and occasionally in veins traversing clay slate with calcite. It was first observed in 1785, in the lead mines of Huelgoet in Brittany, by Gillet Laumont, after whom it is named.

Its principal localities are at the Faroe Islands, Disko in Greenland, in Bohemia at Eule in clay slate, St. Gothard in Switzerland, the Fassa-thal in large masses exhibiting a radiated structure, Hartfield Moss in Renfrewshire, accompanying analcime, the amygdaloidal rocks in the Kilpatrick hills near Glasgow, and in several trap rocks of the Hebrides, and the north of Ireland.

Peter's Point, Nova Scotia, affords fine specimens of this species. It is there associated with apophyllite, thomsonite, and other species of this family. Also found in good specimens at Phipsburg, Maine, and the Charlestown quarries, Mass., in gneiss; also sparingly at Bradleysville, Litchfield Co., Conn., near a paper-mill, in narrow seams in gneiss; and at Southbury, Conn., a little east of the village, on the land of Mr. Stiles. Abundant in many places in the copper veins of Lake Superior in trap and on I. Royal; on north shore of Lake Superior, between Pigeon Bay and Fond du Lac. Found also at Bergen Hill, N. J., in greenstone, with datholite, apophyllite, &c.; sparingly at Phillipstown, N. Y., in feldspar with stilbite and at Columbia bridge, near Philadelphia.

The rapid change to which this mineral is liable, may be prevented by dipping the specimen in a thin solution of gum Arabic. The change consists in a loss of 1 to 2 per cent. of water. Some varieties do not undergo this change. Dufrénoy makes *I*: *I*=84° 30′.

The Ædelforsite of Retzius, or the Red Zeolite of Ædelfors, is referred here by N. J. Berlin, who considers it impure from mixed silica (quartz) and related to the red zeolite of Upsala analyzed by him. It afforded Retzius $\dddot{\mathrm{Si}}$ 60·28, $\dddot{\mathrm{\bar{A}l}}$ 15·42, $\dot{\mathrm{Ca}}$ 8·18, $\dddot{\mathrm{\bar{F}e}}$ 4·16, $\dot{\mathrm{Mg}}$ and $\dot{\mathrm{Mn}}$ 0·42, $\dot{\mathrm{H}}$ 11·07=99·53. A similar mineral from Fahlun yielded Hisinger $\dddot{\mathrm{Si}}$ 60·00, $\dddot{\mathrm{\bar{A}l}}$ 15·6, $\dddot{\mathrm{\bar{F}e}}$ 1·8, $\dot{\mathrm{Ca}}$ 8·0, $\dot{\mathrm{H}}$ 11·6=97·0; while he obtained for the Ædelfors zeolite $\dddot{\mathrm{Si}}$ 53·76, $\dddot{\mathrm{\bar{A}l}}$ 18·47, $\dddot{\mathrm{\bar{F}e}}$ 4·02, $\dot{\mathrm{Ca}}$ 10·90, $\dot{\mathrm{H}}$ 11·23=98·38.

LEONHARDITE, *Blum.*

Monoclinic. *I* : *I*=83° 30′, and 96° 30′; *O* : *I*=114°. Cleavage parallel with *I* very perfect, basal imperfect. Also columnar and granular.

H.=3—3·5. G.=2·25. Lustre of cleavage face pearly, elsewhere vitreous. White, sometimes yellowish, seldom brownish. Subtranslucent. Usually whitens on exposure like Laumonite.

Composition.—$3\dot{\mathrm{Ca}}\dddot{\mathrm{Si}}+4\dddot{\mathrm{\bar{A}l}}\dddot{\mathrm{Si}}^2+15\dot{\mathrm{H}}$=Silica 54·0, alumina 22·3, lime 9·1, water 14·6. Equally near the analyses and analogous to the formula of Laumontite, if written $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+3\dddot{\mathrm{\bar{A}l}}\dddot{\mathrm{Si}}^2+9\dot{\mathrm{H}}$, in which $\dot{\mathrm{R}}$ consists of $\dot{\mathrm{Ca}}$ and $\dot{\mathrm{H}}$ in the proportion of 3 : 1. More probably the oxygen ratio for the bases and silica is 4 : 9, as in hornblende, which (taking $12\dot{\mathrm{H}}$)=Silica 56·2, alumina 22·7, lime 9·2, water 11·9.

Analyses: 1, Delffs, (Pogg. lix, 336, 339); 2, Babo, (ibid); 3, 4, G. O. Barnes, under the direction of J. D. Whitney, (Am. J. Sci. [2], xv, 440):

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{\bar{A}l}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{H}}$
1.	56·128	22·980	9·251	11·641=100, Delffs.
2.	55·00	24·36	10·50	12·30=102·16, Babo.
3.	55·96	21·04	10·49	11·93=99·42, Barnes.
4.	55·04	22·34	10·64	11·93=99·95, Barnes.

Delffs' analysis was made after drying the mineral at 100° cent.; dried at the ordinary temperature it gave 13·547—13·807 water, which corresponds to the above formula. B.B. exfoliates, froths, and easily melts to an enamel. Dissolves in acids.

From a trachytic rock at Schemnitz in Hungary. Also at Copper Falls, Lake Superior Region, a variety which does not alter on exposure.

CATAPLEIITE. Katapleiit, *Weibye* and *Sjögren*, Pogg. lxxix, 299.

In imperfect prismatic crystals with perfect basal cleavage.

H. near 6. G.=2·8. Lustre nearly dull, weak vitreous on surface of fracture. Color light yellowish-brown. Streak isabella-yellow. Opaque.

Composition. — $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+2\dddot{\mathrm{\bar{Z}r}}\,\dddot{\mathrm{Si}}^2+6\dot{\mathrm{H}}=(\tfrac{1}{3}\dot{\mathrm{R}}^3+\tfrac{2}{3}\dddot{\mathrm{\bar{Z}r}})\dddot{\mathrm{Si}}^2+2\dot{\mathrm{H}}$. Analyses by Sjögren, (loc. cit.):

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{\bar{Z}r}}$	$\dddot{\mathrm{\bar{A}l}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{H}}$
1.	46·83	29·81	0·45	10·83	3·61	0·63	8·86=101·02.
2.	46·52	29·33	1·40	10·06	4·66	0·49	9·05=101·55.

B.B. in the platinum forceps fuses easily to a white enamel; with borax a clear colorless glass; blue with cobalt solution. Easily soluble in muriatic acid without gelatinizing.

From the island Lamö near Brevig, Norway, along with zircon, leucophane, mosandrite and tritomite.

DIOPTASE, *Haüy*. Emerald Copper, *Phillips*. Emerald Malachite. Achirite, Kupfer-Smaragd, *W.* Smaragdo-Chalcit, *Br.*

Rhombohedral; $R : R = 126° 24'$; $O : R = 148° 38'$; $a = 0·5281$. Observed planes; rhombohedral, 1 (R), 2, –2; hemi-scalenohedral on three alternate edges as in the figure, with also 2^2; also 1^3; prismatic $i2$, $i\frac{3}{2}$, $i\frac{4}{3}$, $i\frac{8}{7}$, the last three hemihedral.

$O : 2 = 129° 21'$. $i\frac{4}{3} : i2 = 165° 44'$.
$i2 : i2 = 120°$. $i\frac{3}{2} : i2 \doteq 169° 06'$.
$2 : 2 = 95° 54'$. $1^3 : i2 = 146° 36'$.
$2 : i2 = 132° 3'$. $2 : R = 137° 57'$.
$2^2 : i2 = 151°$. $i2 : R = 126° 48'$.

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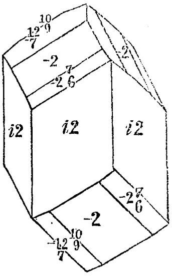


Cleavage: R perfect. Twins: composition face R.

H.=5. G.=3·278, 3·348. Lustre vitreous. Streak green. Color emerald-green. Transparent—subtranslucent. Fracture conchoidal, uneven. Brittle.

Composition.—$\dot{C}u^3\dddot{S}i^2+3\dot{H}$=Silica 38·3, oxyd of copper 50·3, water 11·4=100. Analyses: 1, 2, Hess, (Pogg. xvi, 360); 3, 4, Damour, (Ann. d. Ch. Phys., [3], x. 485):

1.	$\dddot{S}i$ 36·60	$\dot{C}u$ 48·89	$\dot{H}$ 12·29	$\dot{F}e$ 2·00=99·78, Hess.
2.	36·85	45·10	11·52	$\bar{\dddot{A}}l$ 2·36, $\dot{C}a$ 3·39, $\dot{M}g$ 0·22=99·43, Hess.
3.	36·47	50·10	11·40	$\bar{\dddot{F}}e$ 0·42, $\dot{C}a\ddot{C}$ 0·35=98·74, Damour.
4.	38·93	49·51	11·27=99·71, Damour.	

B.B. decrepitates, tinging the flame yellowish-green; in the outer flame becomes black, in the inner red, but does not melt. Fuses with borax to a green globule, and is finally reduced. Insoluble in nitric acid, but soluble and gelatinizing in muriatic.

Dioptase occurs disposed in well defined crystals on quartz, at Altyn Tübé, in the Kirghese Steppes of Siberia, whence it was first brought by a Bucharian merchant, Achir Mamed, after whom it was named Achirite. Also found in the Duchy of Nassau, between Oberlahnstein and Braubach.

The name dioptase is from δια, *through*, and 'οπτομαι, *to see.*

CHRYSOCOLLA. Kieselkupfer. Kieselmalachit. Copper-green. Kupfergrün, Cuivre hydrosilicieux, *H.*

Botryoidal and massive, incrusting or disseminated.

H.=2—3. G.=2—2·238. Lustre vitreous, shining, earthy. Color mountain-green, bluish-green, passing into sky-blue; often brown when impure. Streak white. Translucent—opaque. Fracture conchoidal. Rather sectile; translucent varieties brittle.

Composition.—$\dot{C}u^3\dddot{S}i^2+6\dot{H}$=Silica 34·3, oxyd of copper 45·2, water 20·5; often mixed with carbonate and oxyd of copper. Analyses: 1, Ullmann, (Syst. tab. Uebers. 275); 2, Kobell, (Pogg. xviii, 254); 3, 4, 5, Berthier, (Ann. Ch. Phys. li, 395); 6, Bowen, (Am. J. Sci. viii, 18); 7, Beck, (Am. J. Sci. xxxvi, 111); 8, Scheerer, (Pogg. lxv, 289); 9, C. T. Jackson, (Private communication); 10, Rammelsberg, (J. f. pr. Ch. lv, 488, Pogg. lxxxv, 300); 11, Kittredge, (ib.):

		$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{H}}$	
1.	Siegen,	40·	40·	12·	$\ddot{\mathrm{C}}$ 8=100, Ullmann.
2.	Bogoslowsk,	36·54	40·00	20·20,	gangue 2·10, $\ddot{\bar{\mathrm{Fe}}}$ 1·00=99·84, Kobell.
3.	"	35·0	39·9	21·0	" 1·1, " 3·0=100, Berthier.
4.	Canaveilles, Pyr.,	26·0	41·8	23·5	" 2·5, " 2·5, $\ddot{\mathrm{C}}$ 3·7=100, Ber.
5.	Somerville, N. J.,	35·4	35·1	28·5	" 1·0=100, Berthier.
6.	"	37·25	45·17	17·00=99·43, Bowen.	
7.	Franklin, N. J.,	40·00	42·60	16·00 (with loss),	$\ddot{\bar{\mathrm{Fe}}}$ 1·40=100, Beck.
8.	Arendal, Norway,	35·14	43·07	20·36,	$\ddot{\bar{\mathrm{Fe}}}$, $\ddot{\bar{\mathrm{Al}}}$, $\dot{\mathrm{Ca}}$, $\dot{\mathrm{K}}$ 1·09=99·66, Scheerer.
9.	Copper Harbor,	37·85	27·97	20·00,	$\ddot{\bar{\mathrm{Fe}}}$, 8·90, $\ddot{\bar{\mathrm{Al}}}$ 4·8=99·55, C. T. Jackson.
10.	Lake Superior,	32·55	42·32	20·68,	$\ddot{\bar{\mathrm{Fe}}}$ & $\ddot{\bar{\mathrm{Al}}}$ 1·63, $\dot{\mathrm{Ca}}$ 1·76, $\dot{\mathrm{Mg}}$ 1·06=100, R.
11.	Chili,	40·09	27·97	24·73,	$\dot{\mathrm{Fe}}$ 4·94, $\dot{\mathrm{Ca}}$ 1·49, $\dot{\mathrm{Mg}}$ 0·78=100, Kit.

Ullmann's analysis (No. 1) affords the formula $\dot{\mathrm{Cu}}^3\dddot{\mathrm{Si}}^2+3\dot{\mathrm{H}}$; Nos. 2, 6, 8, 10=$\dot{\mathrm{Cu}}^3\dddot{\mathrm{Si}}^2+6\dot{\mathrm{H}}$; No. 4, $\dot{\mathrm{Cu}}^3\dddot{\mathrm{Si}}^2+12\dot{\mathrm{H}}$; No. 11, $\dot{\mathrm{Cu}}\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$.

Another sample from Copper Harbor gave Dr. Jackson 38·92 per cent. of oxyd of copper, and a third 44·28 per cent. The following are analyses of impure varieties: 1, Thomson, (Min. 1,); 2, Klaproth, (Beit. iv, 34); 3, Kobell, (J. f. pr. Chem. xxxix, 209); 4, Berthier, Ann. d. Mines, [3], xix, 698):

1.		$\dddot{\mathrm{Si}}$ 25·31,	$\dot{\mathrm{Cu}}$ 54·46,	$\dot{\mathrm{H}}$ 5·25,	$\ddot{\mathrm{C}}$ 14·98=100, Thomson.
2.		26·00	50·00	17·00	7=100, Klaproth.
3.	Turinsk, Ural, *brown*,	9·66	13·00	18·00	$\ddot{\bar{\mathrm{Fe}}}$ 59·00=99·66, Kobell.
4.	Chili,	7·1	46·8	15·0	$\dddot{\mathrm{S}}$ 10·1, $\ddot{\bar{\mathrm{Fe}}}$ 1·5, gangue 18·5=99·0, B.

Nos. 1 and 2 contain some carbonate of copper; No. 3, a large amount of brown iron ore, and is called *Kupferpecherz;* 4, some sulphate of copper. The same specimen of this mineral often presents very different appearances at its opposite parts; being sometimes of an earthy appearance, like decomposed feldspar, in one part, and translucent and brittle on the opposite.

Delesse finds some recent stalactitic formations of a bluish-white color, occurring in the galleries of a copper mine in Tuscany, (Ann. d. Mines, [4], ix, 593), to consist of Silica 21·08, alumina 17·83, oxyd of copper 28·37, water 32·72=100. The analysis affords $2\dot{\mathrm{Cu}}^3\dddot{\mathrm{Si}}+\ddot{\bar{\mathrm{Al}}}^3\dddot{\mathrm{Si}}^2+30\dot{\mathrm{H}}$; but it may not be a true chemical compound.

Blackens in the interior flame of the blowpipe on charcoal, without melting. With borax melts to a green glassy globule, and is partly reduced.

Accompanies other copper ores in Cornwall; at Libethen in Hungary; at Falkenstein and Schwatz in the Tyrol; in Siberia, the Bannat, Thuringia, Chili, Saida and Schneeberg, Saxony, Kupferberg, Bavaria; South Australia.

In Somerville and Schuyler's mines, New Jersey, at Morgantown, Pa., and at Wolcottville, Conn., chrysocolla occurs, associated with red copper ore, native copper, and green malachite; in Pennsylvania, near Morgantown, Berks Co.; and at Perkiomen; also with similar associated minerals, and with brown iron ore in Nova Scotia, at the Basin of Mines; also in Wisconsin and Michigan, mixed with carbonate of copper.

Hepatinerz from Turinsk in the Ural, according to Kobell, is a mixture of brown iron ore and chrysocolla; it afforded (J. f. pr. Ch. xxxix, 208) $\dddot{\mathrm{Si}}$ 9·66, $\dot{\mathrm{Cu}}$ 13·00, $\dot{\mathrm{Fe}}$ 59·00, $\dot{\mathrm{H}}$ 18·00. Amorphous, with a yellowish streak.

PYROSMALITE, *Haus.* Pyrodmalit, *Leonh.* Fer Muriatè, *H.*

Hexagonal. $O:1=148° 30'$; $a=0·5307$. Observed planes, O, 1, 2, I. $O:2=129° 13'$, $I:I=120°$. In prisms or tables. Cleavage: basal, perfect; I imperfect. Also massive.

H.=4—4·5. G.=3·0—3·2. Lustre of O, pearly; of other planes, less so. Color pale liver-brown, passing into gray and pistachio-green; usually brown externally, and light greenish-yellow internally. Streak paler than color. Fracture uneven, rather splintery. Somewhat brittle.

Composition.—$(\dot{Fe}, \dot{Mn})^3\dddot{Si}^2+\frac{1}{4}(Fe^2Cl^3+\dddot{\bar{Fe}}\dot{H}^6)$. Analysis by Hisinger, (Afhand. iv, 317):

	$\dddot{Si}$	$\dddot{\bar{Fe}}$	$\dddot{\bar{Mn}}$	$\ddot{\bar{Al}}$	HCl	$\dot{H}$
1.	35·40	32·60	23·10	0·60		6·50=98·20.
2.	35·85	35·48	23·44	——	2·91	*undetermined*, $\dot{Ca}$ 1·21=98·89.

As part of the iron is in the state of a basic chlorid, the second analysis becomes

$\dddot{Si}$ 35·85, $\dot{Fe}$ 21·81, $\dot{Mn}$ 21·14, Fe^2Cl^3 14·095, $\dot{Ca}$ 1·210, $\dot{H}$ and loss 5·895.

In the matrass yields water, and afterwards yellow drops of chlorid of iron. B.B. becomes reddish-brown on charcoal, and emits copious fumes; in a strong heat, fuses to a black slag, which at last becomes a round globule, attractable by the magnet. With borax, fuses readily, and presents the appearances characteristic of iron and manganese. Dissolves perfectly in concentrated nitric acid.

Pyrosmalite occurs at Nya Kopparberg in Westmannland, and at Bjelkegruvan, one of the iron mines of Nordmark in Wermland, Sweden, where it is associated with calc spar, pyroxene, apophyllite, and magnetic iron. A hexagonal prism, in the museum at Stockholm, is nearly an inch in diameter and one and a quarter inches long, and weighs five and a half ounces.

The name pyrosmalite is derived from πυρ, *fire*, and 'οσμη, *odor*, and alludes to the odor given off before the blowpipe.

PORTITE. *Meneghini* and *Bechi*.

Trimetric. In radiated masses; cleavage very distinct parallel to a rhombic prism of 120°.

H.=5. G.=2·4. Lustre vitreous. Color white. Opaque.

Composition.—Analysis by Bechi, (Am. J. Sci. [2], xiv, 63):

$\dddot{Si}$	$\ddot{\bar{Al}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
58·12	27·50	1·76	4·87	0·16	0·10	7·92=100·43.

If the protoxyds are not an essential part of the compound, the mineral corresponds to the formula $\ddot{\bar{Al}}\,\dddot{Si}^2+2\dot{H}$, like Cimolite.

B.B. intumesces much and affords a milk-white enamel. Dissolves in acids even in the cold and gelatinizes.

From the gabbro rosso in Tuscany. Named after M. Porte of Tuscany.

III. CALAMINE SECTION.

TRITOMITE, *Weibye* and *Berlin*, Pogg. lxxix, 299, 1850.

Monometric: tetrahedral, f. 55. Cleavage indistinct. H.=5·5. G.=4·16—4·66. Lustre submetallic, vitreous. Color dull brown. Streak dirty yellowish-gray. Subtranslucent.

Composition.—$\ddot{\bar{R}}\,\dddot{Si}+2\dot{H}$? Analysis by N. J. Berlin, (loc. cit.), $\dddot{Si}$ 20·13, $\ddot{\bar{Al}}$ 2·24, $\ddot{\bar{Ce}}$ 40·36, $\ddot{\bar{La}}$ 15·11, $\dot{Y}$ 0·46, $\dot{Ca}$ 5·15, $\dot{Mg}$ 0·22, $\dot{Fe}$ 1·83, $\dot{Na}$ 1·46, Mn, Cu, Sn, W, 4·62, loss by ignition, 7·86=99·44.

B.B. yields water and gives a weak fluorine reaction; with borax a reddish-yellow glass, which is colorless on cooling. With muriatic acid in powder yields chlorine and gelatinizes.

From the island Lamö near Brevig, Norway, with leucophane and mosandrite in a coarse syenite. The oxygen ratio of bases and silica appears to be 1 : 1 as in garnet and helvin, to which the species is evidently related.

THORITE, *Berzelius*, K. V. Ac. H. 1829. Orangite, *Bergemann.*

Massive and compact.

H.=4·5—5. G.=4·63—4·8; 5·34, Orangite, Berg., 5·19, Damour. Lustre of surface of fresh fracture, vitreous to resinous. Color orange-yellow, also black, sometimes inclining to brown. Streak light orange to dark brown. Transparent in thin splinters to nearly opaque. Fracture conchoidal. Easily frangible.

Composition.—Essentially $\dot{\mathrm{Th}}^3\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$=Silica 16·5, thoria 73·7, water 9·8. Damour's analysis gives 2$\dot{\mathrm{H}}$. Analyses: 1 Berzelius, (loc. cit.); 2, Damour, (Ann. d. M. [5], i, 587); 3, Bergemann, (Pogg. lxxxii, 561):

	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Th}}$	$\dot{\mathrm{Ca}}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dddot{\bar{\mathrm{M}}}\mathrm{n}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\bar{\mathrm{U}}}$	$\dot{\mathrm{Pb}}$	$\ddot{\mathrm{Sn}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
1.	18·98	57·91	2·58	3·40	2·39	0·06	1·61	0·80	0·01	0·14	0·10	0·36	9·50, undissolved, 1·70=99·51.
2.	17·52	71·65	1·59	0·31	0·28	0·17	1·13	0·88	—	0·14	0·83	*tr.*	6·14, =100·14, Damour.
3.	17·70	71·25	—	0·31	$\dddot{\bar{\mathrm{M}}}\mathrm{n}$ and $\dot{\mathrm{Mg}}$ 0·21, $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$ 0·30, $\dot{\mathrm{Ca}}$, $\ddot{\mathrm{C}}$ 4·04, $\dot{\mathrm{H}}$ 6·90=100·74, Berg.								

Heated in a platinum spoon, the orange variety becomes dull brown, and on cooling, orange again. B.B. on charcoal infusible, the edges only being slightly glazed; with borax a yellowish pearl, becoming colorless on cooling; with salt of phosphorus a colorless glass, which becomes milky and greenish on cooling; with borax an orange glass when hot, which becomes grayish on cooling. A little nitre being added, the orange color remains after cooling. With muriatic acids easily forms a jelly before, but not after calcination. The black thorite becomes pale brownish red when heated; and on charcoal forms a yellowish-brown slag.

Found in syenite by M. Esmark at Lövö, near Brevig, in Norway; also at Langesundfiord near Brevig, (orangite, anal. 2, 3). The rare metal Thorium, was first discovered in this mineral by Berzelius.

CERITE. Siliciferous Oxyd of Cerium, Silicate of Cerium. Cererite. Ochroite. Cerinstein, *W.*

Hexagonal. In short 6-sided prisms. Massive; granular.

H.=5·5. G.=4·912, Haidinger. Lustre dull adamantine or resinous. Color between clove-brown and cherry-red, passing into gray. Streak grayish-white. Slightly subtranslucent. Brittle; fracture splintery.

Composition.—$(\dot{\mathrm{Ce}}, \dot{\mathrm{La}})^3\dddot{\mathrm{Si}}+\dot{\mathrm{H}}$=Silica 21·2, protoxyd of cerium 66·1, water 12·7. Analyses: 1, Hisinger, (Afhand. i Fys. iii, 287); 2, Hermann, (J. f. pr. Chem. xxx, 193); 3, Kjerulf, (Ann. Ch. Pharm. xxxvii, 12); 4, Klaproth, (Beit. iv, 140):

		$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Ce}}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{H}}$
1.	Bastnäs,	18·00	68·59	2·00	1·25	9·60=99·44, Hisinger.
2.	"	16·06	26·55	3·53	3·56	9·10, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 1·68, $\dddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·27, Cu *trace*, $\dddot{\bar{\mathrm{L}}}\mathrm{a}$ 33·38, $\ddot{\mathrm{C}}$ 4·62=98·75, Hermann.
3.	"	20·41	56·08	$\dot{\mathrm{Fe}}$4·77	1·18	5·29 $\dot{\mathrm{La}}$ and $\dot{\mathrm{Di}}$ 8·12, Molybdenite 3·27, BiS 0·18=99·30, K.
4.	"	34·50	50·75	3·50	1·25	5·00=95·00, Klaproth.

Hermann's specimen was probably impure from mixture with carbonate of lime. Kjerulf's analyses gives $1\frac{1}{2}\dot{H}$.

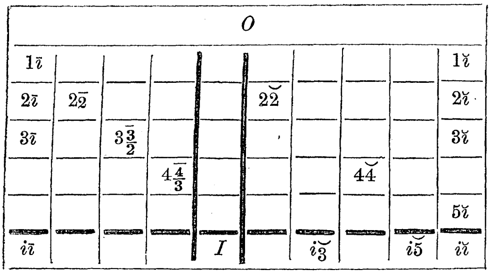
In a matrass yields water. B.B. infusible alone; with borax in the outer flame forms a yellow globule, which becomes almost colorless on cooling; in the inner flame a weak iron reaction. With soda not dissolved, but fuses to a dark yellow slaggy mass. Easily gelatinizes with muriatic acid, when in powder.

Occurs at Bastnäs, near Riddarhyttan, in Westmannland, Sweden, forming a bed in gneiss, and associated with mica, hornblende, copper pyrites, cerine, &c. It bears considerable resemblance to the red granular variety of corundum, but is readily distinguished by its hardness.

Hermann has named the ore analyzed by Klaproth, *Ochroite;* but it is supposed to have been cerite impure with mixed quartz. He deduces for it the formula $\dot{C}e^3\dddot{S}i^2+3\dot{H}$=Silica 32·83, protoxyd of cerium 57·58, water 9·59.

CALAMINE, *M.* Siliceous Oxyd of Zinc. Hydrous Silicate of Zinc, *Thom.* Zinkglas, *Haus.* Zinkkieselerz, *Berz.* Kieselzinkerz, Kieselgalmey. Zinc Oxidé Silicifère, *H.* Galmey, (in part).

Trimetric; hemihedral. *I* : *I*=103° 54′, *O* : 1ĭ=148° 29½′; *a* : *b* : *c*=0·617 : 1 : 1·2776.



Observed Planes: add ½ĭ and 7ĭ.

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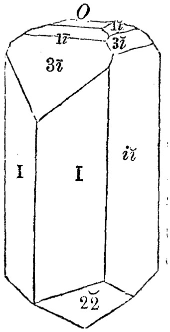


O : 2ĭ=129° 2′. *O* : 1ĭ=154° 13′. ĭ2 : ĭ2=129° 25′.

O : 3ĭ=118° 23′. *O* : 3ĭ=124° 37′. *I* : iĭ=128° 3′.

Cleavage: *I*, perfect, *O*, in traces. Also stalactitic, mammillated, botryoidal, and fibrous forms; also massive and granular.

H.=4·5—5, the latter when crystallized. G.=3·16—3·9, 3·43—3·49, from Altenberg. Lustre vitreous, *O* subpearly, sometimes adamantine. Color white; sometimes blue, green, yellow, or brown. Streak white. Transparent—translucent. Fracture uneven. Brittle. Pyroelectric.

Composition.—$\dot{Z}n^3\dddot{S}i+1\frac{1}{2}\dot{H}$=Silica 25·1, oxyd of zinc 67·4, water 7·5. Perhaps in some or all cases, one third more water, or $\dot{Z}n^3\dddot{S}i+2\dot{H}$=Silica 24·86, oxyd of zinc 65·45, water 9·69. Analyses: 1, Smithson, (Nicholson's Journ. vi, 78); 2, Berzelius, (K. V. Ac. H. 1819, 141); 3, Berthier, (J. d. Mines, xxviii, 341); 4, Thomson, (Phil. Mag. 1840); 5, 6, Hermann, (J. f. pr. Ch. xxxiii, 98):

			$\dddot{S}i$	$\dot{Z}n$	$\dot{H}$
1.	Retzbanya,		25·0	68·3	4·4 =97·7, Smithson.
2.	Limburg,		26·23	66·37	7·40=100, Berzelius.
3.	Breisgau,		25·5	64·5	10·0 =100, Berthier.
4.	Leadhills,	G.=3·164,	23·2	66·8	10·8 =100·8, Thomson.
5.	Nertschinsk,	G.=3·871,	25·38	62·85	9·07, $\dot{P}b$ 2·70=100, Hermann.
6.	"	G.=3·435,	25·96	65·66	8·38=100, Hermann.

Other analyses: K. Monheim, J. f. pr. Ch. xlix, 319; E. Schmidt, (ib. li, 257).

When pulverized, it dissolves in heated sulphuric or muriatic acid, and the solution gelatinizes on cooling. In a matrass yields water. B.B. decrepitates, loses its transparency, intumesces, and emits a green phosphorescent light; fusible with difficulty on the edges on charcoal; with borax melts to a clear glass, which does not become opaque on cooling. Swells up with soda and affords with difficulty fumes of zinc; with cobalt solution becomes at first green, then light blue on the edges, and shows signs of fusion, while the blue color extends into the unfused portion.

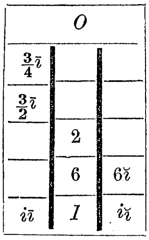
Calamine and Smithsonite are usually found associated in veins in calcareous rocks accompanying ores of blende, iron, and lead, as at Aix la Chapelle, Raibel, Bleiberg, Iserlohn, Tarnowitz, Olkucz, Miedzanagora, Retzbanya, and Mendip Hills, &c. Pseudomorphs imitative of calcareons spar are common in Derbyshire, and also at Schemnitz in Hungary. Large crystals have been found at Nertschinsk.

In the United States, it occurs with calamine in Jefferson county, Missouri; also at the Perkiomen lead mine, and in a lower Silurian rock two miles from Bethlehem, at Friedersville, in Saucon valley, abundant and extensively worked; on the Susquehanna, opposite Selimsgrove; abundantly at Austin's mines in Wythe Co., Virginia.

ALTERED FORMS.—Calamine is sometimes found altered, by substitution, to quartz.

PREHNITE, *Werner*. Koupholite. Edelith. Chiltonite, *Emmons*.

Trimetric. $I:I=99^\circ\ 56'$, $O:1\bar{\imath}=146^\circ\ 11\frac{1}{2}'$; $a:b:c=0{\cdot}66963:1:1{\cdot}19035$. $O:\frac{3}{4}\bar{\imath}=153^\circ\ 20'$, $O:\frac{3}{2}\bar{\imath}=134^\circ\ 52\frac{1}{2}'$, $O:2=119^\circ\ 45'$, $O:6=100^\circ\ 47'$, $O:6\breve{\imath}=106^\circ\ 30'$, $I:i\breve{\imath}=130^\circ\ 2'$. Cleavage: basal, distinct. Tabular crystals often united by O, making broken forms, often barrel-shaped. Reniform, globular, and stalactitic with a crystalline surface. Structure imperfectly columnar or lamellar, strongly coherent; also compact granular or impalpable.



Observed Planes.

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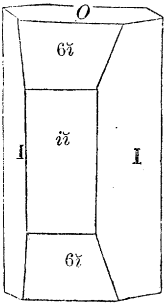


H.=6—6·5. G.=2·8—2·953. Lustre vitreous; O pearly. Color light green, passing into white and gray; often fades on exposure. Subtransparent—translucent; streak uncolored. Fracture uneven. Somewhat brittle. Pyroelectric.

Composition.—2 $\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{Si}}+3\ddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{Si}}+\dot{\bar{\mathrm{H}}}^3\dddot{\mathrm{Si}}$ Berz.; or if 3$\dot{\bar{\mathrm{H}}}$ acts with $\dot{\mathrm{C}}\mathrm{a}$ as base, $(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\ddot{\bar{\mathrm{A}}}\mathrm{l})\,\dddot{\mathrm{Si}}$=Silica 43·8, alumina 24·8, lime 27·1, water 4·3=100. Analyses; 1, 2, Gehlen, (Schw. J. iii, 171); 3, 4, 5, Walmstedt, (Jahresb. v, 217); 6, 7, Thomson and Lehunt, (Min. i, 275); 8, Regnault, (Ann. d. Mines, [3], xiv, 154); 9, Amelung, (Ramm. 2d Supp. 118, Pogg. lxviii, 312); 10, 11, Leonhard, (Pogg. liv, 579); 12, Domeyko, (Ann. d. M. [4], ix, 3).

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	$\ddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\bar{\mathrm{H}}}$	
1. Tyrol,	43·00	23·25	2·00	26·00	4·00,	$\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·25=98·50, Geh.
2. Tyrol, Fassa,	42·88	21·50	3·00	26·50	4·62,	$\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·25=98·75, Geh.
3. Mt. Blanc, *Kouph.*	44·71	23·99	——	25·41	4·45,	$\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·19, $\dot{\mathrm{F}}\mathrm{e}$ 1·25=100, Walm.
4. Dumbarton,	44·10	24·26	——	26·43	4·18,	$\dot{\mathrm{F}}\mathrm{e}$ 0·74=99·71, Walm.
5. Edelfors, *Edelite,*	43·03	19·30	6·81	26·28	4·43,	$\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·15=100·20, Walm.
6. Glasgow, *green,*	43·60	23·00	2·00	22·33	6·40=97·33, Thomson.	
7. " *white,*	43·05	23·84	$\dot{\mathrm{F}}$ 0·64	26·16	4·60,	$\dot{\mathrm{M}}\mathrm{n}$ 0·42, $\dot{\mathrm{K}}$ and $\dot{\mathrm{N}}\mathrm{a}$ 1·03, L.
8. Bourg d'Oisans,	44·50	23·44	$\ddot{\bar{\mathrm{F}}}$ 4·61	23·47	4·44=100·46, Regnault.	
9. Radauthal, Hartz,	44·74	18·06	7·38	27·06	4·13,	$\dot{\mathrm{N}}\mathrm{a}$ 1·03=102·40, Amelung.
10. Niederkirchen,	42·50	30·50	0·04	22·57	5·00,	$\dot{\mathrm{K}}$ 0·02=100·64, Leonhard.
11. pseudomorphs,	44·00	28·50	0·04	22·29	6·00,	$\dot{\mathrm{K}}$ 0·01=100·84, Leonhard.
12. Chili,	43·6	21·6	——	25·0	5·3,	$\dot{\mathrm{F}}\mathrm{e}$ 4·2=99·7, Domeyko.

B.B. on charcoal froths and melts to a slag of a light-green color. With borax a transparent bead. In dilute muriatic acid dissolves slowly after heating or fusing, without gelatinizing; before heating not perfectly soluble. *Koupholite,* which often contains dust or vegetable matter, blackens and emits a burnt odor.

Prehnite was first found at the Cape of Good Hope, by Colonel Prehn, after whom it was named by Werner. Occurs in granite, gneiss, and trap rocks, especially the last.

At St. Christophe, in Dauphiny, associated with axinite and epidote; at Ratschinges and the Fassa valley, Tyrol; in Salzburg; at Friskie Hall and Campsie in Dumbartonshire, and at Hartfield Moss; in Renfrewshire, in veins traversing trap, associated with analcime and thomsonite; also at Corstorphine Hill, the Castle and Salisbury Crag, near Edinburgh; at Oisans in Dauphiny.

In the United States, finely crystallized at Farmington, Woodbury, and Middletown, Conn., and West Springfield, Mass., and Patterson and Bergen Hill, N. J.; in small quantities in gneiss, at Bellows Falls, Vt.; in syenite, at Charlestown, Mass., Milk Row quarry, often in minute tabular crystals, with chabazite; also at Palmer (Three River) and Turner's Falls, Mass., on the Connecticut, in greenstone, and at Perry, above Loring's Cove, Maine; on north shore of Lake Superior, between Pigeon Bay and Fond du Lac; in large veins in the Lake Superior copper region, often occurring as the most common veinstone of the native copper, sometimes including strings or leaves of copper; and at times in radiated nodules disseminated through the copper.

Handsome polished slabs of this mineral have been cut from masses from China.

The formula $(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\ddot{\bar{\mathrm{A}}}\mathrm{l})\,\dddot{\mathrm{Si}}$ is analogous to that of chrysolite in the ratio 1 : 1, and the two species appear to be homœomorphous, $2\breve{\imath} : 2\breve{\imath}$ in chrysolite=99° 7′.

Altered Forms.—Prehnite occurs altered to Green earth and Feldspar.

CHLORASTROLITE, *C. T. Jackson.* *J. D. Whitney,* Bost. J. Nat. Hist. v, 488.

Massive. Finely radiated or stellate in structure.

H.=5·5—6. G.=3·180. Lustre pearly. Color light bluish-green. Slightly chatoyant on the rounded sides.

Composition.—$(\dot{\mathrm{C}}\mathrm{a}, \dot{\mathrm{N}}\mathrm{a})^3\,\dddot{\mathrm{Si}}+2\,(\ddot{\bar{\mathrm{A}}}\mathrm{l}, \ddot{\bar{\mathrm{F}}}\mathrm{e})\,\dddot{\mathrm{Si}}+3\,\dot{\bar{\mathrm{H}}}=(\frac{1}{3}\dot{\mathrm{R}}^3+\frac{2}{3}\ddot{\bar{\mathrm{A}}}\mathrm{l})\,\dddot{\mathrm{Si}}+\dot{\bar{\mathrm{H}}}$=Silica 37·9 alumina 25·1, peroxyd of iron 5·6, lime 18·7, soda 5·2, water 7·5=100.

Analyses by Whitney, (Rep. Geol. L. Sup. 1851, 97):

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	$\ddot{\bar{\mathrm{F}}}\mathrm{e}$, little $\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{K}}$	$\dot{\bar{\mathrm{H}}}$
1.	36·99	25·49	6·48	19·90	3·70	0·40	7·22=100·18.
2.	37·41	24·25	6·26	21·68	4·88		5·77=100·25.

In an open tube yields water and becomes white. B.B. fuses easily with intumescence to a grayish blebby glass. Forms a transparent glass readily with borax, tinged with iron; a blue with cobalt solution. Soluble in muriatic acid, giving a flocky precipitate of silica.

Occurs on the shores of Isle Royale, Lake Superior, in small rounded pebbles, which have come from the trap, and are waterworn; it receives a fine polish. Named from *χλωρος, green, αστρον, star,* and *λιθος, stone.*

SAVITE, *Meneghini.*

Dimetric. In acicular rectangular prisms, very slender, terminating in pyramids or truncated. Radiating.

H.=3. G.=2·450. Lustre vitreous. Colorless. Transparent.

Composition.—$(\dot{\mathrm{Mg}}, \dot{\mathrm{Na}})^3\dddot{\mathrm{Si}}^2+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}+2\dot{\mathrm{H}}$, Bechi=Silica 49·55, alumina 18·36, magnesia 14·56, soda 11·08, water 6·44. Analysis by Bechi, (Am. J. Sci. [2], xiv, 64):

$\dddot{\mathrm{Si}}$ 49·17, $\dddot{\bar{\mathrm{Al}}}$ 19·66, $\dot{\mathrm{Mg}}$ 13·50, $\dot{\mathrm{Na}}$ 10·52, $\dot{\mathrm{K}}$ 1·23, $\dot{\mathrm{H}}$ 6·57=100·67.

B.B. fuses with great difficulty. Soluble in the acids.

Occurs with picranalcime in the Gabbro rosso of Tuscany. Named after M. Savi.

The calculated oxygen ratio for $\dot{\mathrm{R}}$, $\dddot{\bar{\mathrm{R}}}$, $\dddot{\mathrm{Si}}$, $\dot{\mathrm{H}}$, in this species is very near that of Schneiderite, it being 9 : 9 : 26 : 2, and in the latter 9 : 9 : 25 : 2.

SCHNEIDERITE, *Meneghini.*

Confusedly laminato-radiate.

H.=3. Color white. Opaque.

Composition.—$3(\dot{\mathrm{Ca}}, \mathrm{Mg})^3\dddot{\mathrm{Si}}^2+\dddot{\bar{\mathrm{Al}}}^3\dddot{\mathrm{Si}}^2+3\dot{\mathrm{H}}$, Bechi=(if $\dot{\mathrm{Ca}} : \dot{\mathrm{Mg}}=1 : 1$) Silica 47·7, alumina 20·3, lime 16·6, magnesia 11·9, water 3·5. Analysis by Bechi, (Am. J. Sci. [2], xiv, 64):

$\dddot{\mathrm{Si}}$ 47·79, $\dddot{\bar{\mathrm{Al}}}$ 19·38, $\dot{\mathrm{Ca}}$ 16·77, $\dot{\mathrm{Mg}}$ 11·03, $\dot{\mathrm{K}}$ and $\dot{\mathrm{Na}}$ 1·62, $\dot{\mathrm{H}}$ 3·41=100.

B.B. fuses with intumescence to a blue enamel. Dissolves in acids, even in the cold, and gelatinizes. In a closed tube yields water.

Found with sloanite in the Gabbro rosso of Tuscany. Named after M. Schneider, director of the mine of Mount Catini.

CARPHOLITE, *W.* Karpholith.

In radiated and stellated tufts; fibres rather incoherent. Sometimes rhombic prisms of 111° 27′, and 68° 33′, Kengott, with lateral edges truncated.

H.=5—5·5. G.=2·935, Breithaupt; 2·9365, Stromeyer. Lustre silky, glistening. Color pure straw-yellow to wax-yellow. Opaque. Very brittle.

Composition.—$(\dot{\mathrm{Fe}}, \dot{\mathrm{Mn}})^3\dddot{\mathrm{Si}}+3\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}+6\mathrm{H}=(\tfrac{1}{4}\dot{\mathrm{R}}^3+\tfrac{3}{4}\dddot{\bar{\mathrm{Al}}})\dddot{\mathrm{Si}}+1\tfrac{1}{2}\mathrm{H}$. Analyses: 1, Stromeyer, (Untersuch. 410); 2, Steinmann, (Schweig. Jour. xxv, 413):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Mn}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{H}}$	
1.	36·15	28·67	19·16	2·29	10·78,	$\dot{\mathrm{Ca}}$ 0·27, HF 1·47=98·79, Stromeyer.
2.	37·53	26·47	18·33	—	11·36,	$\dddot{\bar{\mathrm{Fe}}}$ 6·27=99·96, Steinmann.

B.B. intumesces, whitens, and fuses slowly to a brown opaque mass. With borax forms a transparent glass, which, in the outer flame, assumes an amethystine color; in the reducing flame, becomes green. Hardly attacked by acids.

Occurs in minute divergent tufts, disposed on granite, along with fluor and quartz, in the tin mines of Schlackenwald. It was named by Werner, in allusion to its color, from *καρφος, straw.*

IV. ZEOLITE SECTION.

I. ANALCIME GROUP. Monometric.

	Oxygen ratio. $\dot{\text{R}}$ $\dddot{\text{R}}$ $\dddot{\text{Si}}$ $\dot{\text{H}}$
Analcime,	1 : 3 : 8 : 2
Picranalcime,	
Glottalite,	
Ittnerite,	1 : 3 : 4 : 2

II. CHABAZITE GROUP. Hexagonal.

Chabazite,	1 : 3 : 8 : 6 (or 5)
"	1 : 3 : 9 : 6
Gmelinite,	1 : 3 : 8 : 6
Levyne,	1 : 3 : 6 : 4

III. GISMONDINE GROUP. Dimetric.

Gismondine,	1 : 3 : $4\frac{1}{2}$: $4\frac{1}{2}$
Edingtonite,	
Faujasite,	1 : 3 : 9 : 9

IV. THOMSONITE GROUP.

Trimetric; $I : I$=90°–92°. Rarely monoclinic, and homœomorphous with the trimetric species. No perfect cleavage.

Harmotome,	1 : 3 : 9 : 5
Phillipsite,	1 : 3 : 9 : 5
Thomsonite,	1 : 3 : 4 : $2\frac{1}{2}$
Natrolite,	1 : 3 : 6 : 2
Scolecite,	1 : 3 : 6 : 3
Sloanite,	1 : 6 : 8 : 4 (?)

V. STILBITE GROUP.

Monoclinic or trimetric, with a pearly diagonal cleavage: $I : I$=130°–138°.

Epistilbite,	1 : 3 : 9 : 5
Heulandite,	1 : 3 : 12 : 5
Brewsterite,	1 : 3 : 12 : 5
Stilbite,	1 : 3 : 9 : 6
Caporcianite,	1 : 3 : 8 : 3

ANALCIME. Cubizit, *W.* Cuboite, *Breit.* Analzim, *L.*

Monometric. In trapezohedrons, f. 39, also f. 37, 38. Cleavage: cubic, in traces. Also massive granular.

H.=5—5·5. G.=2·068, Haidinger; 2·278, Thomson. Lustre vitreous. Color white; sometimes colorless; occasionally grayish, greenish, yellowish, or reddish-white. Streak white. Transparent—nearly opaque. Fracture subconchoidal, uneven. Brittle.

Composition..—$\dot{\text{Na}}^3\dddot{\text{Si}}^2+3\bar{\ddot{\text{Al}}}\dddot{\text{Si}}^2+6\dot{\text{H}}$=Silica 54·6, alumina 23·2, soda 14·0, water 8·1. Analyses: 1, H. Rose, (Gilb. Ann. lxxii, 181); 2, Henry, (Pogg. xlvi, 264); 3, Connel, (Edinb. J. Sci. 1829, 262); 4, Thomson, (Min. i, 438); 5, Avdejev, (Pogg. lv, 107); 6, 7, Riegel, (J. f. pr. Chem. xl, 317; this min. 3d edit.); 8, Waltershausen, (Vulk. Gest. 266):

	$\dddot{\text{Si}}$	$\bar{\ddot{\text{Al}}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$
1. Fassathal,	35·12	22·99	—	13·53	8·27=99·91, Rose.
2. Blagodat, *Cuboite*,	57·34	22·58	0·35	11·86	9·00, $\dot{\text{K}}$ 0·55=101·68, Henry.
3. Kilpatrick,	55·07	22·23	—	13·17	8·22=99·23, Connel.
4. Giant's Causeway,	55·60	23·00	—	14·65	7·90=101·15, Thomson.
5. Brevig,	55·16	23·55	—	14·23	8·26, $\dot{\text{K}}$, $\dot{\text{Ca}}$ *trace*=101·20, Avd.
6. Neiderkirchen,	57·50	23·15	5·63	6·45	8·00, $\bar{\ddot{\text{Fe}}}$ 0·10=100·83, Riegel.
7. "	56·12	24·00	5·82	6·45	8·00, $\bar{\ddot{\text{Fe}}}$ 0·15=100·54, Riegel.
8. Cycl. Ids. G.=2·236,	53·72	24·03	1·23	7·92	8·50, $\dot{\text{Mg}}$ 0·05, $\dot{\text{K}}$ 4·46=99·91, Walt.

B.B. fuses on charcoal, without intumescence, to a clear blebby glass. Gelatinizes with difficulty in muriatic acid. Tinges flame yellow.

The *Cuboite* of Breithaupt (f. 37) has a greenish-gray color, with distinct cleavage. G.=2·24—2·28.

The Cyclopean Islands, near Catania, Sicily, afford pellucid crystals, (f. 37); also the Tyrol; trapezohedral crystals occur in Dumbartonshire, the Kilpatrick Hills, Glen Farg, generally opaque, and sometimes three or four inches through. Other localities are the Faroe Islands, Iceland; the Vincentine, where it occurs in amygdaloid, basalt, and trap, with prehnite, chabazite, apophyllite, &c. At Arendal, in Norway, it occurs in beds of iron ore; and at Andreasberg in the Hartz, in silver mines. Nova Scotia affords fine specimens; crystals like f. 37, 39, occur at Bergen Hill, New Jersey; in gneiss, near Yonkers, Westchester Co., N. Y., (f. 39); at Perry, Maine, with apophyllite, in greenstone; abundant in fine crystals, with prehnite, datholite, and calc spar in the Lake Superior region; in the gangue of the copper, at Copper Falls and northwestern mines, and at Michippacoten Island, (form 2-2), and also at other mines not now worked.

The name *Analcime* is from *αναλκις*, *weak*, and alludes to its weak electric power when heated or rubbed.

Eudnophite of Weibye, von Borck and Berlin, (Pogg. lxxix, 1850), has the composition of Analcime, and although described as trimetric, two of the angles given, *d d* and *d s*, are 120°, as in the dodecahedron, *d*; *O*=130°. H.=5·5. G.=2·27. Mean of two analyses, by von Borck, and Berlin, $\dddot{\text{Si}}$ 55·00, $\bar{\ddot{\text{Al}}}$ 24·36, $\dot{\text{Na}}$ 14·06, $\dot{\text{H}}$ 8·23 =101·65.

It was found in white and grayish crystals with leucophane and mosandrite on the island Lamö, Norway, in syenite. Named from *ευδνοφος*, *obscurity*.

The *Cluthalite* of Thomson, (Min. i, 339,) occurs in flesh-red vitreous crystals in amygdaloid at the Kilpatrick Hills. H.=3·5. G.=2·166. Opaque or subtranslucent. Fragile. Analysis afforded: $\dddot{\text{Si}}$ 51·266, $\bar{\ddot{\text{Al}}}$ 23·560, $\bar{\ddot{\text{Fe}}}$ 7·306, $\dot{\text{Na}}$ 5·130, $\dot{\text{Mg}}$ 1·233, $\dot{\text{H}}$ 10·553=99·048.

ALTERED FORMS.—The *Picranalcime* of Meneghini and Bechi is probably analcime altered by the magnesian process. It occurs in geodes in the Gabbro rosso of Tuscany, and also in the steatitic paste of a metalliferous dyke; forms trapezohedrons and cubo-trapezohedrons with distinct cubic cleavage. H.=5. G.=2·257; Color, flesh-red to colophonite-red; lustre vitreous. *Composition*, according to mean of two analyses by M. Bechi, (Am. J. Sci. [2], xiv, 62); $\dddot{\text{Si}}$ 59·11, $\bar{\ddot{\text{Al}}}$ 22·08, $\dot{\text{Mg}}$ 10·12, $\dot{\text{Na}}$ 0·45, $\dot{\text{K}}$ 0·02, $\dot{\text{H}}$ 7·67=99·45. Formula $\dot{\text{Mg}}^3\ \dddot{\text{Si}}^2+3\bar{\ddot{\text{Al}}}\dddot{\text{Si}}^2+6\dot{\text{H}}$, Bechi, or more nearly $\dot{\text{Mg}}\ \dddot{\text{Si}}+\bar{\ddot{\text{Al}}}\ \dddot{\text{Si}}^2+2\dot{\text{H}}$, Rammelsberg. Associated with calcite, caporcianite, and picrothomsonite.

Glottalite, Thomson. Monometric; cube with angles truncated. Vitreous. Colorless or white. H.=3—4. G.=2·18. *Composition.*—$3\dot{C}a^3\dddot{Si}^2+\ddot{\bar{A}}l^3\dddot{Si}^2+24\dot{H}$. Analysis: $\dddot{Si}$ 37·01, $\ddot{\bar{A}}l$ 16·31, $\ddot{\bar{F}}e$ 0·50, $\dot{C}a$ 23·93, $\dot{H}$ 21·25=99. From greenstone near Port Glasgow on the Clyde in Scotland.

ITTNERITE.

Monometric. Cleavage dodecahedral. Occurs granularly massive.

H.=5·5. G.=2·37—2·40. Color dark bluish or ash-gray, smoky gray. Lustre resinous. Translucent. Fracture imperfectly conchoidal.

Composition.—Essentially $(\dot{N}a, \dot{C}a)^3\dddot{Si}+3\ddot{\bar{A}}l\dddot{Si}+6\dot{H}=(\dot{R}+\ddot{\bar{A}}l)\dddot{Si}^{\frac{4}{3}}+2\dot{H}$, with some NaCl, and $\dot{C}a\ddot{S}$. Analyses by Gmelin, (Schw. J. xxxvi, 74); and J. D. Whitney, (Pogg. lxx, 442):

	$\dddot{Si}$	$\ddot{S}$	$\ddot{\bar{A}}l$	$\dot{C}a$	$\dot{N}a$	$\dot{K}$
1.	34·02	2·86	28·40	7·27	12·15	1·56, $\ddot{\bar{F}}e$ 0·62, HCl 0·75, $\dot{H}$ and HS 10·76=98·36, G.
2.	35·69	4·62	29·14	5·64	12·57	1·20, Cl 1·25, $\dot{H}$ (loss) 9·83=100, Whitney.

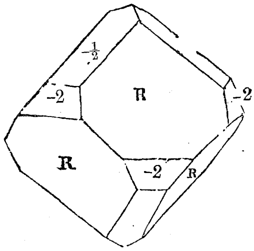
Yields much water in a matrass, in which it differs from the allied species. B.B. fuses easily with strong intumescence and evolution of sulphurous acid to a blebby opaque glass. A clear glass with borax. Gelatinizes perfectly in acids.

From the dolerite of the Kaiserstuhl near Freiberg; at Sasbach in basaltic dolerite; at Endingen in phonolitic dolerite, with pyrites, titanic iron, and apatite.

CHABAZITE. Chabasie, *P. L.* and *H.* Schabasite, *W.* Chabasin, *Haid.* Levyne. Mesolin. Hydrolite, *De Dree.* Sarcolite, *Vauq.* Phacolite, *Breit.* Ledererite, *Jackson.* Acadiolite, *Alger* and *Jackson.* Haydenite, *Cleveland.*

Rhombohedral; $R:R=94°\ 46'$, $O:R=129°\ 15'$; $a=1{\cdot}06$. Usual forms rhombohedrons. Observed planes as in f. 474, 475, with $\frac{2}{3}^2$ replacing the edges $R:-\frac{1}{2}$. $R:-\frac{1}{2}=137°\ 23'$, $-\frac{1}{2}:-\frac{1}{2}=125°\ 13'$;

474



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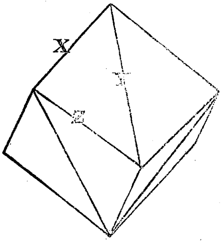

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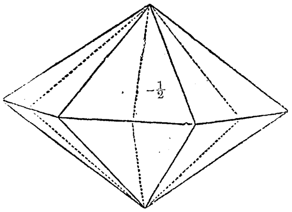

$R:-\frac{1}{2}$ (over -2)$=83°\ 31°'$, $R:-2=119°\ 42'$, $R:\frac{2}{3}2=155°\ 15'$. Twins: Composition parallel with *O;* also parallel to *R.* Cleavage rhombohedral, rather indistinct.

H.=4—4·5. G.=2·08—2·17, Tamnau. Lustre vitreous. Color white, flesh-red; streak uncolored. Transparent—translucent. Fracture uneven. Brittle.

Composition.—$(\dot{\mathrm{Ca}}, \dot{\mathrm{Na}}, \dot{\mathrm{K}})^3\dddot{\mathrm{Si}}^2+3\bar{\dddot{\mathrm{Al}}}\dddot{\mathrm{Si}}^2+18\dot{\mathrm{H}}=(\dot{\mathrm{R}}^3, \bar{\dddot{\mathrm{R}}})\dddot{\mathrm{Si}}^2+4\frac{1}{2}\dot{\mathrm{H}}$; for the Parsboro and Gustafsberg chabazite, and also the acadiolite, $(\dot{\mathrm{Ca}}, \dot{\mathrm{Na}}, \dot{\mathrm{K}})\dddot{\mathrm{Si}}+\bar{\dddot{\mathrm{Al}}}\dddot{\mathrm{Si}}^2+5\dot{\mathrm{H}}$. Analyses: 1, 2, 3, Hofmann, (Pogg. Ann. xxv, 495); 4, Berzelius, (Afh. i Fys. vi, 190); 5, Rammelsberg, (Handw. i, 149); 6, Thomson, (Min. i, 334); 7, Connell, (Edinb. J. 1829, 262); 8, Durocher, (Ann. d. Mines, [3], xix, 585); 9, Genth, (Ann. d. Ch. u. Pharm. lxvi, 274, 1848); 10, Rammelsberg, (2d Supp. p. 34); 11, Engelhardt, (Ann. d. Ch. u. Pharm. lxv, 372); 12, 13, A. A. Hayes, (Am. J. Sci. [2], i, 122); 14, 15, Rammelsberg, (Pogg. lxii, 149); 16, Anderson, (Jameson's Jour. 1843, 23):

		$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1.	Parsboro, N. S.,	51·46	17·65	8·91	1·09	0·17	19·66, $\bar{\dddot{\mathrm{Fe}}}$ 0·85=99·79, Hof.
2.	Fassathal,	48·63	19·52	10·22	0·56	0·28	20·70=99·91, Hofmann.
3.		48·18	19·27	9·65	1·54	0·21	21·10=99·95, Hofmann.
4.	Gustafsberg,	50·65	17·90	9·37	—	1·70	19·90=99·52, Berzelius.
5.	Aussig,	48·36	18·62	9·73	0·25	2·56	(20·47)=100, Rammelsberg.
6.	Kilmalcolm,	48·76	17·44	10·47	—	1·55	21·72=99·93, Thomson.
7.	"	50·14	17·48	8·47	—	2·58	20·83=99·50, Connell.
8.	Faroe,	47·75	20·85	5·74	2·34	1·65	21·30=99·63, Durocher.
9.	Annerode,	47·00	19·71	10·63	0·65	0·33	22·29, $\bar{\dddot{\mathrm{Fe}}}$ 0·15=100·76, G.
10.	Parsboro,	52·14	19·14	7·84	0·71	0·98	19·19=100, Rammelsberg.
11.	Giessen,	48·31	19·47	11·01	—	1·17	19·65, $\dot{\mathrm{Mg}}$ 0·26, Engelhardt
12.	*Acadiolite,*	52·02	17·88	4·24	4·07	3·03	18·30=99·54, Hayes.
13.	"	52·20	18·27	6·58	2·12		20·52=99·69, "
14.	Leipa, *Phacolite,*	46·46	21·45	10·45	0·95	1·29	19·40=100, Rammelsberg.
15.	" "	46·20	22·30	10·34	1·77		19·05, $\dot{\mathrm{Mg}}$ 0·34=100, Ramm.
16.	" "	45·63	19·48	13·30	1·68	1·31	17·98, $\dot{\mathrm{Mg}}$ 0·14, $\bar{\dddot{\mathrm{Fe}}}$ 0·43=99·96, Anderson.

B.B. intumesces and fuses to a blebby glass, nearly opaque. Dissolves in muriatic acid, when pulverized.

The *Acadiolite* is a Nova Scotia chabazite of a flesh red color; form f. 474, with the scalenohedron of f. 475, also the simple rhombohedral form of chabazite; the color is red, though passing into white. In some crystals the color is arranged in a tesselated manner, the angles being nearly colorless.

Haydenite is a yellowish chabazite from Jones's Falls, Maryland. Levy made the form an oblique rhombic prism with $I : I=98°\ 22'$, $O : I=96°\ 5'$. The form is actually a scalenohedron (f. 475) differing but slightly from the rhombohedron; it is apparently the same scalenohedron that occurs in the Nova Scotia chabazite; angle of edge $X=97$–$98°$, of edge Y, about 176°. The crystals are often in twins parallel to R, and they are incrusted with chlorite, and sometimes consist of this mineral, unlike the accompanying heulandite, (beaumontite). Delesse obtained in an analysis of the haydenite (Revue Sci. xxv, 107), $\dddot{\mathrm{Si}}$ 49·5, $\bar{\dddot{\mathrm{Al}}}$, $\bar{\dddot{\mathrm{Fe}}}$ 23·5, $\dot{\mathrm{Ca}}$ 2·70, $\dot{\mathrm{Mg}}$ *trace*, $\dot{\mathrm{K}}$ 2·50, $\dot{\mathrm{H}}$ 21·0=99·2.

Chabazite occurs mostly in trap, basalt, or amygdaloid, and occasionally in gneiss, syenite, and mica slate.

Occurs at the Faroe Islands, Greenland, and Iceland, associated with chlorite and stilbite; at Aussig in Bohemia, in a kind of greenstone, (the *graustein* of Werner); at Annerode near Giessen; at the Giant's Causeway, Kilmalcolm, Renfrewshire, Isle of Skye, &c. In Nova Scotia wine-yellow or flesh-red (the last, the acadiolite), associated with heulandite, analcime, and calcite. *Phacolite* occurs at Leipa in Bohemia.

Both massive and incrusted, at the Paugatuck stone-quarry, Stonington, Conn., with scapolite, sphene, and apatite; also yellowish-red in North Killingworth, on the Essex turnpike; at Hadlyme, Conn., on gneiss; in syenite at Charlestown, Mass.; also at Chester, Mass., in amygdaloid; at Bergen Hill, N. J., in small crystals; in the same rock at Piermont, N. Y. Phacolite has been reported from New York Island.

The name *Chabazite* is from χαβαζιος, an ancient name of a stone. *Phacolite* is from φακος, *a bean*, and λιθος; and *Acadiolite* from a former name of Nova Scotia.

GMELINITE, *Brooke*. Soda Chabazite. Natron-Chabasit. Hydrolite. Herschelite, *Levy*.

Hexagonal. Observed planes as in the figure, with sometimes the pyramidal and prismatic edges truncated; 1 : 1 (pyram.) 142° 26′; (basal)=80° 8′, Brewster, 80° 54′, G. Rose, 80° 6′, Dufrénoy, 79° 44′, Breithaupt, 80° 8′, Brooke and Miller. $O : 1=139° 56′$, $O : 12=143° 56′$. Cleavage: parallel to the faces of a 6-sided prism, perfect, G. Rose, (Kryst. Chem. Min., 1852, 100).

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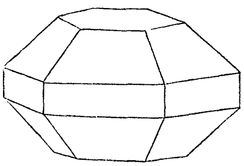

H.=4·5. G.=2·04—2·12. Lustre vitreous. Colorless, yellowish-white, reddish-white, flesh-red, translucent. Brittle.

Composition.—Like that of chabasite, the compound therefore being dimorphous, according to G. Rose. The Herschelite affords the same excepting 15 $\dot{H}$.

Analyses: 1, Connell, (Edinb. New Phil. J. 1838); 2, 3, Rammelsberg, (Pogg. xlix, 211); 4, 5, Damour, (Ann. Ch. Phys. [3], xiv, 99); 6, Waltershausen, (Vulk. Gest. 261):

		$\dddot{Si}$	$\bar{\dddot{Al}}$	$\dot{Ca}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$	
1.	Glenarm,	48·56	18·05	5·13	3·85	0·39	21·66,	$\bar{\dddot{Fe}}$ 0·11=98·75, Connell.
2.	"	46·40	21·09	3·67	7·29	1·60	20·41	=100·47, Rammelsberg.
3.	"	46·56	20·19	3·89	7·09	1·87	29·41	=100·02, Rammelsberg.
4.	*Herschelite*, Etna,	47·39	20·90	0·38	8·33	4·39	17·84	=99·23, Damour.
5.	" "	47·46	20·18	0·25	9·35	4·17	17·65	=99·06, Damour.
6.	" "	46·46	19·21	4·75	5·27	2·88	17·86,	$\dot{Mg}$ 0·42, $\bar{\dddot{Fe}}$ 1·14=97·99, W.

B.B. like chabasite. Gelatinizes with muriatic acid. Waltershausen found a trace of phosphoric acid and supposed it combined with the $\bar{\dddot{Fe}}$. Occurs in amygdaloidal rocks at Montecchio Maggiore, and at Castel in the Vicentine, at Glenarm, and the Island Magee.

Gmelinite is usually considered rhombohedral, and the crystals as twins, secondary to a rhombohedron of 86° 18′. Tamnau makes $R : R$ as in chabasite, and the pyramidal faces the form $\frac{2}{3}^{2}$. The hexagonal cleavage observed by Rose separates it widely from chabasite. It was named after Prof. C. Gmelin, of Tübingen.

Herschelite is from Aci Castello, Etna, Sicily, along with Phillipsite. The crystals are colorless hexagonal prisms and tables, and are generally aggregated like those of Prehnite; bases convex with traces of a flat rhombohedron. Damour's analyses give $(\dot{Na}, \dot{K})^3 \dddot{Si}^2 + 3\bar{\dddot{Al}} \dddot{Si}^2 + 15\dot{H}$, making it a distinct compound from the above. The angles of the pyramidal edges are 124° 45′, and the base makes with the pyramidal faces 132° nearly. H.=5·5. G.=2·06.

Ledererite of Jackson, from Cape Blomidon, Nova Scotia, has the form of Gmelinite. It has the same formula with one third the amount of water. Analysis by Hayes: $\dddot{Si}$ 49·47, $\bar{\dddot{Al}}$ 21·48, $\dot{Ca}$ 11·48, $\dot{Na}$ 3·94, $\bar{\dddot{Fe}}$ 0·14, $\dot{H}$ 8·58, $\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 3·48=98·57, (Am. J. Sci., xxv, 78). G.=2·169. Named after Baron Lederer, formerly Austrian Consul at New York.

LEVYNE, *Brewster*.

Rhombohedral: $R : R=106° 4′$; $O : R=136° 1′$; $a=0·83583$. Observed planes as in the annexed figure, with also -3; $2 : 2=79° 29′$, $O : 3=109° 3′$, $O : 2=117° 23′$. Cleavage, R, indistinct. Twins compounded parallel to O. Crystals often striated; often in druses.

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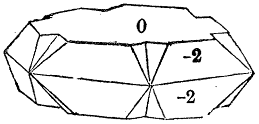

H.=4—4·5. G.=2·09—2·16. Lustre

vitreous. Colorless, white, reddish, yellowish. Transparent to translucent.

Composition.—$\dot{\mathrm{Ca}}\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{A}}\mathrm{l}}\dddot{\mathrm{Si}}+4\dot{\mathrm{H}}=(\dot{\mathrm{Ca}}+\dddot{\bar{\mathrm{A}}\mathrm{l}})\dddot{\mathrm{Si}}^2+4\dot{\mathrm{H}}$, from Damour's analyses, which contain less silica than the others. Berzelius's analyses gives the formula of chabasite. Analyses: 1, 2, Berzelius, (Jahresb. iii, 146, v, 216); 3, Connel, (Phil. Mag. v, 50); 4, 5, Damour, (Ann. d. M. [4], ix, 333):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}\mathrm{l}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1. Faroe, *Levyne*,	48·00	20·00	8·35	2·86	0·41	19·30, $\dot{\mathrm{Mg}}$ 0·4=99·32, Berz.
2. " *Mesolin*,	47·50	21·40	7·90	4·80	——	18·19=99·79, Berz.
3. Skye, *Levyne*,	46·30	22·47	9·72	1·55	1·26	19·51, $\dot{\mathrm{Fe}}$, $\dot{\mathrm{Mn}}$ 0·96=102·07, C.
4. Iceland, *Levyne*,	45·04	21·04	9·72	1·42	1·63	17·49=99·34, Damour.
5. " "	45·76	23·56	10·57	1·36	1·64	17·33=100·22, Damour.

B.B. fuses to a blebby glass nearly opaque. Soluble in acids when pulverized, without gelatinizing.

Found in amygdaloid at Glenarm; Hatfield Moss, Renfrewshire; at Dalsnypen, Faroe; at Godhavn, Disco Island, Greenland; at Skagastrand in Iceland. Named after the English Mineralogist, Mr. Levy.

GISMONDINE, *Beud.* Abrazite, *Breislak.*

Dimetric. In octahedrons, either separate or clustered into mammillated forms with a drusy surface; basal angle 92° 30′, pyramidal 118° 30′, Marignac.

H.=4·5. G.=2·265. Bluish white, grayish, reddish. Lustre splendent. Transparent to translucent.

Composition.—$(\dot{\mathrm{Ca}}, \dot{\mathrm{K}})^2\dddot{\mathrm{Si}}+2\dddot{\bar{\mathrm{A}}\mathrm{l}}\dddot{\mathrm{Si}}+9\dot{\mathrm{H}}$. Analysis by Marignac, (Ann. Ch. Phys. [3], xiv, 41):

$\dddot{\mathrm{Si}}$ 35·88 $\dddot{\bar{\mathrm{A}}\mathrm{l}}$ 27·23, $\dot{\mathrm{Ca}}$ 13·12, $\dot{\mathrm{K}}$ 2·85, $\dot{\mathrm{H}}$ 21·10=100·18.

Easily dissolves in acids and gelatinizes. At 100° C. yields one third of its water. B.B. whitens, intumesces much, and melts to a milky glass.

Occurs at Capo di Bove near Rome, associated with Phillipsite, and often the latter is involved in the grouped crystallizations of the former. The crystalline surfaces of the octahedrons are not even, and afforded Marignac very variable angles; angle at the base from 93° 30′ to 89°, and pyramidal edges from 117° to 122°. The faces of the crystals never have the striæ of those of Phillipsite, and the mammillated specimens are not columnar within; moreover Phillipsite does not lose any of its water below 100°. Kobell analyzed the mineral called Gismondine or zeagonite, with a different result, (J. f. pr. Chem. xviii, 105). (See below.)

Brooke considers them cruciform twins of Phillipsite. Kengott makes them distinct and dimetric, stating that they have an octahedral cleavage.

Zeagonite. Occurs in trimetric crystals, the angles of the fundamental octahedron being according to Kengott, 121° 44′, 120° 37′, 89° 13′, which are near those of Phillipsite. G.=2·213, Kengott, or same as for Phillipsite. Kobell obtained in an analysis of this mineral, (J. f. pr. Ch., xviii, 105), $\dddot{\mathrm{Si}}$ 42·60, $\dddot{\bar{\mathrm{A}}\mathrm{l}}$ 25·50, $\dot{\mathrm{Ca}}$ 7·50, $\dot{\mathrm{K}}$ 6·80, $\dot{\mathrm{H}}$ 17·66=100·06. But it has been supposed that the specimen was a mixture of Phillipsite and Gismondine. Zeagonite and Phillipsite (p. 324) appear to be correctly regarded as one species. Scacchi reports both to the same species, and mentions Somma as a locality.

EDINGTONITE, *Haid.* Brewster's Edinburg Jour. Sci. iii, 316. Antiedrit, *Breit.*

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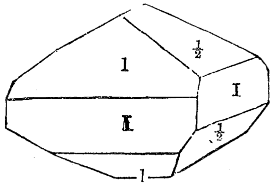

Dimetric; hemihedral. $O:1i=145°\ 59'$; $a=0{\cdot}67473$. Observed planes as in the annexed figure. $O:1=136°\ 20\tfrac{1}{2}'$, $I:1=133°\ 39\tfrac{1}{2}'$, $I:\tfrac{1}{2}=115°\ 26'$, 1:1, over summit, 92° 41′, $\tfrac{1}{2}:\tfrac{1}{2}$ ib. 129° 8′. Cleavage : *I* perfect.

H.=4—4·5. G.=2·7—2·75. Lustre vitreous. Grayish-white. Streak uncolored. Translucent. Brittle.

Composition.—$3\dot{B}a\,\ddot{S}i+4\ddot{\bar{A}}l\,\ddot{S}i+12\dot{H}$. Analysis by Mr. Heddle, (Greg and Lettsom's Brit. Min.):

$\ddot{S}i$ 37·263, $\ddot{\bar{A}}l$ 23·751, $\dot{B}a$ 26·514, $\dot{H}$ 12·462=100.

At a high heat, before the blowpipe, it fuses to a colorless mass, having first given off water, and become white and opaque.

Edingtonite occurs in small crystals, with datholite in the Kilpatrick hills.

FAUJASITE, *Damour.*

Dimetric. $O:1i=127°\ 15'$; $a=1{\cdot}315$. In octahedrons; $1i:1i$ (pyr.)=111° 30′, (bas.)=105° 30.′

H.=5. G.=1·923. Colorless—brown. Fracture vitreous and uneven.

Composition.—$\dot{R}\ddot{S}i+\ddot{\bar{A}}l\,\ddot{S}i^2+9\dot{H}=(\dot{R}+\ddot{\bar{A}}l)\ddot{S}i^3+9\dot{H}$=Silica 46, alumina 17, lime 5, soda 5, water 27.

Analysis by Damour, (Ann. des Mines, [4], xiv, 67):

$\ddot{S}i$ 46·12, $\ddot{\bar{A}}l$ 16·81, $\dot{C}a$ 4·79, $\dot{N}a$ 5·09, $\dot{H}$ 27·02=99·83.

In a matrass yields water. B.B. intumesces and fuses to a white blebby enamel. Soluble in muriatic acid.

Occurs with black augite in mandelstein at Kaiserstuhl in Baden. It was named by Damour, in honor of Faujas de Saint Fond.

From the above dimensions, $O:1=118°\ 16'$, which is near a corresponding angle in apophyllite, etc.; also as near $O:2$ in Zircon, Rutile, etc., or $O:4i$ in Scapolite and Mellilite.

HARMOTOME, *H.* Baryt-Harmotome. Staurolite, *Kirwan.* Andreolite, Andreasbergolite. Kreuzstein, *W.* Morvenite, *Thom.*

Trimetric: $I:I=91°\ 46'$, $O:1\bar{i}=144°\ 24'$; $a:b:c=0{\cdot}716:1:1{\cdot}031$. Observed planes as in figures, with also $1\breve{4}$, 1 and $1\breve{i}$.

$O:1=135°\ 4'$. $O:2\breve{i}=125°\ 45'$. $1\breve{i}:1\breve{i}$ (top)=110° 26′.
$O:i\breve{i}=90°$. 1:1 (mac.)=121° 6′. $2\breve{i}:2\breve{i}$ (top)=71° 30′.
$O:1\breve{i}=145°\ 13'$. 1:1 (brach.)=119° 4′. $1\breve{4}:1\breve{4}$ (brach.)=163° 16′.

Cleavage: $i\bar{i}$ and $i\breve{i}$ imperfect, the latter a little the most distinct. Twins: (fig. 481), composed of four individuals, face of composition *I*; common. Rarely massive.

H.=4·5. G.=2·39—2·498. Lustre vitreous. Color white; passing into gray, yellow, red, or brown. Streak white. Subtransparent—translucent. Fracture uneven, imperfectly conchoidal. Brittle.

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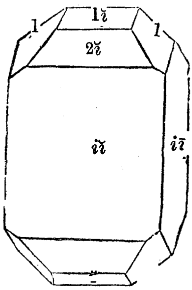

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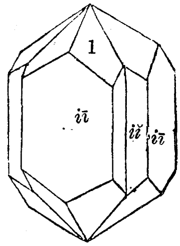

Composition.—$\dot{Ba}\ddot{Si}+\ddot{\bar{Al}}\ddot{Si}^2+5H=(\dot{Ba}+\ddot{\bar{Al}})\ddot{Si}^3+5\dot{H}$=Silica 44·0, alumina 16·6, baryta 24·8, water 14·6=100. Analyses: 1, 2, 3, Köhler, (Pogg. xxxvii, 561); 4, Rammelsberg, (Handw. i, 200); 5, Connel, (Ed. N. Phil. J. July, 1832, 33); 6, Damour, (Ann. des M. [4], ix, 336, and Compt. Rend. xxii, 745); 7, 8, Damour, (Ann. d. Mines, [4], ix, 345):

	$\ddot{Si}$	$\ddot{\bar{Al}}$	$\dot{Ba}$	$\dot{Ca}$	$\dot{K}$	$\dot{H}$	
1. Andreasberg,	46·63	16·82	20·32	0·26	1·02	15·03	=100·08, Köhler.
2. trontian,	46·10	16·41	20·81	0·63	0·90	15·11	=99·96, "
3. Oberstein,	46·65	16·54	19·12	1·10	1·10	15·24	=99·77, "
4. Andreasberg,	48·74	17·65	19·22	—	—	14·66	=100·27, Rammelsberg.
5. Strontian,	47·04	15·24	20·85	0·10	0·88	14·92,	$\dot{Na}$ 0·84, $\ddot{\bar{Fe}}$ 0·24=100·11, C.
6. "	47·74	15·68	21·06	—	0·78	13·19,	$\dot{Na}$ 0·80, $\ddot{\bar{Fe}}$ 0·51=99·76, D.
7. *Morvenite,*	47·60	16·39	20·86	—	0·81	14·16,	$\dot{Na}$ 0·74, $\ddot{\bar{Fe}}$ 0·65=101·21, D.
8. "	47·59	16·71	20·45	—	—	14·16,	$\ddot{\bar{Fe}}$ 0·56=99·47, Damour.

B.B. on charcoal, melts without intumescence to a clear globule. Phosphoresces when heated, giving out a yellow light. Scarcely attacked by the acids, unless they are heated, and then not gelatinizing.

Harmotome occurs in amygdaloid, and also on gneiss and in metalliferous veins.

Strontian, in Argyleshire, affords both simple and compound crystals of this species, the former sometimes an inch through. Occurs also in a metalliferous vein at Andreasberg in the Hartz; at Oberstein in Deuxponts, in siliceous geodes; at Kongsberg in Norway, on gneiss; with analcime in the amygdaloid of Dumbartonshire, in simple crystals.

Named from *αρμος, joint,* and *τεμνω, to cut,* alluding to the intersection of the crystals in the ordinary twins, and the coalescence in a single plane of two ordinary pyramidal faces.

Morvenite occurs at Strontian, and is distinguished by its more brilliant crystals. Damour and Descloizeaux show it to be harmotome, (Ann. d. M. [4], ix, 339).

PHILLIPSITE, *Levy*, Ann., Phil. 2d ser. x, 362. Lime-Harmotome. Christianite, *Descloizeaux.*

Trimetric. Simple and compound crystals like those of harmotome. 1 : 1=121° 20′, 120° 44 and 88° 40′, Marignac; 120° 42′, 119° 18′, and 90°, Brooke and Miller.

H.=4—4·5. G.=2·2; 2·213, Marignac. Lustre vitreous. Color white, sometimes reddish. Streak uncolored. Translucent—opaque.

Composition.—$(\dot{\mathrm{Ca}}, \dot{\mathrm{K}})\ \dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}^2+5\dot{\mathrm{H}}$, G. Rose$=(\dot{\mathrm{R}}+\dddot{\bar{\mathrm{Al}}})\ \dddot{\mathrm{Si}}^3+5\dot{\mathrm{H}}$=Silica 51·3, alumina 19·4, lime 6·4, potash 5·9, water 17·0=100; or $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+3\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}^2+12\dot{\mathrm{H}}$=Silica 50·2, alumina 21·3, lime 7·0, potash 6·5, water 15·0=100; or the last with $15\dot{\mathrm{H}}$= Silica 48·4, alumina 20·6, lime 6·7, potash 6·3, water 18·0=100.

Analyses: 1, 2, Gmelin, (Leonh. Zeits. f. Min. 1825); 3, 4, Köhler, (Pogg. xxxvii); 5, Connel, (Edinb. Phil. J. xxxv, 1843, 375); 6, Marignac, (Ann. Ch. Phys. [3], xiv, 41); 7, 8, Damour, (Ann. d. M. [4], ix, 336); 9, Genth, (Ann. Ch. Pharm. lxvi, 272); 10, 11, Waltershausen, (Vulk. Gest. 263):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$		$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{H}}$	
1. Marburg,	48·51	21·76	6·26	6·33		0·99	17·23	=100·38, Gmelin.
2. “	48·02	22·61	6·56	7·50		0·18	16·75	=100·62, “
3. “	50·45	21·78	6·50	3·95		—	16·82	=99·49, Köhler.
4. Cassel,	48·22	23·33	7·22	3·89		—	17·55	=100·22, “
5. G. Causeway,	47·35	21·80	4·85	5·55	$\dot{\mathrm{Na}}$	3·70	16·96	=100·21, Connel. G. 2·17.
6- Vesuvius,	43·64	24·39	6·92	10·35		—	15·05	=100·35, Marignac.
7. Iceland,	48·41	22·04	8·49	6·19		—	15·60	=100·73, Damour.
8. “	50·16	20·94	7·74	6·50		—	14·66	=100·00, “
9. Marburg,	48·17	21·11	6·97	6·61	“	0·63	16·62	, $\dddot{\bar{\mathrm{Fe}}}$ 0·24, $\dot{\mathrm{Ba}}$ *tr.*=100·35, G.
10. Aci Castello,	48·53	19·88	2·92	3·82	“	6·18	14·76	, “ 2·64,[a] $\dot{\mathrm{Mg}}$ 1·60=100·34, W.
11. Palagonia,	48·37	21·07	3·24	6·15	“	3·41	14·54	, “ 0·71,[a] “ 1·42=98·91, W.

[a] Probably as phosphate.

B.B. intumesces somewhat, and fuses like other zeolites. Pulverized, dissolves very easily in muriatic acid and gelatinizes.

In large translucent crystals in amygdaloid, in the Giant's Causeway in Ireland, and in sheaf-like aggregations at Capo di Bove, near Rome; also in long crystals in radiating masses, at Aci Castello and elsewhere; among the Vesuvian lavas; at Stempel, near Marburg; Habichtswalde near Cassel; Annerode near Giessen; in Iceland. Named after the English mineralogist, J. Phillips.

The name Christianite was given by Descloizeaux to the Marburg harmotome and crystals from an amygdaloid in Iceland.

To phillipsite, Brooke has referred the *zeagonite* and *gismondine*, from Capo di Bove near Rome.

THOMSONITE, *Brooke.* Mesotype, (in part), *Haüy.* Needle Zeolite, (in part), *Werner.* Comptonite, *Brewster.* Chalilite, *Thom.* Triploklas, *Br.* Ozarkite, *Shepard.*

Trimetric. $I : I=90°\ 40'$; $O : 1\bar{i}=144°\ 9'$; $a : b : c=0·7225 : 1 : 1·0117$. Observed planes, as in the annexed figure. $O : 2\breve{i}=125°$, $\breve{i}\breve{i} : I=134°\ 40'$. Cleavage: $\breve{i}\breve{i}$ and $\bar{i}\bar{i}$ easily obtained. Also columnar, structure radiated; also amorphous.

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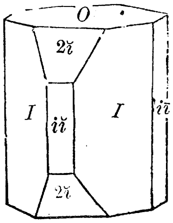

H.=5—5·5. G.=2·35—2·4; 2·35—2·38, Comptonite, Zippe. Vitreous, inclining to pearly. Snow-white: impure varieties brown. Streak uncolored. Transparent—translucent. Fracture uneven. Brittle.

Composition.—$(\dot{\mathrm{Ca}}, \dot{\mathrm{Na}})^3\dddot{\mathrm{Si}}+3\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}+7\dot{\mathrm{H}}$, ($6\dot{\mathrm{H}}$, Waltershausen)=Silica 37·4, alumina 31·8, lime 13·0, soda 4·8, water 13·0.

Analyses: 1, Berzelius, (Jahresb. ii, 96); 2, Rammelsberg, (J. pr. Chem. lix, 349); 3, Retzius, (Jahresb. iv, 154); 4, Zippe, (Verh. Ges. Mus. Böhm., v. 1836, 39); 5, 6, Rammelsberg, (Pogg. xlvi, 288); 7, Melly, (Bib. Univ. N. S. xv, 193); 8, Rammelsberg, (J. f. pr. Chem. lix, 348, mean of results); 9, 10, Smith and Brush, (Am. J. Sci. [2], xvi, 50); 11, 12, Walterhausen, (Vulk. Gest. 272, 277):

	$\dddot{\text{Si}}$	$\ddot{\overline{\text{Al}}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	$\dot{\text{H}}$
1. Kilpatrick,	38·30	30·70	13·54	4·53	—	13·10=100·17, Berzelius.
2. Dumbarton,	38·09	31·62	12·60	4·62		13·40=100·20, Rammelsberg.
3. Faroe,	39·20	30·05	10·58	8·11		13·40, $\ddot{\overline{\text{Fe}}}$ 0·5=101·84, Retzius.
4. Seeberg, *Compt.*,	38·25	32·00	11·96	6·53	—	11·50=100·24, Zippe.
5. " "	38·73	30·84	13·43	3·85	0·54	13·10=100·49, Ramm.
6. " "	38·77	31·92	11·96	4·54		12·81=100, Ramm. G. 2·37.
7. Elbogen,	37·00	31·07	12·60	6·25	—	12·24=99·16, Melly.
8. Hauenstein,	39·63	31·25	7·27	8·03	—	13·30=99·48, Ramm. G. 2·357.
9. *Ozarkite,*	36·85	29·42	13·95	3·91	—	13·80, $\ddot{\overline{\text{Fe}}}$ 1·55=99·88, S. & B.
10. "	37·08	31·13	13·97	3·72	—	13·80=99·70, Smith & Brush.
11. *Carphostilbite,*	39·28	29·50	12·38	4·09	0·38	13·23, $\dot{\text{Mg}}$0·13, $\ddot{\overline{\text{Fe}}}$ 1·49=100·48, W.
12. *Thomsonite,*	39·86	31·45	13·33	5·30	1·00	11·39=102·33, Waltershausen.

B.B. intumesces, becoming white and opaque; the edges merely are rounded at a high heat. When pulverized it gelatinizes with nitric or muriatic acid.

Thomsonite occurs near Kilpatrick, and Lochwinnoch, Scotland, in amygdaloid. Comptonite is met with in the lavas of Vesuvius; in basalt at the Pflasterkaute in Saxe Weimar, at Seeberg and elsewhere in Bohemia in the cavities of clinkstone; in the Cyclopean islands, Sicily, with analcime and phillipsite; in Faroe; in phonolite at Hauenstein, (called Mesolite of Hauenstein.)

Long slender prismatic crystallizations of a grayish white color are obtained at Peter's Point, Nova Scotia, where it is associated with apophyllite, mesotype, laumontite, and other trap minerals.

Ozarkite, as Smith and Brush show, is an amorphous or fibrous radiated Thomsonite. It occurs at the Ozark Mts., Arkansas, with elæolite, and appears to have resulted from its alteration; it is often mixed with apatite in colorless slender prisms. In analysis 10 some $\ddot{\overline{\text{Fe}}}$ is included with the $\ddot{\overline{\text{Al}}}$.

Chalilite of Thomson may be an impure massive thomsonite. It afforded Thomson, (Min. i, 324), and v. Hauer, (Jahrb. Geol. Reichs. 1853):

$\dddot{\text{Si}}$	$\ddot{\overline{\text{Al}}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$	$\ddot{\overline{\text{Fe}}}$
36·56	26·20	10·28	2·72	16·66	9·28=101·70, T.
38·56	27·71	12·01	$\dot{\text{Mg}}$ 6·85	14·32	*tr.*=99·45, H.

From the Donegore Mountains, in the county of Antrim. Color deep reddish-brown.

According to Kengott, Chalilite includes two species. The one analyzed, is massive, with a splintery fracture, subtranslucent to opaque; streak yellowish and a little greasy; B.B. fuses with intumescence; in a tube yields water, and blackens. The other is flesh-red; H.=5, G.=2·24; B.B. fuses with more difficulty than the preceding to a white blebby glass; it appears to contain but little water. (Sitzungs. Wien. Akad., x, 179).

Scoulerite of Thomson is near thomsonite in composition, but contains less alumina and water, and 6½ per cent. of soda. It comes from Port Rush in Ireland, (Phil. Mag. Dec. 1840, 402.)

Carphostilbite from Berufiord, Iceland, is straw-yellow, and columnar; it gives the oxygen ratio for $\dot{\text{R}}$: $\ddot{\overline{\text{R}}}$: $\dddot{\text{Si}}$: $\dot{\text{H}}$=1 : 3 : 4·4 : 2·5. G.=2·362.

PICROTHOMSONITE.—Meneghini and Bechi, (Am. J. Sci., [2], xiv, 63).—This species is like Thomsonite in form and near it in composition. The soda is replaced by magnesia, and it is possibly the result of alteration. It occurs in radiated masses, laminated in structure, and cleaving with equal ease parallel to two sides of a rectangular prism. H.=5. G.=2·278. Lustre pearly. White. Transparent in small fragments. Very fragile.

Composition.—$(\dot{\text{Ca}}, \dot{\text{Mg}})^3\dddot{\text{Si}}+2\frac{1}{2}\ddot{\overline{\text{Al}}}\dddot{\text{Si}}+4\frac{1}{2}\dot{\text{H}}$. Analysis:

$\dddot{\text{Si}}$	$\ddot{\overline{\text{Al}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Na}}$,$\dot{\text{K}}$	$\dot{\text{H}}$
40·36	31·25	10·99	6·26	0·29	10·79=99·94.

B.B. fuses to a white enamel, with intumescence. Dissolves in cold acids and gelatinizes. Occurs with caporcianite in the Gabbro rosso of Tuscany. The name, from *πικρος, bitter,* and Thomsonite, alludes to the magnesia present.

NATROLITE, *W.* Soda Mesotype. Feather Zeolite. Bergmannite, Spreustein. Radiolite. Fäserzeolite, *W.* Natron-Mesotyp, *R.* Lehuntite, *Thom.* Brevicite, *Berz.*

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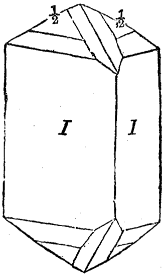

Trimetric. $I : I=91°$, $O : 1\bar{\imath}=144° \ 23'$; $a : b : c=0{\cdot}7165 : 1 : 1{\cdot}0176$; $\frac{1}{2} : \frac{1}{2}$ (mac.)$=143° \ 20'$, (brach.)$=142° \ 40'$, $I : \frac{1}{2}=116° \ 40'$. Crystals usually slender, often acicular; frequently interlacing, divergent, or stellate. Also fibrous, radiating, and massive.

H.=5—5·5. G.=2·17—2·24. Lustre vitreous, sometimes inclining to pearly, especially in fibrous varieties. Color white, or colorless; also grayish, yellowish. Streak uncolored. Transparent—translucent.

Composition.—$\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}+\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+2\dot{\bar{\mathrm{H}}}$=Silica 47·4, alumina 26·9, soda 16·2, water 9·5.

Analyses: 1, Klaproth, (Beit. v, 44); 2–4, Fuchs, (Schw. J. viii and xviii); 5, Thomson, (Min. i, 317); 6, Kobell, (J. f. pr. Chem. xiii, 7); 7, Riegel, (Jahrb. Pharm. xiii); 8, 9, 10, Scheerer, (Pogg. lxv, 276); 11, Thomson, (Min. i, 338); 12, C. G. Gmelin, (Pogg. lxxxi, 311); 13, C. Bergemann, (Pogg. lxxxiv, 491); 14, Souden, (Pogg. xxxiii, 112); 15, 16, Körte, (G. Rose's Mineral System, 1852, 96):

	$\dddot{\mathrm{S}}\mathrm{i}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\bar{\mathrm{H}}}$
1. Högau,	48·00	24·25	1·75	16·50	9·00=99·50, Klaproth.
2. "	47·21	25·60	1·35	16·12	8·88=99·16, Fuchs.
3. Auvergne, *cryst.*	47·76	25·88	—	16·21	9·31=99·16, Fuchs.
4. Tyrol, *massive,*	48·63	24·82	0·21	15·69	9·60=98·95, Fuchs.
5. Antrim, *cryst.*	47·56	26·42	0·58	14·93	10·44, $\dot{\mathrm{C}}\mathrm{a}$1·4=101·33, Thomson.
6. Greenland, *massive,*	46·94	27·00	—	14·70	9·60, $\dot{\mathrm{C}}\mathrm{a}$1·8=100·04, Kobell.
7. Högau,	48·05	25·80	2·10	15·75	9·00=100·70, Riegel.
8. *Bergmannite, red,*	47·97	26·66	0·73	14·07	9·77, $\dot{\mathrm{C}}\mathrm{a}$ 0·68, $\dot{\mathrm{K}}$ *tr.*=99·88, S.
9. " *white,*	48·12	26·96	0·22	14·23	10·48, $\dot{\mathrm{C}}\mathrm{a}$ 0·69, $\dot{\mathrm{K}}$ *tr.*=100·7, S.
10. *Radiolite,*	48·38	26·42	0·24	13·87	9·42, $\dot{\mathrm{C}}\mathrm{a}$0·44,$\dot{\mathrm{K}}$1·54=100·31, S.
11. *Lehuntite,*	47·33	24·00	—	13·20	13·60, $\dot{\mathrm{C}}\mathrm{a}$1·52=99·65, Thomson.
12. Laurvig, *Natrolite,*	48·68	26·37	—	16·00	9·55, $\dot{\mathrm{K}}$0·36=100·96, Gmelin.
13. *Iron Natrolite,*	46·54	18·94	7·49	14·04[a]	9·37, $\dot{\mathrm{F}}\mathrm{e}$ 2·40, $\dot{\mathrm{M}}\mathrm{n}$0·55=99·33B.
14. *Brevicite,*	43·88	28·39	—	10·32	9·63, $\dot{\mathrm{C}}\mathrm{a}$ 6·88, $\dot{\mathrm{M}}\mathrm{g}$ 0·21, Souden.
15. "	48·32	26·24	—	15·97	9·47, $\dot{\mathrm{C}}\mathrm{a}$ *tr.*=100·00, Körte.
16. "	48·50	26·05	—	16·49	9·29, $\dot{\mathrm{C}}\mathrm{a}$ *tr.*=100·33, Körte.

[a] With a little potash.

B.B. natrolite becomes opaque and is often phosphorescent; it fuses quietly to a glassy globule. Gelatinizes readily with acids, even after ignition.

This species occurs in cavities in amygdaloidal trap, basalt, and other allied rocks; and sometimes in seams in granite or gneiss. It is found in the *graustein* of Aussig in Bohemia; in Auvergne; the trap rocks of Kilmalcolm in Renfrewshire, and Glenarm in the county of Antrim and elsewhere. The *Radiolite* is from Brevig. *Bergmannite* is a red or white natrolite, from Zircon syenite near Brevig. *Lehuntite* is from Glenarm, and if Thomson's analysis is correct it contains $3\dot{\bar{\mathrm{H}}}$ like the scolecites, although a soda-mesotype. Kengott finds the angle $I : I=91°$.

The Iron-natrolite (anal. 13, Eisennatrolith) occurs along with the brevicite of Brevig, and is in dull green opaque prismatic crystals and semicrystalline plates. H.=5. G.=2·353. It has one fourth of the alumina replaced by peroxyd of iron.

In North America, natrolite occurs in the trap of Nova Scotia; sparingly at Cheshire, Ct.; also at Copper Falls, Lake Superior, in crystals, sometimes on native copper.

Bergmannite is shown by R. Blum (Pogg. 1852, lxxxvii, 316) to result from the alteration of Elæolite.

The *Brevicite* is found in white fibrous subfoliated masses, probably in syenite. G. Rose describes a crystal from a specimen in the collection of Mr. Krantz, which is from Brevig, and is labelled brevicite, which gives the angles of mesotype: *I* : *I* =91°: obtuser pyramidal edge of one octahedron 142° 55′; of another 96° 6′, (the second 3ĭ, the first being 1.

The analyses (Nos. 14, 15, 16) differ so widely, that it still remains doubtful whether Souden may not have had another mineral. His results show a resemblance to mesole, below. (G. Rose, Kryst. Chem. Min. 1852, p. 95.)

Mesole. Harringtonite.—*Mesole* occurs in implanted globules, with a flat columnar radiate structure. H.=3·5. G.=2·35—2·4. Lustre silky or pearly. Color grayish-white, yellowish, reddish. Streak uncolored. Translucent. Laminæ slightly elastic. The *Harringtonite* is described as snow-white, with a compact texture, much like an almond; very tough.

Composition.—Perhaps $(\dot{\mathrm{N}}\mathrm{a}, \dot{\mathrm{C}}\mathrm{a})^3\dddot{\mathrm{S}}\mathrm{i}^2+3\ddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+8\dot{\mathrm{H}}$ (or $6\dot{\mathrm{H}}$ for Harringtonite, and also Souden's analysis of *brevicite*, p. 327).

Analyses: 1, Berzelius, (Jahresb. iii, 147); 2, 3, Hisinger, (ib. v, 217, xx, 214); 4, Freissmuth, (Schw. J. xxv, 425); 5, Thomson, (Ed. N. Phil. J. xvii, 186); 6, 7, Thomson (Min. i, 329):

	$\dddot{\mathrm{S}}\mathrm{i}$	$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{H}}$
1. Faroe,	42·60	28·00	11·43	5·63	12·70=100·36, Berz.
2. Annaklef,	42·17	27·00	9·00	10·19	11·79=100·15, Hisinger.
3. "	41·52	26·80	8·07	10·80	11·79=98·99, Hisinger.
4. Hauenstein,	44·56	27·56	7·09	7·69	14·13=101·03, Freissmuth.
5. Bombay,	42·70	27·50	7·61	7·00	14·71=99·52, Thomson.
6. *Harringtonite,*	44·96	26·85	11·01	5·56	10·28, $\dot{\mathrm{F}}\mathrm{e}$ 0·88=99·54, T.
7. "	44·84	28·48	10·68	5·56	10·28=99·85, Thomson.

Harringtonite occurs in amygdaloid in the north of Ireland. Mesole occurs at the Faroe Islands; also at Disco Island, Greenland; in Iceland, and elsewhere.

Scheerer describes a monoclinic natrolite crystal having *I* : *I*=125°, 1 : 1=136°, or approaching hornblende, and he supposes natrolite dimorphous, (Pogg. lxxxix, 37).

Altered Forms.—Natrolite occurs altered to Prehnite.

SCOLECITE, *Fuchs.* Lime Mesotype. Needlestone (in part). Mesotype (in part). Kalk-mesotype. Poonahlite, *Brooke.* Antrimolite, *Thomson.* Mesolite or Lime and Soda Mesotype.

Monoclinic; *C*=89° 6′. *I* : *I*=91° 36′, *O* : $\frac{1}{2}i$=161° 16½′; *a* : *b* : *c*=0·6971 : 1 : 1·0282. $\frac{1}{2}:\frac{1}{2}$=144° 40′; $-\frac{1}{2}:-\frac{1}{2}$=144° 20′. Crystals long or short prisms, or acicular. Twins, compounded parallel to the orthodiagonal. Cleavage: *I*, nearly perfect. Also fibrous, massive and radiated.

H.=5—5·5. G.=2·2—2·7. Lustre vitreous, or silky when fibrous. Transparent to subtranslucent. Pyroelectric, the converging end the analogue pole.

Composition.—$\dot{\mathrm{C}}\mathrm{a}\,\dddot{\mathrm{S}}\mathrm{i}+\ddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+3\dot{\mathrm{H}}$=Silica 46·0, alumina 26·1, lime 14·2, water 13·7 =100. For mesolite, $(\dot{\mathrm{C}}\mathrm{a}, \dot{\mathrm{N}}\mathrm{a})\dddot{\mathrm{S}}\mathrm{i}+\ddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+3\dot{\mathrm{H}}$. Analyses: 1–3, Fuchs and Gehlen, (Schw. J.); 4, Guillemin, (Ann. d. Mines, xii, 8); 5, Riegel, (J. f. pr. Chem. xl, 317); 6, Gibbs, (Pogg. lxxi, 565); 7, Gülich, (Pogg. lix, 373); 8, Domeyko, (Ann. d. M. [4], ix, 3); 9, Scott, (Jameson's J. liii, 277); 10, Berzelius, (Jahresb. iii, 147); 11–14, Fuchs and Gehlen, (Schw. J.); 15, Riegel, (loc. cit.); 16, Thomson, (Phil. Mag. 1840); 17, Breidenstein, (Ramm. 5th Supp. 168):

I. *Scolecite, or Lime-mesotype.*

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
1.	Iceland,	48·94	25·99	10·44	—	13·90=99·26, Fuchs and Gehlen.
2.	Faroe, *cryst.*	46·19	25·88	13·86	0·48	13·62=100·03, " "
3.	Staffa, *feathery,*	46·75	24·82	14·20	0·39	13·64=98·80, " "
4.	Auvergne,	49·00	26·50	15·30	—	9·00=99·80, Guillemin.
5.	Niederkirchen,	48·16	23·50	14·50	0·30	13·50=99·96, Riegel.
6.	Iceland,	46·72	25·90	13·71	—	13·67=100, Gibbs.
7.	"	46·76	26·22	13·68	—	13·94=100·6, Gülich.
8.	Chili,	46·3	26·9	13·4	—	14·0 =100·6, Domeyko.
9.	Mull, Scotland,	46·21	27·0	13·45	—	13·78=100·44, Scott.

II. *Mesolite, or Lime-and-soda-mesotype.*

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
10.	Faroe,	46·80	26·50	9·87	5·40	12·30=100·87, Berzelius.
11.	" *cryst.*	47·00	26·13	9·35	5·47	12·25=100·20, Fuchs & Gehlen.
12.	Iceland, *feathery,*	46·78	25·66	10·06	4·79	12·31=99·60, " "
13.	"	47·46	25·35	10·04	4·87	12·41=100·13, " "
14.	Tyrol,	46·04	27·00	9·61	5·20	12·36=100·21, " "
15.	Niederkirchen,	46·65	27·40	9·26	4·91	12·00=100·22, Riegel.
16.	Giant's Causeway,	48·88	26·36	7·64	4·20	12·32, $\dot{\mathrm{M}}\mathrm{g}$2·46=101·86, Thomson.
17.	Iceland,	45·78	27·53	9·00	5·03	12·38, $\dot{\mathrm{K}}$ 0·31=100·03, Breid.

An analysis by Walterhausen, Vulk. Gestein, 260.

B.B. scolecite curls up like a worm, (whence the name from σκωληξ, *a worm*), and finally melts to a bulky shining slag, which in the inner flame becomes a vesicular slightly shining bead.

Occurs in the Berufiord, Iceland, where the crystals often exceed two inches in length, and are occasionally a quarter of an inch thick. It has also been met with in amygdaloid, at the Faroe Islands, Staffa; the Vendayah mountains, Hindostan; in Greenland; at Pargas, Finland; in Auvergne; also in veins in the Kilpatrick hills.

Poonahlite of Brooke has the angle *I* : *I*=91° 49′, Kengott. Gmelin obtained in an analysis, (Pogg. xlix, 538), $\dddot{\mathrm{Si}}$ 45·12, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 30·44, $\dot{\mathrm{Ca}}$ 10·20, $\dot{\mathrm{Na}}$ and *trace* of $\dot{\mathrm{K}}$ 0·66, $\dot{\mathrm{H}}$ 13·39=99·81. From Poonah, Hindostan. Brooke and Miller refer it to this place.

Antrimolite of Thomson (Min. i, 326) occurs in white silky fibrous stalactites, about as large as the finger, in cavities in amygdaloid at Antrim, four miles east of the Giant's Causeway. Fibres divergent from the axes; angle of prism, according to Kengott, 92° 13′, and the outer edges beveled by a prism of 150° 30′. H.=3·75. G.=2·096. Thomson's analyses afforded $\dddot{\mathrm{Si}}$ 43·47, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 30·26, $\dot{\mathrm{Ca}}$ 7·50, $\dot{\mathrm{K}}$ 4·10, $\dot{\mathrm{Fe}}$ 0·19, Cl 0·098, $\dot{\mathrm{H}}$ 15·32. B.B. forms a white enamel without intumescence. Gelatinizes with muriatic acid.

A *zeolitic* mineral from Saspach in Kaiserstuhl, afforded J. Schill (v. Leonh. 1846, 452), $\dddot{\mathrm{Si}}$ 51·50, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 16·51, $\dot{\mathrm{Ca}}$ 6·20, $\dot{\mathrm{K}}$ 6·82, $\dot{\mathrm{M}}\mathrm{g}$ 1·93, H 17·00=99·96. Occurs in tufts of fibres and concretions; G.=1·465. H.=4—5; white or colorless; lustre silky to vitreous. Easily soluble in muriatic acid.

SLOANITE, *Meneghini* and *Bechi*.

Trimetric. *I* : *I*=105°. Cleavage: *I* very distinct. In radiated masses, and often a fracture transverse to the radiation.

H.=4·5. G.=2·441. Lustre pearly. White. Opaque.

Composition.—$(\dot{\mathrm{Ca}}, \mathrm{Mg})^3 \dddot{\mathrm{Si}}^2 + 5\dddot{\bar{\mathrm{A}}}\mathrm{l}\,\dddot{\mathrm{Si}} + 9\dot{\mathrm{H}}$=Silica 42·9, alumina 34·8, lime 11·3, water 11·0=100. Analysis by Bechi, (Am. J. Sci., [2], xiv, 64):

$\dddot{\mathrm{Si}}$ 42·19, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 35·00, $\dot{\mathrm{Ca}}$ 8·12, $\dot{\mathrm{M}}\mathrm{g}$ 2·67, $\dot{\mathrm{Na}}$ 0·25, $\dot{\mathrm{K}}$ 0·30, $\dot{\mathrm{H}}$ 12·50=100·76.

B.B. fuses without intumescence to a white enamel. Dissolves in the acids even in the cold, and gelatinizes.

From the Gabbra rosso of Tuscany.

EPISTILBITE, *G. Rose*, Pogg. vi, 183, and Brewster's Jour. iv, 283. Monophan, *B.*

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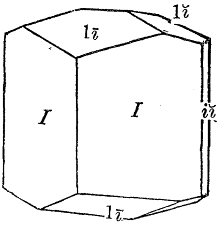

Trimetric. $I:I$=135° 10′, $O:1\bar{i}$=144° 53′; $a:b:c$=1·422 : 1 : 2·4242. Observed planes, as in f. 484, with $2\breve{2}$ replacing edge $I:1\breve{i}$. $1\bar{i}:1\bar{i}$ (top)=109° 46′, $1\breve{i}:1\breve{i}$ (top) =147° 40′, $I:1\bar{i}$=122° 9′, $1\bar{i}:1\breve{i}$=141° 47′. Cleavage: $i\breve{i}$, very perfect: indistinct in other directions. Face I mostly uneven. Occasionally in twins parallel to I. Also granular.

H.=3·5—4. G.=2·249—2·363. Lustre pearly upon the cleavage face: upon I vitreous. Color white, bluish or yellowish-white. Transparent—subtranslucent. Fracture uneven.

Composition.—$(\dot{C}a, \dot{N}a)\dddot{Si}+\ddot{\overline{Al}}\dddot{Si}^3+5\dot{H}$=Silica 59·3, alumina 16·8, lime 9·2, water 14·7, which is identical essentially with the formula of brewsterite, and also with heulandite, taking Damour's formula; it differs from that of stilbite in containing 1 atom less of water. Analyses: 1, 2, G. Rose, (loc. cit.); 3, Dr. Limpricht, (Waltersh. Vulk. Gest. 248); 4, Waltershausen, (ib.):

	$\dddot{Si}$	$\ddot{\overline{Al}}$	$\dot{C}a$	$\dot{N}a$	$\dot{H}$
1. Berufiord,	58·59	17·52	7·56	1·78	14·48=99·93, Rose.
2. "	60·28	17·36	8·32	1·52	12·51 (loss)=100, Rose.
3. "	58·99	18·21	6·92	2·35	14·98=101·44, Limpricht.
4. "	59·22	17·23	8·20	2·46	13·90=101·01, Waltershausen.

B.B. intumesces, and forms a vesicular enamel. Borax dissolves a great part of it, and forms a clear globule. Soluble in concentrated muriatic acid without gelatinizing.

Occurs with scolecite at the Berufiord in Iceland; in Faroe; at Poonah in India; in small flesh-colored crystals at Skye; reported as occurring with stilbite, apophyllite, &c., at Bergen Hill, N. J.

This species exhibits but one system of rings in polarized light, according to Dr. Brewster, while heulandite has two. The double refraction of heulandite is also much greater than that of epistilbite. Yet the angle $I:I$ in this species is near that of heulandite.

Ehrenbergite of Nöggenrath (Lieb. Kopp, 1852, 867) is a pale rose-red amorphous mineral, almost gelatinizing with acids, from trachyte in the Steinbruch. Bischof and Schnabel obtained for it,

$\dddot{Si}$	$\ddot{\overline{Al}}$	$\ddot{\overline{Fe}}$	$\ddot{Mn}$	$\dot{C}a$	$\dot{Mg}$	$\dot{K}, \dot{N}a$	$\dot{H}$ with org. Subs.
64·54	6·04	4·56	4·61	3·96	0·41	8·11	(by loss) 7·77=100, B.
56·77	15·77	1·65	0·80	2·76	1·30	3·78	17·11=100, S.

HEULANDITE. Foliated Zeolite, *J.* and *W.* Stilbite, (in part). Stilbite anamorphique, *Hauy.* Blättriger Stilbit, *Haus.* Blätterzeolit, *W.* Euzeolith. Lincolnite, *Hitchcock.* Beaumontite, *Levy.*

Monoclinic. C=88° 35′, $I:I$=136° 4′, $O:1\grave{i}$=156° 45′; $a:b:c$=1·065 : 1 : 2·4785. Observed planes as in the annexed figures.

$O : 2i = 116^\circ\ 20'$. $2i : -2i = 129^\circ\ 40'$. $ii : I = 111^\circ\ 58'$.
$O : -2i = 114^\circ$. $ii : -1 = 106^\circ\ 32'$. $-1 : -1 = 146^\circ\ 56'$.

Cleavage: clinodiagonal (*ii*) eminent. Also in globular forms; also granular.

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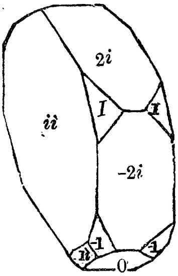

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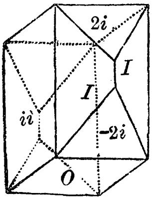

H.=3·5—4. G.=2·2, Haidinger; 2·195, Faroe Islands, Thomson, 2·175, Iceland. Lustre of *ii* pearly; of other faces, vitreous. Color various shades of white passing into red, gray, and brown. Streak white. Transparent—subtranslucent. Fracture subconchoidal, uneven. Brittle.

Composition.—$\dot{Ca}\,\dddot{Si}+\dddot{\overline{Al}}\dddot{Si}^3+5\dot{H}$, Damour=Silica 59·3, alumina 16·8, lime 9·2. water 14·7.

Analyses: 1, Thomson, (Min. i, 347); 2, Rammelsberg, (Handw. i, 302); 3, Damour, (Compt. Rend. xxii, 956, Ann. M. [4], x, 207); 4, Waltershausen, (Vulk. Gest. 252).

	$\dddot{Si}$	$\dddot{\overline{Al}}$	$\dot{Ca}$	$\dot{H}$	$\dddot{\overline{Fe}}$
1. Faroe,	59·15	17·92	7·65	15·40	——=100·12, Thomson.
2. Iceland,	58·20	17·60	7·20	16·00	——=99·00, Rammelsberg.
3. "	59·64	16·33	7·44	14·33	——, $\dot{K}$ 0·74, $\dot{Na}$ 1·16=99·64, D.
4. Berufiord,	58·90	16·81	7·38	14·33	0·12, " 1·63, " 0·57, $\dot{Mg}$ 0·29=100·04, W.

B.B. intumesces and fuses, and becomes phosphorescent. Dissolves in muriatic acid, affording slimy silica, without gelatinizing.

Heulandite occurs principally in amygdaloidal rocks. Also in gneiss, and occasionally in metalliferous veins.

The finest specimens of this species come from Iceland and the Faroe Islands, and from the Vendayah mountains in Hindostan. Red varieties occur at Campsie in Sterlingshire, with stilbite of the same color, and brown in ore beds, at Arendal. It also occurs in the Kilpatrick hills, near Glasgow, on the I. of Skye, in the Fassa Valley, Tyrol, in the Hartz and elsewhere; abundant in the amygdaloid of Abyssinia.

At Peter's Point, Nova Scotia, it occurs in trap, presenting white and flesh-red colors, and associated with laumontite, apophyllite, thomsonite, &c.; also at Cape Blomidon, and other places in the same region, in crystals an inch and a half in length.

In the United States with stilbite and chabazite on gneiss, at Hadlyme, Ct., and Chester, Mass., and with these minerals and datholite, apophyllite, &c., in amygdaloid at Bergen Hill, New Jersey; sparingly at Kipp's Bay, New York Island, on gneiss, along with stilbite; in a fissure in hornblende rock, a few miles southwest of Philadelphia, sparingly; on north shore of Lake Superior, between Pigeon Bay and Fond du Lac.

Also in minute crystals, seldom over half a line long, with haydenite, at Jones's Falls, near Baltimore, on a syenitic schist. Levy has described these crystals, under the name of *Beaumontite,* as modified square prisms. The difference in the lustre of *O* and *ii,* the two faces of the prism, shows that these planes are dissimilar, and that the form cannot be a square prism. In physical and other characters they resemble Heulandite, and the angle *I* : 2*i*, according to Levy, equals 147° 18′, which is near the same angle in this species. Levy makes *I* : *I*=132° 28′; but the author finds 135½° to 136½° by reflected light. Delesse's analysis afforded silica 64·2, alumina 14·1, protoxyd of iron 1·2, lime 4·8, magnesia 1·7, loss and soda 0·6, water 13·4; but it is probable that the specimen was not pure. G.=2·24, (Ann. Ch. Phys. [3], ix, 385).

Named after the English Mineralogist, Mr. Heuland.

Parastilbite. Von Waltershausen thus names (loc. cit. p. 251) a specimen from Borgarfiord, which afforded on analysis, $\ddot{S}i$ 61·87, $\ddot{\bar{A}}l$ 17·83, $\dot{C}a$ 7·32, $\dot{N}a$ 2·00, $\dot{K}$ 1·78, $\dot{H}$ 9·20=100, for which he writes the formula $\dot{R}\,\ddot{S}i+\ddot{\bar{A}}l\,\ddot{S}i^3+3\dot{H}$. It resembles Epistilbite, but he states that the angles are somewhat different. It may be Heulandite.

BREWSTERITE, *Brooke,* Edinb. Phil. Jour. vi, 112. Diagonite, *Breit.*

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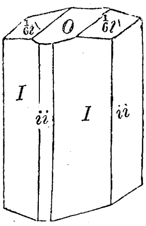

Monoclinic. $C=86°20'$, $I:I=136°$, $O:1i=157°\ 14'$; $a:b:c=1·038:1:2·47$. $O:ii=93°\ 40'$, $O:ii=90°$, $O:\frac{1}{6}i=176°$, $\frac{1}{6}i:\frac{1}{6}i=172°$. Cleavage *ii* highly perfect.

H.=4·5—5. G.=2·12—2·432; the latter according to Thomson. Lustre of *ii* pearly; of other faces, vitreous. Color white, inclining to yellow and gray. Streak white. Transparent—translucent. Fracture uneven.

Composition.—$(\dot{S}r, \dot{B}a)\ddot{S}i+\ddot{\bar{A}}l\dddot{S}i^3+5\dot{H}$=(if Ba : Sr=1 : 2) Silica 53·7, alumina 15·2, baryta 7·6, strontia 10·2, water 13·3; but gives too little alumina. Analyses by Connel and Thomson, (Min. i, 348):

	$\ddot{S}i$	$\ddot{\bar{A}}l$	$\dot{B}a$	$\dot{S}r$	$\dot{C}a$	$\dot{H}$	$\dddot{\bar{F}}e$	
1. Strontian,	53·67	17·49	6·75	8·32	1·35	12·58	0·29	=100·45, Connell.
2. "	53·04	16·54	6·05	9·01	0·80	14·73	——	=100·17, Thomson.

B.B. parts with its water and becomes opaque; then froths and swells up, but fuses with difficulty. Leaves a silica skeleton when fused with salt of phosphorus. Dissolves in the acids with a separation of the silica, and according to Kobell, gelatinizes.

Brewsterite was first observed at Strontian in Argyleshire, associated with calc spar. Occurs also at the Giant's Causeway, coating the cavities of amygdaloid; in the lead mines of St. Turpet; near Freiburg in the Brisgau; in the department of the Isère in France, and in the Pyrenees.

This species was named after Sir David Brewster.

STILBITE, *H.* Desmine, *Breit.* Radiated Zeolite, *J.* Foliated Zeolite. Strahlzeolith, *W.* Blättrich strahliger Stilbite, *Haus.* Garbenstilbit. Sphærostilbite, *B.* Hypostilbite, *B.*

Monoclinic? Breit. $I:I=94°\ 16'$ (whence $\overset{\frown}{i_2}:\overset{\frown}{i_2}=130°\ 12'$, analogue of $I:I$ in Heulandite); 1 : 1(front)=119° 16′, $ii:ii=90°$. Brooke and Miller make $O:ii$ or $ii=90°$, $ii:1=123°$, $ii:1=120°\ 22'$. Cleavage: *ii* perfect, *ii* less so. Twins of a cruciform character are rarely met with. Common in sheath-like aggregations; globular, divergent, and radiated forms; also thin lamellar and columnar.

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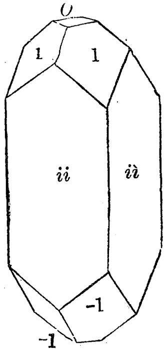

H.=3·5—4. G.=2·094—2·205: 2·161, Haidinger. Lustre of *ii*, pearly; of other faces vitreous. Color white; occasionally yellow, brown, or red. Streak uncolored. Subtransparent—translucent. Fracture uneven. Brittle.

Composition.—$\dot{Ca}\dddot{Si}+\dddot{\overline{Al}}\dddot{Si}^3+6\dot{H}$=Silica 57·6, alumina 16·3, lime 8·9, water 16·3. Analyses: 1, Fuchs and Gehlen, (Schw. J. viii, 253); 2, Hisinger, (ib. xxiii, 63); 3, Retzius, (Jahresb. iv, 153); 4, Moss, (Pogg. lv, 114); 5, Riegel, (J. f. pr. Chem. xl, 317); 6, Hermann, (Bull. Soc. Nat., Moscow, 1848, 318); 7, Münster, (Pogg. lxv, 297); 8, 9, Sjögren, (Ofv. K. V. Ak. 1848, 111); 10, Waltershausen, (Vulk. Gest. 254); 11, Kerl, (B. u. H. Ztg. 1853, No. 2); 12, R. Weber, (ib.); 13, Beudant, (Traitè de Min. ii, 119, 120).

	$\dddot{Si}$	$\dddot{\overline{Al}}$	$\dot{Ca}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
1. Iceland,	55·07	16·58	7·58	1·5		19·30=100·04, F. & G.
2. "	58·00	16·10	9·20	—	—	16·40=99·70, Hisinger.
3. Faroe,	56·08	17·22	6·95	2·17	—	18·35=100·77, Retzius.
4. "	57·18	16·44	7·74	1·11	0·32	17·79=100·58, Moss.
5. Niederkirchen,	58·33	16·66	7·16	1·62	—	14·50, $\ddot{\overline{Fe}}$0·26=98·53, R.
6. Ilmen Mts.; G.=2·19,	56·31	16·25	7·66	1·03	—	17·75, $\dot{Fe}$, $\dot{Mn}$1·0=100 H.
7. Christiana; G.=2·203,	58·53	15·73	7·02	—	—	17·05, $\dot{Mg}$ alk. 3·07, $\ddot{\overline{Fe}}$0·5
8. Gustafsberg,	57·41	16·14	8·97	1·21	1·04	16·60, $\dot{Mg}$ *tra.*=101·40, S.
9. Barbro, Norway,	58·41	16·56	7·89	—	—	16·53, $\dot{Mg}$, $\dot{Mn}$ 0·59=99·93, S.
10. Iceland; G.=2·134,	57·40	16·23	7·71	0·60	0·34	16·68, $\dot{Mg}$0·13=99·09, W.
11. Andreasburg,	56·3	15·9	7·4	—	0·6	17·6, $\ddot{\overline{Fe}}$1·3=99·1, Kerl.
12. Berufiord, Iceland,	58·02	14·94	8·33	—	1·30	17·71=100·30, Weber.
13. *Sphærostilbite*,	55·91	17·61	9·03	0·68	—	17·84=100·07, Beudant.

B.B. intumesces and yields a milk-white bead. With acids yields slimy silica, excepting Beudant's *sphærostilbite*, which forms a jelly.

Stilbite occurs mostly in cavities in amygdaloid or trap. It is also found in some metalliferous veins, and in granite and gneiss.

Abundant on the Faroe Islands, in Iceland, and on the Isle of Skye, in trap; at Andreasberg in the Hartz and Kongsberg and Arendal in Norway, with iron ore; in the Vendayah Mts., Hindostan, in large translucent crystals, having a reddish-tinge; in fine crystals of a brick-red color, in porphyritic amygdaloid, near Kilpatrick in Dumbartonshire; a brown variety on granite, at the copper mines of Gustafsberg, near Fahlun in Sweden; at Andreasberg, Kongsberg, etc.; at Partridge Island, at Nova Scotia, this species forms a perpendicular vein from three to four inches thick, and from thirty to fifty feet long, intersecting amygdaloid; its colors are white and flesh-red.

In the United States, sparingly in small crystals at Chester and the Charlestown syenite quarries, Mass; at the gneiss quarry, Thachersville, Conn., in crystals lining cavities, in coarse granite; at Hadlyme in radiated forms or gneiss, associated with epidote, garnet, and apatite; at Phillipstown, N. Y., in crystals or fan-like groups; opposite West Point, in a vein of decomposing bluish feldspar, intersecting gneiss, in honey-yellow crystals; in the greenstone of Piermont, in minute crystals; in scopiform crystals of a dull yellow color, near Peekskill, N. Y.; and at Bergen Hill, New Jersey, in small but bright crystals; also at the Michipicoten Islands, Lake Superior.

The name stilbite is from στιλβη, *lustre.*

ALTERED FORMS.—Stilbite has been observed changed to quartz. *Hypostilbite* of Beudant from Faroe, is considered a partially altered stilbite. Beudant obtained (loc. cit) $\dddot{Si}$ 52·43, $\dddot{\overline{Al}}$ 18·32, $\dot{Ca}$ 8·10, $\dot{Na}$ 2·41, $\dot{H}$ 18·17=99·96. Two specimens of stilbite analyzed by Thomson, (Min. i, 345), approach hypostilbite.

CAPORCIANITE, *Savi.*

Monoclinic, according to Meneghini, resembling heulandite and near that species in its angles; $2i : -2i = 131°$, $2i : I = 150°$. Cleavage: ii very easy, and also parallel to $2i$; easy parallel to $-2i$. Faces $2i$ minutely striated. Also in twins. Also imperfectly radiated foliaceous. H.=2·5. G.=2·470. Color flesh-red. Lustre pearly.

Composition.—$\dot{C}a^3\dddot{S}i^2+3\dddot{\bar{A}}l\ \dddot{S}i^2+9\dot{H}$, Ramm. and near Laumontite=Silica 53·2, alumina 22·6, lime 12·3, water 11·9=100. Analyses: 1, Anderson, (Jameson's J. 1842, 21); 2, Bechi, (Am. J. Sci. [2], xiv, 62):

	$\dddot{S}i$	$\dddot{\bar{A}}l$	$\dddot{\bar{F}}e$	$\dot{C}a$	$\dot{M}g$	$\dot{K}$	$\dot{N}a$	$\dot{H}$
1.	52·8	21·7	0·1	11·3	0·4	1·1	0·2	13·1=100·7, Anderson.
2.	52·02	22·83	—	9·68	1·11	1·11	0·25	13·17=100·17, Bechi.

B.B. fuses to a white enamel without intumescence. Dissolves easily in acids, and forms a jelly even in the cold.

Occurs in geodes with calcite in the Gabbro rosso of Monte de Caporciano at L'Impruneta and other places in Tuscany. It is sometimes accompanied by native copper.

V. DATHOLITE SECTION.

DATHOLITE. Borate of Lime, *P.* Borosilicate of Lime, *Thom.* Datolith, *W.* Esmarkite, *Haus.* Humboldite, *Levy.* Botryolite, *Haus.* Chaux Boratée Siliceuse, *H.*

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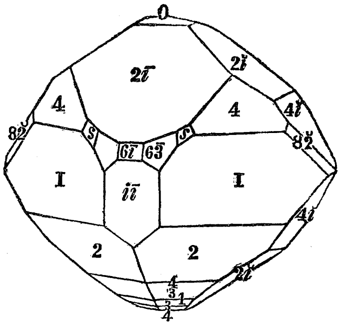

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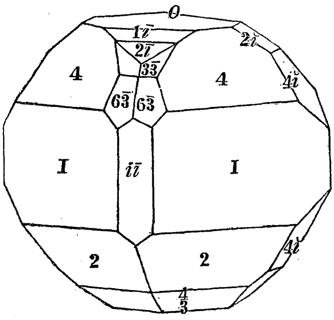

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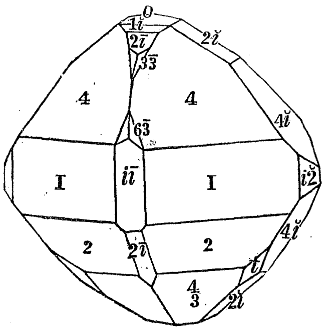

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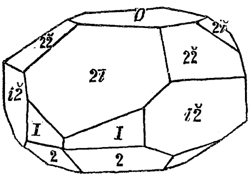

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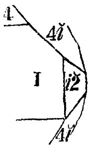

Trimetric and hemihedral, Brooke and Miller. $I : I = 115° 26'$, $O : 1\bar{\imath} = 153° 26'$; $a : b : c = 0{\cdot}5 : 1 : 1{\cdot}5829$.

$O : 2\bar{\imath} = 135°$.
$O : 6\bar{\imath} = 108° 26'$.
$O : 6\bar{3} = 108° 4'$.
$O : 3\bar{3} = 123° 11'$.
$O : 4\bar{2} = 115° 27'$.
$O : 1 = 153° 26'$.
$O : \frac{4}{3} = 141° 45'$.
$O : 2 = 130° 13'$.
$O : 4 = 112° 55'$.
$O : 2\breve{2} = 141° 9'$.
$O : 8\breve{2} = 107° 15'$.
$O : 2\breve{4} = 145° 49'$.
$O : 3\breve{6} = 135° 35'$.
$O : 2\breve{\imath} = 147° 43'$.
$O : 4\breve{\imath} = 128° 22'$.
$6\bar{3} : 6\bar{3}$(mac)$= 157° 23'$.
$3\bar{3} : 3\bar{3}$ " $= 160° 8'$.
$2 : 2$ " $= 131° 52'$.
$\frac{4}{3} : \frac{4}{3}$(ov.$i\bar{\imath}$)$= 141° 24'$.
$i\breve{2} : i\breve{2}$ " $= 76° 44'$.

O									
$\frac{2}{3}\bar{\imath}$									
					$\frac{3}{4}$				
$1\bar{\imath}$					1				
$\frac{4}{3}\bar{\imath}$					$\frac{4}{3}$				
$2\bar{\imath}$					2	$2\breve{2}$	$2\breve{4}$		$2\breve{\imath}$
$3\bar{\imath}$	$3\bar{3}$							$3\breve{6}$	$3\breve{\imath}$
$4\bar{\imath}$			$4\bar{2}$		4	$4\breve{2}$	$4\breve{4}$		$4\breve{\imath}$
		$5\bar{\frac{5}{2}}$							
$6\bar{\imath}$	$6\bar{3}$			$6\bar{\frac{3}{2}}$					
						$8\breve{2}$			
$i\bar{\imath}$				$i\bar{\frac{3}{2}}$	I	$i\breve{2}$			$i\breve{\imath}$

Observed Planes.

Cleavage: $i\breve{2}$ and $i\bar{\imath}$ indistinct. Crystals small and glassy. Also botryoidal and globular, having a columnar structure; also divergent and radiating; also massive.

H.=5—5·5. G.=2·989, (from Arendal), Haidinger. Lustre vitreous, sometimes subresinous on a surface of fracture; color white; sometimes grayish, pale green, yellow, red, or amethystine, rarely dirty olive-green or honey-yellow. Streak white. Translucent. Fracture uneven, subconchoidal. Brittle.

Composition.—$(\dot{C}a^3, \dot{H}^3, \dddot{B})\dddot{S}i^{\frac{2}{3}}$, in which $\dot{H}^3 : \dot{C}a^3 : \dddot{B} = 1 : 2 : 3$ = Silica 37·7, boracic acid 21·8, lime 34·9, water 5·6. $2\dot{C}a^3\dddot{S}i + \dddot{B}^3\dddot{S}i^2 + 3\dot{H}$, Rammelsberg. *Botryolite*, a variety occurring in botryoidal concretions, is supposed to afford more water, but more analyses are needed to show that this is constant. The species is related in formula as well as form to Euclase and Sphene.

G. Rose writes the formula for Datholite $3(\dot{C}a\dddot{B} + \dot{C}a\dddot{S}i) + \dot{H}^3\dddot{S}i$, and the same for Botryolite, except $\dot{H}^6\dddot{S}i$ for the last term. He also states that the formula of the former may be $2\dot{C}a^3\dddot{S}i^2 + 3\dot{H}\,\dddot{B}$, equivalent to two atoms of Wollastonite and three of Sassolin. But the boracic acid appears to be a base in all the silicates in which it occurs, as elsewhere observed.

Analyses: 1, Stromeyer, (Pogg. xii, 157); 2, Du Menil, (Schweig. J. lii, 364); 3, 4, 5, Rammelsberg, (Pogg. xlvii, 175); 6, Whitney, (Am. J. Sci. [2], xv, 435):

	$\dddot{S}i$	$\dot{C}a$	$\dddot{B}$	$\dot{H}$
1. *Datholite*, Andreasberg,	37·36	35·67	21·26	5·71=100, Stromeyer.
2. " "	38·51	35·59	21·34	4·60=100·04, Du Menil.
3. " "	38·477	35·640	20·315	5·568=100, Ramm.
4. " Arendal,	37·648	35·407	21·240	5·705=100, Ramm.
5. *Botryolite*, "	36·085	35·215	19·340	8·635=99·275, Ramm.
6. *Datholite*, I. Royal,	37·64	34·68	21·88(loss)	5·80, $\dddot{M}n$ *tr.*=100, Whitney.

In a matrass affords water; becomes friable in the flame of a candle. B.B. on charcoal becomes opaque, intumesces, and melts to a glassy globule, coloring the flame more or less green. Dissolves readily with borax to a clear glass, and leaves a siliceous skeleton with salt of phosphorus. With cobalt solution affords a blue glass. Dissolves readily and gelatinizes with nitric acid.

Datholite is found in amygdaloid and gneiss; sometimes also in beds of iron ore in primitive rocks. In the latter situation both varieties are found in Arendal in Norway; in agate balls at the Seisser Alp, in the Tyrol. Datholite is met with also in the valley of Glen Farg, Perthshire and Salisbury Craigs; at Utö, Sweden, at Andreasberg, near Wolfstein in Rhenish Bavaria. At Mount Catini, Tuscany, and Toggiana, in Modena; crystals large and transparent.

Occurs crystallized and massive at the Rocky Hill quarry, Hartford, Conn., in the northeast part of Southington, near Mr. Hamlen's, in amygdaloid, both in crystals, fibrous and massive; also in Berlin, near Kensington; in the northwest part of Meriden and at Middlefield Falls, Conn. The best specimens in Connecticut come from Roaring Brook, fourteen miles from New Haven, where the crystals (f. 489, 493) are sometimes half an inch long, and nearly pellucid; the author obtained from a transparent crystal of this locality $I : I = 115° \; 12'$, giving by calculation for $i\breve{2} : i\breve{2}$ $76° \; 28'$. The plane *s*, is not quite even, and is often unpolished. It replaces edge $2\breve{i} : I$; its intersections with $6\bar{3}$ and 4 are not parallel, nor is the intersection with $6\bar{3}$ parallel to that of $6\bar{3}$ and $6\breve{i}$, hence it is probably the plane $\frac{16}{3} \frac{\bar{8}}{5}$. Planes $8\breve{2}$ and $i\breve{2}$ of the Roaring Brook crystals are unpolished. The angles of the form $\frac{16}{3} \frac{\bar{8}}{5}$ are $X = 139° \; 26'$, $Y = 57° \; 8'$, $Z = 141° \; 32'$. Bergen Hill, N. J., has afforded fine specimens, and Patterson, specimens of less interest. Occurs sparingly at Piermont, N. Y. At the hill near Copper Falls, south shore of Lake Superior, it occurs in amygdaloid, and the crystals often include native copper, and are sometimes amethystine in color; also on the south shore of Isle Royal in fine crystals; fig. 490, 491 are from crystals in the cabinet of J. E. Teschemacher; plane $(\frac{6}{5} \frac{\bar{4}}{3})$ gives approximately O (bottom plane), on $t, = 140°–142°$, $i\breve{i}$; $t = 109° \; 30'$, which are near the angles of plane ; but the $2\breve{2}$ intersections of t with 2 and $2\breve{i}$ are not parallel, although those with $\frac{4}{3}$ and $4\breve{i}$ are parallel.

The crystallization of Datholite was shown to be trimetric by Brooke and Miller, a conclusion which the author's observations confirm.

ALLOPHANE, *Stromeyer*. Riemannite.

Reniform and massive; sometimes presenting traces of crystallization on the surface; occasionally almost pulverulent.

H.=3. G.=1·852—1·889. Lustre vitreous or resinous; splendent and waxy internally. Color pale-blue; sometimes green, brown, yellow, or colorless. Streak white. Translucent. Fracture conchoidal and shining. Very brittle.

Composition.—Analyses: 1, Stromeyer, (Unters. 308, and Gilb. Ann. liv, 120); 2, Walchner, (Schw. J. xlix, 154); 3, Guillemin, (Ann. Ch. Ph. xlii, 260); 4, Bunsen, (Pogg. xxxi, 53); 5, Berthier, (Ann. des M. [3], ix, 498); 6, B. Silliman, Jr., (Am. J. Sci., [2], vii, 417):

	$\dddot{\mathrm{Si}}$	$\ddot{\cancel{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{H}}$	$\dot{\mathrm{Cu}}$
1. Grafenthal,	21·92	32·20	41·30	—-$\dot{\mathrm{Cu}}\,\ddot{\mathrm{C}}$ 3·06, $\dot{\mathrm{Ca}}$ 0·73, Gyps. 0·52, $\ddot{\cancel{\mathrm{F}}}\mathrm{e}^3\dot{\mathrm{H}}^3$ 0·27=99·88, Strom.
2. Gersbach,	24·11	38·76	35·75	2·33=100·95, Walchner.
3. Fermi,	23·76	39·68	35·74	0·95=99·83, Guillemin.
4. Friesdorf,	21·05	30.37	40·23	—–, $\dot{\mathrm{Cu}}\ddot{\mathrm{C}}$ 2·39, $\ddot{\cancel{\mathrm{F}}}\mathrm{e}$ 2·74, $\dot{\mathrm{Mg}}\ddot{\mathrm{C}}$ 2·06, B.
5. Beauvais,	21·90	29·20	44·20	—–, Clay 4·7=100, Berthier.
6. Richmond, Ms.	22·65	38·77	35·24	—–, $\dot{\mathrm{Mg}}$ 2·83=99·49, Silliman, Jr.

The formula from analyses 2, 3, and 6, is $\ddot{\cancel{\mathrm{A}}}\mathrm{l}^3\dddot{\mathrm{Si}}^2 + 15\dot{\mathrm{H}}$=Silica 24·22, alumina 40·39, water, 35·39; from 1 the same except $20\dot{\mathrm{H}}$ in place of $15\dot{\mathrm{H}}$.

In a matrass yields water. B.B. speedily deprived of color, and rendered pulverulent, causing some intumescence, and tinging the flame green. Does not fuse alone, but with borax melts readily to a transparent and nearly colorless glass. A jelly with acids.

Allophane occurs lining irregular cavities in a kind of marl, at Saalfield in Thuringia, at Schneeberg in Saxony, Visé in Belgium, and elsewhere. The specimens analyzed by Berthier occur abundantly in the chalk of Beauvais, France; they present a honey-yellow color. It was first observed by Messrs. Riemann and Roepert, and hence has been called *Riemannite.* The first analysis and description were made by Hoffmann and Stromeyer, in 1816. In the United States it occurs with gibbsite at Richmond, Mass., forming a hyaline crust, scaly or compact in structure, and brittle; also at the Bristol Copper Mine, Conn.

Named from ἄλλος, *other*, and φαίνω, *to appear*, in allusion to its change of appearance under the blowpipe.

A yellowish white earthy mineral from Kornwestheim between Stuttgart and Ludwidsburg, with G.=1·794 and 2·098 consists of allophane and aluminite in combination, and is called *Kiesel-aluminite* (*Siliceous aluminite*) by Groningen and Oppel. For their analyses, see Lieb. u. Kopp's Jahersb. 1852, 893, from Württemb. Nat. Jahreshefte, 1851, 189.

SCHRÖTTERITE, *Glocker.* Opal Allophane.

Resembles Allophane. H.=3—3·5. G.=1·95—2·05. Color greenish, yellowish, or at times spotted with brown.

Composition.—$\dddot{\bar{\text{Al}}}{}^4\dddot{\text{Si}}+3\dot{\text{H}}$=Silica 11·2, alumina 49·7, water 39·2. Analyses by Schrötter, (J. f. pr. Chem., xi, 380):

	$\dddot{\text{Si}}$	$\dddot{\bar{\text{Al}}}$	$\dot{\text{H}}$	$\dddot{\bar{\text{Fe}}}$	$\dot{\text{Ca}}$	$\dot{\text{Cu}}$	$\dot{\text{H}}$
1.	11·95	46·30	36·20	2·95	1·30	0·25	0·78=99·73.
2.	11·93	46·28	35·50	2·66	1·03	0·25	0·48=98·14.

Soluble in the acids. B.B. acts like allophane, but burns white.

From Dollinger mountain, near Freienstein, in Styria, in nests between clay-slate and granular limestone.

Appendix to Hydrous Silicates.

CHLOROPAL, *Bernhardi* and *Brandes*, Schweigger's J. xxxv, 29. Nontronite, *Berthier.* Pinguite.

Compact massive, with an opal-like appearance; earthy.

H.=2—3. G.=1·727, 1·870, earthy varieties, the second a conchoidal specimen; 2·105, Thomson, a Ceylon chloropal. Color greenish-yellow and pistachio-green. Opaque—subtransparent. Fragile. Fracture conchoidal and splintery.

Composition.—$\dddot{\bar{\text{Fe}}}\dddot{\text{Si}}{}^2+3\dot{\text{H}}$=Silica 45·9, peroxyd of iron 40·5, water 13·7=100, Kobell. Related to the hydrous silicates of alumina, especially *Halloysite*, pp. 283, 284. Analyses: 1, 2, Bernhardi and Brandes, (loc. cit.); 3, Berthier, (Ann. Ch. Phys. xxxv, 92); 4, Dufrénoy, (Ann. d. M. [3], iii, 393); 5, Jacquelin, (Ann. Ch. Phys. xlvi, 101); 6, Biewend, (J. f. pr. Chem. xi, 162); 7, H. Müller; 8, E. Uricoechea, (7, 8, communicated to the author by E. U.); 9, Kersten, (Schw. J. lxvi, 9):

	$\dddot{\text{Si}}$	$\dddot{\bar{\text{Fe}}}$	$\dddot{\bar{\text{Al}}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$
1. Hungary, *compact*,	46·	33·	1·	2·	18=100, Bernhardi & Brandes.
2. " *earthy*,	45·00	32·00	0·75	2·00	20·00=99·75, B. & Brandes.
3. Nontron, *Nontronite*,	44·0	29·0	3·6	2·1	18·7, clay 0·1=97·5, Berthier.
4. Villefrance, "	40·68	30·19	3·96	2·37	23·00=100·20, Dufrénoy.

		$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Fe}}}$	$\bar{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
5.	Montmort, *Nontronite,*	41·31	35·69	3·31	——	18·63, $\dot{\mathrm{Ca}}$ 0·19, $\dot{\mathrm{Cu}}$ 0·9=100·3, J.
6.	Andreasberg, "	41·10	37·30	——	——	21·56=99·86, Biewend.
7.	Tirschenreuth, "	47·1	35·75	7·15	*tr.*	10·00=100, Müller.
8.	" "	47·59	42·49		0·13[a]	9·79=100, Uricoechea.
9.	Wolfenstein, *Pinguite,*	36·90	29·50	1·80	0·45	25·10, $\dot{\mathrm{Fe}}$ 6·10 $\bar{\dddot{\mathrm{Mn}}}$ 0·15=100, Kerst.

[a] With some potash.

Kobell found, after expelling the water,

1.	Haar,	$\dddot{\mathrm{Si}}$ 52·10	$\bar{\dddot{\mathrm{Fe}}}$ 40·60	$\bar{\dddot{\mathrm{Al}}}$ 3·00	$\dot{\mathrm{Ca}}$ 1·60	$\dot{\mathrm{Mg}}$ 1·08=98·38.
2.	Hungary,	52·33	43·34	2·32	0·93	0·73=99·65.

The chemist does not consider all the water in chemical combination.

B.B. infusible, but becomes black and then brown. With the fluxes gives an iron reaction. Partially dissolved in muriatic acid. Nontronite gelatinizes.

From Hungary. Described as breaking readily into a kind of parallelopiped, the upper end and two adjoining lateral edges of which have the opposite magnetic pole from the lower end and the other two edges.

The *Pinguite* affords the formula $\dot{\mathrm{Fe}}\,\dddot{\mathrm{Si}}+\bar{\dddot{\mathrm{Fe}}}^2\dddot{\mathrm{Si}}^3+15\dot{\mathrm{H}}$. It has a greasy feel. G.=2·3—2·35.

A mineral from Ceylon, resembling chloropal, afforded Thomson, (Min. i, 464):

$\dddot{\mathrm{Si}}$ 53·00, $\bar{\dddot{\mathrm{Fe}}}$ 26·04, $\bar{\dddot{\mathrm{Al}}}$ 1·80, $\dot{\mathrm{Mg}}$ 1·40, $\dot{\mathrm{H}}$ 18·00=100·24.

COLLYRITE. Kollyrite, *Freisleben.* Scarbroite.

Collyrite is a clay-like compound, white, with a glimmering lustre, greasy feel and adhesive to the tongue. G.=2—2·15. H.=1—2. B.B. infusible. Gelatinizes with nitric acid. From Ezquerra in the Pyrenees, in porphyry near Schemnitz, Hungary, near Wessenfels, Saxony. *Scarbroite* from the coast of Scarborough is related to Collyrite. G.=1·48. Does not fall to pieces in water or increase in weight.

Analyses: 1, Klaproth, (Beit. i, 257); 2, Berthier, (Ann.d. M. ii, 476); 3, Kersten, (Schw. J. lxi, 24); 4, Vernon, (Phil. Mag. and Ann. v, 178):

		$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\bar{\dddot{\mathrm{Fe}}}$	$\dot{\mathrm{H}}$
1.	*Collyrite,* Schemnitz,	14·0	45·0	——	42·0=101, Klaproth.
2.	" Ezquerra,	15·0	44·5	——	40·5=100, Berthier.
3.	" Saxony,	23·3	42·8	——	34·7=100·8, Kersten.
4.	*Scarbroite,*	10·50	42·50	0·25	46·75=100, Vernon.

The formula $\bar{\dddot{\mathrm{Al}}}^3\dddot{\mathrm{Si}}+15\dot{\mathrm{H}}$ has been written for Collyrite.

Dillnite is a related substance, white and firm, (H.=3·5), or earthy, (H.=1·8—2), G.=2·574—2·835. It is the gangue of the diaspore of Schemnitz. Analyses by Hutzelmann and Karafiat, (Pogg. lxxviii, 575):

1.	$\dddot{\mathrm{Si}}$ 22·40	$\bar{\dddot{\mathrm{Al}}}$ 56·40	$\dot{\mathrm{Ca}}$ *tr.*	$\dot{\mathrm{Mg}}$ 0·44	$\dot{\mathrm{H}}$ 21·13, $\dot{\mathrm{Fe}}$, $\dot{\mathrm{Mn}}$, alk. *tr.*=100·37. H.
2.	23·53	53·00	0·88	1·76	20·05=99·22, Karafiat.

The analyses correspond to the formula $\bar{\dddot{\mathrm{Al}}}^2\dddot{\mathrm{Si}}+4\frac{1}{2}\dot{\mathrm{H}}$=Silica 24·39, alumina 54·23, $\dot{\mathrm{H}}$ 21·38. Dr. J. L. Smith obtained a very different result for a similar material from the same Schemnitz locality, as given under Pholerite, (q. v.)

WOLCHONSKOITE.

Amorphous. Dull—shining. Color bluish-green, passing into grass-green. Streak bluish-green and shining. Feel resinous. Polished by the nail. Fracture subconchoidal. Adheres slightly to the tongue. Very fragile.

Composition.—Considered an impure hydrated silicate of chrome. Analyses: 1, Berthier, (Mem. ii, 263); 2, Kersten, (Pogg. xlvii, 489); 3, Ilimoff, (Ann. Jour. Mines de Russie, 1842, 366); 4, Bechi, (Am. J. Sci. [2], xiv, 62):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Cr}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Mn}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
1.	27·2	34·0	7·2	——	——	7·2	23·2=98·8, Berthier.
2.	37·01	17·93	10·43	6·47	1·66	1·91	21·84, $\dot{\mathrm{P}}$b 1·01, $\dot{\mathrm{K}}$ *trace*=98·26, Kers.
3·	30·06	31·24	9·39	3·09	——	6·50	12·40, $\dot{\mathrm{C}}$a 1·90, $\dot{\mathrm{P}}$b 0·16=100·74, Ilim.
4.	28·36	8·11	——	41·33	——	——	22·75=100·55, Bechi.

Gelatinizes with hot concentrated muriatic acid, in which half the chromium is dissolved, the rest remains in union with silica. Ilimoff gives 94·74 as the sum of his results. Should 6·50 $\dot{\mathrm{Mg}}$ be 0·50 $\dot{\mathrm{Mg}}$? From Okhansk in Siberia; and a related compound (analysis 4) from Volterra, Tuscany.

CHROME OCHRE.

A clayey material, containing some oxyd of chrome, allied to the preceding. Occurs earthy of a bright green shade of color.

Analyses: 1, Drappier; 2, Duflos, (Schw. J. lxii, 251); 3, Zellner, (Isis, 1834, 637); 4, Wolff, (J. f. pr. Chem. xxxiv, 202):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Cr}}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{H}}$
1. Creuzat, Fr.	64·0	10·5	23·0	——	—— $\dot{\mathrm{C}}$a and $\dot{\mathrm{Mg}}$ 2·5=100, Drappier.
2. Halle,	57·00	5·50	22·50	3·50	11·00=99·50, Duflos.
3. Silesia,	58·50	2·00	30·00	3·00	6·25=99·75, Zellner.
4. Halle,	46·11	4·28	30·53	3·15	12·52, $\dot{\mathrm{K}}$3·44, $\dot{\mathrm{N}}$a0·46=100·49, W. G.=2·701.

The formula ($\dddot{\bar{\mathrm{Al}}}$, $\dddot{\bar{\mathrm{Cr}}}$ $\dddot{\bar{\mathrm{Fe}}}$)$\dddot{\mathrm{Si}}^2$ corresponds nearly to the composition. Wolff's analysis, (No. 4), gives ($\dddot{\bar{\mathrm{Al}}}$, $\dddot{\bar{\mathrm{Cr}}}$)$^3\dddot{\mathrm{Si}}^4+4\dot{\mathrm{H}}$, which is the constitution of a kaolin. It is probably not a true chemical compound.

Chrome ochre occurs at the localities above mentioned; also on Unst in Zetland, Mortenberg in Sweden, and elsewhere.

Miloschin, Herder. *Serbian,* Breit.—Another chromiferous compact mineral, probably a mechanical mixture. Color indigo-blue to celandine-green. H.=2. G.=2·13.

Composition.—Approaches ($\dddot{\bar{\mathrm{Al}}}$, $\dddot{\bar{\mathrm{Cr}}}$)$^3\dddot{\mathrm{Si}}^2+9\dot{\mathrm{H}}$. Analysis by Kersten, (Pogg. xlvii, 485): $\dddot{\mathrm{Si}}$ 27·50, $\dddot{\bar{\mathrm{Al}}}$ 45·01, $\dddot{\bar{\mathrm{Cr}}}$ 3·61, $\dot{\mathrm{C}}$a 0·30, $\dot{\mathrm{Mg}}$ 0·20, $\dot{\mathrm{H}}$ 23·30=99·92.

In a matrass yields water. B.B. infusible. Partly dissolved in muriatic acid.

From Rudniak in Servia, associated with quartz and brown iron ore.

PIMELITE, *Karsten.* Alizite, *Glocker.*

Massive, or earthy. H.=2·5. G.=2·23—2·3: 2·71—2·76, Baer; 1·44—1·46, (alizite), Schmidt. Lustre weak, greasy. Color apple-green. Streak greenish-white. Translucent to subtranslucent. Feel greasy. Does not adhere to the tongue.

Composition.—Analyses: 1, Klaproth, (Beit. ii, 134); 2, Schmidt; 3, W. Baer, (J. f. pr. Ch. lv, 49):

	$\dddot{Si}$	$\dot{Ni}$	$\dot{Mg}$	$\dddot{\bar{F}}e$	$\dot{Ca}$	$\ddot{\bar{A}}l$	$\dot{H}$
1. *Chrysoprase earth,*	35·00	15·63	1·25	4·58	0·42	5·00	38.12, Klaproth.
2. *Alizite,*	54·63	32·66	5·89	$\dot{F}e$1·13	0·16	0·30	5·23=100, Schmidt.
3. *Hard Pimelite,*	35·80	2·78	14·66	$\dddot{\bar{F}}e$2·69		23·04	31·03=100, Baer.

The second corresponds nearly to the oxygen ratio, for the protoxyds, silica and water : 1 : 3 : ½; the third for the protoxyds, peroxyds, silica and water, : 1 : 2 : 3 ; 3.

From Silesia and elsewhere.

MONTMORILLONITE, *Salvetat.*

Rose-red; fragile. From Montmorillon; Confolens in Charente; and near St. Jean de Colle, in Dordogne.

Smectite, Breithaupt, is from Cilley in Lower Styria, and Zeug in Croatia. Supposed formula $\ddot{\bar{A}}l\,\ddot{Si}^3+6\dot{H}$.

Malthacite of Breithaupt, (J. f. pr. Ch. x, 510). In thin plates and massive; soft like wax. G.=1·99—2·01; white or yellowish, and translucent. From basalt at Steindorfel, and greenstone near Beraun in Bohemia. Analyses: 1, Damour, (Bull. Soc. Geol. de Fr. [2], iv, 464); 2, L. A. Jordan, (Pogg. lxxvii, 591); 3, Meissner, (J. f. pr. Ch. x, 510):

	$\ddot{Si}$	$\ddot{\bar{A}}l$	$\dddot{\bar{F}}e$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\dot{H}$
1. *Montmorillonite,*	50·04	20·16	0·68	1·46	0·23	1·27	26·0=99·84, Damour.
2. *Smectite,*	51·21	12·25	2·07	2·13	4·89	—	27·89, Jordan.
3. *Malthacite,*	50·2	10·7	3·1	0·2	—	—	35·8, Meissner.

Razoumoffskin of John, is another clayey or halloysite-like substance from Kosemuth in Silesia. Zellner obtained $\ddot{Si}$ 54·50, $\ddot{\bar{A}}l$ 27·25, $\dot{Ca}$ 2·00, $\dot{Mg}$ 0·37, $\dot{Fe}$ 0·25, $\dot{H}$ 14·25=98·62.

ERDMANNITE, *Berlin,* Pogg. lxxxviii, 160.

In imbedded grains and folia: with no traces of crystallization. G.=3·1. Lustre vitreous. Color dark-brown. In thin splinters. Translucent.

Composition.—Analysis by Blomstrand, of half a gramme, (loc. cit.):

$\dddot{Si}$	Ox. Ce & La	$\ddot{\bar{A}}l$	$\dot{Ca}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Y}$	$\dot{H}$ and loss
31·85	34·89	11·71	6·46	8·52	0·86	1·43	4·28

From the island Stokö in the Langesundfiord, near Brevig. Named in honor of M. Erdmann.

BARALITE.

Massive, and cellular.

H.=4. Lustre glimmering. Color greeenish-black. Opaque. Streak grayish-green.

Composition.—Contains silica, alumina, peroxyd of iron, lime, magnesia and water.

B.B. alone infusible; with borax, a glass colored by iron; with soda partly dissolved. Wholly soluble in muriatic acid. In a tube yields pure water, and becomes brownish.

UNARRANGED SILICATES CONTAINING TITANIC ACID.

The species here included, may perhaps be arranged in some of the groups of silicates, when their composition is better understood. In sphene, a silicate of the same kind, we have pointed out a close relation to the ordinary silicates, the titanic acid acting as a base. The same appears to be true in Keilhauite, which may prove, as we show, to be related to sphene. The other species may have similar relations to some of the anhydrous silicates. The following are suggested as probably the general formulas under which the species fall.

1. Keilhauite,	$(\dot{R}^3, \dddot{\bar{R}})\dddot{Si}^{\frac{2}{3}}$ (like sphene).
2. Tscheffkinite,	$(\dot{R}^3, \dddot{\bar{R}})\ \dddot{Si}^{\frac{2}{3}}$ "
3. Schorlomite,	$(\dot{R}^3, \dddot{\bar{R}})\ \dddot{Si}^{\frac{1}{2}}$.
4. Mosandrite,	$(\dot{R}^3, \dddot{\bar{R}})\ \dddot{Si}+aq$.
5. Wöhlerite,	$(\dot{R}^3, \dddot{\bar{R}})\ \dddot{Si}$.

KEILHAUITE, *A. Erdmann*, K. V. Ac. H. 1844. Yttrotitanite, *Scheerer*, Pogg. lxiii, 459.

Trimetric? $I : I = 122° 30'$, Greg. Cleavage: I, perfect. Also massive.

H.=6·5. G.=3·69. Lustre vitreous to resinous. Brownish-black; in splinters brownish-red and translucent. Streak-powder grayish-brown.

Composition.—Analyses by Erdmann, (loc. cit.):

	$\dddot{Si}$	$\ddot{Ti}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dddot{\bar{Mn}}$	$\dddot{\bar{Ce}}$	$\dot{Ca}$	$\dot{Y}$
1.	30·00	29·01	6·09	6·35	0·67	0·32	18·92	9·62=100·98.
2.	29·45	28·14	5·90	6·48	0·86	0·63	18·68	9·64=99·88.

The oxygen ratio between the bases and silica (reckoning $\ddot{Ti}$ with the former, as in sphene) is very closely 3 : 2, the sphene ratio; and the formula may consequently be $\dddot{\bar{R}}\dddot{Si}^{\frac{2}{3}}$ or $(\dot{R}^3,\dddot{\bar{R}})\dddot{Si}^{\frac{2}{3}}$. The lime ($\dot{Ca}$) united with the $\ddot{Ti}$ is equivalent to a peroxyd (that is $TiO^2+CaO=R^2O^3=\dddot{\bar{R}}$). Erdmann writes the formula $3\dot{Ca}^3\dddot{Si}^2+\dddot{\bar{R}}\dddot{Si}+\dot{Y}\ddot{Ti}^3$, in which the three members have the widely unlike oxygen ratios, 2 : 1, 1 :1, 1 : 3.

B.B. fuses with intumescence easily to a black shining slag. Yields an iron-colored glass with borax, which in the inner flame becomes blood-red. With salt of phosphorus gives an iron color and a silica skeleton, and in the inner flame a violet pearl. Reaction of manganese with soda. In powder wholly dissolved in muriatic acid.

Occurs about one and a half miles from Arendal, Norway, in a feldspathic rock. R. P. Greg, Jun., has a non-terminated crystal two inches long.

TSCHEFFKINITE, *G. Rose*, Reise n. d. Ural.

Massive, amorphous.

H.=5·5. G.=4·508—4·549, G. Rose; 4·5296, H. Rose, and in powder 4·615. Lustre vitreous. Color velvet-black. Streak dark brown. Subtranslucent to opaque.

Analyses by H. Rose, (Pogg. lxii, 591):

$\dddot{\mathrm{Si}}$	$\ddot{\mathrm{Ti}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Fe}}$	Ox. Ce, La, D	$\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$
21·04	20·17	3·50	0·22	0·83	11·21	47·29	0·12=104·38.

The excess in the analysis is owing to the oxydation of the cerium from the state of protoxyd. The titanic acid is supposed still to contain some glucina, alumina, and yttria. The oxygen ratio leads to the probable formula $(\dot{\mathrm{R}}^3, \dddot{\bar{\mathrm{R}}})\,\dddot{\mathrm{Si}}^{\frac{2}{3}}$.

B.B. intumesces very much, becomes a porous mass; in a stronger heat becomes yellow, but does not fuse except in the strongest heat, when it forms a black glass.

Gelatinizes readily on heating in muriatic acid.

From the Ilmen Mountains, Siberia.

SCHORLOMITE, *Shepard,* Am. J. Sci. 2d Ser. ii, 251.

Massive without cleavage.

H.=7—7·5. G.=3·862, Shepard; 3·807, Whitney; 3·783 in coarse powder, Rammelsberg. Color black, often tarnished blue and with pavonine tints; streak grayish-black, with a tinge of lavender-blue. Lustre vitreous. Fracture conchoidal.

Composition.—$\dot{\mathrm{Ca}}^3\,\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Fe}}}\,\dddot{\mathrm{Si}}+\dot{\mathrm{Ca}}\ddot{\mathrm{Ti}}^2$, Whitney=Silica 24·9, oxyd of iron 21·9, lime 30·7, titanic acid 22·5. If the $\ddot{\mathrm{Ti}}$ acts as a base, as in Sphene and Keilhauite, (it forming with $\dot{\mathrm{Ca}}$ an equivalent to a peroxyd), then we have in the above formula, $2\dddot{\mathrm{Si}}+2\,(\ddot{\mathrm{Ti}}+\dot{\mathrm{Ca}})+1\dddot{\bar{\mathrm{Fe}}}+2\dot{\mathrm{Ca}}$ which corresponds to $2\dddot{\mathrm{Si}}+3\dddot{\bar{\mathrm{R}}}+2\dot{\mathrm{Ca}}$. The oxygen ratio between the silica and bases is here 6 : 11. But if the silica be a little too high, the ratio may be 5½ : 11 or 1 : 2, which will afford the formula $2\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^{\frac{1}{2}}+3\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}^{\frac{1}{2}}$, or $(\frac{2}{5}\dot{\mathrm{R}}^3+\frac{3}{5}\dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}^{\,\frac{1}{2}}$=Silica 23·3, titanic acid 22·9, peroxyd of iron 22·4, lime 31·4=100. In Rammelsberg's analysis, the silica was determined only by the loss, and in two of the other analyses there was titanic acid remaining with the silica.

Analyses: 1, 2, Whitney, (Jour. Bost. Nat. Hist. Soc. 1849, vi, 46); 3, Rammelsberg, (J. f. pr Chem. lv, 488, former analysis revised); 4, Crossley, (this Min., 3d edit., 692):

	$\dddot{\mathrm{Si}}$	$\ddot{\mathrm{Ti}}$	$\dot{\mathrm{Ca}}$	$\dddot{\bar{\mathrm{Fe}}}$
1.	25·66	22·10	29·78	21·58=99·12, Whitney.
2.	27·89a	20·43	30·05	21·90=100·27, Whitney.
3.	25·24	22·34	29·38	20·11, $\dot{\mathrm{Mg}}$ 1·36, $\dot{\mathrm{Fe}}$ 1·57=100, Ramm.
4.	26·36[a]	21·56	30·72	22·00, " 1·25, $\dddot{\bar{\mathrm{Mn}}}$ *trace*=101·89, C.

a With some titanic acid.

In a matrass no water. B.B. in platinum forceps fuses on the edges with difficulty to a black mass. The pearl with borax is yellow in the outer flame, and becomes colorless on cooling, unless too much of the assay be used. Also a yellow glass with salt of phosphorus; with tin on charcoal in the inner flame the bead becomes violet.

In small masses with elæolite and brookite in the Ozark Mts., Magnet Cove, Arkansas.

MOSANDRITE. *Erdmann,* Jahresb. xxi, 178.

Monoclinic? In large flat prisms; lateral edges, replaced by planes *I*; also a summit dome, observed by Greg, giving $i\bar{\imath}$ on *I* by reflecting goniometer=147° 30′, $i\bar{\imath}$ on plane of dome=115° by common goniometer, angle of dome thence 130°. Also masssive and fibrous. Cleavage: in one direction distinct, in others indistinct.

H.=4. G.=2·93—2·98. Lustre of cleavage face between vitreous and greasy, of other surfaces resinous. Color dull greenish or reddish-brown. Streak-powder grayish-brown. Thin splinters translucent, bright red by transmitted light.

Composition.—Analysis by Berlin, (Pogg. 1853, 156):

$\dddot{\mathrm{Si}}$	$\ddot{\mathrm{Ti}}$	$\dot{\mathrm{Ce}}$, $\dot{\mathrm{La}}$ $\dot{\mathrm{D}}$	$\dddot{\mathrm{\bar{F}e}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
29·93	9·90	26·56	1·83	0·75	19·07	0·52	2·87	8·90=100·33.

There is some $\dddot{\mathrm{\bar{M}n}}$ with the $\dddot{\mathrm{\bar{F}e}}$. Reckoning the $\ddot{\mathrm{Ti}}$ with the bases, as forming part of a peroxyd, as in Sphene and Keilhauite, the oxygen ratio of the protoxyds, peroxyds, and silica, is nearly 1 : 2 : 3, or of bases and silica 1 : 1 (precisely 16·57 : 15·86); affording the formula $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+2\dddot{\mathrm{\bar{R}}}\dddot{\mathrm{Si}}+4\frac{1}{2}\dot{\mathrm{H}}$, or $(\frac{1}{3}\dot{\mathrm{R}}^3+\frac{2}{3}\dddot{\mathrm{\bar{R}}})\dddot{\mathrm{Si}}+1\frac{1}{2}\dot{\mathrm{H}}$. This excluding the water is the formula of epidote, to which the species may be related.

WÖHLERITE, *Scheerer*, Pogg. lix, 327, 1843.

Trimetric. $I : I = 90° 54'$, $O : 1\bar{i} = 144° 1'$, Descl.; $a : b : c = 0{\cdot}7261 : 1 : 1{\cdot}01583$.

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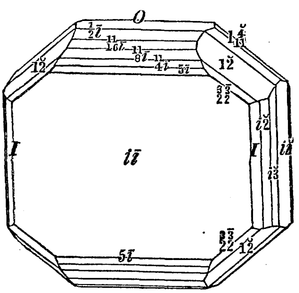

$O : \frac{1}{2}\bar{i} = 160° 3'$.
$O : \frac{11}{16}\bar{i} = 153° 29'$.
$O : \frac{11}{4}\bar{i} = 116° 37'$.
$O : 1\breve{2} = 141° 18'$.
$i\bar{i} : i\breve{2} = 116° 56'$.
$i\bar{i} : I = 135° 27'$.
$i\breve{2} : i\breve{2}$ (ov. $i\breve{i}$) $= 126° 9'$.
$i\breve{3} : i\breve{3}$ (ov. $i\breve{i}$) $= 142° 34'$.
$\frac{1}{2}\bar{i} : \frac{1}{2}\bar{i}$ (ov. O) $= 140° 6'$.

In tabular crystals and prisms: Cleavage: distinct in one direction. Also granular.

H.=5·5. G.=3·41. Lustre vitreous, inclining to resinous. Color light-yellow, wine-, honey-, resin-yellow, brownish, grayish; streak-powder yellowish-white. Transparent — subtranslucent. Fracture more or less conchoidal—splintery.

Composition.—$6\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+3\dddot{\mathrm{\bar{Z}r}}\dddot{\mathrm{Si}}+\ddot{\mathrm{Cb}}\dddot{\mathrm{Si}}=(\frac{6}{10}\dot{\mathrm{R}}^3+\frac{3}{10}\dddot{\mathrm{\bar{Z}r}}+\frac{1}{10}\ddot{\mathrm{Cb}})\dddot{\mathrm{Si}}$=(*if* $\dot{\mathrm{Ca}} : \dot{\mathrm{Na}} = 7 : 2$). Silica 31·2, columbic acid 14·3, zirconia 18·9, lime 27·0, soda 8·6=100. Scheerer writes the formula $\dddot{\mathrm{\bar{Z}r}}^3\ddot{\mathrm{Cb}}+5(\dot{\mathrm{Na}}\dddot{\mathrm{Si}}+\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}})$ which is hardly as near the analyses, and has for its three members the unlike oxygen ratios 1 : 1, 1 : 3, 3 : 1.

If in the above, the $\ddot{\mathrm{Cb}}$ be united with the peroxyds, the ratio of $\dot{\mathrm{R}}^3$ to $\dddot{\mathrm{\bar{R}}}$ will be 3 : 2 and the formula will be essentially that of some Idocrase and Allanite.

Scheerer obtained in his analysis,

$\dddot{\mathrm{Si}}$ 30·62, $\ddot{\mathrm{Cb}}$ 14·47, $\dddot{\mathrm{\bar{Z}r}}$ 15·17, $\dddot{\mathrm{\bar{F}e}}$ 2·12, $\dot{\mathrm{Mn}}$ 1·55, $\dot{\mathrm{Ca}}$ 26·19, $\dot{\mathrm{Na}}$ 7·78, $\dot{\mathrm{H}}$ 0·24=98·14,

with perhaps traces of cerium, and 0·4 of magnesia.

Dissolves easily when heated in strong muriatic acid, with a separation of the silica and columbic acid. B.B. in a strong heat fuses to a yellowish glass. With the fluxes, gives the reaction of manganese, iron, and silica.

Wöhlerite occurs with elæolite in zircon syenite, on an island of the Langesundfjord, near Brevig, in Norway. Some crystals are nearly an inch long.

Eukolite, *Scheerer*, Jahresb. xxv, 375, and Pogg. Ann. lxxii, 561). In reniform masses. Color brown. Resembles wöhlerite. G.=3·01.

Composition.—Analysis by Scheerer, (loc. cit.): $\dddot{\mathrm{Si}}$ 47·85, met. acids and some $\dddot{\mathrm{\bar{Z}r}}$ 14·05, $\dddot{\mathrm{\bar{F}e}}$ 8·24, $\dot{\mathrm{Ca}}$ 12·06, $\dot{\mathrm{Ce}}$ 2·98, $\dot{\mathrm{Na}}$ 12·31, $\dot{\mathrm{Mn}}$ 1·94, $\dot{\mathrm{Mg}}$ *trace.* $\dot{\mathrm{H}}$ 0·94=100·37. Scheerer considers it a wöhlerite, in which the zirconia is replaced by peroxyd of iron. From Rödkindholm near Fredericksvärn, Norway; also near Brevig.

II. TANTALATES, COLUMBATES,* TITANATES,† TUNGSTATES, MOLYBDATES, VANADATES, CHROMATES.

I. PYROCHLORE GROUP. Monometric. Oxygen ratio 1 : 2.

Perofskite, $\dot{C}a\ \ddot{T}i$. ?Pyrrhite.

Pyrochlore, $\dot{R}^3\ \ddot{T}a^2$.

II. SCHEELITE GROUP. Dimetric. Oxygen ratio of bases and acid, 1 : 3.

Scheelite, $\dot{C}a\ \dddot{W}$. Wulfenite, $\dot{P}b\ \dddot{M}o$.

Scheeletine, $\dot{P}b\ \dddot{W}$. ?Azorite.

III. FERGUSONITE GROUP. Dimetric. Oxygen ratio of bases and acid, 2 : 1.

Fergusonite, $(\dot{Y}, \dot{C}e)^6\ddot{T}a$.

IV. TANTALITE GROUP. Trimetric. $I : I$=100°—102°.

Tantalite, $(\dot{F}e, \dot{M}n)\ (\ddot{T}a, \dddot{C}b)$. Samarskite.

Wolfram, $(\dot{F}e, \dot{M}n)\dddot{W}$. Mengite.

Columbite, $(\dot{F}e, \dot{M}n)^3\ \dddot{C}b^2$.

V. POLYMIGNITE GROUP. Trimetric. $I : I$=90° 30′ to 95°

Polymignyte, Æschynite.

Polycrase,

Appendix, Euxenite, Rutherfordite.

VI. YTTROTANTALITE GROUP. Oxygen ratio 1 : 1.

Yttrotantalite, $\dot{R}^3(\ddot{T}a, \dddot{W}, \ddot{\text{Ʉ}})$.

VII. VANADATES, CHROMATES.

Crocoisite, $\dot{P}b\ \dddot{C}r$.

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* The metal of the American Columbite was early named *Columbium*, by Hatchett, (in 1801); and as it is the same which Rose has since called niobium, Hatchett's name is here restored. See Phil. Mag. [4], vii, 461, June 1854.

† The relation of the Titanates to the Columbates, etc., are so close, and at the same time so imperfectly understood and the acids are so often combined in the same mineral, that the species are here arranged together, instead of making a separate head for the Titanates.

VAUQUELINITE,	$(\dot{C}u, \dot{P}b)^3\dddot{C}r^2$.
MELANOCHROITE,	$\dot{P}b^3\dddot{C}r^2$.
DECHENITE,	$\dot{P}b\dddot{V}$.
DESCLOIZITE,	$\dot{P}b^2\dddot{V}$.
VANADINITE,	$\dot{P}b^3\dddot{V}+\frac{1}{3}Pb\,Cl$.
VOLBORTHITE,	$(\dot{C}u, \dot{C}a)^4\dddot{V}+\dot{H}$.
ARÆOXENE,	

PEROFSKITE, *G. Rose*, Pogg. xlviii, 558.

Monometric. Observed planes: *O*, *I*, 1, 2, $i\frac{3}{2}$, $i\frac{4}{3}$, $i\frac{5}{4}$, $\frac{3}{2}\frac{3}{2}$, $\frac{9}{4}\frac{9}{4}$. Usual in cubes; f. 1, 15, 17, etc. Cleavage: cubic, tolerably perfect.

H.=5·5. G.=4·017. Lustre metallic-adamantine; less bright on a cleavage face. Color grayish to iron-black. Opaque—subtranslucent. Streak uncolored, grayish.

Composition.—$\dot{C}a\ddot{T}i$=Titanic acid 59·4, lime 40·6=100. Analyses; 1, Jacobson, (Pogg. lxii, 596); 2, Brooks, (ib.):

	$\ddot{T}i$	$\dot{C}a$	$\dot{M}g$	
1.	58·96	39·20	*trace*	$\dot{F}e$ and *trace* of $\dot{M}n$ 2·06=100·22, Jacobson.
2.	59·00	36·76	0·11	" " " 4·79=100·07, Brooks.

B.B. alone infusible. With salt of phosphorus and borax, the pulverized mineral forms a clear glass colored with titanium; with the former in the inner flame the globule, as long as it is heated, is grayish-green, but becomes of a violet-blue on cooling; in the outer flame, it is greenish-white while hot, and clear and colorless on cooling; slightly acted on by the acids.

Perofskite occurs in crystals or druses of crystals, the largest yet seen not over six lines in length. The forms have been studied by Descloizeaux, (Ann. Ch. Phys. xiii, 1845, 338). It is associated with crystallized chlorite, and magnetic iron in chlorite slate, at Achmatovsk, near Slatoust in the Ural. It is named in honor of von Perofski of St. Petersburg.

In Sphene, as has been shown, $(\dot{C}a+\ddot{T}i)$ is equivalent to a peroxyd; and in this view, Perofskite may be considered as related to Martite and Iserine, which are monometric.

PYROCHLORE. Brewst. Jour. vi, 358. Microlite, *Shepard.* Hydrochlore and Fluochlore, *Hermann.*

Monometric. Observed planes 1, *I*, 22, 33, *O*. In octahedrons; f. 11, 19, 41. Cleavage: octahedral, sometimes distinct, especially in the smaller crystals.

H.=5—5·5. G.=3·802, from Brevig, Berzelius; 4·32, from Miask, Rose; 4·203, Miask, Hermann; 4·203—4·221, from Fredericksvärn, Hayes. Lustre vitreous or resinous. Color pale honey-yellow, brown, dark reddish or blackish-brown. Subtranslucent—opaque. Fracture conchoidal.

Composition.—Analyses: 1, from Miask, 2, Brevig, 3, Fredericksvärn, Wöhler, (Pogg. xlviii, 83); 4, 5, Miask, Hermann, (J. f. pr. Chem. xxxi, 94,l, 188, 192); 6, 7, Fredericksvärn, A. A. Hayes, (Am. J. Sci., xlvi, 164); 8, *Microlite*, Shepard, (Am. J. Sci., xxxii, 338); 9, ib. Hayes, (ib. xlvi, 158):

	C̈b	T̈i	Ṁn	Ḟe	Ċa	Ẏ	Ċe	Ḣ	
1.	67·38	*tr.*	0·15	1·29	10·98	0·81	13·15^{c}	1·16,	Na 3·93, F 3·23, S̈n, Ṁg?=102·08, W.
2.	67·02	*tr.*	1·69	1·33	9·88	——	5·16^{c}	7·06,	Ü 4·60, S̈n, Ṁg, Ṅa *tr.*=97·80, W.
3.	——	62·75	2·75	F̈e 2·16	12·85	——	6·80^{d}	4·20,	Ü 5·18, S̈n 0·61, alk. *tr.*=97·25, W.
4.	62·25	2·23	*tr.*	5·11	13·54	0·70	3·09	0·50,	L̇a 2·00, Z̈r 5·57, K, Na, Li 3·72, F 3·0=101·71, Hermann.
5.	60·83	4·90	——	2·23	9·80	0·94	15·23^{a}	——	Ṁg 1·46, K 0·54, Na 2·69, F 2·21=100·83, Hermann.
6.	53·10	20·20	——	F̈ 2·35	19·45, oxyds of U, Mn, Pb, Sn, 1·20, ign. 0·80=97·10, H.				
7.	59·00^{b}	18·33	——	——	16·73, F̈e and Ü, etc. 0·70, Ṅa 5·63, ign. 0·80=101·19, H.				
8.	75·70	W⃛ Ẏ Ü 7·42, Ċa 14·84, Ḣ 2·04=100, Shepard. *Microlite.*							
9.	79·60	F̈e 0·99, ox. of U and Mn 2·21, Ċa 10·87, Pb 1·60, Sn 0·70=95·97, Hayes.							

a With oxyd of Lanthanum. b With some Lime and Titanic acid. c With Thoria. d Peroxyd of Cerium.

B.B. becomes pale brownish-yellow or lemon yellow, but retains its lustre, and fuses with great difficulty. With borax forms a reddish-yellow transparent globule in the oxydating flame, which, on flaming, becomes opaque; with more of the borax, becomes a white enamel. With salt of phosphorus dissolves completely, and at first, with some effervescence, forming a glass which in the outer flame is yellow while hot, but becomes grass-green on cooling.

Pyrochlore occurs imbedded in syenite at Fredericksvärn and Laurvig in Norway, associated with zircon, polymignite, and phosphate of yttria; also at Brevig with thorite, and at Ilmengebirge near Miask in Siberia.

Named by Berzelius, in allusion to its becoming yellowish-green under the blowpipe, from *πυρ, fire, χλωρος, green.*

Microlite (from the albite vein, Chesterfield, Mass., associated with red and green tourmaline) resembles pyrochlore closely, and is here referred by J. E. Teschemacher, (Am. J. Sci. xliii, 33). It presents the forms of f. 11, 19, and 41. H.=5·5. G.=5·405, Hayes. Colors pale-yellow to brown. The light colored crystals appear to be nearly pure columbate of lime.

PYRRHITE, *G. Rose*, Pogg. xlviii, 562.

Monometric; in octahedrons. Cleavage not observed.
H.=6. Lustre vitreous. Color orange-yellow. Subtranslucent.

Infusible. Small splinters blacken and color the flame deep yellow. Pulverized, it dissolves easily in borax or salt of phosphorus; adding largely of the fluxes, it forms a clear glass, which, with still more of the flux, becomes yellowish-green; with less, the glass remains colorless.

Pyrrhite was found by von Perofski of St. Petersburg, at Alabaschka, near Mursinsk, where it occurs in drusy feldspar cavities, containing also tables of lithia mica, crystals of albite, and white topaz. The largest crystal was but three lines long. The name is from *πυρρος, yellow.*

With this species J. E. Teschemacher identifies small orange-yellow octahedrons found with albite at the Azores. The crystals are a half to two lines long, and those of minute size are transparent.

According to chemical and blowpipe trials by A. A. Hayes, on specimens furnished him by Mr. Teschemacher, these crystals consist of columbate of zirconia, colored apparently by oxyds of iron, uranium, and manganese.

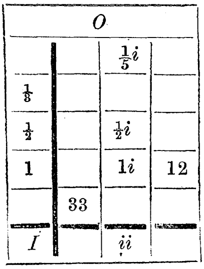
B.B. in the forceps, on the first impulse of the heat, becomes darker, and the fine orange color returns on cooling, even if the heat has been high; at the melting point of cast iron, in the reduction flame, the flame becomes permanently darker and brown. With borax (6 parts to 1 of assay) it dissolves and affords a clear colorless glass, which becomes instantly opaline or opaque on flaming; transferred to the oxydating flame becomes opaque. With salt of phosphorus (in the same proportion) in the inner flame gives a clear glass, and when reduced, the glass is green; but in the outer becomes yellow. With a little more of assay, the glass remains clear. With soda (12 parts to 1 of assay) dissolves; some clear portions are seen in the globule while hot, but on cooling, opacity precedes the crystallization of the globule; finally a gray-brown slag remains, which cooled from the outer flame, has a green color indicating oxyd of manganese. Decomposed by much soda, and the resulting mass heated with nitric acid, gives a heavy white insoluble powder, which with boiling water takes a white flocculent form; the powder exhibited all the characters of columbic (niobic) acid. The acid solution, when mixed with carbonate of ammonia, remains clear; heated, some oxyd of iron falls, and the fluid is light yellow; with oxalic acid, a white earth separates, which, heated with sulphuric acid to destroy the oxalic acid, dissolves, and the fluid forms with potash before complete neutralization, a white double salt, which has the characters of that from zirconia, but may also contain oxyd of cerium. The oxalate when first formed did not afford when heated the cinnamon-brown color characteristic of deutoxyd of cerium. The extremely small amount of the mineral under examination forbids the expression of certainty respecting the base. Although inclining to the opinion of the existence of cerium in the mineral, from the red color of the crystals, Mr. Hayes observes that he obtained no positive proof on this point.

SCHEELITE, *Leonh.* Tungstate of Lime. Tungsten. Scheelin calcaire, *H.* Schwerstein, *W.*

Dimetric; hemihedral in planes 12 and 33. *O* : 1*i*=123° 59′; *a*=1·4835.

O : 1=115° 29′. 1 : 1 (pyr.)=100° 40′. 1*i* : 1*i* (bas.)=112° 2′.
O : 33=102° 2′. 1 : 1 (bas.)=129° 2′. 1 : 1*i*=140° 20′.
O : 12=121° 5′. 1*i* : 1*i* (pyr.)=108° 12′. 12 : 1*i*=157° 21′.

Cleavage: 1, most distinct, 1*i*, interrupted, *O* traces. Twins: planes of composition *I* and *ii*. Also reniform with columnar structure; and massive granular.



O			
		$\frac{1}{5}i$	
$\frac{1}{8}$			
$\frac{1}{2}$		$\frac{1}{2}i$	
1		1*i*	12
	33		
I		*ii*	

Observed Planes.

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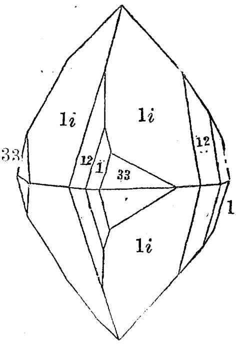

Schlackenwald.

H.=4·5—5. G.=6—6·076. Lustre vitreous, inclining to adamantine. Color white, inclining to yellow and brown; sometimes almost orange-yellow. Streak white. Subtransparent—translucent. Fracture uneven. Brittle.

Composition.—$\dot{Ca}\dddot{W}$=Lime 19·46, tungstic acid 80·6.

Analyses: 1, Klaproth, (Beit. iii, 44); 2, Berzelius, (Afh. i Fys. iv, 305); 3, 4, Brandes and Bucholz, (Schweig. xx, 285); 5, Choubine, (Ann. des M. Russ. 1841, 317); 6, Rammelsberg, (Pogg. lxxviii, 514); 7, Bowen, (Am. J. Sci. v, 118); 8, Domeyko, (Ann. d. M., [4], iii, 15); 9, Delesse, (Bull, Geol. Soc. [2], x, 17):

		$\dddot{W}$	$\dot{Ca}$	$\ddot{Si}$	$\overline{Fe}$	
1.	Cornwall,	75·25	18·70	1·50	1·25,	$\ddot{\overline{Mn}}$ 0·75=97·45, Klaproth.
2.	Westmannland, Sweden,	80·417	19·40	——	——	=99·817, Berzelius.
3.	Schlackenwald,	78·00	19·06	2·00	——	=99·06, B. and B.
4.	Zinnwald,	76·50	16·60	2·94	1·50,	$\dot{Ca}$ and $\dddot{\overline{Al}}$ 1·1=98·54, B. and B.
5.	Katherinenburg,	78·41	18·88			$\dot{Mg}$ 0·65=97·94, Ch.; G. 6·071.
6.	Neudorf,	78·64	21·56	——	——	=100·20, Ramm.; G. 6·03.
7.	Monroe, Ct.,	76·05	19·36	2·54	1·03,	$\ddot{\overline{Mn}}$ 0·31=99·29, Bowen.
8.	Coquimbo,	75·75	18·05	0·75	——	$\dot{Cu}$ 3·30=97·85, Domeyko.
9.	Framont,	80·35	19·40	——	——	=99·75, Delesse.

B.B. on charcoal, fuses on thin edges to a semi-transparent glass. Soluble with borax to a transparent glass, which afterwards becomes opaque and crystalline. With salt of phosphorus forms a glass, colorless in outer flame, in inner green when hot, and fine blue, cold. With tin the glass deepens in color and becomes green. In muriatic or nitric acid decomposed, leaving a yellow powder soluble in ammonia.

Tungstate of lime is usually associated with crystalline rocks, and is commonly found in connection with tin ore, topaz, fluor, apatite, molybdena, or wolfram, in quartz.

Occurs at Schlackenwald and Zinnwald in Bohemia; in fine crystals at Caldbeck Fell, near Keswick, with apatite, molybdena, and wolfram. Also at Schellgaden in Salzberg, Neudorf in the Hartz; Ehrenfriedersdorf in Saxony; Pösing in Hungary; Dalecarlia and Bitsberg in Sweden; Framont in the Vosges with pyrites in polished crystals giving Delesse for the angles of octahedron 1, 100° 5′ and 130° 31′, G.=6·05; and Coquimbo, Chili.

In the United States, crystallized and massive at Monroe and Huntington, Conn., at Lane's mine, with wolfram, pyrites, rutile, and native bismuth, in quartz.

ALTERED FORMS.—Occurs altered to Wolfram, a tungstate of iron and manganese, by the action of a solution of bicarbonate of iron and manganese, or perhaps mainly through sulphate of iron arising from the decomposition of pyrites.

SCHEELETINE, *Beud.* Tungstate of Lead. Stolzit, *Haid.* Scheelbleierz. Scheelsaures Blei. Scheelbleispath. Bleischeelat. Wolframbleierz.

Dimetric: *O* : 1*i*=122° 33′; *a*=1·567. Usual forms octahedral. Observed planes, 1, ½, 2, *I*, 1*i*; sometimes hemihedral in 1 and 1*i*.

O : ½=132° 4′. 1 : 1 (pyr.)=99° 44′. 1*i* : 1*i* (pyr.)=106° 50′.
O : 1=114° 17′. 1 : 1 (bas.)=131° 25′. 1*i* : 1*i* (bas.)=114° 54′.
O : 2=102° 42′. 2 : 2 (pyr.)=92° 46′.

Crystals often indistinctly aggregated. Cleavage: *O* imperfect; 1 still more so.

H.=2·75—3. G.=7·87—8·13. Lustre resinous, subadamantine. Color green, yellowish-gray, brown, and red. Streak uncolored. Faintly translucent.

Composition.—$\dot{Pb}\dddot{W}$=Tungstic acid 51, oxyd of lead 49.

Analyses: 1, Kerndt as the mean of two analyses of specimens from Zinnwald, (J. f. pr. Ch. xlii, 116); 2, E. J. Chapman, (Phil. Mag. [4], vi, 120):

1.	$\dddot{W}$ 51·736,	$\dot{Pb}$ 45·993,	$\dot{Ca}$ 1·397,	$\dot{Fe}$ & $\dot{Mn}$ 0·471,	Kerndt.
2.	59·50,	33·26,	6·37,	———	=99·13, Ch.

B.B. melts and gives off vapors of lead, leaving a dark colored submetallic crystalline globule, having a pale-gray streak. Soluble in nitric acid with a yellow precipitate.

Scheeletine occurs at Zinnwald in Bohemia, with quartz and mica; at Bleiberg in Carinthia, accompanying molybdate of lead; in Chili, probably near Coquimbo.

WULFENITE, *Haid.* Molybdate of Lead. Gelb-bleierz, *Wern.* Yellow Lead Ore. Bleigelb, *Haus.* Bleimolybdat.

Dimetric: sometimes hemihedral in 1, 1*i*, and *i* $\frac{3}{2}$. *O* : 1*i*=126° 26′; *a*=1·574. In modified square tables and octahedrons. *O* : 1=114° 12′. 1 : 1 (bas.)=131° 35′. $\frac{2}{3}i$: $\frac{2}{3}i$ (bas.)=92° 43′. 1 : 1 (pyr.)=99° 40′. 1*i* : 1*i* (pyr.)=106° 44′. $\frac{1}{2}i$: $\frac{1}{2}i$ (bas.)=76° 23′.

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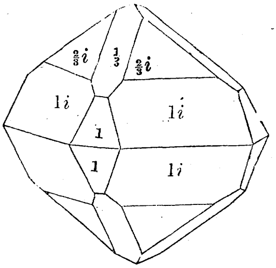

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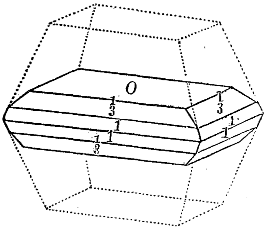
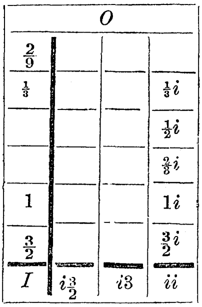


Phenixville.



Observed Planes.

Cleavage: 1 very smooth; *O* and $\frac{1}{3}$ much less distinct. Also granularly massive, coarse or fine, firmly coherent.

H.=2·75—3. G.=6·3—6·9. Lustre resinous or adamantine. Color wax-yellow, passing into orange-yellow; also siskin and olive-green, yellowish-gray, grayish-white, brown. Streak white. Subtransparent—subtranslucent. Fracture subconchoidal. Brittle.

Composition.—$\dot{Pb}\dddot{Mo}$=Molybdic acid 38·5, oxyd of lead 61·5. Analyses: 1, Göbel, (Schw. J. xxxvii, 71); 2, Melling, (Rammelsberg, 1st Supp. 59); 3, 4, Parry and J. Brown, (Proc. Phil. Soc. Glasgow, April, 1847); 5, C. Bergemann, (Pogg. lxxx, 400):

1. Carinthia,	$\dddot{Mo}$ 40·5	$\dot{Pb}$ 59·0=99·5,	Göbel.
2. "	40·293	61·903=102·196,	Melling.
3. "	39·30	60·35=99·65,	Parry.
4. "	39·19	60·23=99·42,	Brown.
5. Zacatecas,	37·65	62·35=100,	Bergemann.

A red variety contains a trace of *chromic acid.*

B.B. decrepitates briskly and becomes darker, and afterwards on cooling, the color disappears. On charcoal it fuses and is absorbed, leaving behind globules of metallic lead. With borax in the exterior flame, it fuses readily to a slightly colored glass; in the interior flame, the glass is transparent, but on cooling becomes all at once dark and opaque. Melts readily with salt of phosphorus, producing a green glass, when the proportion of the mineral is small, but black and opaque, if large.

This species occurs in veins in limestone with other ores of lead, at Swarzenbach, Bleiberg, and Windisch-Kappel in Carinthia. It is also met with at Retzbanya in Hungary, and at Moldawa in the Bannat, where its crystals are red and have considerable resemblance to chromate of lead.

It is found in small quantities at the Southampton lead mine, Mass., and in fine reddish orange crystals, containing a trace of chromic acid, at Wheatley's lead mine, near Phenixville, Pa., (fig. 2), and also in still thinner tables.

A molybdate of lead from Pamplona, S. A., afforded Boussingault, (Ann. Ch. Phys. xlv, 325), $\dot{P}b$ 73·8, $\dddot{M}o$ 10·0, $\ddot{C}$ 2·9, HCl 1·3, $\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 1·3, $\dddot{C}r$ 1·2, $\dddot{\bar{F}}e$ 1·7, $\dddot{\bar{A}}l$ 2·2, quartz 3·7=98·1. He considers it a basic salt with the formula $\dot{P}b^3\dddot{M}o$.

AZORITE, *J. E. Teschemacher*, Am. J. Sci. [2], iii, 32.

Dimetric. In minute octahedrons, somewhat shorter portionally than the regular octahedron, with the basal edges replaced; angle of pyramid (by reflective goniometer) 123° 15′, M : e=133° 40′, or near Zircon. Cleavage none.

H.=4—4·5. Translucent to opaque. White with a faint greenish-yellow tinge, or colorless. Vitreous in fracture.

Composition.—According to A. A. Hayes, columbate of lime. B.B. infusible; smaller crystals become opaque white; larger in outer flame reddish, and light yellow in inner. With borax, on platinum wire, dissolves with extreme slowness and difficulty to a transparent globule, sometimes faint greenish; with more borax opaque on flaming. With salt of phosphorus slowly dissolved, producing a faint green color.

From the Azores, in an albitic rock along with black tourmaline and pyrrhite. First distinguished and described by J. E. Teschemacher. The largest crystal seen was but 1½ lines in diameter. There is some resemblance in form to cryptolite, (p. 320), but a re-examination of the species by Mr. Hayes corroborates his first announcement that the mineral contains neither cerium nor phosphoric acid.

FERGUSONITE, *Haidinger*, Edinb. Trans. x, 274.

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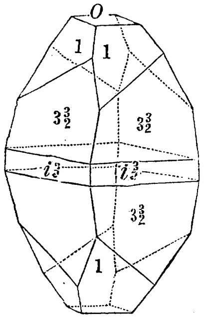


Dimetric, hemihedral. $O : 1i=124° 20′$; $a=1·464$. Observed planes as in the annexed figure. $O : 1=115° 46′$, $1 : 1=100° 54′$, and 128° 28′, $3\frac{3}{2} : 3\frac{3}{2}=91° 59′$, $i\frac{3}{2} : 3\frac{3}{2}=169° 17′$. Cleavage: 1, in distinct traces.

H.=5·5—6. G.=5·838, Allan; 5·800, Turner. Lustre externally dull, on the fracture brilliantly vitreous and submetallic. Color brownish-black; in thin scales, pale liver-brown. Streak pale brown. Subtranslucent—opaque. Fracture imperfect conchoidal.

Composition.—$(Y, \dot{C}e)^6 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{T}}a$. Analysis by Hartwall, (K. V. Ac. H., 1828, 167):

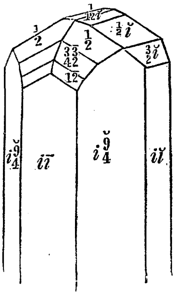
$\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{T}}a$ 47·75, $\dot{Y}$ 41·91, $\dot{C}e$ 4·68, $\dddot{\bar{Z}}r$ 3·02, $\ddot{S}n$ 1·00, $\dddot{\bar{U}}$ 0·95, $\dddot{\bar{F}}e$ 0·34=99·65.

B.B. infusible, but loses color; with borax fuses with difficulty, and forms a glass, which is yellow while hot, with some interspersed white spots of undissolved matter. With soda decomposed without solution, leaving a reddish slag; affords globules of tin.

Discovered by Gisècke, near Cape Farewell, in Greenland, disseminated in quartz, and named in honor of Robert Ferguson, of Raith.

TANTALITE, Ferro-tantalite. Columbate of Iron. Tamela-tantalite. Kimito-Tantalite. Kassiterotantal. Siderotantal.

499



Trimetric. Observed planes as in the figure. $I : I = 101° 32'$, $O : 1\bar{i} = 122° 3\frac{1}{2}'$; $a : b : c = 1{\cdot}5967 : 1 : 1{\cdot}2247$.

$O : \frac{1}{2}\breve{i} = 146° 54'$. $\frac{1}{2} : \frac{1}{2}$(adj.)$= 126°$.
$O : \frac{3}{2}\breve{i} = 117° 2'$. $1\bar{2} : 1\bar{2}$(adj.)$= 141° 48'$.
$O : \frac{1}{12}\breve{i} = 173° 49'$. $i\bar{i} : i\frac{9}{4} = 118° 33'$.
$i\bar{i} : 1\bar{2} = 143° 6\frac{1}{2}'$. $\frac{1}{2}\breve{i} : \frac{1}{2}\breve{i}(top)= 113° 48'$.
$i\bar{i} : \frac{1}{2} = 123° 45'$. $\frac{3}{2}\breve{i} : \frac{3}{2}\breve{i}(top)= 54° 4'$.
$i\bar{i} : \frac{3}{4}\bar{\frac{3}{2}} = 135° 4'$. $\frac{1}{12}\breve{i} : \frac{1}{12}\breve{i}(top)= 167° 38$.

Also massive.

H.=6—6·5. G.=7·1—7·963. Lustre nearly pure metallic. Color iron-black. Streak reddish-brown. Opaque. Brittle.

Composition.—($\dot{\text{Fe}}$, $\dot{\text{Mn}}$) ($\ddot{\text{Ta}}$, $\ddot{\text{Cb}}$). Analyses: 1, 2, Berzelius, (Schw. J. xvi, 259, 447, and xxxi, 374); 3, Nordenskiöld, (Jahresb. xii, 190); 4, Jacobson, (Pogg. lxiii, 317); 5, Brooks, (ib.); 6, Wornum, (ib.):

	$\ddot{\text{Ta}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\ddot{\text{Sn}}$	$\dot{\text{Cu}}$	$\dot{\text{Ca}}$
1. Kimito,	83·2	7·2	7·4	0·6	—	—=98·4, Berzelius.
2. "	85·67	12·93	1·61	0·80	—	0·56, $\ddot{\text{Si}}$ 0·72=102·29, Berzelius.
3. Tamela,	83·44	13·75	1·12	—	—	—=98·31, Nordenskiöld.
4. "	84·15	14·68	0·90	0·32	1·81	0·07=101·93, Jacobson. G.=7·197.
5. "	84·70	14·29	1·78	0·50	0·04	—=100·81, Brooks.
6. "	77·83	8·47	4·89	6·81	0·24	0·50=98·74, Wornum. G.=7·187.

The tantalite from Finbo and Broddbo (*cassiterotantalite* of Hausmann) contains much oxyd of tin as a mechanical mixture. Berzelius found—

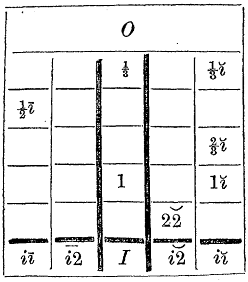
	$\ddot{\text{Ta}}$	$\dddot{\bar{\text{Fe}}}$	$\dddot{\bar{\text{Mn}}}$	$\ddot{\text{Sn}}$	$\dot{\text{Ca}}$
1. Finbo,	66·99	7·67	7·98	16·75	2·40=101·79.
2. Broddbo,	68·22	9·58	7·15	8·26	1·19, $\ddot{\text{W}}$ 6·19=100·59.
3. "	66·35	11·07	6·60	8·40	1·50, " 6·12=100·19.

Tantalite is confined mostly to albite, or oligoclase granite, and is usually associated with beryl. It occurs in Finland, both at Tamela and Kimito. In the Kamito tantalite, part of the iron is replaced by manganese. Near Harkasaari, tantalite is associated with rose quartz and gigantolite, in albitic granite. At Katiala it is associated with lithia mica, black tourmaline, and colorless beryl.

WOLFRAM, *M.* Tungstate of Iron. Tungstate of Iron and Manganese. Scheelate of Iron and Manganese. Scheelin Ferruginé, *H.*

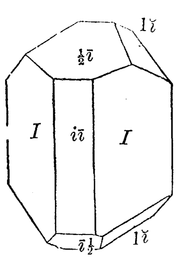
Trimetric. $I : I = 101° 5'$, Rose, (101° 45′, Kerndt, 101°, Descloizeaux), $I : i\bar{i} = 140° 32'$, $i\bar{i} : \frac{1}{2}\bar{i} = 117° 20'$, $1\breve{i} : 1\breve{i}$ (over the summit)$= 99° 12'$, $i\bar{i} : i\bar{2} = 157° 38'$. Crystals often monoclinic in habit, half of the planes $\frac{1}{3}$, 1, $\frac{1}{2}\bar{i}$, and $2\breve{2}$, being absent or much smaller than the other half. Cleavage: $i\breve{i}$ perfect, $i\bar{i}$ imperfect. Twins: planes of composition $i\bar{i}$, $\frac{2}{3}\breve{i}$, and rarely $\frac{1}{3}\breve{i}$. Also irregular lamellar; coarse divergent columnar; massive granular, the particles strongly coherent.

H.=5.—5·5. G.=7·1—7·55. Lustre submetallic. Color dark grayish or brownish-black. Streak dark reddish-brown. Opaque. Sometimes weak magnetic.



Observed Planes.

500



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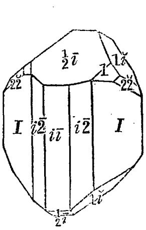

Composition.—$(\dot{Fe},\dot{Mn})\dddot{W}$; either $2\dot{Fe}\dddot{W}+3\dot{Mn}\dddot{W}$, or $4\dot{Fe}\,\dddot{W}+\dot{Mn}\dddot{W}$.

Analyses: 1, 2, Schaffgotsch, (Pogg. lii, 475); 3, Ebelmen, mean of two analyses, (Ann. Ch. Phys. [3], viii, 505); 4, Kussin, (Ramm. 3d Supp. 127); 5—10, Kerndt, (J. f. pr. Chem. xlii, 81); 11, R. Schneider, (J. f. pr. Chem. xlix, 322); 12, 13, Schaffgotsch, (loc. cit.); 14, Ebelmen, mean of 5 analyses, (loc cit.); 15, Rammelsberg, (2d Supp. 175); 16—19, Kerndt, (loc. cit.); 20—22, R. Schneider, (loc. cit.):

I. Formula, $2\dot{Fe}\dddot{W}+3\dot{Mn}\,\dddot{W}$.

		G	$\dddot{W}$	$\dot{Fe}$	$\dot{Mn}$
1.	Zinnwald,	7·191	75·33	9·55	15·12=100, Schaffgotsch.
2.	"	7·191	75·66	9·49	14·85=100, "
3.	"		75·99	9·62	13·96, $\dot{Ca}$ 0·48=100·05, Ebelmen.
4.	"		75·92	9·38	14·04=99·34, Kussin.
5.	"	7·223	76·34	9·61	14·21=100·16, Kerndt.
6.	"	7·231—7·22	75·62	9·55	14·85=100·02, "
7.	Lane's Mine,	7·411—7·486	75·47	9·53	14·26=99·26, "
8.	"	7·208—7·269	75·96	9·74	14·50=100·00, "
9.	Schlackenwald,	7·482—7·535	75·68	9·56	14·30=99·54, "
10.	Altenberg,	7·198—7·189	75·44	9·64	14·90=99·98, "
11.	Zinnwald,		76·01	9·81	13·90, $\dot{Ca}$ 1·19=100·91, R. Schn.

II. Formula, $4\dot{Fe}\dddot{W}+\dot{Mn}\,\dddot{W}$.

12.	Ehrenfriedersdorf,		76·10	19·16	4·74=100, Schaffgotsch.
13.	Chanteloup,	7·437	76·00	18·33	5·67=100, "
14.	Limoges,		76·20	19·19	4·48, $\dot{Mg}$ 0·80=100·67, Ebelmen.
15.	Harzegerode,	7·143	75·56	20·17	3·54=99·27, Rammelsberg.
16.	"	7·23	75·90	19·25	4·80=99·95, Kerndt.
17.	Monte Video,	7·5—7·513	76·02	19·21	4·75=99·98, "
18.	Nertschinsk,	7·5	75·64	19·55	4·81=100·00, "
19.	Chanteloup,	7·48—7·51	75·83	19·32	4·84=99·99, "
20.	Hartz, Glasebach,		76·04	19·61	4·98, $\dot{Ca}$ 0·28, $\dot{Mg}$ *tr.*=100·92, Sch.
21.	" Pfaffenberg,		76·21	18·54	5·23, " 0·40, " 0·36=100·74, "
22.	" Meiseberg,		76·25	20·27	3·96, " 0·28, " 0·15=100·91, "

Sp. gr. of the second group generally greater than that of the first.

B.B. decrepitates, and melts at a high temperature to a magnetic globule, whose surface is covered with crystals, having a metallic lustre. With borax forms a green bead. With but little salt of phosphorus in the inner flame, if tin be added and the whole heated, the color becomes green and it fuses to a clear globule, of a deep red color.

Wolfram is often associated with tin ores; also with galena, in veins traversing graywacke; also in quartz, with native bismuth, tungstate of lime, pyrites, galena, blende, &c. It occurs at Cornwall, much to the detriment of the tin ores; in fine crystals at Schlackenwald, Schneeberg, Geyer, Freiberg, Altenberg, Ehrenfriedersdorf, Zinnwald, and Nertschinsk, and other places mentioned above; at Limoges, in France; near Redruth in Cornwall; in Cumberland, (both varieties, the first at Lochfell, the second at Godolphin's Bale); and on the island of Rona, one of the Hebrides. The crystals of Zinnwald are remarkable as hemitropes.

In the United States it occurs at Lane's mine, Monroe, Conn., in quartz, associated with native bismuth, and the other minerals above mentioned, often pseudomorphous after tungstate of lime; also reported from near Mine La Motte, Missouri; in small quantities in Trumbull, Conn., at the topaz vein; massive and in crystals on Camdage farm, near Blue Hill Bay, Me.

This species is shown to be isomorphous with columbite by G. Rose, (Pogg. lxiv, 171). Descloizeaux found in the angles of Wolfram, some evidence that the crystals were monoclinic. But G. Rose shows from the twins that the form is trimetric, and not oblique.

A mineral from Schlackenwald, occurring with fluor spar and apatite, in fine needles of a brownish-red color, and G.=6·45, probably an altered wolfram, afforded Rammelsberg on analysis, (Ramm. 3d Supp. 127),

$\dddot{\mathrm{W}}$ 67·05, $\dot{\mathrm{F}}\mathrm{e}$ 6·72, $\dot{\mathrm{M}}\mathrm{n}$ 19·73, $\dot{\mathrm{C}}\mathrm{a}$ 3·02, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 1·01, $\dddot{\mathrm{S}}\mathrm{i}$ 0·08, $\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}$ and F 0·61, ign. 0·78=100.

Altered Forms.—Wolfram occurs altered to Scheelite, by a substitution of lime for iron.

COLUMBITE, *Hatchett*. Tantalite, (in part). Tantale Oxidé, *H.* Niobite, *Haid.* Baierine, *Beud.* Torrelite, *Thom.*

Trimetric. $I : I = 100° \ 40'$, $O : 1\bar{i} = 133° \ 22\frac{1}{2}'$; $a : b : c = 1·0584 : 1 : 1·2059$.

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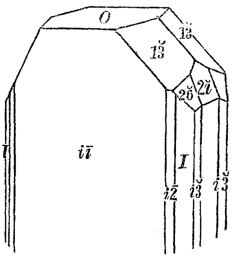
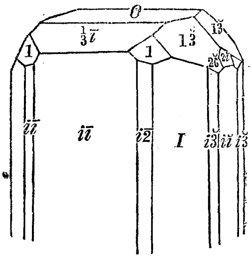


Bodenmais.

503



Middletown, Conn.

$O : \frac{1}{3}\bar{i} = 160° \ 34'$.
$O : \frac{2}{3}\bar{i} = 144° \ 48'$.
$O : 1 = 126° \ 2'$.
$O : 1\breve{3} = 136° \ 36'$.
$O : 2\breve{6} = 119° \ 11'$.
$O : 2\breve{i} = 119° \ 40'$.
$\frac{1}{3}\bar{i} : \frac{1}{3}\bar{i}$ (top) 141° 8′.
$\frac{2}{3}\bar{i} : \frac{2}{3}\bar{i}$ (ib.) 109° 35′.

$1 : 1$(brac.)102° 58′.
$1 : 1$(mac.)117° 53′.
$1 : 1$(bas.) 107° 56′.
$1\breve{3} : 1\breve{3}$(brac.)150° 17′.
$2\breve{6} : 2\breve{6}$(ib.) 160° 29′.
$2\breve{i} : 2\breve{i}$ (top) 59° 20′.
$i\bar{i} : i\bar{2} = 157° \ 29'$.

$i\bar{2} : i\bar{2}$(mac.)134° 58′.
$i\bar{i} : I$(ib.) 140° 20′.
$i\breve{i} : i\breve{3} = 158° \ 6'$.
$i\breve{3} : i\breve{3}$ (brac.) 136° 12′.
$i\bar{i} : 1\breve{3} = 104° \ 52'$.
$i\breve{i} : 1 = 121° \ 3\frac{1}{2}'$.
$i\breve{i} : 1\breve{3} = 129° \ 36'$.

O						
$\frac{1}{6}\bar{i}$						
$\frac{1}{3}\bar{i}$						
$\frac{2}{3}\bar{i}$						
			1	$1\breve{3}$		$1\breve{i}$
$\frac{4}{3}\bar{i}$						$\frac{4}{3}\breve{i}$
					$2\breve{6}$	$[2\breve{i}$
$i\bar{i}$	$i\bar{3}$	$i\bar{2}$	I	$i\breve{3}$		$i\breve{i}$

Observed Planes: Add (?) $i\bar{\frac{5}{3}}$, $i\bar{\frac{7}{4}}$, $\frac{3}{5}\breve{i}$.

Twins: face of composition $2\breve{i}$. Cleavage: $i\bar{i}$ and $i\breve{i}$, the former most distinct. Occurs also rarely massive.

H.=6. G.=5·4—6·4; 5·469—5·85, Connecticut; 5·7—6·39, Bavarian. Lustre submetallic; a little shining. Color iron-black, brownish-black, grayish-black; often iridescent. Streak dark red to black. Opaque. Fracture subconchoidal, uneven. Brittle.

Composition.—Essentially protoxyd of iron and of manganese with columbic acid=$(\dot{F}e, \dot{M}n)^3\ddot{C}b^2$. Analyses: 1, Wollaston; 2, Schlieper, (Pogg. lxiii, 317); 3, 4, 5, 6, H. Rose, (ib.); 7, Avdejev, (ib.); 8, Jacobson, (ib.); 9, Hermann, (J. f. pr. Chem. xxxviii, 121); 10, Bromeis, (Pogg. lxxi, 157); 11, 12, Damour, (Comptes Rend. xxviii, 353); 13, Hermann, (J. f. pr. Chem., xliv, 207); 14, T. S. Hunt, (Am. J. Sci., [2], xiv, 340); 15, H. Müller, (J. f. pr. Ch. lviii, 183):

		G.	$\ddot{C}b$	$\dot{F}e$	$\dot{M}n$	$\ddot{S}n$	$\dot{C}u$	
1.	Connecticut,	——	80·	15·	5·	——	——	=100, Wollaston.
2.	Middletown,	5·469—5·495	78·83	16·66	4·71	0·29	0·07,	$\dot{C}a$ 0·45, $\dot{N}i$ 0·22=101·23.
3.	"	5·708	79·62	16·37	4·44	0·47	0·06,	$\dot{C}a$ *trace*=100·96, Rose.
4.	Bodenmais,	6·39	81·07	14·30	3·85	0·45	0·13,	" " =98·80, Rose.
5.	"	——	81·34	13·89	3·77	0·19	0·10,	" " =99·29, Rose.
6.	"	5·7	79·68	15·10	4·65	0·12	0·12,	" " =99·67, Rose.
7.	"	6·02—6·08	80·64	15·33	4·65	0·10		" 0·21=100·93, Avd.
8.	"	5·976	79·73	14·77	4·77	0·10	1·51	=100·89, Jacobson.
9.	Ilmen Mts.	5·43—5·73	80·47	8·50	6·09,			$\dot{Y}$ 2·0 $\dot{M}g$ 2·44, $\ddot{U}$ 0·50=100, Herm.
10.	"	5·461	78·60	12·76	4·48[a]			$\dot{C}a$ 0·75, $\dot{M}g$ 3·01, $\ddot{\dot{U}}$ 0·56, $\dot{C}u$ *trace*=100·17, Bromeis.
11.	Limoges,	5·6—5·727	78·44	14·96	6·52			=99·92, Damour.
12.	"	" "	78·90	14·50	7·15			=100·55, Damour.
13.	Middletown,	5·8	78·22	14·06	5·63,			$\dot{M}g$ 0·49, $\ddot{S}n$ 0·4, $\ddot{W}$ 0·26=99·06, Hn.
14.	Haddam,	5·85	80·60	15·57	3·25,			$\dot{C}u$ 0·50, $\ddot{S}n$ *tr.*=99·92, Hunt.
15.	Tirschenreuth,		73·6	25·1	5·2,			$\ddot{S}n$ 0·7=104·6, Müller.

[a] Includes Yttria.

Damour finds in a Limoges variety 78·74 columbic acid, $\dot{F}e$ 14·50, $\dot{M}n$ 7·17=100·41 (Ann. des M. [4], xiv, 423). The yttria and uranium of the Ilmen columbite, Hermann attributes to a mixture with Samarskite.

Specimens of the highest specific gravity at Bodenmais, give a black powder, and others of less gravity a dark reddish brown. The Limoges specimens (analysis 11, 12) resemble those of Bavaria, in streak; and Damour has proposed for this variety the name *Baierine;* but Rose has shown that the metal *pelopium,* supposed to distinguish the variety, is identical with Columbium, (Rose's *niobium*).

Wollaston's analysis was made on four grains of the original specimen in the British Museum, sent out from Connecticut by Governor Winthrop to Sir Hans Sloane.

B.B. alone, on charcoal, infusible. With borax, in powder, fusion takes place slowly but perfectly, forming a blackish-green glass.

Columbite of Bodenmais, in Bavaria, on the Rabenstein, near Zwiesel, occurs in granite. In the United States it occurs both in feldspathic and albitic granite.

The occurrence of columbite in America was first made known by Mr. Hatchett's examination of a specimen, sent by Governor Winthrop to Sir Hans Sloane, then President of the Royal Society, which was labeled as found at Neatneague. Dr. S.

L. Mitchill stated (Med. Repos. vol. viii) that it was taken from a spring at New London, Conn. No locality has since been detected at that place. But the rediscovery of it at Haddam, first published by Dr. Torrey, (Amer. J. Sci. iv, 52), has led to the belief that the latter was its original locality. It has since been discovered more abundantly near Middletown.

At Haddam it occurs in a granite vein, with chrysoberyl, beryl, and automolite; also two miles from the chrysoberyl locality, (anal. 14); also at the iolite locality.

Finer crystals come from a feldspar quarry near Middletown, along with albite; figure 503, represents one with brilliant faces three quarters of an inch long; another described by Professor Johnston, (Amer. J. Sci., xxx, 387), weighed before it was broken, fourteen pounds; and the part figured about six inches in length and breadth, weighed 6 lbs. 12 oz.; it exhibits the faces $i\bar{i}$, $i\breve{i}$, $i\bar{2}$, I, $i\breve{3}$, $\frac{1}{3}\bar{i}$, and another imperfect plane, which appears to be $1\breve{3}$. Chesterfield, Mass., has afforded some fine crystals, associated with blue and green tourmalines and beryl in granite; also Acworth, N. H., but this locality is now apparently exhausted. It has also been observed at Beverly, Mass.; at Plymouth, N. H., with beryl; at Greenfield, N. Y., with chrysoberyl.

Ildefonsite.—A columbite from Ildefonso, Spain, with a submetallic vitreo-adamantine lustre, and $I : I$=121° 46′, nearly the angle of the prism $2\breve{i}$ above; G.=7·416, Haidinger.

SAMARSKITE, *H. Rose.* Uranotantal, *G. Rose.* Yttroilmenite, *Herm.*

Trimetric: angle of prism $i\bar{2}$, 135° to 136°, (whence $I : I$=100° 40′ to 101° 40′, near columbite). Usually in flattened grains.

H.=5·5—6. G.=5·614—5·68, Uranotantalite; 5·398—5·45, Yttroilmenite; 5·45—5·69, North Carolina. Lustre of surface of fracture shining and submetallic. Color velvet-black. Streak dark reddish-brown. Opaque. Fracture subconchoidal.

Composition.—Analyses: 1, 2, 3, Peretz, under the direction of Rose, (Pogg. lxxi, 157); 4, Hermann, (his latest results, J. f. pr. Chem. l, 178); 5, T. S. Hunt, (Am. J. Sci. [2], xiv, 341):

		Met. acids.	$\dot{U}$($\ddot{Ʉ}$?)	$\dot{F}e$	$\dot{Y}$	$\dot{M}g$	$\dot{C}a$ & $\dot{M}n$
1.		56·38	14·16	15·43	9·15	0·80	0·92=96·84.
2.		56·00	16·70	15·90	11·04	0·75	1·02=101·41.
3.		55·91	16·77	15·94	8·36	0·75	1·88=99·61.
4.		56·36	U16·63	8·87	13·29	0·50	$\dot{C}e$ & $\dot{L}a$ 2·85 $\dot{M}n$ 1·20, ign. 0·33=100·03, Herm.
5.	N. Carolina,	$\ddot{\dot{C}}b$ 54·81	$\ddot{Ʉ}$17·03	14·07	11·11		$\dot{C}e$, $\dot{L}a$ 3·95, ign. 0·24=101·21, T. S. Hunt.

The acid is the columbic with some tungstic, according to Rose. Hermann's name *yttroilmenite* alludes to the supposed new metal *ilmenium,* alledged to exist in this species; in his recent analysis he makes the acid columbic with a little ilmenic acid.

Heated slightly in a glass tube, it decrepitates, disengages sometimes a little moisture, and glows like gadolinite, becoming of a brownish-black color. In the platinum forceps it melts on the edges to a black glass. On platinum wire with borax the pulverized mineral fuses easily, and forms in the inner flame a yellowish glass, and in the outer a yellowish-green glass; with muriatic acid forms with difficulty a green solution.

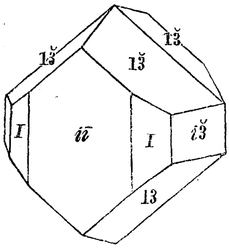
Uranotantalite occurs in reddish-brown feldspar, with crystallized æschynite, in the Ilmen mountains, near Miask in the Ural. The largest pieces met with were of the size of hazel-nuts.

If the occurring prism of Samarskite is $i\breve{3}$ instead of $i\bar{2}$ (as in Mengite), then $I : I$ becomes 100° 57′ to 102° 20′.

MENGITE, *G. Rose.* Ilmenite, *Brooke*, Phil. Mag. x, 1831.

Trimetric. $I:I=100° 28'$, $O:1\bar{i}=133° 42'$; $a:b:c=1{\cdot}0463:1:1{\cdot}2071$.

504



$O:1\breve{3}=136° 50'$, $i\breve{3}:i\breve{3}$(adj.)$=136° 20'$.
$I:i\bar{i}=140° 14'$. $1\breve{3}:1\breve{3}$(mac.)$=151° 26'$.
$i\bar{i}:i\breve{3}=111° 50'$. $1\breve{3}:1\breve{3}$(brac.)$=101° 10'$.

Occurs in short prisms often terminated by four-sided pyramids. No distinct cleavage.

H.=5—5·5. G.=5·48. Lustre submetallic, splendent, of surface of fracture subvitreous. Color iron-black. Streak chestnut-brown. Fracture uneven.

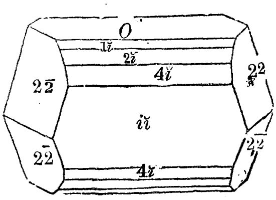
Composition.—Contains, according to G. Rose, (Reise, n. d. Ural. ii, 1842, 83), Zirconia, peroxyd of iron, and titanic acid. B.B. infusible, but becomes magnetic. With salt of phosphorus, in the outer flame, gives a greenish yellow clear glass; in the inner, a yellowish red, which is deepened by adding tin. With soda a manganese reaction.

Occurs in granite veins in the Ilmen mountains. The crystals are imbedded in albite, and the largest are but two or three lines long.

Brooke's name *Ilmenite* being preoccupied, was changed by Rose to Mengite. The mengite of Brooke is monazite.

POLYMIGNYTE, *Berzelius*, K. V. Ac. H. 1824, p. 338.

505



Trimetric. Observed planes as in the annexed figure. $I:I=91°44'$, $O:1\bar{i}=144°3'$; $a:b:c=0{\cdot}7252:1:1{\cdot}0308$.

$O:1\breve{i}=144° 53'$. $2\bar{2}:2\bar{2}$(mac.)$136° 28'$.
$O:2\breve{i}=125° 15'$. $2\bar{2}:2\bar{2}$(brac.)$99° 14'$.
$O:2\bar{2}=121° 49'$. $2\bar{2}:2\bar{2}$(bas.)$116° 22'$.
$i\breve{i}:4\breve{i}=160° 26'$. $1\breve{i}:1\breve{i}$(ov. O)$109\ 46'$.
$i\breve{i}:2\bar{2}=111° 46'$.

Cleavage: $i\breve{i}$ and O in traces. Crystals generally slender and thin, and striated longitudinally.

H.=6·5. G.=4·77—4·85. Lustre submetallic, but brilliant. Color black. Streak dark brown. Opaque. Fracture perfect conchoidal, presenting, like the surface, a brilliancy almost metallic.

Composition.—Analysis by Berzelius, (K. V. Ac. H. 1824, ii, 339),

$\ddot{\mathrm{Ti}}$ 46·30, $\ddot{\bar{\mathrm{Z}}}\mathrm{r}$ 14·14, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 12·20, $\dot{\mathrm{C}}\mathrm{a}$ 4·20, $\ddot{\bar{\mathrm{M}}}\mathrm{n}$ 2·70, $\ddot{\bar{\mathrm{C}}}\mathrm{e}$ 5·00, $\dot{\mathrm{Y}}$ 11·50=96·04,

with a trace of potash, magnesia, silica, and oxyd of tin.

B.B. alone unchanged. With borax yields easily a glass colored by iron; with tin the bead becomes reddish, inclining to yellow. Not easily dissolved by salt of phosphorus to a glass, which is reddish in the reducing flame.

Occurs at Fredericksvärn in Norway, imbedded in feldspar and zircon syenite. Its crystals sometimes exceed an inch in length. It has been reported by Prof. C. U. Shepard as occurring at Beverly, Mass.

POLYCRASE. Polykras, *Scheerer*, Pogg. lxii, 430.

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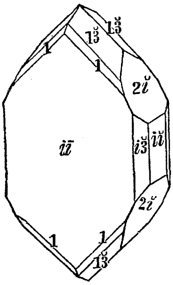


Trimetric. $I : I = 95°$, $O : 1\bar{\imath} = 134° 15'$; $a : b : c = 1·02655 : 1 : 1·0913$. Observed planes as in the figure.

$O : 2\breve{\imath} = 118°$.
$O : 1 = 125° 41\frac{1}{2}'$.
$O : 1\breve{3} = 139° 59'$.
$1\breve{3} : 1\breve{3}$(mac.)$= 96° 40'$.
$1\breve{3} : 1\breve{3}$(brac.)$= 152°$.
$1 : 1$(mac.)$= 112° 32'$.
$1 : 1$(brac.)$= 106° 24'$.
$i\breve{3} : i\breve{3}$(ov. $i\breve{\imath}$)$= 140°$.
$i\breve{\imath} : 1\breve{3} = 160°$.

Crystals thin linear. Cleavage none.

H.=5·5. G.=5·09—5·12. Lustre bright. Color black; in splinters brownish. Streak grayish brown. Fracture conchoidal.

Composition.—Near Polymignyte, but containing in addition columbic acid, protoxyd of uranium, and but little lime with no manganese. B.B. decrepitates, glows and becomes brown, but infusible. Yields with borax a glass which is yellow in the outer flame and brown in the inner. With soda on platinum gives a weak reaction of manganese. Dissolves imperfectly in muriatic acid, and perfectly in heated sulphuric.

From Hitteroe, Norway, in granite with gadolinite and orthite; crystals ½ to 1½ inches long. Named from πολυς, *many*, and κρασις, *mixture.* On crystallization of Polycrase, see Am. J. Sci. [2], xviii, 46, 47.

ÆSCHYNITE, *Berzelius*, Jahresb. ix, 195.

Trimetric. $I : I = 90° 34'$, $O : 1\bar{\imath} = 145° 58'$; $a : b : c = 0·675 : 1 : 1·01$. Observed planes, I, $i\bar{2}$, $2\breve{\imath}$, $1\breve{2}$. $i\bar{2} : i\bar{2} = 127° 19'$, (Rose), $2\breve{\imath} : 2\breve{\imath}(top)= 73° 34'$, $1\bar{2} : 1\bar{2}$(mac.)$= 136° 36'$, (brach.) $83° 4'$, (basal), $112° 52'$. Cleavage: $i\breve{\imath}$ in traces. Crystals usually striated and imperfect.

H.=5—6. G.=4·9—5·14. Lustre resinous—submetallic, nearly dull. Color nearly black, inclining to brownish-yellow when translucent. Streak gray, or yellowish-brown, almost black. Subtranslucent—opaque. Fracture small subconchoidal.

Composition.—Analyses: 1, Hartwall, (Pogg. xvii, 483, Jahresb. ix, 195); 2, Hermann, (new anal. J. f. pr. Chem. l. 193):

1. $\ddot{\mathrm{T}}\mathrm{i}$ 56·0, $\ddot{\bar{\mathrm{Z}}}\mathrm{r}$ 20·0, $\ddot{\bar{\mathrm{C}}}\mathrm{e}$ 15·0, $\dot{\mathrm{C}}\mathrm{a}$ 3·8, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 2·6, $\ddot{\mathrm{S}}\mathrm{n}$ 0·5=97·9, Hartwall.
2. $\ddot{\mathrm{T}}\mathrm{i}$ 25·90, $\ddot{\mathrm{C}}\mathrm{b}$ 33·20, $\ddot{\bar{\mathrm{C}}}\mathrm{e}$ 22·20, $\dot{\mathrm{C}}\mathrm{e}$ 5·12, $\dot{\mathrm{F}}\mathrm{e}$ 5·45, $\dot{\mathrm{L}}\mathrm{a}$ 6·22, $\dot{\mathrm{Y}}$ 1·28, $\dot{\mathrm{H}}$ 1·20=100·57, H.

In a matrass yields water, and in an open tube traces of fluorine. B.B. on charcoal swells and becomes yellow, but does not fuse, though forming a black slag on the edges. With borax readily forms a dark-yellow glass, which is colorless on cooling, and with tin in the inner flame becomes red; with salt of phosphorus yields a transparent colorless bead, which with more of the salt appears yellow and clouded. Affords some tin.

From Miask in the Ural, in feldspar with mica and zircon. Named from αισχυνη, *shame*, by Berzelius, in allusion to the inability of chemical science, at the time of its discovery, to separate the two unlike substances, titanic acid and zirconia.

EUXENITE, *Scheerer*, Pogg. l, 149, and lxxii, 561.

Trimetric? Form a rectangular prism ($i\bar{i}$, $i\breve{i}$) with lateral edges replaced by *I*, and a pyramid at summit, also with two domes, one parallel to each diagonal; $I : I$ about 120°, $i\bar{i} : I$=150°, angle (mac.) of pyramid 100°, $i\bar{i}$: pyramid=136°, *I* : pyr.=132°, $i\bar{i}$: macrodome=153°, $i\breve{i}$: brachydome=124°; faces rough, and angles may be in error several degrees, R. P. Greg. Commonly massive, without any traces of cleavage.

H.=6·5. G.=4·6—4·76. Lustre metallic, greasy. Color brownish-black; in thin splinters a reddish-brown translucence lighter than the streak. Streak-powder reddish brown. Fracture subconchoidal.

Composition.—Analyses by Scheerer, (loc. cit.):

	Jölster, G.=4·60.	Tvedenstrand, G.=4·73—4·76.
Titanic and metallic acids,	57·60	53·64
Yttria,	25·09	28·97
Protox. uranium,	6·34	7·58
Protox. cerium and lanthanum,	3·14*	2·91
Protox. iron,	——	2·60
Lime,	2·47	——
Magnesia,	0·29	——
Water,	3·97	4·04=99·74.

* Protoxyd of cerium 2·18; ib. lanthanum 0·96.

Scheerer has ascertained that the mineral contains columbic acid in place of tantalic. The Jölster euxenite contains the most titanic acid; yet Scheerer does not doubt the identity of the two minerals.

B.B. infusible. With borax in the oxydation flame becomes yellow or brownish-yellow, and the same after cooling; by flaming, forms a yellowish enamel; color but little changed in the reduction flame. With salt of phosphorus dissolves in the oxydation flame, forming a yellow pearl, which on cooling becomes colorless.

Euxenite comes from Jölster in Norway, where it was obtained by Prof. Keilhau; also near Tvedenstrand. Named by Scheerer from ευξενος, *a stranger*, in allusion to the rarity of its occurrence.

RUTHERFORDITE, *Shepard*, Amer. Assoc. iv, 311, Am. J. Sci. [2], xii, 209.

In crystals and grains, without cleavage. Monoclinic, with $I : I$=93°, according to Shepard.

H.=5·5, Hunt. G.=5·58—5·69, Shepard, 5·55, Hunt. Lustre of fracture shining vitreo-resinous, and color blackish-brown; opaque, but thin fragments translucent and smoky orange-brown by transmitted light. Streak and powder yellowish-brown, near fawn-color. Fracture conchoidal. Brittle.

Composition.—According to Shepard contains titanic acid, oxyd of cerium, and possibly oxyd of uranium and yttria; according to some unfinished trials by T. S. Hunt, (Am. J. Sci. [2], xiv, 344), it contains probably 58·5 per cent. or more of titanic acid, with 10 per cent. of lime, with other ingredients undetermined.

Occurs at the gold mines of Rutherford Co., North Carolina, along with rutile, brookite, zircon, and monazite.

YTTRO-TANTALITE. Tantale Oxidé Yttrifère, *H.*

Three varieties; the *black*, *yellow*, and *brown* or *dark*.

Black: indistinct traces of crystallization in four- or six-sided irregular prisms and plates. H.=5·5. G.=5·395, Berz., 5·67, Rose, and 6·40 after heating. Lustre submetallic. Color iron-black. Streak gray. Opaque.

Yellow: not crystalline, and occurring in laminæ in the fissures of feldspar. H.=5. G.=5·882, Ekeberg. Lustre resinous on the surface, vitreous in the fracture. Color yellowish-brown—greenish. Streak white. Opaque.

Brown: occurs with the yellow in thin plates, or rarely grains presenting no trace of crystallization. H.=4·5—5. Lustre vitreous, inclining to resinous. Color black, with a very light shade of brown, slightly yellow when in thin plates by transmitted light; streak white.

Composition.—$\dot{R}^3(\ddot{\bar{T}}a, \dddot{W}, \ddot{\bar{U}})$. Analyses: 1—4, Berzelius, (Afhandl. iv, 268, 272, and Schw. J. xvi, 451); 5, H. Rose, (Pogg. lxxii, 155):

	$\ddot{\bar{T}}a$	$\dddot{W}$	$\ddot{\bar{U}}$	$\dot{Y}$	$\dot{C}a$	$\ddot{\bar{F}}e$
1. *Yellow*, $\dot{Y}^3(\ddot{\bar{T}}a, \ddot{\bar{U}})$,	60·12	1·04	6·62	29·78	0·50	1·16=99·23.
2. " . " ...	59·50	1·25	3·23	29·90	3·29	2·72=99·89.
3. *Black*, $(\dot{Y}, \dot{C}a, \dot{F}e)^3(\ddot{\bar{T}}a, \dddot{W})$,	57·00	8·25	0·50	20·25	6·25	3·50=95·75.
4. *Brownish-black*, $(\dot{Y}, \dot{C}a)^3\ddot{\bar{T}}a$,	51·82	2·59	1·11	38·52	3·26	0·55=97·85.
5. *Black* (after ignition),	58·65	0·60	3·94	21·25	7·55	$\dot{F}e$ 6·29, $\dot{M}g$ 1·40, $\dot{C}u$ 0·40=100·08, Rose.

Loss in analysis 5 by ignition, 3·9—5·54 per cent.; the specimen was from Ytterby.

B.B. infusible alone, but decrepitate and assume a light color. The black variety froths and fuses with carbonate of soda. They dissolve in borax, but are not acted on by acids.

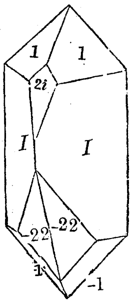
These varieties of yttro-tantalite occur in Sweden at Ytterby, in red feldspar, and at Broddbo and Finbo, near Fahlun, imbedded in quartz and albite, associated with garnet, mica, and pyrophysalite.

CROCOISITE, *Kobell.* Chromate of Lead. Red Lead Ore. Krokoit, *Breit.* Rothbleierz. Plomb Chromaté. Lehmannite.

O					
					½ì
1*i*			1		1ì
2*i*					2ì
4*i*			4		
ii	*i*2	$\frac{3}{2}$	*I*	*i*2̀	*i*ì
	−22				2ì
−1*i*			−1		1ì
					½ì

Observed Planes. Add −3*i*, −4*i*.

507



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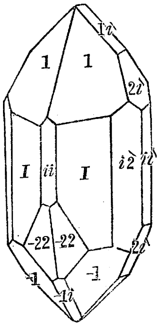


Monoclinic, *C*=78° 1′; *I* : *I*=93° 44′, *O* : 1ì=137° 31′; *a* : *b* : *c*=0·9773 : 1 : 1·044.

O : 1=131° 45′. *O* : 2ì=118° 38′. 1 : 1=118° 58′.
O : *I*=98° 43′. *i*2 : *i*2=129° 48′. –1 : –1=107° 54′.
O : *ii*=101° 59′. *ì*2 : *ì*2=123° 50′. –22 : –22=131° 38.

Cleavage: *I* tolerably distinct; *O* and *ii* less so. Surface *I* streaked longitudinally; the faces mostly smooth and shining. Also imperfectly columnar and granular.

H.=2·5—3. G.=5·9—6·1. Lustre adamantine—vitreous. Color various shades of bright hyacinth-red. Streak orange-yellow. Translucent. Sectile.

Composition.—$\dot{\mathrm{Pb}}\,\dddot{\mathrm{Cr}}$=Oxyd of lead 68·7, chromic acid 31·3. Analyses: 1, Pfaff, (Schw. J. xviii, 72); 2, Berzelius, (ib. xxii, 54):

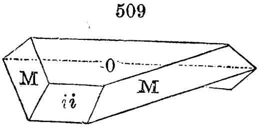
1.	$\dot{\mathrm{Pb}}$ 67·912	$\dddot{\mathrm{Cr}}$ 31·725=99·637, Pfaff.
2.	68·50	31·50=100, Berzelius.

Blackens in the blowpipe flame, and decrepitates if quickly heated, but may be fused to a shining slag, containing globules of lead. It undergoes a partial reduction in glass of borax, at the same time coloring it green. Dissolves with effervescence in nitric acid, and produces a yellow solution. With soda yields easily metallic lead.

Occurs at Nischne Tagilsk in the Ural, and in narrow veins, traversing decomposed gneiss, and associated with gold, pyrites, galena, quartz, and vauquelinite; in Brazil, at Congonhas do Campo, in fine crystals in decomposed granite; at Retzbanya in Hungary, at the mine of St. Anthony; at Moldawa in the Bannat; on Luzon, one of the Philippine Islands.

VAUQUELINITE. Chromate of Lead and Copper, *Phil.*

509



Monoclinic. Crystals usually minute, irregularly aggregated. Twins: annexed figure; face of composition a plane on the acute solid angle: *O* : *O* (of the two individuals)=134° 30′; *O* : *ii*=149° nearly. Also reniform or botryoidal, and granular; amorphous.

H.=2·5—3. G.=5·5—5·78. Lustre adamantine to resinous, often faint. Color dark-green to brown, sometimes nearly black. Streak siskin-green or brownish. Faintly translucent—opaque. Fracture uneven. Rather brittle.

Composition.—$\dot{\mathrm{Cu}}^3\dddot{\mathrm{Cr}}^2+2\dot{\mathrm{Pb}}^3\dddot{\mathrm{Cr}}^2=(\dot{\mathrm{Cu}},\dot{\mathrm{Pb}})^3\dddot{\mathrm{Cr}}^2$=Oxyd of lead 61·2, oxyd of copper 10·9, chromic acid 27·9. Analysis by Berzelius, (Afhandl. vi, 246):

$\dot{\mathrm{Pb}}$ 60·87, $\dot{\mathrm{Cu}}$ 10·80, $\dddot{\mathrm{Cr}}$ 28·33=100.

B.B. on charcoal slightly intumesces and fuses to a gray submetallic globule, yielding at the same time, small beads of lead. With borax or salt of phosphorus affords a green transparent glass in the outer flame, which in the inner after cooling is red to black, according to the amount of mineral in the assay; the red color is more distinct with tin. Partly soluble in nitric acid.

Occurs with crocoisite at Beresof in Siberia, generally in mammillated or amorphous masses, or thin crusts; also at Pont Gibaud in the Puy de Dome; and with the crocoisite of Brazil.

At the lead mine near Sing Sing, it has been found by Dr. Torrey in green and brownish-green mammillary concretions, and also nearly pulverulent.

John describes a greenish or brownish *chromo-phosphate of lead and copper*, from Beresof, Siberia, as occurring in small crystalline concretions, having the surface covered with capillary prisms; H.=2—3; opaque to subtranslucent; fracture uneven; powder dull greenish. Analysis afforded (v. Leonh. 1845, 67) $\dot{Pb}$, $\ddot{Cr}$ 45·0, $\dot{Pb}$ 19·0, $\dot{Cu}$ 11·20, $\dddot{P}$ 4·10, $\ddot{Cr}$ 7·50, manganese *tr.*, $\dot{H}$ 1·78, impurities 11·42. To a large extent soluble in nitric or muriatic acid.

MELANOCHROITE, *Hermann.* Phœnikochroite, *Glocker.* Subsesquichromate of Lead, *Thom.* Phœnicite.

Trimetric? Crystals usually tabular, and reticularly interwoven. Cleavage in one direction perfect. Also massive.

H.=3—3·5. G.=5·75. Lustre resinous or adamantine, glimmering. Color between cochineal and hyacinth-red; becomes lemon-yellow on exposure. Streak brick-red. Subtranslucent—opaque.

Composition.—$\dot{Pb}^3\ddot{Cr}^2$=Chromic acid 23·3, protoxyd of lead 76·7. Analysis: Hermann, (Pogg. xxviii, 162):

Chromic acid 23·31, Protoxyd of lead 76·69=100.

The same result was obtained by G. Rose, (Leonh. 1839, 575).

B.B. on charcoal fuses readily to a dark mass, which is crystalline when cold. In the reducing flame on charcoal, lead is sublimed. Gives the reaction of chrome with fluxes.

Occurs in limestone at Beresof, in the Ural, with crocoisite, vauquelinite, pyromorphite, and galena. Named from μελας, *black*, and χροα, *color.*

DECHENITE, *C. Bergemann*, Pogg. lxxx, 393.

In small botryoidal masses; texture crystalline. Some appearances of a rhombohedral cleavage.

H.=4. G.=5·81. Lustre of fresh fracture greasy. Color when purest dull-red; also yellowish. Streak yellow.

Composition.—$\dot{Pb}\dddot{V}$=Vanadic acid 45·34, oxyd of lead 54·66. Analyses, by C. Bergemann, (loc. cit.):

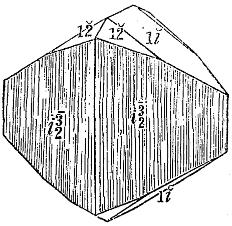
	$\dddot{V}$	$\dot{Pb}$
1. *Dull-red,*	47·164	52·915=100·079.
2. "	46·101	53·717=99·818.
3. *Yellowish,*	49·27	50·57 =99·84.

B.B. alone fuses easily to a yellowish glass; on charcoal does not decrepitate, but forms a yellowish-green pearl which yields a slag containing some grains of lead. Sometimes traces of arsenic with more of the assay. With soda a white enamel containing grains of lead.

From the Lauter Valley in Rhenish Bavaria, near Nieder-Schlettenbach, where it occurs in the variegated sandstone.

DESCLOIZITE, *A. Damour*, Ann. Ch. Phys, 1854.

510



Trimetric. $I : I$=100° 28′, $O : 1\bar{i}$= 143° 14′; $a : b : c$=0·747 : 1 : 1·2052. Angles (Descloizeaux):

$i\bar{\tfrac{3}{2}} : i\bar{\tfrac{3}{2}}$=122° 6′.
$1\breve{i} : 1\breve{i}$ (top)=116° 25′.
$1_{\breve{2}} : 1_{\breve{2}}$ (adj.)=127° 10′.
$1_{\breve{2}} : 1_{\breve{2}}$ (ov. $1\breve{i}$)=115° 10′.
$1_{\breve{2}} : 1\breve{i}$=147° 35′.
$O : 1\breve{i}$=148° 12½′.

Cleavage none. $1\breve{2}$ brightest, $1\breve{i}$ undulated; $\acute{i}\frac{3}{2}$ striated.

H.=3·5. G.=5·839. Lustre bright. Color mostly deep black; smallest crystals olive, with a chatoyant bronze lustre, by transmitted light along the edges light brown inclining to red; in a surface of fracture, colors zoned with straw-yellow, reddish-brown and black, nearly clear at middle and darkest at extremities of crystals.

Composition.—$\dot{\mathrm{Pb}}^2\dddot{\mathrm{V}}$=Vanadic acid 29·3, oxyd of lead 70·7. Mean of two analyses, (loc cit.):

$\dddot{\mathrm{V}}$	$\dot{\mathrm{Pb}}$	$\dot{\mathrm{Zn}}$	$\dot{\mathrm{Cu}}$	$\overline{\ddot{\mathrm{Fe}}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{H}}$	Cl	$\overline{\ddot{\mathrm{Mn}}}$	Sand.
22·46	54·70	2·04	0·90	1·50	5·32	2·20	0·32	6·00	3·44=98·88.

The oxyds of manganese, iron, copper and zinc are regarded as impurities. B.B. on charcoal fuses and is partially reduced to a globule of metallic lead enveloped in a black scoria. With borax in the reducing flame a green glass, and with nitre in the oxydating flame, a violet color due to manganese. With salt of phosphorus in the reduction flame a glass of a chrome-green color, which is orange-yellow in the oxydation flame. Dissolves in cold dilute nitric acid.

Occurs in small crystals, 1 to 2 mm. thick, clustered on a siliceous and ferruginous gangue from South America, and associated with acicular green pyromorphite.

VANADINITE. Vanadate of Lead. Vanadinbleierz.

Hexagonal. In simple hexagonal prisms. Usually in implanted globules or incrustations.

H.=2·75—3. G.=6·6623—7·23. Lustre of surface of fracture resinous. Color light brownish-yellow, straw-yellow, reddish-brown. Streak white or yellowish. Subtranslucent—opaque. Fracture uneven, or flat conchoidal. Brittle.

Composition.—$\dot{\mathrm{Pb}}^3\dddot{\mathrm{V}}+\frac{1}{3}\mathrm{Pb\,Cl}$=Vanadate of lead 89·7, chlorid of lead 10·3=100. Analyses: 1, Berzelius, (Schw. J. lxiii, 119); 2, R. D. Thomson, (Thomson's Min. i, 574); 3, Damour, (Ann. d. Mines, [3], xi, 161):

1. Zimapan, Van. lead 74·00, Chlor. lead 25·33, $\overline{\ddot{\mathrm{Fe}}}^2\dot{\mathrm{H}}^3$ 0·67=100, Berz.

2. Scotland, $\dddot{\mathrm{V}}$ 23·44, $\dot{\mathrm{Pb}}$ 66·33, Pb 7·06, H Cl 2·45, $\overline{\ddot{\mathrm{Fe}}}$ and $\ddot{\mathrm{Si}}$ 0·16=99·43, T.
3. ? 15·86, 63·73, 6·62, Cl 2·26, $\dot{\mathrm{Zn}}$6·35, $\dot{\mathrm{Cu}}$ 2·96, $\dot{\mathrm{H}}$3·80=101·60, D.

B.B. in a pair of forceps, it fuses, intumesces, and retains its yellow color on cooling; if kept some time in fusion, however, it changes into a steel gray porous mass, which, upon charcoal, with soda, yields globules of metallic lead. On charcoal it fuses with much frothing into a bead, resembling the original assay. With salt of phosphorus on platinum wire, it forms a transparent pearl, of a fine green color in the inner flame, and yellowish-brown in the outer. It forms green solutions with the sulphuric and muriatic acids, and a beautiful yellow solution with nitric acid.

This mineral was first discovered at Zimapan in Mexico, by Del Rio. It has since been obtained among some of the old workings at Wanlockhead in Dumfriesshire, where it occurs in small globular masses, sprinkled over calamine, or forming thin coatings on the surface of that mineral, and also in hexagonal crystals; also at Beresof in the Urals, with pyromorphite.

VOLBORTHITE, *Hess*, Bull. Acad. Sci. St. Petersburg, iv, No. 2. Knauffite.

Hexagonal. In small tables, often aggregated in globular forms. Cleavage: in one direction very perfect.

H.=3—3·5. G.=3·459—3·860, Credner, the first *green*, the other a *gray* variety. Lustre pearly to vitreous. Color olive-green; also gray. Streak clear yellowish-green, nearly yellow. Thin splinters, translucent.

Composition.—A variety analyzed by Credner afforded $(\dot{C}u, \dot{C}a)^4\dddot{V}+\dot{H}$; and when $\dot{C}u$ to $\dot{C}a$=5 : 2, (analysis 1)=Vanadic acid 37·5, oxyd of copper 45·9, lime 13·0, water 3·6,=100; when 3 : 2, (analyses 2, 3)=Vanadic acid 38·3, oxyd of copper 39·4, lime 18·5, water 3·7=100. Analyses of specimens from Frederichsrode, by Credner, (Pogg. lxxiv, 546):

	$\dddot{V}$	$\dot{C}u$	$\dot{C}a$	$\dot{M}g$	$\dot{M}n$	$\dot{H}$	
1. *Green*,	36·58	44·15	12·28	0·50	0·40	4·62,	gangue 0·10=98·63.
2. *Gray*,	39·02	38·27	16·65	0·92	0·52	5·05	" 0·76=101·18.
3. "	36·91	38·90	17·40	0·87	0·53	4·62	" 0·77=100.

The green mineral has a perfect cleavage in one direction ; streak greenish yellow. The gray variety is fine crystalline granular; powder brownish yellow. H.=3·5.

B.B. in a glass tube gives off some water, and blackens, without further change. On charcoal fuses readily without intumescence, and finally forms a graphite-like slag, which does not fuse to a globule. Affords a chrome-green globule with borax. With salt of phosphorus and a little of the mineral, on platinum, forms a pearl which is yellow in the oxydation flame, and green in the reduction flame.

Volborthite was first discovered by Volborth, with copper ores, in the collection of Dr. Rauch, and occurs at Syssersk and Nischne Tagil, also in the Permian formation (Kupfersandstein) at several mines in the districts of Jugowskoi and Motowilicha. Also found at Fredericksrode in Thuringia.

A vanadate of copper ($=\dot{C}u\dddot{V}$) has been reported as occurring in the Ural at Wosskressensk with native copper, copper glance, and malachite. It is pearly, of a citron-yellow color, foliated in structure, and occurring either reniform or pulverulent.

VANADATE OF LEAD AND COPPER, *Domeyko*, Ann. des Mines, [4], xiv, 150.—This ore has a dark brown or brownish-black color, and has been observed only in an earthy state, looking much like a ferruginous clay or earth. It occurs in cavities in an arseno-phosphate of lead along with amorphous carbonates of lead and copper. B.B. fuses easily and affords a black pearl, a little blebby; gives a clear green pearl with salt of phosphorus or borax and a globule of lead containing copper on charcoal. In nitric acid easily soluble.

Composition.—$\dot{P}b^6\dddot{V}+\dot{C}u^6\dddot{V}$. Analyses by Domeyko, (loc. cit.):

	$\dddot{V}$	$\overset{\cdots}{\ddot{A}}s$	$\overset{\cdots}{\ddot{P}}$	$\dot{C}u$	$\dot{P}b$	Pb Cl	$\dot{C}a$	$\dddot{\bar{F}}e$, $\dddot{\bar{A}}l$	$\dddot{S}i$	$\dot{H}$	
1.	13·5	4·6	0·6	14·6	54·9	0·3	0·5	3·5	1·0	2·70,	clay 1·0=97·2.
2.	13·33	4·68	0·68	16·97	51·97	0·37	0·58	3·42	1·33	2·70,	" 1·52=97·55.

Considering the arsenic and phosphoric acids as combined with lead constituting the arsenophosphate with which the mineral is associated, the analysis affords very closely the above formula.

This ore occurs at the silver mine called Mina Grande, or Mina de la Marqueza, in Chili, till recently worked for copper and silver.

Vanadate from the Lake Superior Copper Region.—An ore similar in color and clayey appearance to Domeyko's mineral, has been announced by J. E. Teschemacher among specimens from the Cliff Mine, in the Lake Superior Copper Region. The presence of vanadium was ascertained by both blowpipe and acid tests. The color is a dark chocolate, and also a bright yellow. The exact state of composition of the vanadic acid is doubtful. There is no oxyd of lead in the ore, and the brown variety is mixed with an earthy oxyd of iron; when carefully separated from the gangue, it was found to contain no copper.

ARÆOXENE, *von Kobell*, J. f. pr. Ch. 1, 496.

Massive; imperfectly crystalline, with traces of a columnar structure. H.=3. Color deep red, with a brownish tinge: streak pale yellowish

Composition.—Contains according to Kobell (loc. cit.), 48·7 p. c. of oxyd of lead, and 16·32 of oxyd of zinc, along with vanadic acid. The oxyds of lead and zinc are nearly in equal equivalents, and the oxygen of the bases at least equals that of the acid, as in vanadinite and volborthite, and unlike dechenite.

B.B. on charcoal fuses with intumescence, yielding an arsenical odor and a globule of lead; more lead if soda be added; with borax a bright green glass in the reduction flame, light olive-green and then clear yellow in the oxydation flame, and pale greenish on cooling. In powder decomposed easily in heated concentrated muriatic acid, the liquid first yellow, then brownish, and after giving out chlorine emerald-green. On adding spirits of wine, heating it, and pouring off from the solution the separated chlorid of lead, it is still green; concentrating it with a vapor bath and diluting it with water, takes a fine sky-blue color: in this characteristic it is like other vanadium compounds.

From Dahn in the Palatinate, associated with galena. Resembles crocoisite, but color darker.

III. SULPHATES.—SELENATES.

I. ANHYDROUS SULPHATES OR SELENATES.

1. CELESTINE GROUP. Trimetric.

Glaserite,	$\dot{K}\,\dddot{S}$.	Anhydrite,	$\dot{Ca}\,\dddot{S}$.
Thenardite,	$\dot{Na}\,\dddot{S}$.	Anglesite,	$\dot{Pb}\,\dddot{S}$.
Barytes,	$\dot{Ba}\,\dddot{S}$.	Almagrerite,	$\dot{Zn}\,\dddot{S}$.
Celestine,	$\dot{Sr}\,\dddot{S}$.	Leadhillite,	$\dot{Pb}\,\dddot{S}+3\dot{Pb}\,\ddot{C}$.
"	$(\dot{Ba}, \dot{Sr})\dddot{S}$.		

Appendix.—Caledonite.

2. DREELITE GROUP. Rhombohedral.

Dreelite,	$\dot{Ca}\,\dddot{S}+3\dot{Ba}\,\dddot{S}=(\frac{1}{4}\dot{Ca}+\frac{3}{4}\dot{Ba})\dddot{S}$.
Susannite,	$\dot{Pb}\,\dddot{S}+3\dot{Pb}\,\dot{C}$.

3. GLAUBERITE GROUP. Monoclinic,

Glauberite,	$\dot{Na}\,\dddot{S}+\dot{Ca}\,\dddot{S}=(\dot{Na}, \dot{Ca})\dddot{S}$.
Lanarkite,	$\dot{Pb}\,\dddot{S}+\dot{Pb}\,\ddot{C}$.

Appendix.—Connellite. Selenate of Lead. Reussin.

[The compounds of sulphates and carbonates, or sulphato-carbonates, have the crystallization of the sulphates, the carbonic acid being wholly subordinated, as regards the form produced, to the sulphuric, the more powerful acid. Thus *Leadhillite* is homœomorphous with Anglesite, Celestine, etc., *Susannite* with Dreelite, and *Lanarkite* with Glauberite; and these species are here arranged accordingly.]

GLASERITE, *Hausm.* Aphthitalite. Sulphate of Potash. Arcanite, *Haidinger.* Aphthalose, *Beudant.* Vesuvian Salt, *Lond. Phil. Trans.*, 1813. Kalisulphat, *Naum.*

Trimetric. $I:I=104° 52'$, $O:1\bar{\imath}=119° 46'$; $a:b:c=1{\cdot}749:1:1{\cdot}3$. Observed planes O, $1\bar{\imath}$, $\frac{1}{3}\bar{\imath}$, $\bar{\imath}\bar{\imath}$, 1, $2\breve{2}$, $1\breve{\imath}$, $\frac{1}{2}\breve{\imath}$, $\breve{\imath}\breve{\imath}$. $O:\frac{1}{3}\bar{\imath}=149° 46'$, $O:\frac{1}{2}\breve{\imath}=146° 4'$, $1\bar{\imath}:1\bar{\imath}$ (basal)$=120° 29'$, $1\breve{\imath}:1\breve{\imath}$ (ib.)$=106° 46'$, $\frac{1}{3}\bar{\imath}:\frac{1}{3}\bar{\imath}$ (ib.)$=60° 28'$, $\frac{1}{2}\breve{\imath}:\frac{1}{2}\breve{\imath}=67° 52'$. Occurs in thin tables and in blades made up of aggregated crystals; also massive, or imperfectly mammillary, and in crusts.

H.=3—3·5. G.=1·731. Lustre vitreous, inclined to resinous. Color white, sometimes tinged with blue or green. Transparent to translucent or opaque. Taste saline and bitter, disagreeable.

Composition.—$\dot{K}\ddot{S}$=Potash 54·1, sulphuric acid 45·9. A specimen from Vesuvius contained sulphate of potash 71·4, sulphate of soda 18·6, chlorid of sodium 4·6, chlorid of ammonium, copper, and iron 5·4=100, (Phil. Trans, 1813). Fuses before the blowpipe, without intumescence.

Found at Vesuvius, upon lava, in delicate crystallizations and also in masses often an inch or more in thickness.

THENARDITE, *J. L. Casaseca*, Ann. Ch. Phys. xxxii, 311. Anhydrous Sulphate of Soda.

Trimetric. $I:I=103° 26'$, $O:1\bar{\imath}=120° 36'$, Hausmann; $a:b:c=1{\cdot}6905:1:1{\cdot}267$, $O:1\breve{\imath}=126° 51'$, $1\breve{\imath}:1\breve{\imath}$ (top)$=73° 42'$, (basal) $=106° 18'$. Cleavage: basal, nearly perfect.

H.=2—2·5. G.=2·73. Lustre vitreous. Color white. Translucent. Covered with a white powder on exposure to the air.

Composition.—$\dot{Na}\dddot{S}$=Soda 56·3, sulphuric acid 43·7; analysis by Casaseca, (loc. cit.), Anhydrous sulphate of soda 99·78, carbonate of soda 0·22; by A. Dick of a specimen from Tarapaca, (Phil. Mag. [4], v, 373), $\dddot{S}$ 55·11, $\dot{Na}$ 42·37, insol. 2·19=99·67. Wholly soluble in water. Colors the blowpipe flame deep yellow.

Occurs at Espartinas in Spain, 5 leagues from Madrid, and 2½ from Aranjuez. The water exudes during winter from the bottom of a basin, and becoming concentrated in the summer season, deposits crystals of thenardite. Also at Tarapaca, with Glauberite and Hayesine, the crystals of which locality give some of the angles nearly of Trona, according to H. J. Brooke, (loc. cit.)

BARYTES. Heavy Spar. Sulphate of Barytes. Hepatite, *Haus.* Barytine, *B.* Baroselenite. Aehrenstein. Bolognian Spar. Cawk. Litheospore. Allomorphite, *Breit.* Schwerspath. Stangenspath, *W.* Calstronbaryte, *Shepard.*

Trimetric. $I : I=101° 40'$, $O : 1\bar{i}=121° 50'$; $a : b : c=1{\cdot}6107 : 1 : 1{\cdot}2276$.

$O : \frac{1}{4}\bar{i}=158° 4'$.
$O : \frac{1}{2}\bar{i}=141° 8'$.
$O : 1\bar{i}=121° 50'$.
$O : \frac{3}{2}\bar{3}=111° 36'$.
$O : \frac{1}{4}=152° 33'$.
$O : \frac{1}{2}=133° 54'$.

$O : 1=115° 42'$.
$O : \frac{1}{2}\breve{i}=146° 43'$.
$O : 1\breve{i}=127° 18'$.
$1 : 1$(mac.)$=111° 38'$.
$1 : 1$(brac.)$=91° 22'$.
$1 : 1$(bas.)$=128° 36'$.

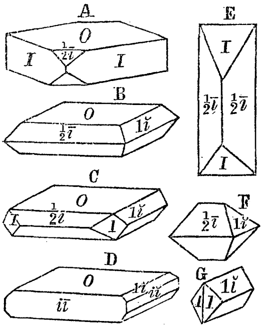
$i\bar{2} : i\bar{2}=135° 40'$.
$i\breve{2} : i\breve{2}=116° 55'$.
$\frac{1}{2}\bar{i} : \frac{1}{2}\bar{i}(top)=102° 17'$.
$1\bar{i} : 1\bar{i}$ " $=63° 40'$.
$\frac{1}{2}\breve{i} : \frac{1}{2}\breve{i}$ " $=113° 26'$.
$1\breve{i} : 1\breve{i}$ " $=74° 36'$.

Crystals usually tabular, as in figures; sometimes prismatic, (f. 513). Cleavage: basal rather perfect, I somewhat less so, $i\breve{i}$ imperfect. Twins: plane of composition $i\bar{i}$, the compound character being apparent in the striæ of the plane O. Also in globular forms, fibrous or lamellar, crested; coarsely laminated, laminæ convergent and often curved; also granular; colors sometimes banded as in stalagmite.

O								
$\frac{1}{8}\bar{i}$				$\frac{1}{8}$				
$\frac{1}{6}\bar{i}$								
$\frac{1}{5}\bar{i}$				$\frac{1}{5}$				
$\frac{1}{4}\bar{i}$				$\frac{1}{4}$				
$\frac{1}{3}\bar{i}$				$\frac{1}{3}$				
$\frac{1}{2}\bar{i}$				$\frac{1}{2}$	$\frac{1}{2}\breve{2}$		$\frac{1}{2}\breve{i}$
$1\bar{i}$				1	$1\breve{2}$		$1\breve{i}$
$\frac{3}{2}\bar{i}$	$\frac{3}{2}\bar{3}$					$\frac{3}{2}\breve{3}$	
$i\bar{i}$		$i\bar{2}$	$i\bar{\frac{3}{2}}$	I	$i\breve{2}$		$i\breve{i}$

Observed Planes.

511



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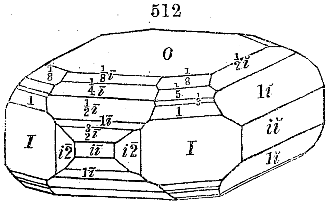
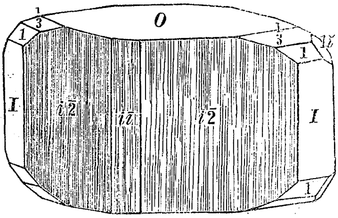


Cheshire.

513



Virginia.

H.$=2{\cdot}5$—$3{\cdot}5$. G.$=4{\cdot}3$—$4{\cdot}72$; $4{\cdot}4864$, G. Rose, a colorless crystal. Lustre vitreous, inclining to resinous; sometimes pearly.

Streak white. Color white; also inclining to yellow, gray, blue, red, or brown. Transparent to translucent—opaque. Sometimes fetid, when rubbed.

Composition.—$\dot{\mathrm{Ba}}\dddot{\mathrm{S}}$=Sulphuric acid 34·33, and baryta 65·67. Oxyd of iron, silica, carbonate of lime, and alumina, occur sometimes as impurities, and sulphate of strontian is a common ingredient. E. Riegel obtained from a crystalline variety, (Jahrb. pr. Pharm. xxiii, 348), $\dot{\mathrm{Ba}}\dddot{\mathrm{S}}$ 93·92, $\dot{\mathrm{Sr}}\dddot{\mathrm{S}}$ 0·86, $\dddot{\mathrm{Si}}$ 3·75, $\dddot{\overline{\mathrm{Fe}}}$ 0·64, $\dot{\mathrm{H}}$ 0·50=99·67. Freisleben found 8 per cent. of silica in a variety from Nassau; and Rammelsberg 15·12 per cent. of sulphate of strontia in another from Görzing; G.=4·488. The *Allomorphite*, Breith. from near Saalfeld, according to Gerngross, contains 1·9 per cent. of sulphate of lime as impurity; but von Hauer found none, (Jahrb. k. k. geol. R. 1853, 152). *Hepatite* is an impure spar affording a fetid odor on friction. The Calstronbaryte contains according to Heidingsfeld, (Ramm. 5th Supp. 206), $9\dot{\mathrm{Ba}}\dddot{\mathrm{S}}$, $1\dot{\mathrm{Sr}}\dddot{\mathrm{S}}$, $1\dot{\mathrm{Ca}}\dddot{\mathrm{S}}$, the analysis affording $\dddot{\mathrm{S}}$ 36·91, $\dot{\mathrm{Ba}}$ 54·58, $\dot{\mathrm{Sr}}$ 4·01, $\dot{\mathrm{Ca}}$ 2·52, $\dddot{\overline{\mathrm{Fe}}}$ 1·83=99·85. Decrepitates before the blowpipe, and is difficultly fusible, or only on the edges. In the inner flame is reduced to a sulphuret, and the globule, when moistened, smells slightly hepatic. Not acted upon by the acids. Does not tinge the flame red like strontian when tested with muriatic acid and alcohol.

Heavy spar occurs commonly in connection with beds or veins of metallic ores. It is met with in secondary limestones, sometimes forming distinct veins, and often in crystals along with calcite and celestine.

At Dufton, England, large transparent crystals occur; one of them of a tabular form, has been described as weighing forty-two pounds, and measuring ten inches across its basal plane. Some of the most important European localities are at Felsöbanya and Kremnitz, at Freiberg, Marienberg, Clausthal, Przibram, and at Roya and Roure in Auvergne. At Freiberg in Saxony, a variety occurs composed of indistinct prismatic crystals, and having a pearly lustre; this is the *Stangenspath* of Werner. Rounded masses, composed of diverging columnar particles, occur at Mount Paterno, near Bologna, which have hence been called the *Bolognese stone.* At Staffordshire and Derbyshire is found an opaque massive variety, of an earthy appearance and dirty-white color; this variety has been called *cawk.*

In Cheshire, Conn., large crystals, sometimes transparent, (f. 512 and simpler forms), occur in veins of red sandstone with vitreous copper and green malachite. Other similar localities are at Berlin, Farmington, and Southington, of the same State. Formerly found, but now exhausted, at Pillar Point, opposite Sackett's Harbor, N. Y., constituting a vein two to three feet thick, in compact limestone. Large slabs, when polished, are often quite beautiful. Earthy and foliated varieties and delicate crystals are found at the Perkiomen lead mine, in Pennsylvania. At Scoharie, N. Y., a fibrous variety occurs with carbonate of lime, and the two are often mechanically mingled. In St. Lawrence Co., N. Y., fine tabular crystals occur in De Kalb, at Fowler with specular iron, at the Parish ore bed, and on the farm of J. Morse, in Gouverneur, with calc spar and specular iron, and on the banks of Laidlaw lake in Rossie; the crested barytes is found at Hammond, with crystals of iron pyrites. At Wolcott, Wayne Co., near the stratum of lenticular iron ore, and on the south side of the Mohawk, opposite Little Falls, are other localities of some interest; also at Hatfield and Leverett in Massachusetts; Piermont, N. Hampshire; Brown's Creek and Haysboro', near Nashville, Tennessee, and at the lead mines of the west; also at Eldridge's gold mine, in Buckingham Co., Virginia, (f. 513); three miles S. W. from Lexington, in Rockbridge Co.; a beautiful white variety is found on the plantation of J. Hord, Esq., Fauquier Co., Virginia; in large veins in sandstone on the west end of I. Royale, L. Superior, and on Spar Id., north shore, one vein, (containing also calcite), fourteen feet wide, sometimes in crystals; in trap of north shore, veins numerous. There is a vein twenty-seven inches wide at Landsdown, Canada West, affording fine crystals.

The white varieties of heavy spar are ground up and employed as a white paint, either alone or mixed with white lead.

ALTERED FORMS.—Heavy Spar occurs altered to Calcite, Spathic Iron, Cerusite, Quartz, Limonite, Red Iron Ore, Pyrites, Psilomelane, Göthite.

CELESTINE. Sulphate of Strontian. Zölestine, *Wern.* Cölestin.

Trimetric. $I:I=104°\ 2'$ ($103°\ 30'$—$104°\ 30'$), $O:1\bar{\imath}=121°\ 19\frac{1}{2}'$; $a:b:c=1{\cdot}6432:1:1{\cdot}2807$.

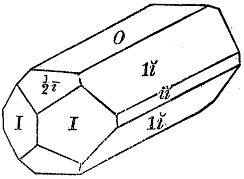
O					
					$\frac{1}{12}\breve{\imath}$
$\frac{1}{4}\bar{\imath}$	$\frac{1}{4}$				$\frac{1}{4}\breve{\imath}$
$\frac{1}{3}\bar{\imath}$	$\frac{1}{3}$				$\frac{1}{3}\breve{\imath}$
$\frac{1}{2}\bar{\imath}$					$\frac{1}{2}\breve{\imath}$
			$\frac{3}{5}\breve{3}$		
$\frac{8}{4}\bar{\imath}$					
$1\bar{\imath}$	1	$1\breve{2}$	$1\breve{3}$	$1\breve{4}$	$1\breve{\imath}$
				$\frac{4}{3}\breve{4}$	
			$\frac{3}{2}\breve{3}$		
					$2\bar{\imath}$
$i\bar{\imath}$	I	$i\breve{2}$			$i\breve{\imath}$

Observed Planes.

$O:\frac{1}{4}\bar{\imath}=157°\ 38'$.
$O:\frac{1}{2}\bar{\imath}=140°\ 35'$.
$O:\frac{3}{4}\bar{\imath}=129°\ 3'$.
$O:\frac{1}{4}=152°\ 29'$.
$O:1=115°\ 38'$.
$O:1\breve{\imath}=127°\ 56'$.
$O:1\breve{2}=123°\ 17'$.
$O:1\breve{3}=125°\ 38'$.
$O:1\breve{4}=126°\ 35'$.
$1:1$(mac.)$=112°\ 35'$.
$1:1$(brach.)$=89°\ 26'$.
$1:1$(basal)$=128^{c}\ 44'$.
$i\breve{2}:i\breve{2}=114°\ 44'$.
$\frac{1}{2}\bar{\imath}:\frac{1}{2}\bar{\imath}(top)=101°\ 11'$.
$1\breve{\imath}:1\breve{\imath}(top)=75°\ 52'$.

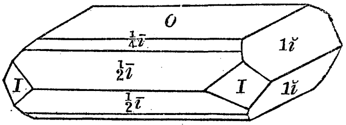
Cleavage: O perfect; I distinct; $i\breve{\imath}$ less distinct. Also, fibrous and radiated; sometimes globular; occasionally granular.

514



Etna.

515



L. Erie.

H.$=3$—$3{\cdot}5$. G.$=3{\cdot}92$—$3{\cdot}963$; $3{\cdot}9593$, Beudant, from small crystals. Lustre vitreous, sometimes inclining to pearly. Streak white. Color generally white, often faint bluish or reddish. Transparent—subtranslucent. Fracture imperfectly conchoidal—uneven. Very brittle.

Composition.—$\dot{\mathrm{Sr}}\dddot{\mathrm{S}}$=Sulphuric acid 43·6, and strontia 56·4. Analyses by Leonhard, (Lieb. Kopp. 1849, 776), and Madrell, (Hartm. Nachtr. 142). Often mixed with carbonate of lime, sulphate of baryta, or oxyd of iron. B.B. becomes opaque and decrepitates; on charcoal in the outer flame fuses rather easily to a milk-white alkaline globule. Phosphoresces when heated.

Celestine is usually associated with secondary or silurian limestone, or sandstone. Also in trap rocks, and in beds of gypsum, often with sulphur.

Sicily, at Girgenti and elsewhere, affords splendid groups of crystals along with sulphur and gypsum. Fine specimens are met with at Bex in Switzerland, and Conil in Spain; at Dornburg, near Jena; in the department of the Garonne, France; in the Tyrol; Retzbanya, Hungary; at Norten, in Hanover. A fibrous variety of a blue color occurs in clay, at Dornburg, near Jena. Also found at Aust Ferry, near Bristol; in trap rocks near Tantallan, in East Lothian; at the Calton Hill, Edinburg; near Knaresborough, in Yorkshire; at Popayan, New Grenada.

Specimens, finely crystallized, of a bluish tint, are found in compact limestone about Lake Erie, particularly on Drummond's island. Schoharie and Lockport, N.Y., have afforded good specimens; also the Rossie lead mine, N. Y.; Chaumont Bay, Depeauville and Stark, (farm of James Coill), New York. A blue fibrous celestine occurs near Frankstown, Logan's Valley, Huntington Co., Pennsylvania, associated with pearl spar and anhydrite.

The celestine of Drummond's Island, Lake Erie, contains sulphate of barytes, and gave Hugard the angle 103° 30′. That of Kingston, C.W., (*baryto-celestine* of Thomson), is pure celestine, according to T. S. Hunt, as the specific gravity 3·921 would indicate. The same is found at Sydenham, C. W.

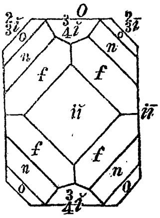
ANHYDRITE. Cube Spar, Muriacite, *W.* Karstenite, *Haus.* Vulpinite. Anhydrous Sulphate of Lime.

Trimetric: $I : I = 102° 56'$, $O : 1\bar{i} = 120° 42\frac{1}{2}'$, $a : b : c = 1{\cdot}684 : 1 : 1{\cdot}256$. Observed planes as in the annexed figure.

$O : \frac{2}{3}\bar{i} = 131° 42'$. $O : 1\breve{i} = 126° 19'$. $i\breve{i} : n(\frac{6}{4}\ \frac{\breve{18}}{8}) = 143° 37'$.
$O : \frac{3}{4}\breve{i} = 134° 25'$. $i\breve{i} : o(\frac{3}{4}\ \frac{\breve{9}}{8}) = 124° 10'$. $i\breve{i} : f(\frac{9}{4}\ \frac{\breve{27}}{8}) = 153° 50'$.

Cleavage: O very perfect; $i\breve{i}$ also perfect; $i\bar{i}$ somewhat less so. Also fibrous, lamellar, granular, and sometimes impalpable. The lamellar and columnar varieties often curved or contorted.

516



H.=3—3·5. G.=2·899—2·957. Lustre: O and $i\breve{i}$ somewhat pearly; $i\bar{i}$ vitreous, in massive varieties, vitreous inclining to pearly. Color white, sometimes a grayish, bluish or reddish tinge; also brick-red. Streak grayish-white. Fracture uneven; of finely lamellar and fibrous varieties, splintery.

Composition.—$\dot{C}a\dddot{S}$=Lime 41·2, sulphuric acid 58·8. B.B. whitens, but does not exfoliate, and is finally covered with a friable enamel. With borax, dissolves with effervescence to a transparent glass, becoming yellow or brownish-yellow on cooling.

Anhydrite has been variously denominated *muriacite, anhydrite, tripe stone,* (*gekrösstein*), according to its structure; the first, when crystallized in broad lamellæ; the second when granular; and the third when composed of contorted plates. *Vulpinite* is a siliceous variety, containing 8 per cent. of silex, and having the hardness 3·5. Pseudomorphs in cubes, imitative of rock salt, have been described by Haidinger.

Crystallized anhydrite occurs at the salt mines of Bex in Switzerland, and at Salzburg near Hall in the Tyrol. At Aussee, both crystallized and massive, the latter brick-red. Also at Sulz on the Neckar, in Würtemberg; at Bleiberg in Carinthia; at Lüneberg, Hanover; at Lauterberg in the Hartz; at Kapnik in Hungary; at Ischl in Upper Austria; and at Berchtesgaden in Bavaria. The variety *gekrösstein* has been found principally at Wieliczka in Poland. The *Vulpinite,* from Vulpino, Italy, admits of being cut and polished for ornamental purposes.

In the United States, at Lockport, N. Y., fine blue, in geodes of black limestone, accompanied with crystals of calcareous spar and gypsum. In Nova Scotia it forms extensive beds at the estuary of the Avon and the St. Croix river, also near the Five Islands, and elsewhere, associated with gypsum, in the carboniferous formation.

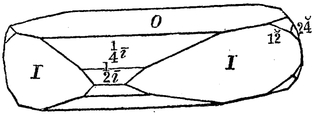
ALTERED FORMS.—Absorbs moisture and changes to gypsum. Extensive beds are sometimes thus altered in part or throughout, as at Bex, in Switzerland, where, by digging down 60 to 100 feet, the unaltered anhydrite may be found. Sometimes specimens of anhydrite are altered between the folia or over the exterior.

ANGLESITE, *Beud.* Sulphate of Lead. Lead Vitriol. Bleivitriol. Vitriolbleierz, *W.*

Trimetric: $I : I$=103° 38′, (103° 43½′, Kokscharov, Pogg. xc, 158), $O : 1\bar{i}$=121° 21′; $a : b : c$=1·6415 : 1 : 1·2715.

$O : \frac{1}{2}\bar{i}$=140° 37′. $O : 1\breve{i}$=127° 45′. $1\breve{i} : 1\breve{i}$ (top)=75° 29′.
$O : 1$=115° 33′. 1 : 1 (mac.) 112° 13′. $\frac{1}{2}\bar{i} : \frac{1}{2}\bar{i}$ (top)=101° 15′.
$O : \frac{1}{2}$=133° 44′. 1 : 1 (brac.) 89° 41′. $i\breve{2} : i\breve{2}$ (ov. $i\breve{i}$)=115° 6′.
$O : 1\breve{2}$=123° 9′. 1 : 1 (bas.) 128° 54′.

517



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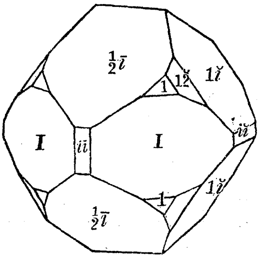

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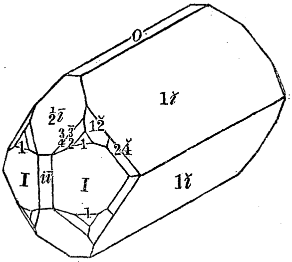

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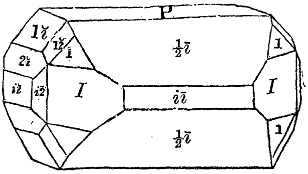


O						
		$\frac{1}{6}$				
$\frac{1}{4}\bar{i}$						
$\frac{1}{2}\bar{i}$		$\frac{1}{2}$				
	$\frac{3}{4}\frac{\bar{3}}{2}$					
		1		$1\breve{2}$		$1\breve{i}$
				$2\breve{2}$	$2\breve{4}$	$2\breve{i}$
$i\bar{i}$		I	$i\breve{\frac{4}{3}}$	$i\breve{2}$		$i\breve{i}$

Observed Planes.

Cleavage: I, O, but interrupted. The planes I and $i\bar{i}$, often vertically striated, and $\frac{1}{2}\bar{i}$ horizontally. Also lamellar, and massive granular.

H.=2·75—3. G.=6·259—6·298. Lustre highly adamantine in some specimens, in others inclining to resinous and vitreous. Color white, tinged yellow, gray, green, and sometimes blue. Streak uncolored. Transparent—opaque. Fracture conchoidal. Very brittle.

Composition.—$\dot{Pb}\dddot{S}$=Sulphuric acid 26·4, oxyd of lead 73·6=100. Analyses: 1, Klaproth, (Beit. iii, 162); 2, Stromeyer, (Unters. 226); 3, Thomson, (Min. i, 559):

	$\dddot{S}$	$\dot{Pb}$	$\dddot{\text{F}}\text{e}^2\dot{H}^3$	$\dot{H}$
1. Wanlockhead,	25·75	70·50	—	2·25=98·50, Klaproth.
2. Zellerfeld,	26·09	72·47	0·09	0·51, $\dddot{\text{M}}$n 0·07=99·23, Strom.
3. Leadhills,	25·65	74·05	—	0·30=100, Thomson.

Decrepitates in the flame of a candle, and frequently becomes slightly reddish. B.B. in powder, melts to a bead which cools milk-white; and in the inner flame affords metallic lead by the addition of soda.

This ore of lead results, in many instances, from the decomposition of galena. At Leadhills it frequently occurs, occupying the cubical cavities of galena, or disposed on the surface of this ore. This locality, and also Wanlockhead, afford large and beautiful crystals of this mineral, some of which are transparent, of a tabular form, and several inches in diameter; occurs also at Pary's mine in Anglesea, Mellanoweth, in Cornwall, Derbyshire in large crystals, Clausthal, Zellerfield and Giepenbach, in the Hartz, near Siegen in Prussia, at Schapbach in the Black Forest, Badenweiler in Breisgau, and on Sardinia. Small, but extremely perfect transparent crystals, have been brought from Fondon in Granada. The massive varieties are met with in Siberia, Andalusia, and Alston Moor in Cumberland.

In the United States, it occurs in large crystals at Wheatley's mine, Phenixville, Pa., (f. 517, 518, 519); in the Missouri lead mine; at the lead mine of Southampton, Mass.; at Rossie, N. Y., with galena at the Walton gold mine, Louisa Co., Va.

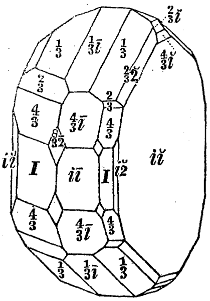
ALTERED FORMS.—Anglesite occurs altered to cerusite ($\dot{Pb}\ddot{C}$.)

ALMAGRERITE. *Anhydrous Sulphate of Zinc, Breit.*—According to Breithaupt, this sulphate occurs at the mine of Barranco Jaroso in the Sierra Almagrera, Spain, in crystals isomorphous with Anglesite and Heavy Spar. G.=4·331. (B. u. H. Ztg., 1852, No. 7; Ramm. 5th Suppl., 26).

LEADHILLITE. Sulphato-tricarbonate of Lead, *Brooke*, Ed. Phil. Jour. iii, 117. Rhomboidal Carbonate of Lead. Bleisulphotricarbonat, *Ramm.* Ternärbleierz.

Trimetric, Brooke and Miller. $I : I$=103° 16′, $O : 1\breve{i}$=120° 10′; $a : b : c$=1·7205 : 1 : 1·2632. Observed planes as in f. 521, with also $i\breve{2}$ replacing edge between I and $i\breve{i}$. Hemihedral in I and some other planes; hence monoclinic in aspect, or rhombohedral when in compound crystals.

521



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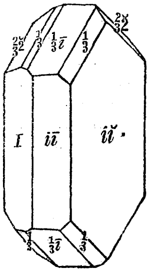
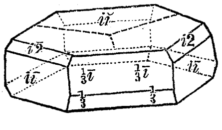


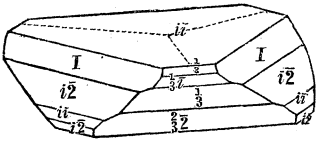
523



$O : \frac{1}{3}\breve{i}$=150° 10′.
$O : \frac{1}{3}$=126° 11′.
$i\breve{i} : \frac{1}{8}\breve{i}$=119° 50′.
$i\breve{i} : \frac{4}{3}\breve{i}$=156° 27′.
$i\breve{i} : \frac{2}{3}\breve{2}$=128° 14′.
$i\breve{i} : \frac{1}{8}$=111° 30′.
$i\breve{i} : I$=128° 22′.
$i\breve{i} : i\breve{2}$=111° 36
$i\breve{i} : i\breve{i}$=90°.

Cleavage: $i\tilde{i}$ very perfect; $i\tilde{i}$ *traces*. Twins, f. 523, 524, (drawn with $i\tilde{i}$ as top plane), consisting of 3 crystals; face of composition $1\bar{i}$, (see f. 525); also parallel with *I*.

524



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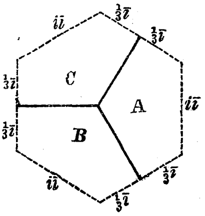


H.=2·5. G.=6·2—6·5. Lustre of $i\tilde{i}$ pearly, other parts resinous, somewhat adamantine. Color white, passing into yellow, green or gray. Streak uncolored. Transparent—translucent. Conchoidal fracture scarcely observable. Rather sectile.

Composition.—$\dot{Pb}\,\dddot{S}+3\dot{Pb}\ddot{C}$=Sulphate of lead 27·44, carbonate of lead 72·56. Analyses: 1, Berzelius, (Jahresb, iii, 134); 2, Stromeyer, (Gött. gel. Anz. 1825, 113):

	$\dot{Pb}\,\dddot{S}$	$\dot{Pb}\,\ddot{C}$	
1.	28·7	71·0=99·7,	Berzelius.
2.	28·3	72·7=100,	Stromeyer.

B.B. intumesces at first, and then turns yellow; but white on cooling. Easily reduced on charcoal. Effervesces briskly in nitric acid, and leaves a white precipitate.

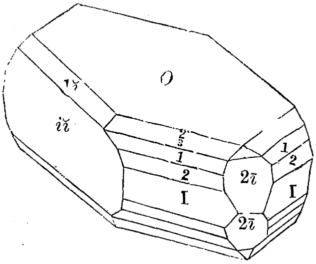
This ore has been found principally at Leadhills, associated with other ores of lead; Grenada is also stated to be a locality of it, and the island of Serpho, Grecian Archipelago. The crystals seldom exceed an inch in length, and are commonly smaller. Reported by C. U. Shepard, (Am. J. Sci. [2], xv, 446), from Newberg District, South Carolina, but there is some doubt as to the locality.

Brooke and Miller, who show that the form of Leadhillite is trimetric, make the prism $\frac{1}{3}\bar{i}$ (of 120° 20′), the fundamental vertical prism, and appear to regard the species as related to Aragonite. The fact that the twins are not formed parallel to the faces of this prism, (as they should be if the prism $\frac{1}{3}\bar{i}$ were homologous with the Aragonite prism), and the close approximation in angle to Anglesite, shown above, besides other reasons, have led the author to adopt the position of the crystals here given, which exhibits the Anglesite relation. Susannite (rhombohedral) and Leadhillite (trimetric) are mutually dimorphs, and so also are Dreelite and Anglesite. Now Susannite and Dreelite are nearly identical in angle; and therefore Leadhillite and Anglesite must be equally related. Since in Susannite the sulphuric acid dominates over the carbonic acid and impresses on the lead salt its character, (or the form of the sulphate), the same should be the case with its correlate Leadhillite—this species being the very same chemical compound. (See on this subject, Am. J. Sci. [2], vol. xviii). The hemihedrism of the species gives origin to the peculiar rhombohedral aspect of the twins. The angles of these twins are near those of Susannite.

CALEDONITE, *Beud.* Cupreous Sulphato-Carbonate of Lead, *Brooke*, Ed. Phil. Jour. iii, 117. Halbazurblei, *Ramm.*

Trimetric. $I:I$=95°, $O:1\bar{i}$=123° 9′; $a:b:c$=1·5314 : 1 : 1·0913. Observed planes as in the annexed figure. $O:1\breve{i}$=125° 29′, $O:2\bar{i}$=108° 5′, $O:\frac{2}{3}$=125° 50′, $O:1$=115° 43′, $I:i\tilde{i}$=132° 30′, 1 : 1 (pyr.)=105° and 96° 45′. Cleavage *I* and *O* indistinct, $i\tilde{i}$ more obvious. Crystals sometimes large, usually minute, and occasionally in bunches diverging from a point.

526



H.=2·5—3. G.=6·4. Lustre resinous. Color deep verdigris or bluish-green; inclining to mountain-green if the crystals are delicate. Streak greenish-white. Translucent. Fracture uneven. Rather brittle.

Composition.—Analysis by Brooke, (Ed. Phil. J. iii, 119):

$\dot{Pb}\dddot{S}$ 55·8 $\dot{Pb}\ddot{C}$ 32·8 $\dot{Cu}\ddot{C}$ 11·4=100, Brooke.

B.B. easily reduced. Soluble in nitric acid, with slight effervescence.

Occurs at Leadhills, Scotland, accompanying other ores of lead, in crystals with Linarite, at Roughten Gill in Cumberland; also reported from Tanné in the Hartz, and from Mine la Motte, Missouri.

DREELITE, *Dufrênoy*, Ann. de Ch. et de Ph. lx, 102.

Rhombohedral. $R : R = 93^\circ$ or 94°. Cleavage: rhombohedral, in traces.

H.=3·5. G.=3·2—3·4. Lustre pearly; splendent on a surface of fracture. Streak and color white.

Composition.—$\dot{Ca}\dddot{S}+3\dot{Ba}\dddot{S}$. Analysis by Dufrénoy, (loc. cit.):

$\dot{Ba}\dddot{S}$ 61·73 $\dot{Ca}\dddot{S}$ 14·275 $\dot{Ca}\ddot{C}$ 8·05 $\dddot{Si}$ 9·71 $\ddot{Al}$ 2·405 $\dot{Ca}$ 1·52 $\dot{H}$ 2·31=100.

In small unmodified crystals, disseminated on the surface, and in the cavities of a quartzose rock, at Beaujeu, France, Dep. of the Rhone; also at Badenweiler, (Baden).

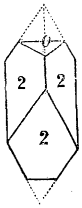
It was named by Dufrénoy in honor of M. de Drèe, a liberal patron of science.

Thomson has analyzed another compound of the sulphates of baryta and lime, (Min. i, 106), consisting of 71·9 of the former to 28·1 of the latter; it was from Harrowgate in Yorkshire.

SUSANNITE, *Haidinger*.

Rhombohedral. $R : R = 94^\circ$, $O : R = 128^\circ\ 3'$; $a = 1{\cdot}1062$. Observed planes, -2, O, i, 2, 4, -14. $O : 2R = 111^\circ\ 13'$, $O : 4 = 101^\circ\ 30'$, $2 : 2 = 72^\circ\ 30'$. Cleavage O easily obtained.

527



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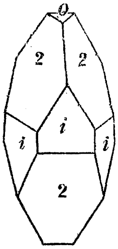


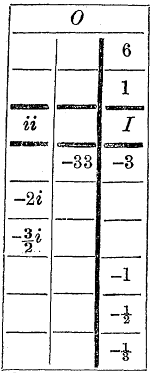
H.=2·5. G.—6·55. Lustre resinous—adamantine. Color white, green, yellow, brownish-black. Streak uncolored.

Composition.—Same as for Leadhillite. Analysis by Brooke, (Edinb. Phil. J., New Series, iii, 117, 138), Sulphate of lead 27·5, carbonate of lead 72·5.

In attached crystals at Leadhills in Scotland, and at Moldawa in the Bannat. Formerly referred to Leadhillite, the compound crystals of which it resembles.

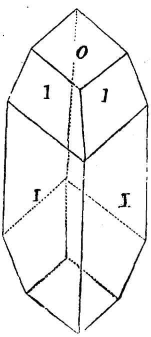
The rhombohedron *R* of Susannite, as it is assumed by Haidinger, equals very nearly –2 of Dreelite, which it is here made. (The minus sign is omitted in the figure).

GLAUBERITE, *Brongniart*, J. des Mines, xxiii, 5. Brongniartin, *v. Leonh.*



Observed Planes.

530



Monoclinic. *C*=68° 16′, *I*: *I*=83° 20′, *O* : 1ì=136° 30′; *a* : *b* : *c*=0·8454 : 1 : 0·8267. *O* : ìi=111° 44′, *O* : 1=136° 49′, *O* : –3=88° 57′, *O* : *I*=104° 15′, 1 : 1=116° 20′, –1 : –1=95° 22′, –33 : –33=136° 8′, B. & M. According to Senarmont, (Ann. Ch. Phys. [3], xxxvi, 157), *I*: *I*=82° 56′ (to 83° 15′), *O* : 1=137° 37′, *O* : 3=89° 6′, *O* : *I*=105° 17′, (104° 52′—105° 17′), 1 : 1=116° 52′, (116° 18′—116° 52′), –33 : –33=135° 20′. Cleavage: *O* perfect. H.=2·5—3. G.=2·64—2·85. Lustre vitreous. Color pale-yellow or gray. Streak white. Fracture conchoidal; brittle. Taste slightly saline.

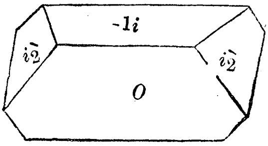
Composition.—$(\frac{1}{2}\dot{N}a+\frac{1}{2}\dot{C}a)\dddot{S}$=Sulphate of soda 51·1, and sulphate of lime 48·9. Kobell obtained from a specimen from Berchtesgaden, (v. Leonh. 1846, 840), Sulphate of soda 48·6, sulphate of lime 51·0. Crystals from Atacama gave Hayes, (Jour. Bost. Nat. Hist. Soc. iv, 498), Sulphuric acid 67·22, soda 21·32, lime 20·68, iron 0·14 =99·56.

Ulex found in the Peruvian mineral, $\dot{C}a$ 19·6, $\dot{N}a$ 21·9, $\dddot{S}$ 55·0, $\ddot{B}$ 3·5=100, the boracic acid being due to mixture. Kengott obtained from an Ischl specimen, (Sitz. Wien, Akad.), $\ddot{S}$ 57·52, $\dot{C}a$ 20·37, $\dot{N}a$ 21·60, Na 0·20, Cl 0·31. In water it loses its transparency, and is partly dissolved. On long exposure it absorbs moisture and falls to pieces. Before the blowpipe it decrepitates and melts to a clear glass. On charcoal, it first whitens, then fuses to a transparent bead, opaque on cooling.

In crystals in rock salt at Villa Rubia, near Ocana in New Castile: also at Aussee, in Upper Austria, in Bavaria; and at the salt mines of Vic, in France, (*O* : *I*=104° 11′, Duf.) Province of Tarapaca, Peru, with the Hayesine, (affording the above figure and Senarmont's angles.)

LANARKITE, *Beud.* Dioxylite. Sulphato-Carbonate of Lead, *Brooke*, Ed. Phil. Jour. iii, 117.

531



Monoclinic. *I* : *I*=85° 48′. ì2 : ì2 (front) 49° 50′, Greg. *O* : –1*i*=120° 45′. Plane ì2 usually rounded, and the crystals aggregated lengthwise, and seldom distinct. Cleavage : *O* perfect; –1*i* less perfect. Laminæ flexible as in gypsum.

H.=2—2·5. G.=6·3—7. Lustre of the cleavage face pearly; other parts adamantine, inclining to resinous. Streak white. Color greenish-white, pale-yellow or gray. Transparent—translucent.

Composition.—$\dot{P}b\dddot{S}+\dot{P}b\ddot{C}$=Sulphate of lead 53·15, carbonate of lead 46·85. Analysis by Brooke, (loc. cit.); Thomson, (Phil. Mag. 1840, Dec. 402):

Carbonate of lead 46·9, sulphate of lead 53·1=100.
" " 46·04, " " 43·96=100, G.=6·3197.

B.B. fuses to a globule, which is white on cooling. Dissolves in nitric acid without perceptible effervescence.

At Leadhills, Scotland. Massive in Siberia and at Tanné in the Hartz; at Biberweier, Tyrol.

Appendix to the Anhydrous Sulphates, etc.

REUSSIN, *Karsten.*

In white, flat, six-sided crystals, and also acicular, in radiating groups. Also a mealy efflorescence. Color white. Taste saline and bitter.

Composition.—Analysis by Reuss, (Crell's Anal. 1791, ii, 18);

$\dot{N}a\dddot{S}$ 66·04, $\dot{M}g\dddot{S}$ 31·35, CaCl 2·19, Gypsum 0·42.

From the neighborhood of Seidlitz in Bohemia.

SELENATE OF LEAD. Selenbleispath, *Kersten*, Pogg. xlvi, 277.

In small spheres and botryoidal masses. Cleavage distinct in one direction.

H.=3—4. Lustre greasy—vitreous. Color sulphur-yellow. Streak uncolored. Brittle. Fracture fibrous.

According to Rose's examination, it consists of selenic acid and oxyd of lead, with a small proportion of oxyd of copper. On coal it fuses readily to a black slag, giving off a strong selenium odor, and is finally reduced to a metallic globule. With borax it fuses and forms a yellowish-green pearl, which is of the same color on cooling. With soda, on charcoal, metallic lead is obtained.

Occurs with seleniuret of antimony and lead, malachite, etc., at the Friederichsglück mine, near Hilburghausen, and at Eisfeld.

CONNELLITE. Sulphato-chlorid of Copper, *Connel,* Proc. Brit. Assoc. for 1847.

Hexagonal. In hexagonal prisms with truncated edges. Lustre vitreous. Color fine blue. Translucent.

Composition.—From trials by Connel, supposed to be a compound of a sulphate and chlorid of copper.

Associated with arsenate of copper in Cornwall.

II. HYDROUS SULPHATES.

[As in the case of other hydrous minerals, there are but few species that can be arranged in groups. For the most part, each of the Hydrous Sulphates belongs to a distinct group, represented by a single species alone. The exceptions to this are the Alum Group, monometric, with the oxygen ratio for the bases, acid and water, 1 : 3 : 6 ; the Vitriol Group, monoclinic, having the ratio 1 : 3 : 7 ; the Epsomite Group, trimetric, with the same ratio. The Epsomite and Vitriol Groups are mutually dimorphous. The species are here placed according to the oxygen ratio, commencing with that containing the most acid and least water.]

	Oxygen ratio.	Formula.
	$\dot{R}+\dddot{\bar{R}}$ $\dddot{S}$ H	
Misenite,	1 : 6 : 1	$\dot{K}\dddot{S}+\dot{H}\dddot{S}$.
Polyhalite, III.	1 : 3 : $\frac{1}{2}$	$\dot{R}\dddot{S}+\frac{1}{2}\dot{H}$.
Gypsum, IV. (Gypsum Gr.),	1 : 3 : 2	$\dot{C}\mathrm{a}\dddot{S}+2\dot{H}$.
Astrakanite,	1 : 3 : 2	$(\dot{M}\mathrm{g}, \dot{N}\mathrm{a})\dddot{S}+2\dot{H}$.
Mascagnine, III. (Mascagnine Gr.),	1 : 3 : 2	$(NH^4O)\dddot{S}+2\dot{H}$.
Coquimbite, VI. (Coquimbite Gr.),	1 : 3 : 3	$\dddot{\bar{F}}\mathrm{e}\dddot{S}^3+9\dot{H}$.
Cyanosite, V. (Cyanosite Gr.),	1 : 3 : 5	$\dot{C}\mathrm{u}\dddot{S}+5\dot{H}$.
Alunogen,	1 : 3 : 6	$\dddot{\bar{A}}\mathrm{l}\dddot{S}^3+18\dot{H}$.
Alum, I. (Alum Gr.),	1 : 3 : 6	$\dot{R}\dddot{S}+\dddot{\bar{R}}\dddot{S}^3+24\dot{H}$.
Epsomite, III. (Epsomite Gr.),	1 : 3 : 7	$\dot{M}\mathrm{g}\dddot{S}+7\dot{H}$.
Goslarite, “	1 : 3 : 7	$\dot{Z}\mathrm{n}\dddot{S}+7\dot{H}$.
Copperas, IV. (Vitriol Gr.),	1 : 3 : 7	$\dot{F}\mathrm{e}\dddot{S}+7\dot{H}$.
Bieberite, “		$(\dot{C}\mathrm{o}, \dot{M}\mathrm{g})\dddot{S}+7\dot{H}$.
? Pyromeline, “		$\dot{N}\mathrm{i}, \dddot{S}, \dot{H}$.
Johannite,		$\ddot{U}, \dddot{S}, \dot{H}$.
Glauber Salt, IV.	1 : 3 : 10	$\dot{N}\mathrm{a}\dddot{S}+10\dot{H}$.
Botryogene, IV.	1 : 2 : 3	$(\dot{R}^3, \dddot{\bar{R}})\dddot{S}^2+9\dot{H}$.
Copiapite,		$\dddot{\bar{F}}\mathrm{e}, \dddot{S}, \dot{H}$.
Apatelite,		
Alunite, VI. (Alunite Gr.),	1 : $\frac{6}{5}$: $\frac{3}{5}$	$\dot{K}\dddot{S}+3\dddot{\bar{A}}\mathrm{l}\dddot{S}+6\dot{H}$.
? Jarosite, VI.		$\dot{K}, \dot{F}\mathrm{e}$ or $\dddot{\bar{F}}\mathrm{e}, \dddot{S}, \dot{H}$.
Websterite,	1 : 1 : 9	$\dddot{\bar{A}}\mathrm{l}\dddot{S}+9\dot{H}$.

Pissophane,	
Linarite, IV.	$\dot{\mathrm{Pb}}\dddot{\mathrm{S}}+\dot{\mathrm{Cu}}\dot{\mathrm{H}}$.
Brochantite, III.	$\dot{\mathrm{Cu}}\dddot{\mathrm{S}}+3\dot{\mathrm{Cu}}\dot{\mathrm{H}}$.
Lettsomite,	$\mathrm{Cu}^6\dddot{\mathrm{S}}+\dddot{\mathrm{Al}}\dddot{\mathrm{S}}+12\dot{\mathrm{H}}$.
Medjidite,	

MISENITE, *A. Scacchi*, Mem. Geol. sulla Campania, 1849, p. 98.

In silky fibres of a white color. Soluble; in taste, acid and bitter.

Composition.—$\dot{\mathrm{K}}\dddot{\mathrm{S}}+\dot{\mathrm{H}}\dddot{\mathrm{S}}$. Analysis by Scacchi, (loc. cit. and J. f. pr. Ch. lv, 54):
$\dddot{\mathrm{S}}$ 56·93, $\dot{\mathrm{K}}$ 36·57, $\dddot{\mathrm{Al}}$ 0·38, $\dot{\mathrm{H}}$ 6·12=100.

Fuses easily in the flame of a spirit lamp.
Occurs in a hot tufa cavern, near Misene.

POLYHALITE.

Trimetric. A prism of 115°, with acute edges truncated. Usually in compact fibrous masses.

H.=2·5—3. G.=2·7689. Lustre resinous or slightly pearly. Streak red. Color flesh or brick-red, sometimes yellowish. Translucent—opaque. Taste bitter and astringent, but very weak.

Composition.—$\dot{\mathrm{R}}\dddot{\mathrm{S}}+\frac{1}{2}\dot{\mathrm{H}}$, in which $\dot{\mathrm{R}}=\dot{\mathrm{K}}$, $\dot{\mathrm{Mg}}$, $\dot{\mathrm{Ca}}$ in the ratio 1 : 1 : 2, (analyses 1 to 3), or 1 : 1 : 4, (anal. 5). Analyses: 1, Stromeyer, (Unters. i, 144); 2, Rammelsberg, (Pogg. lxviii, 512); 3, C. A. Joy, (Inaug. Dissert., 49); 4, 5, von Hauer, (Sitz. Wien. xi, 385):

	$\dot{\mathrm{Ca}}\dddot{\mathrm{S}}$	$\dot{\mathrm{Mg}}\dddot{\mathrm{S}}$	$\dot{\mathrm{K}}\dddot{\mathrm{S}}$	NaCl	$\dddot{\mathrm{Fe}}$	$\dot{\mathrm{H}}$
1. Ischl,	44·47	20·03	27·70	0·19	0·34	5·95=98·94, Strom.
2. Aussee,	45·43	20·59	28·10	0·11	0·33	5·24, $\dddot{\mathrm{Si}}$ 0·2=100, Ramm.
3. Gmund,	42·78	19·85	28·11	1·75	$\dot{\mathrm{Fe}}\dddot{\mathrm{S}}$ 0·36	6·41, $\dot{\mathrm{Na}}\dddot{\mathrm{S}}$ 0·75=99·21, Joy.
4. Hallstatt,	56·41	11·04	14·81	12·16	——	5·58=100, v. Hauer.
5. Ebensee,	61·18	13·53	19·12	0·23	$\dddot{\mathrm{Fe}}$ 0·41	6·05=100·52, v. Hauer.

Becomes opaque in the flame of a candle, and of a brownish color. B.B. fuses instantly. But slightly soluble in water.

Occurs at the mines of Ischl, Aussee, Hallstatt and Ebensee, in Austria, with common salt, gypsum, and anhydrite; at Berchtesgaden in Bavaria.

The name Polyhalite is derived from πολύς, *many*, and ἁλς, *salt*, in allusion to the number of salts in the constitution of the mineral.

The specimens from Vic in Lorraine, analyzed by Berthier, are supposed to be glauberite mixed with rock salt.

GYPSUM. Sulphate of Lime. Alabaster. Selenite. Satin Spar. Gyps. Plaster of Paris. Schaumkalk. Γύψος.

Monoclinic. $C=66°\ 14'$, $I : I=138°\ 28'$, $1\grave{i} : 1\grave{i}=128°\ 31'$; $a : b : c=0{\cdot}9 : 1 : 2{\cdot}4135$. Angles from B. and M.

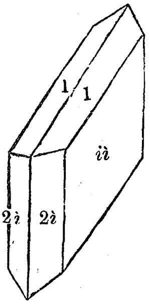
$O : \grave{i}\grave{i}=66°\ 14'$. $O : I=67°\ 52'$. $O : 4\grave{i}=126°\ 12'$.
$O : 1\grave{i}=127°\ 44'$. $O : 2=98°\ 46'$. $1 : 1=143°\ 42'$.
$O : 3\grave{i}=87°\ 58'$. $O : 1=88°\ 8'$. $2\grave{i} : 2\grave{i}=111°\ 42'$.
$O : 1=125°\ 35'$. $O : 2\grave{i}=145°\ 41'$. $1 : I=122°\ 17'$.

Cleavage: *ii* eminent; *I* imperfect, fibrous; *O* imperfect, conchoidal. Twins: plane of composition *O*, as in f. 534, reëntering angle 104° 32′; also 1*i* or plane truncating edge 1 : 1, and reëntering angle 79° 32′, made by plane *ii*, form often lenticular. Lamellar-stellate, lamellar and granular; often massive, and sometimes nearly impalpable.

$O(a)$					
$1i(d)$		$1(l)$			
		$2(v)$			$2i(m)$
$3i(e)$	$33(w)$	$3(u)$		$3\grave{3}(y)$	
					$4i(h)$
					$6i(k)$
$ii(t)$		$I(n)$	$i\grave{2}(x)$	$i\grave{3}(s)$	$ii(b)$

Observed Planes.

532



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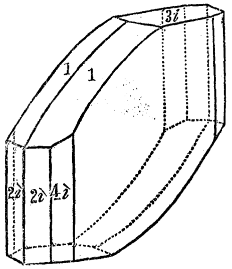

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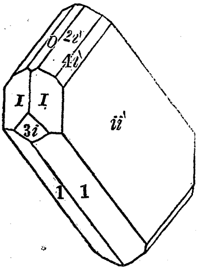

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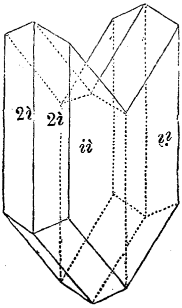

H.=1·5—2. G.=2·314—2·328, when pure crystals. Lustre of *ii* pearly and shining, other faces subvitreous. Massive varieties often glistening, sometimes dull earthy. Color usually white; sometimes gray, flesh-red, honey-yellow, ochre-yellow, blue; impure varieties often black, brown, red, or reddish-brown. Streak white. Transparent—opaque.

Composition.—$\dot{C}a\dddot{S}+2\dot{H}$=Sulphuric acid 46·51, lime 32·56, water 20·93. De la Trobe found in the gypsum of the volcano of Albay, island of Luzon, 6·43 of silica, (Ramm. 4th Supp., 89). B.B. becomes opaque-white, exfoliates, and falls to powder. At a high heat it fuses with difficulty to a white enamel. The white powder obtained by heat, if moistened, soon becomes very firmly solid. No effervescence with acids when pure. Soluble in 400 to 500 parts of water.

The transparent varieties are called *Selenite;* the fine massive varieties, *Alabaster;* the fibrous, *Satin Spar*. *Schaumkalk* is a variety in small scales of a pearly lustre.

Gypsum often forms extensive beds in secondary countries, and is also found in tertiary and recent deposits; occasionally in crystalline rocks. It is also a product of volcanoes, occurring about fumaroles, or where sulphur gases are escaping, being formed from the sulphuric acid generated, and the lime afforded by the decomposing lavas—lime being contained in augite and labradorite. It is also produced by the decomposition of pyrites when lime is present; and often about sulphur springs where sulphuretted hydrogen is emitted, this gas changing through reaction with vegetable matter into sulphuric acid. Gypsum is also deposited on the evaporation of sea-water and brines.

Fine specimens are found in the salt mines of Bex in Switzerland; at Hall in the Tyrol; in the sulphur mines of Sicily; in the gypsum formation, near Oçana, in Spain; in the clay of Shotover Hill, near Oxford; and large lenticular crystals have been met with at Montmartre, near Paris. Derbyshire affords the fibrous varieties. Alabaster occurs at Castelino, 35 miles from Leghorn, whence it is taken to Florence for the manufacture of vases, figures, &c. Gypsum also occurs in acicular crystals in most volcanic regions.

This species occurs in extensive beds in several of the United States; and more particularly New York, Ohio, Illinois, Virginia, Tennessee, and Arkansas, and is usually associated with salt springs. Also in Nova Scotia, Peru, &c.

Handsome selenite and snowy gypsum occur in New York, near Lockport, (occasionally f. 532), in limestone along with pearl spar and anhydrite; also near Camillus, Onondaga County, occasionally crystals are met with in the vicinity of Manlius In Ohio, large transparent crystals, have been found at Poland and Canfield, Trumbull County; in Maryland, large grouped crystals on the St. Mary's in clay; also near the mouth of the Patuxent; in Iowa, in perfect crystals in the shales of the coal measures on Cedar river, a branch of the Des Moines, and elsewhere on the latter river. Selenite and Alabaster occur in Davidson County, Tennessee, and large beds of gypsum with rock salt in Washington County, Virginia, eighteen miles from Abingdon. In the Mammoth Cave, Kentucky, it presents singular imitations of vines, flowers, and shrubbery.

Plaster of Paris, or gypsum which has been heated and ground up, is used for making moulds, taking casts of statues, medals, &c., for producing a hard finish on walls; also in the manufacture of artificial marble, as the scagliola tables of Leghorn, and in the glazing of porcelain.

The fibrous variety when cut *en cabochon*, and polished, resembles cat's eye.

Gypsum is related in form to heulandite, a fact brought out in the view above taken of the crystallization, (Am. J. Sci. [2], xvii, 85). To the table of observed planes the lettering of Brooke and Miller for the planes is added. Plane I of f. 534 would be situated on f. 533, between $2\grave{\imath}$ and $3\grave{\imath}$ below, or the back $2\grave{\imath}$ and $3\grave{\imath}$ above. Kengott obtained from an English crystal $2\grave{\imath} : 2\grave{\imath} = 111° 14'$, (Sitz. Wien. Ak. xi).

Note.—The gypsum of East River, Pictou, Nova Scotia, according to Prof. W. R. Johnson, and that of Southern Virginia, according to Prof. W. B. Rogers, (Am. J. Sci. [2], v, 113, 1848), contain 1 atom of water to 2 of sulphate of lime, ($2\dot{\mathrm{C}}\mathrm{a}\dddot{\mathrm{S}}+\dot{\mathrm{H}}$). The passage of anhydrite into gypsum is exemplified on a large scale in many places, as at the Canaria valley and at Bex in Switzerland, (Blum, Pseud. p. 24; Am. J. Sci. xlviii, 69), and the compound here described may have been formed in the course of the transition.

Altered Forms.—Gypsum occurs altered to calcite.

ASTRAKANITE, *Rose*.

In imperfect prismatic crystals, whitish and translucent.

Composition.—$\dot{\mathrm{M}}\mathrm{g}\dddot{\mathrm{S}}+\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}+4\dot{\mathrm{H}}$=Sulphate of magnesia 35·9, of soda 42·5, water 21·6. Analysis by Göbel:

$\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}$ 41·00, $\dot{\mathrm{M}}\mathrm{g}\dddot{\mathrm{S}}$ 35·18, $\dot{\mathrm{H}}$ 21·56, Mg Cl 0·33, Gypsum and sand 1·75.

From the salt lakes east of the mouth of the Volga. Rammelsberg suggests that this species may be the same as Blödite. The *Blödite* of John from Ischl afforded John, $\dot{\mathrm{M}}\mathrm{g}\dddot{\mathrm{S}}$ 36·66, $\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}$ 33·34, $\dot{\mathrm{M}}\mathrm{n}\dddot{\mathrm{S}}$ 0·33, NaCl 0·33, $\dot{\mathrm{H}}$ 22·00=92·66, with 0·34 sulphate of peroxyd of iron.

MASCAGNINE. Maskagnin, *Karsten, Reuss*. Sulphate of Ammonia.

Trimetric. $I : I = 107° 40'$, $O : 1\breve{\imath} = 122° 56'$, $a : b : c = 1{\cdot}5437 : 1 : 1{\cdot}3680$. Cleavage: $\breve{\imath}\breve{\imath}$ perfect; O imperfect.

$O : \frac{1}{2}\breve{i} = 150° 34'$. $\frac{1}{2}\breve{i} : \frac{1}{2}\breve{i}$(bas.)$= 58°52'$. $\dot{i}\breve{2} : \dot{i}\breve{2} = 111° 15'$.
$O : \frac{3}{2}\breve{i} = 125° 34'$. $\frac{3}{2}\breve{i} : \frac{3}{2}\breve{i} = 118° 52'$. $\frac{1}{2} : \frac{1}{2}$ (over I)$= 87° 26'$.

Usually in mealy crusts and stalactitic forms.

H.=2—2·5. G.=1·72—1·73. Lustre when crystallized, vitreous. Color yellowish-gray, lemon-yellow. Translucent. Taste pungent and bitter.

Composition.—$\mathrm{NH^4O}\dddot{\mathrm{S}}+2\dot{\mathrm{H}}$=Sulphuric acid 52·33, $\mathrm{NH^4O}$ 34·67, water 12·00. Dissolves readily in water.

Occurs about volcanoes, in the fissures of the lava, as at Etna, Vesuvius, and the Lipari Isles, and is one of the products of the combustion of mineral coal. It was named in honor of Professor Mascagni, its discoverer, (v. Dei Lagoni del Sinesee del Valterrano in Siena, 1779).

COQUIMBITE. White Copperas. Neutrales Schwefelsaures Eisenoxyd.

Hexagonal. Prisms usually with the terminal edges deeply replaced. $O : 1 = 151°$, $I : 1 = 119°$, $1 : 1 = 128° 8'$. Cleavage: I imperfect. Also in fine granular masses.

H.=2—2·5. G.=2—2·1. Color white, yellowish, brownish, sometimes with a pale violet tint. Taste astringent.

Composition.—$\dddot{\bar{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{S}}^3+9\dot{\mathrm{H}}$=Sulphuric acid 42·7, peroxyd of iron 28·5, water 28·8 =100. Analyses: 1, 2, H. Rose:

	$\dddot{\mathrm{S}}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{H}}$
1. *Crystalline,*	43·55	24·11	0·92	0·73	0·32	0·31	30·10=100·04, Rose.
2. *Granular,*	43·55	35·21	0·78	0·14	0·21	0·37	29·98=100·24, "

Wholly soluble in cold water: if the solution be heated, peroxyd of iron is copiously precipitated. Dilute muriatic acid dissolves the whole, except a portion of silica.

Forms a bed in a feldspathic or trachytic rock, in the province of Coquimbo, about half a day's journey from Copiapo. The bed of salt is on the increase, and is probably derived from decomposing sulphurets. Pits twenty feet deep have been formed in it by the people of the country. Occurs also in Bolivia near Calama, constituting the greater part of a large hill.

J. H. Blake refers here octahedral crystals, (Blakeite of last edition of this work), from Coquimbo analyzed by him, (Jour. Bost. Soc. N. Hist.), as follows: $\dddot{\mathrm{S}}$ 41·37, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 26·79, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 1·05, $\dot{\mathrm{M}}\mathrm{g}$ 0·30, $\dddot{\mathrm{S}}\mathrm{i}$ 0·82, $\dot{\mathrm{H}}$ 29·40=99·68. The same octahedral form was assumed on recrystallization. It is possible that the mineral examined was an *iron alum.* Requires further investigation.

CYANOSITE. Cyanose, *Beud.* Sulphate of Copper. Blue Vitriol. Copper Vitriol. Kupfervitriol. Chalcanthit, *Glocker.*

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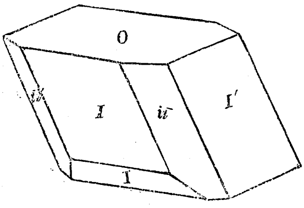

Triclinic. $O : I = 109° 32'$, $O : I' = 127° 40'$, $I : I' = 123° 10'$, $O : 1 = 125° 38'$, $I : 1 = 126° 10'$, $O : \dot{i}\bar{i} = 120° 50'$, $O : \dot{i}\breve{i} = 103° 27'$ and $76° 33'$. Cleavage: I imperfect, I' very imperfect. Occurs also amorphous, stalactitic, reniform.

H.=2·5. G.=2·213. Lustre vitreous. Color Berlin-blue to sky-blue, of different shades. Streak uncolored. Subtransparent—translucent. Taste metallic and nauseous. Somewhat brittle.

Composition.—$\dot{C}u\dddot{S}+5\dot{H}$=Sulphuric acid 32·1, oxyd of copper 31·8, water 36·1.
B.B. on charcoal with soda affords metallic copper. Soluble in water. A polished plate of iron introduced into the solution causes the copper to be deposited upon it.

Blue vitrol is found in waters issuing from mines, and in connection with rocks containing copper pyrites, by the decomposition of which it is formed. Its foreign localities are the Rammelsberg mine near Goslar in the Hartz, Fahlun in Sweden, also Anglesea, and Wicklow; also Rio Tinto mine, Spain. The waters of the Rio Tinto mine have yielded annually 1800 cwt. of copper, consuming 2400 cwt. of iron. At Wicklow about 500 tons of iron were laid in the pits at one time, and in about twelve months the bars were dissolved, and every ton of iron yielded a ton and a half to two tons of a reddish mud, which was oxyd of copper, each ton affording 16 cwt. of pure copper. Found at the Hiwassee copper mine in Polk Co., Tennessee, 30 miles from Cleveland.

When purified, it is employed in dyeing operations, and in the printing of cotton and linen, and for various other purposes in the arts. It is manufactured mostly from old sheathing copper, copper trimmings, and refinery scales.

ALUNOGEN, *Beudant.* Feather Alum, *in part.* Hair Salt, *in part.* Neutral Sulphate of Alumina. Davyt. Federalaun. Halotrichite, *Glocker.* Haarsalz, *Werner.* Thonerde Schwefelsaure.

Usually in delicate fibrous masses or crusts; also massive.
H.=1·5—2. G.=1·6—1·8. Lustre vitreous—silky. Color white, or tinged with yellow or red. Subtranslucent—subtransparent. Taste like that of common alum.

Composition.—$\ddot{\bar{A}}l\dddot{S}^3+18\dot{H}$=Alumina 15·42, sulphuric acid 35·99, water 48·59. Analyses: 1, 2, Boussingault, (Ann. Ch. Ph. xxx, 109); 3, Mill, (Quart. Journ. 1828, p. 382); 4, Hartwall, (Jahresber. x, 178); 5, H. Rose, (Pogg. xxvii, 317); 6, 7, 8, 9, Rammelsberg, (Pogg. xliii, 130, 399); 10, Herapath, (Chem. Gaz. 1846, p. 422):

	$\ddot{\bar{A}}l$	$\dddot{S}$	$\dot{H}$	$\ddot{\bar{F}}e$	$\dot{M}g$	$\dot{C}a$	$\ddot{S}i$
1. Saldana,	16·00	36·40	46·60	0·004	0·004	0·002	——=99·010, Bouss.
2. Pasto,	14·98	35·68	49·34	——	——	——	——=100·00, "
3. Chioachi, *Davyte*,	15·00	29·00	51·80	1·20	——	——	——=Earthy 3·0=100·00, Mill.
4. Milo,	14·98	40·31	40·94	——	0·85	——	1·13, $\dot{N}a$ 1·13, $\dot{K}$ 0·26, HCl 0·40=100, Hart.
5. Copiapo,	14·63	36·97	44·64	2·58	0·14	——	1·37=100·33, Rose.
6. Kolosoruk,	15·57	35·82	48·61	——	——	——	——=100, Ramm.
7. Friesdorf,	14·87	37·38	45·16	——	——	0·15	$\dot{K}$0·22, $\dot{F}e$2·46=100·24, R.
8. Potschappel,	12·78	35·71	47·02	——	0·27	0·64,	$\dot{K}$0·32, $\dot{F}e$0·67, $\dot{M}n$1·02, R.
9. Freienwalde,	11·23	35·64	48·84[a]	——	1·91	0·45	$\ddot{S}i$ 0·43, $\dot{F}e$ 0·72, $\dot{K}$ 0·47, $\dot{M}n$ 0·31=100, Ramm.
10. Adelaide, N. S. W.,	17·09	35·63	46·70	——	$\dot{C}u$0·04 and earthy substance 0·50, H.		

[a] And loss.

B.B. intumesces and fuses easily. Very soluble.

This species, a hydrous sulphate of alumina, results both from volcanic action and the decomposition of pyrites in coal districts and alum shales, and occurs at the localities above mentioned, besides many others. It is found as an efflorescence in numerous places in the United States.

A salt of allied composition from Ararat, analyzed by Göbell, (Schw. J. lx, 401), afforded alumina 38·75, sulphuric acid 58·58, sulphate of protoxyd of iron 2·78=100·11=$\ddot{\bar{A}}l\dddot{S}^2$; the water was not determined.

The *Keramohalite* of J. Jurasky, (Ost. Blat. f. Lit. 1847), from near Königsberg in Hungary, has the same composition as alunogen. It occurs in crystalline crusts and also in six-sided tables, with two angles of 92° and four of 134°, the crystallization monoclinic. G.=1·6—1·7. Jurasky obtained for its composition, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 14·30, $\dot{\mathrm{F}}\mathrm{e}$ 2·15, $\dddot{\mathrm{S}}$ 36·75, $\dot{\mathrm{H}}$ 44·60, insoluble 2·01=99·81.

Occurs in thick druses with iron vitriol.

NATIVE ALUM.

Under the head of Alum are included several compounds, monometric in crystallization, having the general formula $\dot{\mathrm{R}}\dddot{\mathrm{S}}+\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}^3+24\dot{\mathrm{H}}$, $\dot{\mathrm{R}}$ standing for different bases, as potash, soda, magnesia, protoxyd of manganese, &c. Crystals octahedral, (f. 11, 16). Soluble in water. Taste astringent, more or less like common alum.

1. Potash Alum. Native Alum. Kalialaun.

Usually fibrous, or as an efflorescence. H.=2—2·5. G.=1·75. Vitreous, the fibrous varieties sometimes somewhat pearly. Color white. Transparent—opaque.

Composition.—$\dot{\mathrm{K}}\dddot{\mathrm{S}}+\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}^3+24\dot{\mathrm{H}}=$Sulphate of potash 18·4, sulphate of alumina 36·2, and water 45·4. B.B. fuses in its water of crystallization, and froths, forming a spongy mass. Soluble in from 16 to 20 times its weight of cold water, and in little more than its weight of boiling water.

Effloresces on argillaceous minerals, and more particularly alum slate. Whitby, in Yorkshire, is a noted locality, also Hurlet and Campsie near Glasgow. Also obtained at the volcanoes of the Lipari isles and Sicily. Cape Sable, Maryland, affords large quantities of alum annually.

2. Soda Alum. Solfatarite, *Shep.* Alun sodifère, *Duf.* Natronalaun.

In fibrous crusts or masses. H.=2—3. G.=1·88. Resembles the preceding, but more soluble.

Composition.—$\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}+\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}^3+24\dot{\mathrm{H}}=$Sulphate of soda 15·5, sulphate of alumina 37·4, water 47·1. Analysis by Thomson, (Ann. Lyc. N. Y., 1828):

From St. Juan near Mendoza, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 12·00, $\dot{\mathrm{N}}\mathrm{a}$ 7·96, $\dddot{\mathrm{S}}$ 37·70, $\dot{\mathrm{H}}$ 41·96=99·62.

Occurs on the island of Milo, at the Solfatara near Naples, and near Mendoza, on the east of the Andes.

Thomson found for the composition of a soda alum from Southern Peru, which he called Subsesquisulphate of alumina (L. and E. Phil. Mag. xxii, 188), $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 22·55, $\dot{\mathrm{N}}\mathrm{a}$ and $\dddot{\mathrm{S}}$ 6·50, $\dddot{\mathrm{S}}$ 32·95, $\dot{\mathrm{H}}$ 39·20=101·20. G.=1·584.

3. Magnesia Alum. Pickeringite, *Hayes.* Magnesia-alaun, *Ramm.* Talkerde-alaun, *Kobell.*

In white fibrous masses, and in efflorescences like the preceding. Lustre silky. Becomes opaque on exposure.

Composition.—$\dot{\mathrm{M}}\mathrm{g}\dddot{\mathrm{S}}+\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}^3+24\dot{\mathrm{H}}=$Sulphate of magnesia 13·4, sulphate of alumina 38·3, and water 48·3. Analysis by A. A. Hayes, (Am. J. Sci. xlvi, 360):

From near Iquique, S. A., $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 12·130, $\dot{\mathrm{M}}\mathrm{g}$ 4·682, $\dddot{\mathrm{S}}$ 36·322, $\dot{\mathrm{H}}$ 45·450, $\dot{\mathrm{F}}\mathrm{e}$ and $\dot{\mathrm{M}}\mathrm{n}$ 0·430, $\dot{\mathrm{C}}\mathrm{a}$ 0·126, HCl 0·604=99·744.

Part of the magnesia is often replaced by protoxyd of manganese, producing a Mangano-magnesian Alum.

Stromeyer obtained (Pogg. xxxi, 137) for a specimen from a cave near Bosjesman river, southern Africa:

$\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 11·515, $\dot{\mathrm{M}}\mathrm{g}$ 3·690, $\dot{\mathrm{M}}\mathrm{n}$ 2·167, $\dddot{\mathrm{S}}$ 36·770, $\dot{\mathrm{H}}$ 45·739, KCl 0·205=100·86.

It covers the floor of the cave to a depth of six inches. The roof is a reddish quartzose conglomerate, containing magnesia and pyrites. It rests on a bed of epsom salt, 1½ inches thick.

Manganesian Alum. Apjohnite, *Glocker.* $\dot{\mathrm{M}}\mathrm{n}\dddot{\mathrm{S}}+\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}^3+24\dot{\mathrm{H}}=$Sulphate of manganese 16·3, sulphate of potash 37·0, water 46·7. Occurs near Lagoa-Bay, in South Africa.

Apjohn (Phil. Mag. xii, 103) obtained,

$\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 10·65, $\dddot{\bar{\mathrm{M}}}\mathrm{n}$ 7·33, $\dddot{\mathrm{S}}$ 32·79, $\dot{\mathrm{H}}$ 48·15, $\dot{\mathrm{M}}\mathrm{g}\dddot{\mathrm{S}}$ 1·08=100.

It is found in fine crystallizations like asbestus, with a silky lustre. An alum from Alum Point, Great Salt Lake, Rocky Mountains, afforded Dr. L. D. Gale, (Stansbury's Exped, to the Salt Lake, 420), in an imperfect analysis: $\dddot{\mathrm{S}}$ 18·0, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 4·0, $\dot{\mathrm{M}}\mathrm{n}$ 8·9, $\dot{\mathrm{H}}$ 73·0. Crystallizes in acicular (4-sided?) prisms.

IRON ALUM. HALOTRICHITE. Eisenalaun. Federalaun and Haarsalz *in part.* Alun de plume, *Duf.*

Fibrous, silky, yellowish white; becomes dull and pulverulent on exposure. Taste like that of alum, but somewhat inky.

Composition.—$\dot{\mathrm{F}}\mathrm{e}\dddot{\mathrm{S}}+\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}^3+24\dot{\mathrm{H}}$=Sulphate of iron 16·4, of alumina 37·0, water 46·6=100. Analyses: 1, Berthier (Ann. d. Mines, v, 257); 2, Rammelsberg, (Pogg. xliii, 399); 3, B. Silliman, Jr., (private communication):

	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dddot{\mathrm{S}}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{H}}$
1.	8·8	12·0	34·4	0·8	44·0=100, Berth.
2. Mörsfeld,	10·914	9·367	36·025	0·235	43·025, $\dot{\mathrm{K}}$ 0·434=100, R.
3. Oroomiah,	10·617	8·150	33·812	——	41·611, $\dddot{\mathrm{S}}\mathrm{i}$ 3·340, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 1·050=99·580, S.

Occurs at Bodenmais and at Mörsfeld in Rhenish Bavaria. Also at Oroomiah, Persia, where the inhabitants use it for making ink of a fine quality. Specimens analyzed by Dr. Thomson from Curlet and Campsie, appear to be iron-alum mixed with sulphate of iron. Occurs probably at Rossville, Richmond Co., N. Y. (Beck). The name *Halotrichite* is from *ἁλς*, *salt*, and *θριξ*, *hair.*

The *Hversalt* of Forchammer (Berz. Jahresb. xxiii, 263) is an allied alum in which part of the alumina is replaced by peroxyd of iron, and part of the protoxyd of iron by magnesia. It contained—

$\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 11·22, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 1·23, $\dot{\mathrm{F}}\mathrm{e}$ 4·57, $\dot{\mathrm{M}}\mathrm{g}$ 2·19, $\dddot{\mathrm{S}}$ 35·16, $\dot{\mathrm{H}}$ 45·63=100.

Formula, $(\dot{\mathrm{F}}\mathrm{e}, \dot{\mathrm{M}}\mathrm{g})\,\dddot{\mathrm{S}}+(\dddot{\bar{\mathrm{A}}}\mathrm{l}, \dddot{\bar{\mathrm{F}}}\mathrm{e})\,\dddot{\mathrm{S}}^3+24\dot{\mathrm{H}}$. From Iceland.

Halotrichine of Scacchi (Mem. Geol. Camp., Nap. 1849, p. 84) is a silky alum from the Solfatara, etc., giving the formula $3\dot{\mathrm{F}}\mathrm{e}\dddot{\mathrm{S}}+2\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}^3+54\dot{\mathrm{H}}$. It afforded $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 9·76, $\dot{\mathrm{F}}\mathrm{e}$ 10·20, $\dddot{\mathrm{S}}$ 34·12, water 45·92.

AMMONIA ALUM. TSCHERMIGITE. Fibrous and in octahedrons like the preceding. H.=1—2. G.=1·56.

Composition.—$\mathrm{NH^4O}\dddot{\mathrm{S}}+\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}^3+24\dot{\mathrm{H}}$=Sulphate of ammonia 14·6, of potash 37·8, water 47·6. Analyses: 1, Pfaff, (Handb. der Analyt. Chem. ii, 47); 2, Lampadius, (Gilb. Ann. lxx, 182, lxxiv, 303); 3, Stromeyer, (Pogg. xxxi, 137):

	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\mathrm{NH^3}$	$\dddot{\mathrm{S}}$	$\dot{\mathrm{H}}$	$\dot{\mathrm{M}}\mathrm{g}$
1. Tschermig,	12·14	6·58	36·00	45·00	0·28 =100, Pfaff.
2. "	12·34	4·12	38·58	44·96	—— =100, Lamp.
3. "	11·602	3·721	36·065	48·390	0·115=99·893, Strom.

B.B. yields with soda ammonia, and on charcoal alone, sulphate of ammonia. From Tschermig, Bohemia. This salt is manufactured and used in France in place of potash alum.

VOLTAITE, *A. Scacchi.* R. Acad. Sci. Nap. 1840.

Monometric. In octahedrons, cubes, dodecahedrons and combinations of these forms.

Lustre resinous. Color dull oil-green, greenish-black, brown or black. Streak grayish-green. Opaque.

Composition.—$\dot{\mathrm{F}}\mathrm{e}\dddot{\mathrm{S}}+\dddot{\bar{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{S}}^3+24\dot{\mathrm{H}}$, Scacchi=$\dot{\mathrm{F}}\mathrm{e}\dddot{\mathrm{S}}$ 15·4, $\dddot{\bar{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{S}}^3$ 40·6, $\dot{\mathrm{H}}$ 44·0. Dufrénoy's analysis is not correct according to Scacchi,(Mem. Geol. Camp. Napoli, 1849,89).

Soluble in water with difficulty and at the same time decomposes. Abich has obtained a similar salt artificially, in which part of the alumina is replaced by peroxyd of iron.

This species was first observed at the Solfatara near Naples, by Breislak, (1792). It has been found by F. Ulrich at the Rammelsberg mine, near Goslar. The last contains protoxyd of manganese, as well as of iron.

EPSOMITE, *Beud.* Epsom salt. Bittersalz, *Wern.* Sulphate of Magnesia.

Trimetric and generally hemihedral, in the octahedral modifications. $I : I$=90° 34′, $O : 1\bar{\imath}$=150° 2′ ; $a : b : c$=0·5766 : 1 : 1·01. $1\breve{\imath} : 1\breve{\imath}$ (basal)=59° 27′, $1\bar{\imath} : 1\bar{\imath}$ (basal)=59° 56′. Cleavage: brachydiagonal, perfect. Also in botryoidal masses and delicately fibrous crusts.

H.=2·25. G.=1·751. Lustre vitreous—earthy. Streak and color white. Transparent—translucent. Taste bitter and saline.

Composition.—$\dot{\mathrm{M}}\mathrm{g}\,\ddot{\mathrm{S}}+7\dot{\mathrm{H}}$, when pure=Magnesia 16·26, sulphuric acid 32·52, water 51·22. B.B. deliquesces, but is difficultly fusible before the water of crystallization is driven off. Very soluble in water. Does not effervesce with the acids.

Common in mineral waters, and as an efflorescence on rocks. In the former state it exists at Epsom. At Idria, in Carniola, it occurs in silky fibres, and is hence called *hairsalt* by the workmen. Also obtained at the gypsum quarries of Montmartre, near Paris; in Fitou, Dep. of the Aude, France; in Aragon and Catalonia, in Spain; in the Cordillera of St. Juan, in Chili; and in a grotto in Southern Africa, where it forms a layer 1½ inches thick. The salt from this last locality was analyzed by Stromeyer, and found to contain sulphate of magnesia 42·654, sulphate of manganese 7·667, water 49·243=99·564. The roof of the grotto is a quartzose conglomerate, containing manganese and pyrites.

The floors of the limestone caves of Kentucky, Tennessee, and Indiana, are in many instances covered with Epsomite, in minute crystals, mingled with the earth. In the Mammoth Cave, Kentucky, it adheres to the roof in loose masses like snow balls. It effloresces from the calcareous sandstone, ten miles from Coeymans, on the east face of the Helderberg, N. Y. Said to occur also over the California plains, east of San Diego, (Am. Jour. of Sci. [2], vi, 389). Also effloresces from a pyritiferous serpentine at Marmora, Canada West.

Sulphate of magnesia is dimorphous. According to Haidinger and Mitscherlich, the above described form is produced when crystallization takes place below 15° C, (60° F), but a monoclinic form, between 25° C and 30° C.

GOSLARITE, *Haid.* Zinc Vitriol. Sulphate of Zinc. Zinc Sulfate, *H.* White Vitriol.

Trimetric: $I : I$=90° 42′; $O : 1\bar{\imath}$=150° 10′; $a : b : c$=0·5735 : 1 : 1·0123. Observed planes I, $i\bar{\imath}$, $i\breve{\imath}$, $i\breve{2}$, $1\bar{\imath}$, $1\breve{\imath}$, $1,2\breve{2}$. $1\bar{\imath} : 1\bar{\imath}$ (top) 120° 20′, $1\breve{\imath} : 1\breve{\imath}$ (top)=120° 3′, $O : 1$=140° 57½′, 1 : 1 (mac.)=127° 27′, 1 : 1 (brach.)=126° 45′. Cleavage: $i\breve{\imath}$ perfect.

H.=2—2·5. G.=2·036 ; 1·9—2·1. Lustre vitreous. Color white, reddish, bluish. Transparent—translucent. Brittle. Taste astringent, metallic and nauseous.

Composition.—$\dot{\mathrm{Z}}\mathrm{n}\ddot{\mathrm{S}}+7\dot{\mathrm{H}}$=Sulphuric acid 27·9, oxyd of zinc 28·2, water 43·9=100. In a matrass yields water. B.B. intumesces, gives off its sulphuric acid, and covers the charcoal with a white coating of oxyd of zinc. Easily soluble in water.

This salt is supposed to be formed by the decomposition of blende. It occurs at the Rammelsberg mine in the Hartz, at Schemnitz in Hungary, at Fahlun in Sweden, and at Holywell in Wales. It is of rare occurrence in nature.

It is manufactured for the arts, and is very extensively employed in medicine and dyeing. White vitrol, as the term is used in the arts, is the sulphate of zinc in a granular state, like loaf sugar, produced by melting and agitation while cooling.

COPPERAS. Green Vitriol. Melanterite, *Beud.* Eisen-Vitriol, *Haus.* Sulphate of Iron.

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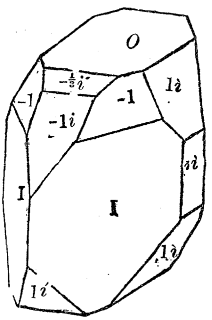

Monoclinic. $C = 75° 40'$; $I : I = 82° 21'$, $O : 1i = 123° 44'$; $a : b : c = 1{\cdot}310 : 1 : 0{\cdot}8474$.

$O : ii = 104° 20'$. $O : -1i = 136° 13'$.
$O : I = 80° 37'$ $O : 1i = 123° 44'$.
$O : -\frac{1}{3}i = 159° 6'$. $-1 : -1 = 101° 32'$.

Cleavage: *O* perfect, *I* less so. Generally massive and pulverulent.

H.=2. G.=1·832. Lustre vitreous. Color, various shades of green, passing into white; becoming yellowish on exposure. Streak uncolored. Subtransparent—translucent. Taste sweetish, astringent, and metallic. Fracture conchoidal. Brittle.

Composition.—$\dot{\text{F}}\text{e}\ddot{\text{S}}+7\dot{\text{H}}$=Sulphuric acid 28·8, protoxyd of iron 25·9, water 45·3.

B.B. becomes magnetic; yields a green glass with borax. Soluble in twice its weight of water, and the solution is blackened by a tincture of nut galls. Exposed to the air, becomes covered with a yellow powder, which is the sulphate of the peroxyd of iron.

This salt usually proceeds from the decomposition of iron pyrites, which readily affords it, if occasionally moistened while exposed to the atmosphere. Occurs near Goslar in the Hartz, and also at Hurlet near Paisley, and in several of the Saxon and Hungarian mines. Usually accompanies iron pyrites in the United States, occurring as an efflorescence; at Copperas Mt., a few miles east of Bainbridge, Ohio, it is associated with alum and pyrites. It is employed in dyeing and tanning and in the manufacture of ink and Prussian blue.

BIEBERITE, *Haid.* Cobalt vitriol. Red Vitriol. Sulphate of Cobalt. Kobalt-vitriol. Rhodalose, *Beud.*

Monoclinic. Usually in stalactites and crusts, investing other minerals. Lustre vitreous. Color flesh and rose-red. Subtransparent—translucent. Friable. Taste astringent.

Composition.—$(\dot{\text{C}}\text{o}, \dot{\text{M}}\text{g})\ddot{\text{S}}+7\dot{\text{H}}$, from Winkelblech's analysis. Analyses: 1, Kopp, (Gehlen's J. [2], vi, 157); 2, Winkelblech, (Ann. d. Pharm. xiii, 265); 3, Beudant; 4, 5, Schnabel, (Ramm. 4th Suppl. 118):

		$\ddot{\text{S}}$	$\dot{\text{C}}\text{o}$	$\dot{\text{H}}$
1.	Bieber,	19·74	38·71	41·55=100, Kopp.
2.	"	29·053	19·909	46·830, $\dot{\text{M}}\text{g}$ 3·864=99·656, Winkelblech.
3.	"	30·2	28·7	41·2, $\ddot{\bar{\text{F}}}\text{e}$ 0·9, Beudant.
4.	Siegen,	28·81	23·30	45·22, $\dot{\text{C}}\text{a}$ 0·43, $\dot{\text{M}}\text{g}$ 0·88, Cl 0·09, earthy subst. 1·14 =100·12, Schn.
5.	"	20·84	16·50	38·13, $\dot{\text{C}}\text{a}$ *tr.*, $\dot{\text{M}}\text{g}$ *tr.*, Cl 0·05, earthy, 24·04=100, S.

In a matrass yields water, and when strongly heated, sulphurous acid. Communicates a blue color to glass of borax.

In the rubbish of old mines at Bieber, near Hanau, and at Leogang in Saltzburg

PYROMELINE, *v. Kobell.* Nickel Vitriol, *T. S. Hunt.*

In capillary interlacing crystals, apparently rhombic, or as a greenish-white efflorescence. Taste metallic astringent.

Composition.—A hydrated sulphate of nickel. Heated, gives off water, and the residue, which is perfectly soluble, is simply sulphate of nickel.

At Wallace mine, Lake Huron, upon a sulphuret of nickel and iron, mostly as an efflorescence.

This description is from Hunt. *Pyromeline* of v. Kobell, (J. f. pr. Ch. lviii, 44), is probably the same species. It occurs as an earthy crust, pale yellow, with native bismuth and arsenical nickel at the Friekerichs mine near Bayreut. B.B. intumesces and shoots out into worm-like processes, (whence the name), becoming pale yellow; with a stronger heat fuses to a gray magnetic bead; gives reactions of a hydrous sulphate of nickel mixed with some arsenic acid.

JOHANNITE. Sulphate of the Protoxyd of Uranium. Uranvitriol.

Monoclinic. $C=85° 40'$, $I : I=69°$. Crystals flattened, and from one to three lines in length; arranged in concentric druses or reniform masses.

H.=2—2·5. G.=3·19. Lustre vitreous. Color beautiful emerald-green, sometimes passing into apple-green. Streak paler. Transparent—translucent; sometimes opaque. Taste bitter, rather than astringent.

Composition.—According to John's researches, a hydrous sulphate of the protoxyd of uranium.

Somewhat soluble in water. Solution precipitated chestnut-brown by prussiate of potash, yellowish-green by alkalies, and in brown flocks by an infusion of nutgalls.

Discovered by John near Joachimstahl in Bohemia, after whom the species is named. Found also at Johanngeorgenstadt; and reported from the Middletown feldspar quarry by Shepard.

URANGREEN, Hartmann, (Urangrün, Uranchalzit). A basic sulphate of the oxyds of copper and uranium. From Joachimstahl.

GLAUBER SALT. Sulphate of Soda. Mirabilite, *Haid.* Exanthalose, *Beudant.* Soude Sulfatée, *H.* Glaubersalz.

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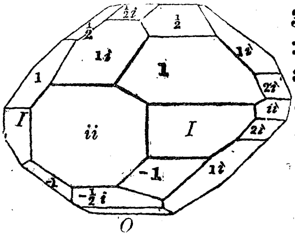


Monoclinic. $C=72° 15'$, $I : I=86° 31'$, $O : 1i=130° 19'$; $a : b : c=1·1089 : 1 : 0·8962$. Observed planes as in the annexed figure.

$O : ii=107° 45'$. $1 : 1$(front) $93° 12'$.
$O : \frac{1}{2}i=147° 34'$. $-1 : -1$(front)$110° 42'$.
$O : 1i=122° 5'$. $ii : 1i=130° 10'$.
$O : -\frac{1}{2}i=155° 41'$. $ii : \frac{1}{2}i=104° 41'$.
$O : 2i=113° 0'$.

Cleavage: ii perfect. Usually in efflorescent crusts.

H.=1·5—2. G.=1·481. Lustre vitreous. Color white. Transparent—opaque. Taste cool, then feebly saline and bitter.

Composition.—$\dot{Na}\dddot{S}+10\dot{H}$=Soda 19·3, sulphuric acid 24·8, water 55·9. Beudant's *Exanthalose* from Vesuvius contains but two of water, ($2\dot{H}$).

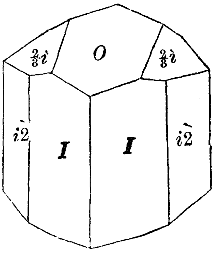
Occurs at Ischl and Hallstadt in Austria, also in Hungary, Switzerland, Italy, Spain, &c. Abundantly deposited at the hot springs at Carlsbad. At Kailua, on Hawaii, Sandwich Islands, abundant in a cavern, and forming from the action of volcanic heat and gases on salt water; effloresces with other salts on the limestone below the Genesee Falls, Rochester, N. Y.; also near the Sweetwater river, Rocky Mountains.

The artificial salt was first discovered by a German chemist by the name of Glauber, and hence its name.

Taking the plane $1\grave{i}$ as $2\grave{i}$, the axes are nearly those of pyroxene, becoming $a : b : c$=0·55445 : 1 : 0·8962.

BOTRYOGEN. Red Iron-vitriol. Neoplase, *Beud.* Rother Vitriol. Fer Sulfaté Rouge, *Duf.*

539



Monoclinic. C=62° 26′, $I : I$=119° 56′, $O : 1\grave{i}$=152° 1½′; $a : b : c$=0·9188 : 1 : 1·5334. Observed planes as in the figure, with also $1i$ (on acute solid angle of base), 1 (on acute edge of base), and $i\grave{i}$. $O : I$= 113° 37′, $O : 1\grave{i}$=125° 31′, $O : 1$=121° 4′, $I : i\grave{2}$=160° 54′, $i\grave{2} : i\grave{2}$=98° 16′, $\frac{2}{3}\grave{i} : \frac{2}{3}\grave{i}$= 141°, $O : \frac{2}{3}\grave{i}$=160° 30′; I and $i\grave{2}$ vertically striated. Cleavage parallel to I. Crystals usually small. Often in reniform and botryoidal shapes, consisting of globules with a crystalline surface.

H.=2—2·5. G.=2·039. Lustre vitreous. Color deep hyacinth-red; massive varieties sometimes ochre-yellow; streak ochre-yellow,. a little shining. Translucent. Taste slightly astringent.

Composition.—$\dot{Fe}^3\dddot{S}^2+3\dddot{\overline{Fe}}\dddot{S}^2+36\dot{H}$, Berz.=$(\frac{1}{4}\dot{Fe}^3+\frac{3}{4}\dddot{\overline{Fe}})\dddot{S}^2+9\dot{H}$=Sulphate of protoxyd of iron 19·0, ib. of peroxyd 48·3, water 32·7=100. Analyses by Berzelius, (Afh. iv, 307):

	$\dot{Fe}\dddot{S}$	$\dot{Fe}\dddot{\overline{Fe}}\dddot{S}$	$\dot{Mg}\dddot{S}$	$\dot{Ca}\dddot{S}$	$\dot{H}$ and loss.
1.	6·77	35·85	26·88	2·22	28·28=100.
2.	6·85	39·92	17·10	6·71	31·42=100.

B.B. intumesces and gives off water, producing a reddish-yellow earth, which, by using the reduction or oxydizing flame, is changed to protoxyd or peroxyd of iron. Remains unaltered if kept dry, but in a moist atmosphere it becomes covered with a dirty yellowish powder. Partly soluble in boiling water, leaving an ochreous residue.

Occurs at the copper mine of Fahlun, in Sweden, coating gypsum or pyrites. Named from *βοτρυς, a bunch of grapes.*

COPIAPITE, *Haid.* Yellow Copperas. Basisches Schwefelsaures Eisenoxyd.

In small grains, sometimes consisting of delicate hexagonal tables; angles undetermined. Cleavage: basal, perfect. Also fibrous and incrusting.

Lustre pearly. Color yellow. Translucent.

Composition.—Analyses: 1, 2, H. Rose, (Pogg. xxvii, 309); 3, Prideaux, (corrected):

	$\dddot{S}$	$\dddot{\bar{F}}e$	$\dddot{\bar{A}}l$	$\dot{M}g$	$\dddot{S}i$	$\dot{C}a$	$\dot{H}$
1. *Foliated, Copiapite,*	39·60	26·11	1·95	2·64	1·37	——	29·67=101·34, Rose.
2. *Fibrous, Stypticite,*	31·73	28·11	——	0·59	1·43	1·91	36·56=100·53, "
3. Chili, *Fibroferrite,*	28·9	34·4	——	——	——	36·7=100, Prideaux.	

The first gives the formula $\dddot{\bar{F}}e^2\dddot{S}^5+18\dot{H}$, and the second (called *Stypticite*) $2\dddot{\bar{F}}e\dddot{S}^2+21\dot{H}$. But it is doubted that they are pure chemical compounds. The third is the *Fibroferrite* of Prideaux, formula $\dddot{\bar{F}}e^3\dddot{S}^5+27\dot{H}$.

Found incrusting the Coquimbite, in the district of Copiapo, a province of Coquimbo.

The *Pitticite* of Beudant, from Fahlun, (or *Vitriol Ochre*), contains, according to Berzelius, Sulphuric acid 15·9, peroxyd of iron 62·4, water 21·7=$\dddot{\bar{F}}e^2\dddot{S}+6\dot{H}$.

A stalactitic iron sinter from Hackelsberg, (Pogg. lxxxix, 489), afforded Hochstetter, $\dddot{S}$ 15·19, $\dddot{\bar{F}}e$ 64·34, $\dot{H}$ 20·70, $\dot{P}b$ 0·61, Cu and As, *trace*=100·84. Another, from Rammelsberg in the Hartz, afforded Jordan, (J. f. pr. Ch. ix, 95), $\dddot{S}$ 9·796, $\dddot{\bar{F}}e$ 68·750, $\dot{H}$ 15·524, $\dot{Z}n$ 1·293, $\dot{C}u$ 0·500, impurities 4·137=100.

Misy. At Rammelsberg, near Goslar in the Hartz, an impure sulphate of the peroxyd mixed with other sulphates is called *Misy.* It occurs in small crystalline scales pearly in lustre or subvitreous, color sulphur-yellow; scales rhombic tables with the acute lateral edge truncated. Decomposed in water, but not properly soluble. Analysis by Dr. List, (Ann. Chem. u. Pharm. lxxiv, 239):

$\dddot{S}$ 42·922, $\dddot{\bar{F}}e$ 30·066, $\dot{Z}n$ 2·491, $\dot{M}g$ 2·812, $\dot{K}$ 0·318, $\dot{H}$ 21·391=100.

In another trial $\dddot{S}$ 43·208, $\dddot{\bar{F}}e$ 30·365. Excluding impurities, the composition becomes $\dddot{S}$ 47·075, $\dddot{\bar{F}}e$ 40·622, $\dot{H}$ 12·313=$\dddot{\bar{F}}e^2\dddot{S}i^5+6\dot{H}$, or Copiapite with two-thirds less of water.

APATELITE, *Meillet*, Ann. d. Mines, [4], iii, 808.

Resembles Copiapite.

Composition.—$2\dddot{\bar{F}}e^2\dddot{S}^3+3\dot{H}$. Analysis by Meillet, (loc. cit.):

$\dddot{S}$ 42·90, $\dddot{\bar{F}}e$ 53·30, $\dot{H}$ 3·96=100·16.

It occurs at Meudon and Auteuil, in small friable nodules or balls of a clear yellow color, disseminated in an argillaceous bed connected with the plastic clay.

Tectizite, *Breit.*—Supposed to be a hydrous sulphate of peroxyd of iron; but composition not ascertained. Occurs in small pyramidal and acicular crystals, and massive. H.=1·5—2. Color clove-brown. Easily soluble in water, and attracts moisture readily. From near Schwarzenberg in Saxony, and Bräunsdorf in the Erzgebirge.

ALUNITE. Alum Stone. Alaunstein. Alumine sous-sulfatée alkaline, *H.*

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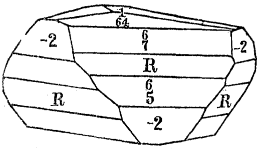


Rhombohedral. $R:R=89°\ 10'$, $O:R=124°\ 40'$, Breit.; $a=1·2523$. Observed planes R, O, and the rhombohedrons $\frac{6}{7}$, $\frac{1}{64}$, $-\frac{6}{5}$, and -2, Breit.

$O:2=109°\ 4'$. $O:\frac{1}{64}=178°\ 42'$.
$O:\frac{6}{5}=119°\ 57'$. $\frac{6}{5}:\frac{6}{5}=82°\ 26'$.
$O:\frac{\ }{7}=128°\ 55.'$ $2:2=70°\ 8'$.

Cleavage: basal nearly perfect; R indistinct. Also massive, having a granular or impalpable texture.

H.=3·5—4. G.=2·58—2·752. Lustre of R vitreous, basal plane somewhat pearly. Color white, sometimes grayish or reddish. Streak white. Transparent—subtranslucent. Fracture flat conchoidal, uneven; of massive varieties, splintery; and sometimes earthy. Brittle.

Composition.—$\dot{K}\dddot{S}+3\ddot{\bar{Al}}\dddot{S}+6\dot{H}$=Alumina 37·13, sulphuric acid 38·53, potash 11·34, water 13·00. Analyses: 1, 2, Cordier, (Ann. des M. iv, 205, and v, 203, and Ann. Ch. Phys. ix, 71); 3, Descotils, (Ann. d. Mines, i, 319); 4, Berthier, (Ann. d. Mines, [4], ii, 459); 5, Sauvage, (ib. [4], x, 85):

	$\ddot{\bar{Al}}$	$\dddot{S}$	$\dot{K}$	$\ddot{\bar{Fe}}$	$\dot{H}$	Silica
1. Mt. Dor,	31·80	27·00	5·80	1·44	3·72	28·40=98·16, Cord.
2. Tolfa, *cryst.*,	39·65	35·49	10·02	—	14·83	(and loss), Cord.
3. Tuscany,	40·0	35·6	13·8	—	10·6	——=100, Desc.
4. Hungary,	26·0	27·0	7·3	4·0	8·2	26·5=100, Berth.
4. Milo,	30·0	31·0	9·40	—	10·6	19=100, Sauv.

The silica, which is an impurity, amounts to 60 per cent. in some varieties. B.B. decrepitates, and is infusible both alone and with soda. With borax, forms a colorless globule. In a matrass yields water, and finally sulphate of ammonia. When pulverized, soluble in sulphuric acid.

Met with in crystals at Tolfa, near Civita Vecchia, in the neighborhood of Rome; also at Musay and Bereghszasz in Hungary; on Milo, Argentiera, and Nevis, Grecian Archipelago; and at Pic de Sancy, France, Dep. Puy de Dome. It occurs with volcanic rocks. The compact varieties from Hungary are so hard as to admit of being used for millstones. Alum is obtained from it by repeatedly roasting and lixiviating, and finally, crystallizing by evaporation.

JAROSITE, *Breithaupt*, Berg. u. Hüttenm. Ztg. 1852.

Rhombohedral. $R : R=88° \; 58'$; $O : R=124° \; 32'$; $a=1·2584$. Cleavage: basal. G.=3·256. Color yellowish.

Composition.—Perhaps $\dot{K}\dddot{S}+4\dot{Fe}\dddot{S}+6\dot{H}[+\ddot{\bar{Fe}}\dot{H}]$ Ramm; $\dot{K}\dddot{S}+4\,\ddot{\bar{Fe}}\dddot{S}+9\dot{H}$, Gelbeisenerz, Ramm. Analysis: 1, Richter, (loc. cit.); 2, Rammelsberg, (Pogg. xliii, 132); 3, Scheerer, (Pog. xlv, 188):

	$\dddot{S}$	$\ddot{\bar{Fe}}$	$\ddot{\bar{Al}}$	$\dot{K}$	$\dot{Na}$	$\dot{H}$
1. *Jarosite*,	28·8	52·5	1·7	6·7[a]	—	9·2=98·9, Richter.
2. *Gelbeisenerz*,	32·111	46·736	$\dot{Ca}$ 0·643	7·882	—	13·564 (*tr.* of Am.)=100·936, Ramm.
3. *Soda-Copperas*,	32·42	49·37		—	4·03	13·13=99·55, Scheer.

[a] With little soda.

The potash-copperas (Gelbeisenerz, Vitriolgelb) from Bohemia is recognized by Rammelsberg as related to the Jarosite, though perhaps not identical with it. The soda-copperas is similar.

From Baranco Jaroso in the Sierra Almagrera, Spain. May be isomorphous with alunite.

WEBSTERITE, *Levy, Duf.* Aluminite. Hallite. Subsulphate of Alumina.

Reniform, massive; impalpable.

H.=1—2. G.=1·6606. Lustre dull, earthy. Color white. Opaque. Fracture earthy. Adheres to the tongue, and is meagre to the touch.

Composition.—$\ddot{\bar{Al}}\dddot{S}+9\dot{H}$=Alumina 29·8, sulphuric acid 23·2, water 47·0. Analyses: 1, Stromeyer, (Unters. 99); 2, Schmid, (J. f. pr. Ch. xxxii, 495); 3, 4, Stromeyer, (loc. cit.); 5, Dufrénoy, (Min. ii, 1845, 366); 6, Dumas, (ib.); 7, Lassaigne, (Ann. Ch. Phys. xxix, 98); 8, Marchand, (J. f. pr. Ch. xxxii, xxxiii); 9, Backs, (ib); 10, Wolff, (ib.); 11, Marchand, (ib.); 12, Martens, (ib.); 13, Schmid, (ib.):

		$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\mathrm{S}}$	$\dot{\mathrm{H}}$
1.	Halle,	20·263	23·365	46·372=100, Stromeyer.
2.	"	29·23	23·25	46·34, $\dot{\mathrm{C}}\mathrm{a}$ 1·18=100, Schmid.
3.	Morl,	30·98	23·68	45·34=100, Strom.
4.	Newhaven,	29·87	23·37	46·76=100, Strom.
5.	Lunel Vieil,	29·72	23·45	46·80=99 97, Dufrénoy.
6.	Auteuil,	30·00	23·00	47·00=100, Dumas.
7.	Epernay,	39·70	30.06	39·94, $\dot{\mathrm{C}}\mathrm{a}\dddot{\mathrm{S}}$ 0·30=100, Lassaigne.
8.	S. of Halle,	39·50	11·45	48·80=99·75, Marchand.
9.	"	37·71	12·22	49·18, $\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$ 1·00=100·11, Backs.
10.	"	38·81	12·44	47·07, $\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$ 1·68=100, Wolff.
11.	"	36·00	17·00	47·2=100·2, Marchand.
12.	"	35·96	14·04	50·00=100, Märtens.
13.	"	36·17	14·54	49·03=99·74, Schmid.

The formula of the analyses 1 to 6, (true websterite), is $\ddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}+9\dot{\mathrm{H}}$. The others are either different compounds or impure websterite. Rammelsberg writes their constitution as follows, putting W for the above formula:

No. 7, $2\mathrm{W}+\ddot{\bar{\mathrm{A}}}\mathrm{l}(?\dot{\mathrm{H}})$.
Nos. 8—10, $2\mathrm{W}+3\ddot{\bar{\mathrm{A}}}\mathrm{l}\dot{\mathrm{H}}^{6}$, $(=\ddot{\bar{\mathrm{A}}}\mathrm{l}^{5}\dddot{\mathrm{S}}^{2}+36\dot{\mathrm{H}}$, *Marchand*).
No. 11, $3\mathrm{W}+2\ddot{\bar{\mathrm{A}}}\mathrm{l}\dot{\mathrm{H}}^{4}$, $\dot{\mathrm{H}}$ $(=\ddot{\bar{\mathrm{A}}}\mathrm{l}^{5}\dddot{\mathrm{S}}^{3}+36\dot{\mathrm{H}}$, *Marchand*).
Nos. 12, 13, $\mathrm{W}+\ddot{\bar{\mathrm{A}}}\mathrm{l}\dot{\mathrm{H}}^{6}$, $(=\ddot{\bar{\mathrm{A}}}\mathrm{l}^{2}\dddot{\mathrm{S}}+15\dot{\mathrm{H}}$, *Marchand*).

A variety from Huelgoet, analyzed by Berthier, corresponds to $2\mathrm{W}+3\ddot{\bar{\mathrm{A}}}\mathrm{l}\dot{\mathrm{H}}^{4}$.

Fuses with difficulty. Easily soluble in acids without effervescence. Absorbs water, but does not fall to pieces. At 100° C. gives up half its water.

It occurs at Newhaven, Sussex, in reniform and botryoidal concretions, imbedded in ferruginous clay, which rests on the chalk strata; also under similar circumstances at Epernay, in Lunel Vieil, and Auteuil, in France, and in plastic clay, with gypsum, at Hallé and Morl in Prussia.

PISSOPHANE, *Breithaupt*. Garnsdorffite.

Amorphous, or stalactitic.

H.=1·5. G.=1·93—1·98. Lustre vitreous. Color pistachio-, asparagus-, or olive-green. Transparent. Very fragile. Fracture conchoidal.

Composition.—Erdmann (Schweig J. lxii, 104) obtained:

		$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dddot{\mathrm{S}}$	$\dot{\mathrm{H}}$		
1.	*Green*,	35·155	9·738	12·700	41·690	gangue and loss,	0·717=100.
2.	"	35·301	9·799	12·487	41·700	"	0·709=100.
3.	*Yellow*,	6·799	40·060	11·899	40·131	"	1·111=100.

Probably not a simple mineral. Perhaps Nos. 1 and 2, $\ddot{\bar{\mathrm{R}}}^{3}\dddot{\mathrm{S}}+15\dot{\mathrm{H}}$, and No. 3, $\ddot{\bar{\mathrm{R}}}^{2}\dddot{\mathrm{S}}+15\dot{\mathrm{H}}$. The relation in the former is more exactly $\ddot{\bar{\mathrm{R}}}^{5}\dddot{\mathrm{S}}^{2}+30\dot{\mathrm{H}}$. For the most part insoluble in water. Easily soluble in muriatic acid. B.B. becomes black. In a glass tube gives alkaline water.

Occurs at Garnsdorf, near Saalfeld, and at Reichenbach, Saxony, on alum slate.

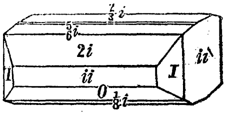
LINARITE, *Brooke*. Cupreous Anglesite. Cupreous Sulphate of Lead, *Brooke*. Bleilasur. Kupferbleispath. Linarit.

Monoclinic. $C=77°\ 15'$; $I:I$ (over ii)$=61°$, $O:1i=140°\ 5'$, $a:b:c=0·4927:1:0·5745$. Observed planes, as in the annexed figure, with also $\frac{1}{8}i$, $\frac{2}{3}i$, $\frac{5}{6}i$ and $2i$, on the acute edge between O and ii, and the lateral plane ii (B. & M.) $O:ii=102°\ 45'$, $ii:1i=105°$

35′, $ii : 2i$=128° 6′, $ii : \frac{2}{3}i$=96° 18′. Twins: composition face ii common; $O : O'$=154° 30′. Cleavage: very perfect parallel to ii; less so to O.

H.=2·5—3. G.=5·2—5·5. Lustre vitreous or adamantine. Color deep azure blue. Streak pale blue. Translucent. Fracture conchoidal.

541



Composition.—$\dot{Pb}\ddot{S}+\dot{Cu}\dot{H}$=Sulphate of lead 75·7, oxyd of copper 19·8, water 4·5. Analyses: 1, Brooke, (Ann. Phil. [2], iv, 117, 1822); 2, Thomson, (Phil. Mag. 1840, Dec. 402):

		$\dot{Pb}\ddot{S}$	$\dot{Cu}$	$\dot{H}$
1.	Wanlockhead,	75·4	18·0	4·7=98·1, Brooke.
2.	"	74·8	19·7	5·5=100, Thomson; G.=5·2137.

In the blowpipe flame, it affords indications of copper and lead.

This mineral occurs at Leadhills; also at Roughten Gill, in Cumberland, in crystals sometimes an inch long; at Linares in Spain, and near Ems.

ALTERED FORMS.—Linarite occurs altered to Cerusite, a change like that of Anglesite to Cerusite.

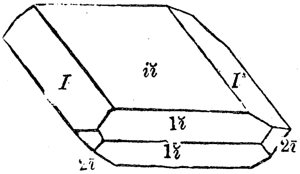
BROCHANTITE. Brochantit, *Levy*. Konigine, *Levy*. Krisuvigite, *Forchhammer*.

Trimetric. $I : I$=104° 10′, $O : 2\bar{i}$=147° 14½′; $a : b : c$=0·3232 : 1 : 1·2838. Observed planes as in the annexed figure, with $\breve{i}\breve{2}$. $\breve{i}\breve{2} : \breve{i}\breve{2}$ (ov. $\breve{i}\breve{i}$)=114° 36′, $1\breve{i} : 1\breve{i}$ (ov. $\breve{i}\breve{i}$)=28° 8′, $\breve{i}\breve{i} : 1\breve{i}$=104° 4′, $2\bar{i} : 2\bar{i}$ (ov. O)=114° 29′, $\breve{i}\breve{i} : \bar{i}\bar{i}$=90°.

Cleavage: $\breve{i}\breve{i}$ very perfect; I in traces. Also massive; reniform with a columnar structure.

H.=3·5—4. G.=3·8—3·91. Lustre vitreous. Color emerald-green, blackish-green. Streak paler green. Transparent—translucent.

542



Composition.—$\dot{Cu}\ddot{S}+3\dot{Cu}\dot{H}[=\dot{Cu}^4\ \ddot{S}\ \dot{H}^3]$=Sulphuric acid 17·7, protoxyd of copper 70·3, water 12·0. Analyses: 1, 2, Magnus, (Pogg. xiv, 141); 3, Forchammer, (J. f. pr. Ch. xxx, 396); 4, Berthier, (Ann. Ch. Phys. 1, 360):

		$\ddot{S}$	$\dot{Cu}$	$\dot{Zn}$	$\dot{Pb}$	$\dot{H}$
1.	Retzbanya,	17·132	62·626	8·181	0·030	11·887=99·856, Magnus.
2.	"	17·426	66·935	3·145	1·048	11·917=100·471, Magnus
3.	*Krisuvigite*,	18·88	67·75	——	——	12·81=99·44, Forchhammer.
4.	Mexico,	16·6	66·2	——	——	17·2=100, Berthier.

The last from Mexico, corresponds to $\dot{Cu}^4\ddot{S}\ \dot{H}^4$.

Rivot found in crystals of brochantite of a fine green color, which afforded a slight effervescence with acids, $\ddot{S}$ 19·4, $\dot{Cu}$ 57·9, $\dot{H}$ 13·5, with $\dot{Cu}$ 5·0, $\ddot{C}$ 1·2, $\dot{H}$ 1·2=98·2. The mineral had undergone partail alteration, as shown by the carbonate of copper present, (Delesse's Extr. de Min., Ann. d. M. [5], iii, 740).

B.B. fuses on charcoal and yields metallic copper.

Occurs in small but well defined crystals, with malachite and native copper, at Katherinenburg in Siberia; the Konigine was found at the same locality; also in small brilliant crystals with malachite in a quartzose rock near Roughten-Gill, in Cumberland; and at Retzbanya. The Krisuvigite occurs in small beds at Krisuvig in Iceland.

Brochantite was named by Levy after Brochant de Villiers.

LETTSOMITE, *Percy.* Velvet Copper Ore. Cuivre Velouté, *Levy.* Kupfersammterz.

Occurs in spherical globules or in druses consisting of short delicate fibres, and having an appearance like velvet. Color clear smalt-blue. Lustre pearly.

Composition.—$(\dot{\mathrm{Cu}}^6\dddot{\mathrm{S}}+3\dot{\mathrm{H}})+(\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}+9\dot{\mathrm{H}})$ Rammelsberg=Sulphuric acid 16·78, oxyd of copper 49·85, alumina 10·76, water 22·59. Analyses by J. Percy, (Phil. Mag. [3], xxxvi, 100):

$\dddot{\mathrm{S}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{H}}$
15·39	11·70		43·16	23·06=98·30.
14·12	11·06	1·18	46·59	23·06, insol. 2·35=98·36.

Occurs sparingly at Moldawa in the Bannat, coating the cavities of an earthy hydrated oxyd of iron; and according to Percy, a white amorphous substance occurs sparingly with it, consisting of alumina and sulphuric acid.

MEDJIDITE, *J. L. Smith,* Am. J. Sci. 2d ser. v, 337. Sulphate of Uranium and Lime.

Massive, with an imperfectly crystalline structure.

H.=2·5. Lustre vitreous in the fracture. Color dark amber. Transparent.

Composition.—$\dddot{\bar{\mathrm{U}}}\dddot{\mathrm{S}}+\dot{\mathrm{Ca}}\dddot{\mathrm{S}}+15\dot{\mathrm{H}}$, according to Smith. In a matrass easily yields water. At redness blackens, being converted into oxyd of uranium and sulphate of lime. Dissolves readily in dilute muriatic acid.

Occurs near Adrianople, Turkey, on pitchblende, associated with Liebigite in some places with crystals of sulphate of lime; also at Joachimstahl, with Liebigite on Uranium ore. Supposed to be due to the decomposition of pyrites. Externally often dull from loss of water. It was named in honor of the Turkish sultan Abdul Medjid.

IV. BORATES.

Boracic acid occurs in but few minerals; viz. Datholite, Danburite, Axinite, Tourmaline and Warwickite, with the following. It is a remarkable fact that in all of them, as far as known, the crystallization is either hemihedral or oblique. Boracite and Rhodizite are hemihedral monometric; Danburite, hemihedral trimetric; Tourmaline, hemihedral rhombohedral; while Danburite and Axinite are triclinic. In Tourmaline and Axinite, boracic acid acts the part of a base; and if the same may be admitted to be the case in Boracite, it is in composition as well as form, related to the protoxyds and magnetite.

BORACITE, *Werner*. Borate of Magnesia, *P.* Borazit. Magnésie boratée, *H.*

Monometric; tetrahedral. Figs. 1, 53, 54, and the following. Observed planes as in the figures, with also 22 and $5\frac{5}{3}$.

Cleavage: octahedral, in traces. Also amorphous.

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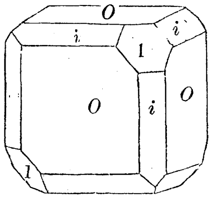

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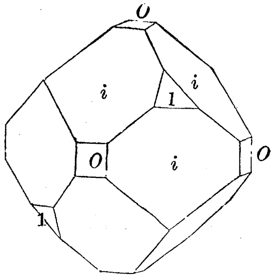

H.=7. G.=2·974, Haidinger; 2·9134, massive, Karsten. Lustre vitreous, inclining to adamantine. Color white, inclining to gray, yellow and green. Streak white. Subtransparent—translucent. Fracture conchoidal, uneven. Pyro-electric, even when massive.

Composition.—$\dot{Mg}^3\dddot{B}^4$=Boracic acid 70·0, magnesia 30·0. Stromeyer, (Gilbert's Annalen, xlviii, 215), Arfvedson, (K. V. Ac. H., 1822, p. 92), and Rammelsberg, (Pogg. xlix, 445), obtained:

Boracic acid,	67	69·6	69·252
Magnesia,	33=100, St.	30·3=100, Arf.	30·748=100, Ramm.

A *compact boracite* from Stassfurth, afforded Karsten, (Pogg. Ann. lxx, 557), Magnesia 29·48, boracic acid 69·49, with 1·03 of carbonate of iron and manganese, and hydrated oxyd of iron. H.=4·5, G.=2·91.

B.B. intumesces, and forms a glassy globule, crystalline and white on cooling. Observed in beds of anhydrite, gypsum or salt; in crystals at Kalkberg and Schildstein in Lüneberg, Hanover; at Segeberg near Kiel in Holstein; at Luneville, La Meurthe, France: massive or as part of the rock of the Salt Mine at Stassfurth, Prussia.

RHODIZITE, *G. Rose*, Poggendorff's Annalen, xxxiii, 253.

Monometric and tetrahedral, like boracite; planes 1 smooth and shining, *i* often uneven. H.=8. G.=3·3—3·42.

B.B. in the platinum forceps, fuses with difficulty on the edges to a white opaque glass, tinging the flame at first green, then green below and red above, and finally red throughout. With borax and salt of phosphorus, fuses to a transparent glass.

Supposed to be a lime boracite. It was found by G. Rose in minute crystals on red tourmalines from near Mursinsk, Siberia, and named from ʽροδιζειν, in allusion to its tinging flame red. The largest crystals seen were two lines in diameter.

HYDROBORACITE, *Hess.* Hydrous Borate of Lime and Magnesia.

Resembles fibrous and foliated gypsum. H.=2. G.=1·9—2. Color white, with spots of red from iron. Thin plates translucent.

Composition.—$\dot{C}a^3\dddot{B}^4+\dot{M}g^3\dddot{B}^4+18\dot{H}$=Boracic acid 47·7, lime 14·3, magnesia 10·3, water 27·7. Analyses by M. Hess, (Pogg. xxxi, 49):

	$\dddot{B}$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$
1.	49·922	13·298	10·430	26·330=100.
2.	49·22	13·74	10·71	26·33=100.

B.B. fuses to a clear glass, tinging the flame slightly green, and not becoming opaque. In a matrass affords water. Somewhat soluble in water, and yielding a slightly alkaline reaction. Dissolves easily in muriatic and nitric acids.

Hydroboracite was first observed by Hess, in a collection of Caucasian minerals. The specimen was full of holes filled with clay, containing different salts. It may be mistaken for gypsum, but is readily distinguished by its fusibility.

HAYESINE. Borate of Lime, *Hayes.* Borocalcite. Borsaurerkalk. Hydroborocalcit. Tiza.

In masses having a globular form, consisting of interwoven fibres. Opaque, snow-white, silky, and having a peculiar odor.

Composition.—$\dot{C}a\dddot{B}^2+6\dot{H}$, Hayes=Boracic acid 45·98, lime 18·45, water 35·57. Analyses: 1, A. A. Hayes, (Am. Jour. Sci. [2], xviii, 95); 2, Bechi, (ib. xvii, 129):

	$\dddot{B}$	$\dot{C}a$	$\dot{H}$
1. Peru,	46·11	18·89	35·00=100.
2. Tuscany,	51·135	20·850	26·250=100.

Hayes observes in Am. J. Sci. xviii, 95, July, 1854, that the pure mineral does not contain soda, and the soda in the following analyses he attributes to impurities. Ulex obtained, (Ann. Ch. u. Pharm. lxx, 49), Boracic acid 49·5, lime 15·9, soda 8·8, water 25·8; and A. Dick, (Phil. Mag. [4], vi, 50), Boracic acid (by loss) 45·46, lime 14·32, soda 8·22, potash 0·51, sulphuric acid 1·10, NaCl 2·65, sand 0·32, *I* and $\dddot{P}$ *trace.* Ulex gives the formula $\dot{N}a$, $2\dot{C}a$, $5\dddot{B}+10\dot{H}$. (Named *Ulexite* in last edition of this work, on the ground of a supposed difference in composition from the Hayesine).

Occurs over the dry plains near Iquique in Southern Peru, in white reniform masses, from the size of a hazlenut to that of a potato, where it is called *tiza;* the masses consist of interwoven silky fibres which rapidly absorb water, and have a slightly saline taste. It is associated with Pickeringite. The mineral analyzed by Professor Bechi forms an incrustation at the Tuscan lagoons.

BORAX. Tincal. Pounxa. Swaga. Zala. Borate of Soda.

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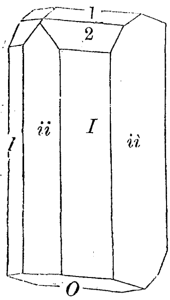


Monoclinic. *C*=73° 25′, *I* : *I*=87°, *O* : 2*i*=132° 49′; *a* : *b* : *c*=0·4906 : 1 : 0·9095. Observed planes as in the annexed figure, with also 4*i*. *O* : *I*=78° 40′ and 101° 20′, *O* : 1=139° 30′, *O* : 2=115° 53′, *O* : 4*i*=114° 51½, *O* : *ii*=90′, *ii* : *I*=133° 30′. Cleavage: *ii* perfect; *I* less so; *ii* in traces. Plane of composition *ii; O* : : *O*=146° 50′.

H.=2—2·5. G.=1·716. Lustre vitreous—resinous; sometimes earthy. Color white; sometimes grayish, bluish or greenish. Streak white. Translucent — opaque. Fracture conchoidal. Rather brittle. Taste, sweetish-alkaline, feeble.

Composition.—$\dot{N}a\dddot{B}^2+10\dot{H}$=Boracic 36·58, soda 16·25, water 47·17. B.B. puffs up, and afterwards fuses to a transparent globule, called the glass of borax. It is soluble in water; the solution changes vegetable blues to greens. With fluor spar and bisulphate of potash, it colors the flame around the powder a clear green.

Borax was originally brought from a salt lake in Thibet. The borax is dug in masses from the edges and shallow parts of the lake, and in the course of a short time the holes thus made are again filled. This crude borax was formerly sent to Europe under the name of tincal, and there purified. It is now extensively made from the boracic acid of the Tuscan lagoons, by the reaction of this acid on carbonate of soda. It has also been found at Potosi in Peru, and in Ceylon. It occurs in solution in the mineral springs of Chambly, St. Ours, &c., Canada West, (Hunt, Logan's Geol. Rep. 1853).

This salt is employed in several metallurgical operations as a flux, is sometimes used in the manufacture of glass and gems, and extensively in the process of soldering.

Prof. Bechi has analyzed a borate occurring as an incrustation at the Tuscan lagoons, which afforded $\dddot{\text{B}}$ 43·56, $\dot{\text{N}}\text{a}$ 19·25, $\dot{\text{H}}$ 37·19=100, giving the formula $\dot{\text{N}}\text{a}\dddot{\text{B}}^2+6\dot{\text{H}}$, (Am. J. Sci., [2], xvii, 128).

LAGONITE.

An earthy mineral of an ochreous yellow color.

Composition.—$\dddot{\text{F}}\text{e}\dddot{\text{B}}^3+3\dot{\text{H}}$=Boracic acid 49·5, peroxyd of iron 37·8, water 12·7=100. Analysis by Prof. Bechi, (Am. J. Sci. [2], xvii, 129):

$\dddot{\text{B}}$ 47·95, $\dot{\text{F}}\text{e}$ 36·26, $\dot{\text{H}}$ 14·02, $\dot{\text{M}}\text{g}$, $\dot{\text{C}}\text{a}$ and loss 1·77.

Occurs as an incrustation at the Tuscan lagoons.

LARDERELLITE, *Bechi.*

Very light, white and tasteless. Appearing under the microscope to be made up of minute oblique rectangular tables; M:T=110°, Amici.

Composition.—$\text{NH}^4\text{O}\dddot{\text{B}}^4+4\dot{\text{H}}$. Analysis by Prof. Bechi, (Am. J. Sci. [2], xvii, 130):

$\dddot{\text{B}}$ 68·556, NH^4O 12·734, $\dot{\text{H}}$ 18·325.

Dissolves in hot water, and is transformed into a new salt, represented by the formula $\text{NH}^4\text{O}\dddot{\text{B}}^6+9\dot{\text{H}}$.

Occurs at the Tuscan lagoons.

WARWICKITE, *Shepard,* Am. J. Sci., xxxiv, 313, xxxvi, 85.—Enceladite, *T. S. Hunt,* ib., [2], ii, 30.

Monoclinic ? $I:I$=93°—94°. Usual in rhombic prisms with obtuse edges truncated, and the acute beveled, summits generally rounded; surfaces of larger crystals not polished. Cleavage: macrodiagonal perfect, affording surface with vertical striæ and traces of oblique cross cleavages.

H.=3—4. G.=3·188, Hunt. Lustre submetallic pearly on cleavage surface to subvitreous; often nearly dull. Color dark hair-brown to dull black, sometimes a copper-red tinge on cleavage surface. Streak bluish-black. Fracture uneven. Brittle.

Composition.—Essentially a borotitanate of magnesia and iron, with over 20 per cent. of boracic acid, Smith and Brush, (Am. J. Sci., [2], xvi, 293).

Yields water. B.B. alone infusible, but becomes lighter in color; with borax a clear bead colored by iron; with salt of phosphorus a bead orange while hot, and purplish gray and opaque on cooling. Reaction of boracic acid.

Occurs in granular limestone two and a half miles S. W. of Edenville, N. Y., with spinel, chondrodite, serpentine, etc. Crystals usually small and slender; sometimes over two inches long, and three-eighths of an inch broad.

V. PHOSPHATES, ARSENATES, ANTIMONATES, NITRATES.

1. ANHYDROUS.

1. APATITE GROUP.—Crystallization Hexagonal. Oxygen ratio of bases and acids, (exclusive of fluorid or chlorid), 3 : 5.

Apatite,	$\dot{\mathrm{C}}\mathrm{a}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\frac{1}{3}\mathrm{Ca(Cl,F)}$.	Zwieselite,	$(\dot{\mathrm{F}}\mathrm{e}, \dot{\mathrm{M}}\mathrm{n})^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\frac{1}{3}\mathrm{FeF}$?
Osteolite,		Pyromorphite,	$\dot{\mathrm{P}}\mathrm{b}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\frac{1}{3}\mathrm{PbCl}$.
Cryptolite,	$\dot{\mathrm{C}}\mathrm{e}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$.	Mimetene,	$\dot{\mathrm{P}}\mathrm{b}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}+\frac{1}{3}\mathrm{PbCl}$.

2. XENOTIME GROUP.—Crystallization Dimetric. Oxygen ratio 3 : 5.

Xenotime,	$\dot{\mathrm{Y}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$.

3 MONAZITE GROUP.—Monoclinic. Oxygen ratio 3 : 5 to 4 : 5.

Monazite,	$(\dot{\mathrm{C}}\mathrm{e},\dot{\mathrm{L}}\mathrm{a}, \dot{\mathrm{T}}\mathrm{h})^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$.	Kühnite,	$\dot{\mathrm{R}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}$
Wagnerite,	$\dot{\mathrm{M}}\mathrm{g}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\dot{\mathrm{M}}\mathrm{g}\ \mathrm{F}$.	Lazulite.	

4. TRIPLITE GROUP.—Trimetric. Oxygen ratio 3 : 5 to 4 : 5.

Triphyline,	$\dot{\mathrm{R}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$?	Triplite,	$\dot{\mathrm{R}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$.

5. FISCHERITE GROUP.—Trimetric. Oxygen ratio 6 : 5.

Fischerite,	$\dddot{\bar{\mathrm{A}}}\mathrm{l}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+8\dot{\mathrm{H}}$.	Peganite,	$\dddot{\bar{\mathrm{A}}}\mathrm{l}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+6\dot{\mathrm{H}}$.

Appendix. Hopeite, Amblygonite, Herderite, Carminite.

6. ROMEINE GROUP.

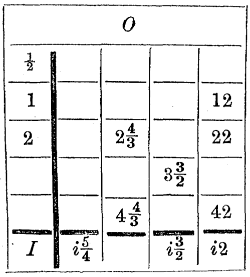
Romeine,	$\dot{\mathrm{R}}^3\dddot{\mathrm{S}}\mathrm{b}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{S}}\mathrm{b}$.

APATITE, *Werner*. Phosphate of Lime. Spargelstein. Phosphorit, *W.* Asparagus stone. Moroxite. Eupyrchroite, *Emmons*. Augustite. Pseudo-apatite, *Breit.*

Hexagonal: often hemihedral. $O : 1 = 139° 47'$; $a = 0{\cdot}7323$. Figures 190, 191, and the annexed.

$O : \frac{1}{2}$=157° 5′.	$O : 3\frac{3}{2}$=110° 3′.	O : 42=108° 51.
O : 2=120° 36′.	O : 12=143° 47′.	$I : 3\frac{3}{2}$=149° 37′.
$O : 4\frac{4}{3}$=105°.	O : 22=124° 30′.	1 : 1 (pyr.)=142° 20′.

Descloizeaux makes 1 : 1=142° 15′, and O : 1=139° 45′. Cleavage: O, imperfect; I, more so. Also globular and reniform, with a fibrous or imperfectly columnar structure; also massive, structure granular.



O				
$\frac{1}{2}$				
1				12
2		$2\frac{4}{3}$		22
			$3\frac{3}{2}$	
		$4\frac{4}{3}$		42
I	$i\frac{5}{4}$		$i\frac{3}{2}$	$i2$

Observed Planes.

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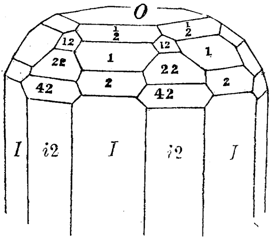


H.=5, sometimes 4·5. G.=3·25. Lustre vitreous, inclining to subresinous. Streak white. Color usually sea-green, bluish-green; often violet blue; sometimes white; occasionally yellow, gray, red, and brown; none bright. Transparent—opaque. A bluish opalescence sometimes in the direction of the vertical axis, especially in white varieties. Cross fracture conchoidal and uneven. Brittle.

Composition.—$\dot{\text{Ca}}^3\ddot{\text{P}}+\frac{1}{3}\text{Ca(Cl, F)}$=Phosphoric acid 42·26, lime 50·0 fluorine 3·77, calcium 3·97; or phosphate of lime 92·26, and fluorid of calcium 7·74, with Ca Cl sometimes replacing part of the fluorid. According to G. Rose, (Pogg. ix):

	Snarum, Norway,	Cabo de Gata, Spain.	Arendal, Norway.	Greiner, Tyrol.	St. Gothard, Tyrol.
Phosphate of lime,	91·13	92·066	92·189	92·16	92·31
Chlorid of Calcium,	4·28	0·885	0·801	0·15	trace
Fluorid of Calcium,	4·59	7·049	7·01	7·69	7·69
	G.=3·174	G.=3·235	G.=3·194	G.=3·175	G.=3·197

Other analyses: 1, Rammelsberg; 2, Weber, (Monatsb. Preuss. Akad. 1851, 173); 3, C. A. Joy, (Inaug. Diss., 45); 4, T. H. Henry, (Phil. Mag):

	$\ddot{\text{P}}$	$\dot{\text{Ca}}$	Ca	Cl	F	
1. Schwarzenstein,	42·58	49·66	4·06	0·07	3·63,	Rammelsberg.
2. Snarum,	41·54	53·46	—	2·66	?	$\ddot{\text{F}}\text{e}$, $\ddot{\text{C}}\text{e}$, $\dot{\text{Y}}$ 1·79, Weber.
3. Faldige,	43·01	55·24	—	0·05	?	$\ddot{\text{F}}\text{e}$ 0·09, Joy.
4. Huel Franco,	41·34	53·38	—	—(loss)		2·32, $\dot{\text{F}}\text{e}$, $\dot{\text{M}}\text{n}$, 2·96, Henry.

Weber's analysis corresponds to 90·66 per cent. $\dot{\text{Ca}}^3\ddot{\text{P}}$, 4·17 Ca Cl, 3·07 Ca F. Bischof has found magnesia in some apatites. The *Eupyrchroite* of Emmons (a compact concretionary subfibrous variety) afforded C. T. Jackson the constituents of apatite, with only the impurities $\dot{\text{F}}\text{e}$ 2·00, $\dot{\text{Ca}}\ddot{\text{C}}$ 2·77, $\dot{\text{H}}$ 0·50. G.=3·053.

B.B. infusible alone except on the edges; gives the test of phosphoric acid, With biphosphate of soda or borax fuses without difficulty to a glass, which on cooling, has a crystalline structure; also fuses if mixed with carbonate of iron; dissolves slowly in nitric acid, without effervescence. Some varieties are phosphorescent.

Apatite usually occurs in crystalline rocks. It is often found in veins in gneiss or mica slate, and particularly those containing tin and iron ore; also in granular limestone. It is sometimes met with in serpentine, and occasionally, as in Spain, in ancient volcanic rocks.

Among its localities are Ehrenfriedersdorf in Saxony, Schwarzenstein and Pfitsch in the Tyrol; Amberg in Bavaria; Zinnwald and Schlackenwald in Bohemia; Caldbeck Fell in Cumberland, Devonshire; St. Gothard in Switzerland. The greenish-blue variety, called *moroxite,* occurs at Arendal in Norway, and Pargas, Finland. The *asparagus stone* or *spargelstein* variety, which is obtained at Zillerthal in the Tyrol, and Villa Rica, Spain, is translucent, and has a wine yellow-color; it is imbedded in talc. The *phosphorite* or massive radiated varieties are mostly obtained from Estremadura in Spain, and Schlackenwald in Bohemia.

Large crystals of apatite are found in St. Lawrence County, New York, in white limestone, along with scapolite, sphene, &c. One crystal from Robinson's farm, in Hammond, was nearly a foot in length, and weighed eighteen pounds. The prisms are frequently well terminated. Also in crystals about a mile southeast of Gouverneur, and two miles north; and also in Rossie, with sphene and pyroxene, two miles north of the village of Oxbow. Also on the bank of Vrooman lake, Jefferson Co., in white limestone, fine green prisms from half to five inches long; Sanford mine, East Moriah, Essex Co., in magnetic iron ore, which is often thickly studded with six-sided prisms; also at Long Pond, Essex Co.; near Edenville, Orange Co. in prisms from half an inch to twelve inches long, of a bright asparagus green color, imbedded in white limestone; and in the same region, blue, grayish-green, and grayish white crystals; two miles south of Amity, emerald and bluish-green crystals; at Long Pond, Essex Co., with garnet and idocrase; at Greenfield, Saratoga Co., St. Anthony's Nose, and Corlaer's Hook, less interesting; fibrous mammillated (*Eupyrchroite*) at Crown Point, Essex Co., about a mile south of Hammondsville; at Hurdstown, Essex Co., where a shaft has been sunk and the apatite mined; masses brought out weigh occasionally two hundred pounds, and some cleavage prisms have the planes three inches wide. In *New Hampshire,* crystals, often large, are abundant, four miles south of the north village meeting-house Westmoreland, in a vein of feldspar and quartz, in mica slate, along with molybdenite; some fine crystals at Piermont, N. H., in white limestone on the land of Mr. Thomas Cross. In *Maine,* on Long Island, Blue-hill Bay, in veins ten inches wide, intersecting granite. In *Massachusetts,* crystals occasionally six inches long, are obtained at Norwich, (northeast part), in gray quartz; at Bolton abundant, the forms seldom interesting; also sparingly at Chesterfield, Chester, Sturbridge, Hinsdale, and Williamsburgh. In *Pennsylvania,* at Leiperville, Delaware Co., in Bucks Co., three miles west of Attleboro. Apatite has also been found near Baltimore, *Maryland;* at Dixon's quarry, Wilmington, *Delaware,* of a rich blue color; on the Morris Canal, near Suckasuny, N. J., of a brown color, in massive magnetic pyrites; Phosphate of lime in nodules occurs in Silurian rocks in Canada and elsewhere, which are supposed to be coprolites; at Burgess, C. W., in large green crystals; at Grand Calumet in calcite, in delicate blue crystals; in trap of St. Norbert, C. E., in transparent amethyst, rose, or colorless crystals, some one inch long, and one-sixth in diameter.

Apatite was named by Werner from *απαταω, to deceive,* in allusion to the mistake of the older mineralogists with regard to the nature of its many varieties.

The *Pseudoapatite* is an impure apatite; analysis by Rammelsberg, J. pr. Chem. lv, 486.

The *talc-apatite* of Hermann, (J. f. pr. Ch. xxxi, 101), is from chlorite slate in the Schischimskian mountains near Slatoust. It contains Lime 37·50, magnesia 7·74, phosphoric acid 39·02, sulphuric acid 2·10, chlorine 0·91, fluorine and loss 2·23, oxyd of iron 1·00, insoluble 9·50=100, whence the formula $3\,\dot{\mathrm{C}}\mathrm{a}^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\dot{\mathrm{M}}\mathrm{g}^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$. But from the variety of its constituents and the large per-centage of insoluble ingredients, Berzelius suggests that the magnesia may possibly come from the gangue. G.= 2·70—2·75. In six-sided crystals, grouped or single.

Altered Forms.—The *Osteolite* of Bromeis is supposed to be apatite which has become earthy in appearance, and lost its fluorine and chlorine, (Ann. Ch. Pharm., lxxix, 1). It has a compact texture like lithographic stone, or else is earthy, and adheres to the tongue. G.=2·89. Composition, $\dot{\mathrm{C}}\mathrm{a}^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$. Analyses: 1, Bromeis, compact part, (loc cit.); 2, Rütz, earthy, (ib.); 3, Ewald, intermediate part, (ib.); 4, G. Besanez, (Ann. Ch. Pharm., lxxxix, 221):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dddot{\mathrm{S}}\mathrm{i}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{N}}\mathrm{a}$	$\ddot{\mathrm{C}}$	$\dot{\mathrm{H}}$
1. Hanau,	36·88	49·41	4·50	1·85	0·93	0·47	0·76	0·62	1·81	2·28= 99.51
2. "	37·41	49·24	2·75	2·78	1·25	0·79	0·81	0·46	2·34	3·45=101·28
3. "	37·16	48·20	2·03	2·31	*trace*	1·85	0·73	0·43	2·55	3·63= 98·80
4. Amberg,	42·00	48·16	4·97	1·56	——	0·75	0·04	0·02	2·21	1·31=101·02

From near Hanau between Ostheim and Eichen, and also from Amberg in the Erzgebirge. Occurs in altered dolonite.

CRYPTOLITE, *Wöhler*, Götting. gel. Anzeig. 1846, 19, and Poggendorff's Annalen, lxvii, 424.

In acicular hexagonal prisms. G. about 4·6. Wine-yellow, transparent.

Composition.—$\dot{\mathrm{C}}\mathrm{e}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$, in which the cerium is part didymium=Protoxyd of cerium 69·4, phosphoric acid 30·6. Analysis by Wohler, (loc. cit.):

Oxyd of cerium 73·70, protoxyd of iron 1·51, phosphoric acid 27·37=102·58.

The excess is owing as supposed to a change of the protoxyd of cerium to peroxyd. Soluble in concentrated sulphuric acid. Not altered by a moderate calcination.

Occurs in the green and red apatite of Arendal, and distinguished on putting the apatite in dilute nitric acid; constitutes 2 or 3 per cent. of the mass; it was found especially in the red apatite, or in reddish points of the green, and associated with particles of magnetic iron, hornblende, and another cerium ore of a hyacinth-red color, supposed to be monazite. This mineral was looked for in the yellowish apatites of Snarum without success. Occurs also with apatite in the Tyrol. (?) Named from κρυπτος, *concealed.*

It has been suggested that Cryptolite is a cerium apatite.

Phosphocerite, *H. Watts*, Quart. J. Chem. Soc. July 1, 1849, ii, 131.—The phosphocerite, as recognized by Mr. Watts, has the composition essentially of the cryptolite, but is said to differ in crystalline form. According to Watts and Chapman, (loc. cit. p. 154), the form is probably dimetric; yet as the crystals of both this species and the cryptolite are microscopic, the two, as observed by Chapman, may yet be brought together. They occur as a grayish yellow powder along with the cobalt ore of Tunaberg, and are associated with dark purple crystals of another kind and dodecahedral form, ($\mathrm{Fe}^3\mathrm{S}^4$), which are strongly magnetic. The crystalline forms most common in the powder are an octahedron and a square or rectangular prism, terminating in a four-sided pyramid parallel with the lateral planes, resembling fig. 382, under zircon. G.=4·78. H.=5·0—5·5. Colorless or pale sulphur-yellow. Lustre vitreo-resinous or adamantine.

Composition.—$(\dot{\mathrm{C}}\mathrm{e}, \dot{\mathrm{L}}\mathrm{a}, \dot{\mathrm{D}})^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$. Analysis by Watts, (loc. cit.): Protoxyd of cerium, lanthanum, didymium 67·38, phosphoric acid 29·66, oxyd of iron 2·95=100.

The oxyd of iron and a little cobalt detected are probably impurities. B.B. according to Chapman, it vitrifies partially on the edges, tinging the flame at the same time slightly green. Affords the reaction of phosphoric acid and also of cerium, producing however with borax and salt of phosphorus a glass which is pale violet-blue when cold, either due to the presence of didymium, or a minute portion of cobalt ore.

[The analysis of cryptolite gives more nearly the oxygen proportion of 2 : 3, corresponding to 10 of $\dot{\mathrm{C}}\mathrm{e}$ and 3 of $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$.]

ZWIESELITE, *Breit.* Phosphate of Iron and Manganese. Eisenapatit, *Fuchs.*

Hexagonal? Supposed to be isomorphous with Apatite. Occurs in crystalline masses. Cleavage: distinct in three directions, but imperfect.

H.=5. G.=3·97. Lustre greasy, color clove-brown. Streak grayish-white. Fracture uneven or imperfect conchoidal.

Composition.—($\dot{\mathrm{Fe}}$, $\dot{\mathrm{Mn}}$)$^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}+\frac{1}{3}$Fe F; $\dot{\mathrm{Fe}}^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}+$Fe F, Rammelsberg. Analyses: 1, Fuchs, (J. f. pr. Ch. xviii, 499); 2, Rammelsberg, (4th Supp. 247):

$\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	F	Fe	$\dddot{\mathrm{Si}}$
35·60	35·44	20·34	3·18	4·76	0·68, Fuchs.
30·33	41·42	23·25	6·00=100, Rammelsberg.		

B.B. decrepitates, and finally melts to a bluish-black glass, attracted by the magnet.

This mineral was met with near Zwiesel in Bavaria, imbedded in granite.

PYROMORPHITE. Phosphate of Lead. Braunbleierz, Grünbleierz, *Wern* and *Hoff.* Traubenblei, *Haus.* Buntbleierz. Nussierite, *Danhauser.* Polysphærite. Miesite, *Beud.*

Hexagonal. $O:1=139°\ 38'$; $a=0·7362$. Observed planes, O, I, $i2$, 1, 2, 4, 22.

$O:4=106°\ 23'$. $O:22=124°\ 11'$. $1:1(\text{pyr.})=142°\ 12'$.
$O:2=120°\ 28'$. $I:i2=150°$. $I:22=135°\ 46'$.

Cleavage: I and 1 in traces, I commonly striated horizontally. Often globular, (Polysphærite), reniform, and botryoidal, with a columnar structure; also fibrous and granular.

H.=3·5—4. G.=6·5871—7·048. Lustre resinous. Color green, yellow, and brown, of different shades, sometimes fine orange-yellow, owing to an intermixture with chromate of lead. Streak white, sometimes yellowish. Subtransparent—subtranslucent. Fracture subconchoidal, uneven. Brittle.

Composition.—Essentially $\dot{\mathrm{Pb}}^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}+\frac{1}{3}$Pb Cl, Ca F usually replacing some of the Pb Cl, and arsenic acid some of the phosphoric acid. Analyses: 1–5, Kersten, (Schw. J. lxii, 1, and Pogg. xxvi, 489); 6, 7, Lerch, (Ann. Ch. u. Pharm. xlv, 328):

		$\dot{\mathrm{Pb}}^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}$	PbCl	CaF	$\dot{\mathrm{Ca}}^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}$
1.	Freiberg, *brown,*	77·02	10·84	1·09	11·05=100, Kersten.
2.	Mies, *brown,*	81·65	10·64	0·25	7·46=100, “
3.	“ “ *cryst.*	89·27	9·66	0·22	0·85=100, “
4.	Bleistadt, *brown cryst.,*	89·17	9·92	0·14	0·77=100, “
5.	Poullaouen, *cryst.,*	89·91	10·09	——	——=100, “
6.	Bleistadt, *brown cryst.,*	87·38	10·23	0·07	0·86, $\dot{\mathrm{Fe}}^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}$ 0·77=90·31, L.
7.	“ “	88·42	9·57	0·20	1·58, “ 0·50=100·27, L.

B.B. on charcoal, melts without addition, and the globule on cooling assumes a polyhedral form, and a dark color; in the reducing flame, becomes bluish. Dissolves readily in heated nitric acid.

Pyromorphite occurs principally in veins, and acompanies other ores of lead.

Fine specimens occur at Leadhills and Wanlockhead; and Poullaouen and Huelgoet in Brittany; at Zschopau and other places in Saxony; at Przibram, Mies, (*Miesite,* brown variety), and Bleistadt, in Bohemia; and at Sonnenwirbel near Freiberg; Clausthal in the Hartz; in fine crystals at Nassau; Beresof in Siberia; Cornwall and Wicklow in Ireland.

Pyromorphite has been found in good specimens at the Perkiomen lead mine, near Philadelphia, and very fine at Phenixville; also in Maine, at Lubec and Lenox; in New York, a mile south of Sing Sing; sparingly at Southampton, Massachusetts, and Bristol, Conn.; in good crystallizations of bright green and gray colors, in Davidson Co., N. C.

Named from πυρ, *fire,* μορφη, *form,* alluding to the crystalline form the globule assumes on cooling. This species passes into the following.

Nussierite is considered by Dufrénoy an impure pyromorphite, containing some arsenate of lead. It is from Nussière, Dep. of Rhone, France.

Altered Forms.—Occurs altered to Galena, (PbS), Calamine, ($\dot{\mathrm{Zn}}^3\dddot{\mathrm{Si}}+1\frac{1}{2}\dot{\mathrm{H}}$), Calcite, and Limonite; to Galena, probably through the action of sulphuretted hydrogen.

MIMETENE. Green Lead Ore. Arsenate of Lead. Grünbleierz, *W.* Traubenblei, *Haus.* Kampylite, *Breit.* Hedyphane. Mimetite.

Hexagonal. $O:1=139°\ 6'$; $a=0{\cdot}7491$. Observed planes as in pyromorphite. $O:2=120°$, $O:22=123°\ 41$. Cleavage: 1, imperfect. H.=3·5. G.=7·19—7·25, Mimetene; 5·3—5·5, Hedyphane; 6·8—6·9, Kampylite. Lustre resinous. Color pale-yellow, passing into brown; sometimes orange-yellow (kampylite) from the presence of chromate of lead; sometimes whitish when containing much phosphate of lime, (hedyphane). Streak white or nearly so. Subtransparent—translucent. Sectile.

Composition.—$(\dot{Pb}, \dot{Ca})^3(\ddot{As}, \overset{\cdot\cdot\cdot\cdot\cdot}{P})+\frac{1}{3}Pb\,Cl$. Analyses: 1, Wöhler, (Pogg. iv, 167); 2, 3, Dufrénoy, (Traité, iii, 46): 4, Kersten, (Schw. J. lxii):

	$\dot{Pb}^3\ddot{As}$	$\dot{Pb}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$	PbCl
1. Johanngeorgenstadt,	82·74	7·50	9·60=99·84, Wöhler.
2. Horhausen,	86·70	2·15	10·40=98·25, Dufrénoy.
3. Cornwall,	84·55	4·50	9·05=98·10, Dufrénoy.
4. Longbansh., *Hedyphane*,	60·10	——	10·29=, $\dot{Ca}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 15·51, $\dot{Ca}^3\ddot{As}$ 12·98=98·88, K.

A Zacatecas ore afforded C. Bergemann, (Pogg. lxxx, 401), $\ddot{As}$ 23·065, Cl 2·445, $\dot{Pb}$ 74·961=100·471, corresponding to $\dot{Pb}^3\ddot{As}+\frac{1}{3}PbCl$=Arsenic acid 23·2, oxyd of lead 67·5, chlorid of lead 9·3=100. Analysis by Rammelsberg, Pogg. xci, 316.

Dissolves easily in nitric acid, especially if heated. B.B. fuses to a brownish-yellow mass; and on charcoal gives out copious arsenical fumes and affords a globule of lead.

Occurs at Huel Unity, near Redruth, in Cornwall, and at several other of the Cornish mines; also at Beeralston in Devonshire, and Caldbeckfell in Cumberland. At St. Prix, in the Department of the Saone, in France, in capillary crystals; at Johanngeorgenstadt, in fine yellow crystals; at Nertschink, Siberia, in reniform masses, brownish red; also at Zinnwald and Badenweiler.

The *Hedyphane* is from Longbanshyttan in Sweden, usually in amorphous masses, and subadamantine or resinous in lustre. *Kampylite* occurs at Alstonmoor and Badenweiler.

Domeyko has analyzed an impure ore related to mimetene from Chili, Maria Grande, east of the silver mines of Arqueros. Its color is dirty yellow, with an earthy or slightly resinous appearance. B.B. fuses with intumescence to a gray metallic scoria, giving a bluish tint to the flame.

Composition.—According to Domeyko, (Ann. d. M. [4], xiv, 145):

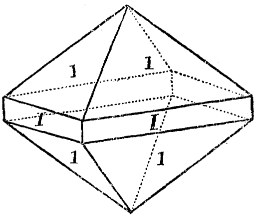
PbCl 9·05, $\dot{Pb}$ 58·31, $\dot{Cu}$ 0·92, $\ddot{As}$ 11·55, $\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 5·13, $\dddot{V}$ 1·86, $\dot{Ca}$ 7·96, $\ddot{\bar{A}}l$, $\ddot{Zr}$? $\ddot{\bar{F}}e$ 1·10, clay [2·00, ign. 1·12=99·00.

It is associated with a vanadate of lead and copper.

XENOTIME. Phosphate of Yttria. Phosphorsaure Yttererde. Ytterspath.

Dimetric. $O:1=138°\ 45'$; $a=0{\cdot}6201$. Observed planes as in the annexed figure. 1 : 1 (pyram.) 124° 26′, (basal) 82° 30′, $I:1=131°\ 15'$. Cleavage: I, perfect.

548



H.=4—5. G.=4·39—4·55. Lustre resinous. Color yellowish-brown, reddish-brown, hair-brown, flesh-red; streak pale brown, yellowish, or reddish. Opaque. Fracture uneven and splintery.

Composition.—$\dot{\text{Y}}^3\overset{..}{\dddot{\text{P}}}$=Phosphoric acid 37·06, yttria 62·94=100. Analysis by Berzelius, (K. V. Ac. H. 1824, 334): Phosphoric acid 33·49 with *trace* of HF, yttria 62·58, subphosphate of iron 3·93=100. Scheerer found in the xenotime of Norway, $\overset{..}{\dddot{\text{P}}}$ and $\ddot{\text{Si}}$ 32·0, $\dot{\text{Y}}$ and $\dot{\text{Fe}}$ 68·0.

B.B. alone infusible. With borax affords a colorless globule, which becomes milky on flaming and opaque with more of the flux. With salt of phosphorus dissolves with great difficulty to a colorless glass. With soda effervesces and yields a light gray infusible slag. Usual reaction of phosphoric acid. Insoluble in acids.

From a granite vein at Hitteröe, with polycrase, malacone and orthite; also at Ytterby, Sweden. Also in the United States in the gold washings of Clarksville, Georgia, (f. 548), associated with zircon, rutile and kyanite; in McDowall Co., N. C.

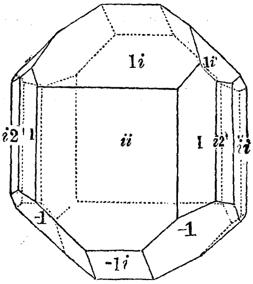
The angle *O* : 1 in xenotime is near *O* : 1 in pyromorphite, with which it is dimorphous.

MONAZITE, *Breithaupt*. Mengite, *Brooke*. Edwardsite and Eremite, *Shepard.*

Monoclinic. *C*=76° 14′; *I* : *I*=93° 10′, *O* : 1ì=138° 8′; *a* : *b* : *c*=0·94715 : 1 : 1·0265. Observed planes as in the annexed figures.

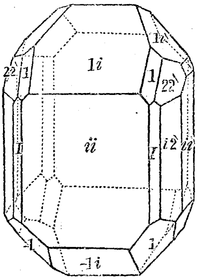
O : 1ĭ=143° 6′. 1 : 1(front)=119° 22′. ĭĭ : *I*=136° 40′.
O : –1ĭ=130° 6′. –1 : –1 " =106° 36′. i$\grave{2}$: i$\grave{2}$ (front)=55° 42′.
O : ĭĭ=103° 46′. 2$\grave{2}$: 2$\grave{2}$ " =81° 4′. ĭĭ : 1=131° 53′.
O : 1=133° 39′. ĭĭ : 1ĭ=140° 40′. ĭĭ : –1=118° 13′.
O : –1=121° 6′. ĭĭ : –1ĭ=126° 8′. ĭĭ : 2$\breve{2}$=120° 10′.
O : 22=121° 18′. ĭĭ : 1ì=100° 13′. 2$\grave{2}$: 2ì=152° 56′.
O : 2ì=119° 10′. ĭĭ : 2ì=93° 6′. 1 : *I*=146° 17′.
O : ìì=90°. 1ĭ : –1ĭ (top)=93° 12′. –1 : *I*=138° 58′.

551



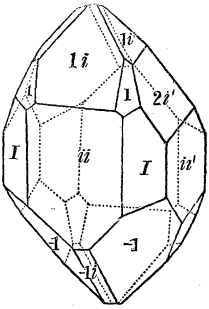
Norwich, Ct.

552



Watertown, Ct.

553



Watertown, Ct.

Crystals usually flattened prisms and small. Cleavage: *O* very perfect, and brilliant.

H.=5—5·5. G.=4·9—5·25. Lustre inclining to resinous. Color brownish-hyacinth-red, clove-brown, or yellowish-brown. Subtransparent—subtranslucent. Rather brittle.

Composition.—($\dot{\mathrm{C}}$e, $\dot{\mathrm{L}}$a, $\dot{\mathrm{T}}$h)$^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$. Analyses: 1, Kersten, (Pogg. xlvii, 385); 2, Hermann, (J. f. pr. Chem. xxxiii, 90):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\dot{\mathrm{C}}$e	$\dot{\mathrm{L}}$a	$\dot{\mathrm{T}}$h	$\ddot{\mathrm{S}}$n	$\dot{\mathrm{M}}$n	$\dot{\mathrm{C}}$a
1.	28·50	26·00	23·40	17·95	2·10	1·86	1·68, $\dot{\mathrm{K}}$ and $\ddot{\mathrm{T}}$i *trace*=101·49.
2.	28·05	37·36	27·41	——	1·75	*trace*	1·46, $\dot{\mathrm{M}}$g 0·80, $\dot{\mathrm{F}}$e *trace*=99·59.

The presence of thoria in this mineral is considered certain, notwithstanding Hermann's result. Tin was detected in this species by Rose, with the blowpipe.

B.B. infusible, becoming gray or greenish-yellow. With borax, slowly dissolves and forms a globule, which is bright yellowish-green, or yellowish-red while hot, and colorless when cold. Decomposed by muriatic acid.

Monazite was first brought by Fiedler from the Ural. It occurs near Slatoust in granite, along with flesh-red feldspar. In the United States it is found in small crystals from one sixteenth to three fourths of an inch long, with the sillimanite of Norwich, and sparingly with the same mineral at Chester, Ct. A few minute crystals (the eremite of Shepard) were found in a boulder of albitic granite, containing also a few minute zircons and tourmalines, in the northeastern part of Watertown, Ct. Good crystals are obtained with the sillimanite of Yorktown, Westchester Co., N. Y.; also near Crowder's Mountain, N. C.

The crystal affording the author the above angles (f. 552) was a fine one with polished faces, well calculated for accurate measurements.* Hermann gives the angle *I* : *I* 92° 30′; Breithaupt 94° 35′; Descloizeaux 93°.

Monazitoid, Hermann, J. f. pr. Chem. xl, 21. This mineral is monazite in crystallization and external characters. H.=5. G.=5·281. Hermann states that the brown color is distinct. Hermann obtained in his analysis,

$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 17·94, $\dot{\mathrm{C}}$e 49·35, $\dot{\mathrm{L}}$a 21·30, $\dot{\mathrm{C}}$a 1·50, $\dot{\mathrm{H}}$ 1·36, subst. like tantalum 6·27, $\dot{\mathrm{M}}$g, $\overset{\cdot\cdot\cdot}{\overline{\mathrm{F}}}$e, *a trace*=97·72. B.B. infusible. With the fluxes like monazite.

WAGNERITE, *Fuchs.* Pleuroclase. Talc Phosphorsäurer. Fluophosphate of Magnesia, *Thom.* Magnésie Phosphatée.

O						
				$\frac{1}{2}$		$\frac{1}{2}\grave{\imath}$
	$\frac{3}{4}3$					
$1\dot{\imath}$		12		1	$1\grave{2}$	$1\grave{\imath}$
						$\frac{3}{2}\grave{\imath}$
						$2\grave{\imath}$
$\dot{\imath}\dot{\imath}$		$\dot{\imath}2$	$\dot{\imath}\frac{3}{2}$	*I*	$\dot{\imath}\grave{2}$	
				−2		
				−1	$-1\grave{2}$	

Observed Planes.

Monoclinic. $C=71°\ 53'$, $I : I=95°\ 25'$, $O : 1\grave{\imath}=144°\ 25'$ (B. & M.); $a : b : c=0{\cdot}78654 : 1 : 1{\cdot}045$.

$O : \frac{1}{2}\grave{\imath}=160°\ 19'$.
$O : 1\dot{\imath}=135°\ 18'$.
$O : \dot{\imath}\dot{\imath}=108°\ 7'$.
$O : I=$
$\dot{\imath}\dot{\imath} : 1\dot{\imath}=116°\ 35'$.
1 : 1 (front)=112° 6′.
−1 : −1 " =127° 32′.
12 : 12 " =142° 48′.
$\frac{1}{2} : \frac{1}{2}$ " =138° 54′.
$1\grave{2} : 1\grave{2}$ " =106° 4′.
$-1\grave{2} : -1\grave{2}$ " =119° 0′.
$\dot{\imath}2 : \dot{\imath}2$ " =131° 4′.
$\dot{\imath}\grave{2} : \dot{\imath}\grave{2}$ (side)=122° 25′.

Most of the prismatic planes deeply striated. Cleavage: *I*, and the orthodiagonal, imperfect; *O* in traces.

H. = 5—5·5. G. = 3·068 transparent crystal, and 2·985 untransparent, Rammelsberg. Lustre vitreous. Streak white. Color

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* See article by the author, Am. J. Sci. xxxiii, 1838, 70. Figure 3, in that article is zircon, and not monazite.

yellow, of different shades; often grayish. Translucent. Fracture uneven and splintery across the prism.

Composition.—$\dot{Mg}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}+MgF$=Phosphoric acid 43·32, magnesia 37·64, fluorine 11·35, Mg 7·69.

Analysis by Fuchs, (Schweig. J. xxxiii, 269, revised by Rammelsberg), and Rammelsberg, (Ann. der Ph. u. Ch. lxiv, 251 and 405, and 2d Suppl. p. 168):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{Ca}$	HF
1,	41·73	46·66	4·50	——	6·50=100·39, Fuchs.
2.	40·61	46·27	4·59	2·38	F 9·36=103·21, Ramm.

B.B. fuses with difficulty, alone, to a dark greenish-gray glass; with borax or salt of phosphorus dissolves readily, and forms a colorless pearl. Nitric or sulphuric acid gently heated, evolves from its powder fumes of hydrofluoric acid.

This rare species occurs in the valley of Höllengraben, near Werfen, in Saltzburg, Austria, in irregular veins of quartz, traversing clay state.

KUHNITE, *B.* and *M.* Magnesian Pharmacolite. Berzeliit, *Kühn*, Ann. Ch. u. Pharm. xxxiv, 211, Chaux arseniatée anhydre, *Duf.*

Massive, with cleavage in one direction.

H.=5—6. G.=2·52. Lustre waxy. Color dirty-white or honey-yellow. Brittle.

Composition.—$(\dot{Ca}, \dot{Mg}, \dot{Mn})^3\overset{\cdot\cdot\cdot\cdot\cdot}{As}$=Arsenic acid 61·5, lime 22·5, magnesia 16·0=100.

Analyses by Kühn, (loc. cit.):

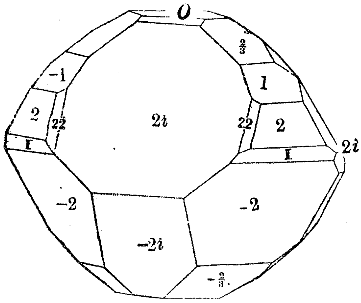
	$\dot{Ca}$	$\dot{Mg}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{As}$	$\dot{Mn}$	
1.	23·22	15·68	58·51	2·13	ign. 0·30=99·84.
2.	20·96	15·61	56·46	4·26	2·95, insol. 0·23=100·47.

B.B. infusible, but becomes gray. Affords the reaction of arsenic, and of manganese with fluor spar. Wholly soluble in nitric acid.

Occurs at Longbanshytta in Sweden, with an ore of iron and granular bitter spar.

LAZULITE. Azurite, *P.* Azurestone. Hydrous diphosphate of alumina and magnesia, *Thom.* Blue spar. Feldspath bleu, *H.* Voraulite. Klaprothine. Blauspath, *W.*

554



Monoclinic. $C=88° 15'$, $I:I=91° 30'$, $O:1i=139° 45'$, Prüfer; $a:b:c=0·86904:1:1·0260$. Observed planes as in the annexed figure, (Prüfer, Nat. Abh. Wien. i, 169).

$O:2i=121° 10'$.
$O:\frac{2}{3}i=150° 15'$.
$O:\frac{2}{3}=140° 20'$.
$O:1=129° 10'$.
$O:I=90° 23'$.
$O:-\frac{2}{3}=141° 3'$.
$2:2$ (front)$=100° 20'$.
$-2:-2$ " $=99° 40'$.
$2i:\frac{2}{3}=141° 38'$.

$O:-2=111° 37'$.
$O:2i=120° 42\frac{1}{2}'$.
$1:1$ (front)$=115° 30'$.

Twins: face of composition *ii*. Cleavage: lateral, indistinct. Also massive.

H.=5—6. G.=3·057, Fuchs; 3·067—3·121, Prüfer; 3·122, Smith and Brush. Lustre vitreous. Color azure-blue; commonly a fine deep blue, viewed along one axis, and a pale greenish-blue, along another. Streak white. Subtranslucent—opaque. Fracture uneven. Brittle.

Composition.—$2(\dot{\mathrm{M}}\mathrm{g}, \dot{\mathrm{F}}\mathrm{e})^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\ddot{\bar{\mathrm{A}}}\mathrm{l}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}^3+5\dot{\mathrm{H}}$, Smith and Brush=Phosphoric acid 43·88, alumina 31·77, protoxyd of iron 8·90, magnesia 9·89, water 5·56. From other analyses, $2(\mathrm{Mg}, \mathrm{Fe})^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\ddot{\bar{\mathrm{A}}}\mathrm{l}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}^3+6\mathrm{H}$=phosphoric acid 46·79, alumina 27·10, protoxyd of iron 7·10, magnesia 11·87, water 7·12. Perhaps $(\dot{\mathrm{R}}+\ddot{\bar{\mathrm{A}}}\mathrm{l})\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\dot{\mathrm{H}}$.

Analyses: 1, Fuchs, (Schweig. J. xxiv, 373); 2, R. Brandes, (ib. xxx, 385); 3 to 8, Rammelsberg, (Pogg. lxiv, 260); 9, 10, Smith and Brush, (Am. J. Sci. [2], xvi, 370):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{H}}$
1. Rädelgraben,	41·81	35·73	9·34	2·64	—	6·06, $\dddot{\mathrm{S}}\mathrm{i}$ 2·1=87·68, F.
2. Krieglach,	43·32	34·50	13·56	0·80	0·42	0·50, $\dddot{\mathrm{S}}\mathrm{i}$ 6·5=99·6, Br.
3. Gratz, G.=3·11,	42·41	29·58	10·67	10·60	1·12	5·62=100, Ramm.
4. " "	43·84	33·09	9·00	6·69	1·44	5·94=100, "
5. " "	46·99	27·62	11·19	6·47	2·12	5·61=100, "
6. Krieglach, G.=2·02,	40·95	36·22	12·85	1·64	1·42	6·92=100, "
7. " "	47·36	30·05	12·20	1·89	1·65	6·85=100, "
8. " "	47·73	27·48	12·16	1·91	4·32	6·40=100, "
9. North Carolina,	43·38	31·22	10·06	8·29	—	5·68, $\dddot{\mathrm{S}}\mathrm{i}$ 1·07=99·70, S.B.
10. " "	44·15	32·17	10·02	8·05	—	5·50, $\dddot{\mathrm{S}}\mathrm{i}$ 1·07=100·96, "

In a matrass yields water and loses its color. B.B. on charcoal, intumesces slightly and at a high heat assumes a blebby, glassy appearance, but does not fuse. With borax, yields a clear colorless globule. Forms a fine blue with cobalt solution. Rammelsberg found more or less silica as impurity which is excluded in the results above given.

Occurs both massive and crystallized in narrow veins, traversing clay slate, in the torrent beds of Schladming and Rädelgraben, near Werfen in Saltzburg, with spathic iron; in Gratz, near Vorau, and elsewhere, and in Krieglach, in Styria. From the locality at Vorau it has been called *voraulite.* Also at Tijuco in Minas Geraes, Brazil. It is abundant at Crowder's Mt., Lincoln Co., N. C.

The name lazulite is derived from an Arabic word *azul,* meaning ***heaven,*** and alludes to the color of the mineral.

TURQUOIS. Calaite. Agaphite. Johnite. Kalait and Türkis. Birousa *of the Persians.* Callais (probably) of *Pliny.*

Reniform, stalactitic or incrusting. Cleavage none.

H.=6. G.=2·6—2·83; 2·621, Hermann. Lustre somewhat waxy, internally dull. Color a peculiar bluish-green. Streak white. Feebly subtranslucent—opaque. Fracture small conchoidal.

Composition.—Contains, according to John, (Ann. des Mines, [2], iii, 231), Zellner (Isis, 1834, 637), and Hermann, (J. f. pr. Ch. xxxiii, 282):

	$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\dot{\mathrm{H}}$	$\dot{\mathrm{C}}\mathrm{u}$	
1. Silesia,	44·50	30·90	19·00	3·75	$\dot{\mathrm{F}}\mathrm{e}$ 1·80=99·95, John.
2. "	54·50	38·90	1·00	1·50	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 2·8=98·70, Zellner.
3. Blue Oriental,	47·45	27·34	18·18	2·02	" 1·10, $\dddot{\bar{\mathrm{M}}}\mathrm{n}$ 0·50, $\dot{\mathrm{C}}\mathrm{a}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 3·41=100, H.

Formula from the first and last analyses, $\ddot{\bar{\mathrm{A}}}\mathrm{l}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+5\dot{\mathrm{H}}=\ddot{\bar{\mathrm{A}}}\mathrm{l}$ 46·9, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 32·6, $\dot{\mathrm{H}}$ 20·5. The green Oriental turquois afforded Hermann only 5·64 per cent. of phosphoric acid, and is evidently a mechanical mixture, containing but little turquois. Specific gravity of the last 2·621.

Berzelius obtained in his analysis, phosphate of alumina, phosphate of lime, silica, oxyd of iron, and copper.

In the matrass decrepitates violently, and yields water. B.B. in the reducing flame becomes brown, and colors it green, but infusible; fuses readily with borax or salt of phosphorus to a transparent glass, which on cooling is faint copper green in the outer flame, and cloudy red in the inner, especially if tin be added. Soluble in muriatic acid without effervescence.

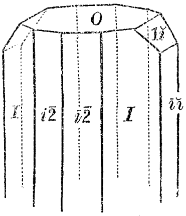
Occurs in a mountainous district in Persia, not far from Nichabour. According to Agaphi, the only naturalist who has visited the locality, turquois occurs only in veins which traverse the mountain in all directions. A less pure variety is found in Silesia, and Oelsnitz in Saxony.

It receives a good polish, and when finely colored, is highly esteemed as a gem. The Persian king is said to retain for his own use all the larger and finely tinted specimens. The *occidental* or *bone turquois* is said to be fossil bones or teeth colored with oxyd of copper.

TRIPHYLINE, *Fuchs*. Tetraphyline. Perowskine.

Trimetric. Mean of observations from Norwich crystals (f. 549), $I:I=94°$, $i\bar{2}:i\bar{2}=130°$ (128°–134°), $I:i\bar{2}=160°$, $O:1\breve{i}=131°$; ib. from Bodenmais, R. P. Greg, Jr., (f. 550), $I:I=93\frac{1}{2}°$ (from angle $i\bar{2}:i\bar{2}$ and $I:i\bar{2}$), $i\bar{2}:i\bar{2}=133°$, $I:i\bar{2}=160°$, $O:1\breve{i}=133°$, $O:1\bar{i}=130°$, $O:1\bar{i}$ (back) 130°, $i\bar{2}:1\bar{i}=137°$. Surfaces rather rough and nearly dull in observed crystals, and angles not constant. Cleavage: O sometimes perfect; I and one diagonal imperfect, the latter least so. Commonly massive.

549



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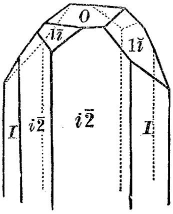


H.=5. G.=3·6. Subresinous. Color greenish-gray; also bluish. Streak grayish-white. Translucent in thin fragments.

Composition.—Analyses: 1, Fuchs, (J. f. pr. Chem. iii, 98, v, 319); 2, 3, Rammelsberg, (Pogg. lxxxv, 439); 4, Baer, (Arch. Pharm. [2], lvii, 374):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{n}$	$\dot{\mathrm{L}}\mathrm{i}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1. Bodenmais,	41·47	48·57	4·70	3·40	——	——	0·68, $\dddot{\mathrm{S}}\mathrm{i}$ 0·53=99·35. Fuchs.
2. "	39·35	41·42	9·43	7·08	1·07	0·35	1·28=99·98, Ramm.
3. "	40·72	39·97	9·80	7:28	1·45	0·58	——, $\dddot{\mathrm{S}}\mathrm{i}$ 0·25=100·05, R.
4. "	36·36	44·52	5·76	5·09	5·16	1·19,	$\dot{\mathrm{C}}\mathrm{a}$ 1·0, $\dot{\mathrm{M}}\mathrm{g}$ 0·73, $\dddot{\mathrm{S}}\mathrm{i}$ 1·78=100·59, B.

Formula $(\dot{\mathrm{F}}\mathrm{e}, \dot{\mathrm{M}}\mathrm{n}, \dot{\mathrm{L}}\mathrm{i})^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, from Fuchs's analysis=Phosphoric acid 42·64, protoxyd of iron 49·16, of manganese 4·75, lithia 3·45. The same ($\dot{\mathrm{R}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$) from Baer's analysis, supposing the silica united to part of the protoxyds. Rammelsberg deduces for No. 2, $\dot{\mathrm{R}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\dot{\mathrm{R}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, for No. 3, (mean of 4 analyses), $3\dot{\mathrm{R}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\dot{\mathrm{R}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$. Rammelsberg's analyses give very nearly the oxygen ratio 2 : 3, equivalent to $\dot{\mathrm{R}}^{10}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}{}^3$.

B.B. fuses easily to a dull steel gray magnetic bead, coloring the flame bluish-green or somewhat reddish. Dissolves readily in borax, and affords a green glass, and with soda the reaction of manganese. Soluble in the acids.

Triphyline occurs at Bodenmais in Bavaria; and f. 550, is from a large somewhat distorted Bavarian crystal in the cabinet of R. P. Greg, Jr.; it has the appearance of being altered. Named from τρις, *three*, and φυλη, *family*, in allusion to its containing three phosphates.

Tetraphyline, (or Perowskine), a similar compound, is from Keiti, in Finland. In the analysis below, the excess is supposed to be due to an incorrect determination of the lithia. It differs in physical characters from the preceding, in presenting a yellow color on its surface of fresh fracture, which by degrees becomes black. It afforded Berzelius and Nordenskiöld, (Jahresb. xv, 211), $\ddot{\text{P}}$ 42·6, $\dot{\text{F}}\text{e}$ 38·6, $\dot{\text{M}}\text{n}$ 12·1, $\dot{\text{L}}\text{i}$ 8·2, $\dot{\text{M}}\text{g}$ 1·7=103·2.

ALTERED FORMS.—Triphyline and Triplite undergo alteration, by taking up water, the protoxyds passing to peroxyds, and the former losing also its alkalies. The following compounds are supposed to have thus originated. Analyses: 1, Fuchs, (J. f. pr. Chem.); 2, Delffs, (Blum's Lehrb. d. Orykt. 2 Aufl. 537); 3, Dufrénoy, (Ann. Ch. Phys. xli, 342); 4, Rammelsberg, (Pogg. lxxxv, 439); 5, Dufrénoy, (loc. cit. p. 337); 6, Damour, (Ann. d. M. [4], xiii, 341); 7, 8, W. J. Craw, (Am. J. Sci. [2], xi, 99); 9, J. W. Mallet, (ib., xviii, 33):

		$\ddot{\text{P}}$	$\ddot{\bar{\text{F}}}\text{e}$	$\ddot{\bar{\text{M}}}\text{n}$	$\dot{\text{F}}\text{e}$	$\dot{\text{M}}\text{n}$	$\dot{\text{H}}$	$\ddot{\text{S}}\text{i}$
1.	Bodenmais,	35·70	48·17	8.94	——	——	5·30	1·40=99·51, F.
2.	" *Pseudotriplite*,	35·71	51·00	8·07	——	——	4·52	——, insol. 0·70=100, Delffs.
3.	Limoges, *Heterosite*,	41·77	——	——	34·89	17·57	4·40	0·22=98·85, Duf.
4.	" "	32·18	31·46	30·01	——	——	6·35	——=100, Ram.
5.	Limoges, *Hureaulite*,	38·00	——	——	11·10	32·85	18·00	——=99·95, Duf.
6.	" *Alluaudite*,	41·25	25·62	1·06	——	23·08	2·65	0·60, $\dot{\text{N}}\text{a}$ 5·47=99·73, Damour.
7.	Norwich, Mass.,	41·35	27·36	24·70	——	——	2·07	——, $\dot{\text{L}}\text{i}$ 2·27, $\dot{\text{C}}\text{a}$ 1·97, $\dot{\text{M}}\text{g}$ *tr.* insol. 0·29=100·01, Craw.
8.	" "	44·64	26·02	23·30	——	——	2·07	——, $\dot{\text{L}}\text{i}$ 2·20, $\dot{\text{C}}\text{a}$ 1·61, $\dot{\text{M}}\text{g}$ *tr.* insol. 0·30=100·14, Craw.
9.	" "	43·04	29·50	22·59, $\dot{\text{C}}\text{a}$ 0·09, $\dot{\text{M}}\text{g}$ 0·73, $\dot{\text{L}}\text{i}$ 1·79, $\dot{\text{H}}$ 2·05=99·79, Mallet.				

No. 1, Fuchs regards as altered Triphyline.

Pseudotriplite corresponds to the formula $(\ddot{\bar{\text{F}}}\text{e}, \ddot{\bar{\text{M}}}\text{n})^3\ddot{\text{P}}^2+2\dot{\text{H}}$.

Heterosite, by Rammelsberg's analysis, gives $\ddot{\text{R}}^7\ddot{\text{P}}^4+6\dot{\text{H}}$; but reckoning it as an anhydrous protoxyd compound, the formula becomes, according to Rammelsberg, $\dot{\text{R}}^3\ddot{\text{P}}+\dot{\text{R}}^4\ddot{\text{P}}$. It is of a brownish violet color, to greenish gray. Dufrénoy gives G.=3·52, or 3·39 after exposure.

Hureaulite is described as monoclinic with $I:I$=117° 30′, $O:I$=101° 12′, $1\grave{i}:1\grave{i}$=88°, $I:1\grave{i}$=116° 56′. Cleavage none. H.=5. G.=2·27. Color reddish-yellow, a little lighter than hyacinth-red. Translucent. Formula from analysis $\dot{\text{R}}^5\ddot{\text{P}}^2+8\dot{\text{H}}$. B.B. very fusible to a black metallic globule. Has some resemblance in appearance to zircon. From the Commune of Hureaux near Limoges.

Alluaudite has 3 cleavages at right angles with one another, one more perfect than the others. H above 4; G.=3·468. Color clove-brown. Streak yellowish. Lustre dull. Subtranslucent to opaque. Fracture shining, scaly. Formula from analysis $\dot{\text{R}}^3\ddot{\text{P}}+\ddot{\bar{\text{F}}}\text{e}\ddot{\text{P}}+\dot{\text{H}}$, or reckoning the iron as all protoxyd, $\dot{\text{R}}^5\ddot{\text{P}}^2+\dot{\text{H}}$. From Chanteloub, near Limoges.

The *Norwich mineral* (Massachusetts) is found only in crystals, some an inch long and wide, associated with spodumene in quartz. The crystals vary much in their angles; the faces are smooth but hardly polished. The following angles were obtained by the author from eight crystals, (the right hand $i\bar{2}$ is here accented).

	I	II	III	IV	V	VI	VII	VIII
$i\bar{2}:i\bar{2}'$	128°	131°–132°	127°–130½°	130½°	126°	134°	128°	130°
$i\bar{2}:i\breve{i}$			113	113		108	108	
$i\bar{2}:i\breve{i}$		121½–122				120	115	118–119
$O:1\breve{i}$		131	129–132					
$i\bar{2}:1\breve{i}$		101½–102						
$i\bar{2}':1\breve{i}$		113½	110	110–112				
$i\bar{2}$ (or $i\bar{2}'$) : I	159	162						
O : obtuse edge of I		94–97		90		93	100	90
		86–87	86		86		80	90
$I:I$			93					

Many of the crystals have a monoclinic form, while others are trimetric; but the latter is probably the normal form. They closely resemble the crystal from Bavaria, which according to Greg is trimetric. Cleavage not distinct. Color black. Streak brownish-red. Opaque. Brittle. H.=5·5. In composition it is quite near the alluaudite, as observed by Mallet.

TRIPLITE. Ferruginous Phosphate of Manganese. Eisenpecherz, (in part), *W.* Pitchy Iron Ore.

Trimetric. Imperfectly crystalline. Cleavage: unequal in three directions perpendicular to each other, one much the most distinct.

H.=5—5·5. G.=3·44—3·8. Lustre resinous, inclining to adamantine. Color brown or blackish-brown. Streak yellowish-gray. Subtranslucent—opaque. Fracture small conchoidal.

Composition.—$(\dot{\mathrm{M}}\mathrm{n}, \dot{\mathrm{F}}\mathrm{e})^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$=Phosphoric acid 33·2, protoxyd of iron 33·6, protoxyd of manganese 33·2=100. Analysis by Berzelius, (Schw. J. xxvii, 70):

$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 32·8, $\dot{\mathrm{M}}\mathrm{n}$ 32·6, $\dot{\mathrm{F}}\mathrm{e}$ 31·9, $\dot{\mathrm{C}}\mathrm{a}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 3·2=100·5.

B.B. on charcoal fuses easily to a black scoria. Dissolves readily in nitric acid without effervescence. With borax gives a glass colored with manganese,

Occurs at Limoges in France, in a vein of quartz in granite, accompanied by apatite.

FISCHERITE, *Hermann*, J. f. pr. Ch. xxxiii, 285.

Trimetric, Kokscharov. $I : I$=118° 32′; $a : b : c = \infty : 1 : 1{\cdot}189$. $I : \widehat{i2}$ (beveling plane)=160° 48′, $\breve{i2} : \breve{i2}$=99° 52½ and 80° 7½′, $\breve{i2} : \breve{ii}$=139° 56′. Also crystalline, massive.

G.=2·46. Colorless; dull-green, when massive. Translucent.

Composition.—$\dddot{\bar{\mathrm{A}}}\mathrm{l}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+8\dot{\mathrm{H}}$=Alumina 41·82, phosphoric acid 28·88, water 29·29.

B.B. becomes white, spotted with blackish; yields much water, but no fluorine. Analysis gave Hermann, (loc. cit.):

$\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 38·47, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 29·03, $\dot{\mathrm{H}}$ 27·50, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ and $\dddot{\bar{\mathrm{M}}}\mathrm{n}$ 1·20, $\dot{\mathrm{C}}\mathrm{u}$ 0·80, $\dot{\mathrm{C}}\mathrm{a}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ and gangue 3·00.

From Nischne Tagilsk, where it occurs in veins in a ferruginous sandstone and clay slate.

Peganite of Breithaupt, according to Hermann, has the composition of Fischerite excepting that it contains $6\dot{\mathrm{H}}$. Hermann obtained for it, (J. f. pr. Ch. xxxiii, 287),

$\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 44·49, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 30·49, $\dot{\mathrm{H}}$ 22·82, $\dot{\mathrm{C}}\mathrm{u}$, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ and gangue 2·20=100,

affording the formula $\dddot{\bar{\mathrm{A}}}\mathrm{l}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+6\dot{\mathrm{H}}$.

It occurs in crusts formed of small prismatic crystals, which are rhombic prisms of 127°, having the acute lateral edge truncated. Color green to white. H.=3—4. G.=2·49—2·54. Occurs at Strigis near Freiberg in Saxony.

Erdmann analyzed a Strigis mineral (*Striegisan* of Breithaupt) with a very different result, as seen from the analyses under Wavellite, to which species the specimens evidently pertain. *Peganite* has till recently been placed under Wavellite.

Variscite, Breithaupt, (J. f. pr. Chem. x, 506). Contains the same ingredients as the above, but is not yet accurately analyzed. Reniform; apple-green; with white shining streak, weak greasy lustre, and translucent. Yields water in a matrass. B.B. in the forceps infusible, but becomes white; in the outer flame, colors the flame deep bluish-green; with borax and salt of phosphorus forms a pale yellowish green glass; with soda fuses with effervescence, but imperfectly; with cobalt solution, becomes blue.

Occurs in quartz and siliceous slate at Messbach in Voigtland.

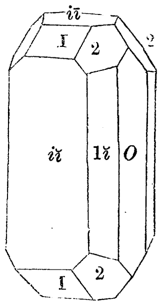
HOPEITE, *Brewster*. Trans. Royal Soc. Edinb. x, 107. Zinkphyllit, *Breit.*

Trimetric. $I:I=101°$, $O:1\bar{i}=133° 19'$, (Levy); $a:b:c=1{\cdot}0607:1:1{\cdot}2131$. Observed planes as in the annexed figure with also $2\breve{i}$, $3\breve{i}$ and $\dot{i}\bar{3}$. $O:1\breve{i}=138° 50'$, $1\breve{i}:1\breve{i}$ (ov. O)$=97° 40'$, $O:2\breve{i}=119° 47'$, $2:2$ (mac.) 106° 36′, (brach.) 87° 3′, (bas.) 140°. Cleavage: $\breve{i}\breve{i}$ highly perfect. Plane *O* striated. Also in reniform masses, and amorphous.

H.=2·5—3. G.=2·76—2·85. Lustre vitreous; $\breve{i}\breve{i}$ somewhat pearly. Color grayish-white; reddish-brown when compact. Streak white. Transparent—translucent. Sectile.

Dissolves without effervescence in muriatic or nitric acid, and is slowly affected by sulphuric acid. B.B. gives out water, and then melts with difficulty to a clear colorless globule, tinging the flame green. The globule obtained with borax remains clear on cooling. With soda it affords a scoria which is yellow when hot, and gives out copious fumes of zinc and some of cadmium. The fused mineral forms a fine blue glass, with a solution of cobalt. Hopeite is supposed, therefore, to be a hydrous compound of phosphoric acid and oxyd of zinc, with a small portion of cadmium.

555



It has been observed in the calamine mines of Altenberg, near Aix la Chapelle. It was named in honor of Prof. Hope of Edinburgh.

The angle of $\frac{1}{2}\breve{i}:\frac{1}{2}\breve{i}$ in Hopeite is near $\dot{i}\breve{2}:\dot{i}\breve{2}$ in Fischerite.

AMBLYGONITE, *Breith.*

Trimetric. Cleavage parallel to a rhombic prism of 106° 10′, rather perfect; less so parallel to its shorter diagonal. Also massive, columnar.

H.=6. G.=3—3·11. Lustre vitreous, inclining to pearly on *I*. Color pale mountain or sea-green. Subtransparent—translucent. Fracture uneven.

Composition.—Analyses: 1, Berzelius, (Gilb. Ann. lxv, 321); 2, 3, Rammelsberg, (Pogg. lxiv, 265):

	$\dddot{\text{P}}$	$\dddot{\text{Al}}$	$\dot{\text{Li}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	F	
1. Chursdorf,	56·69	35·69	9·11	——	——	——	Berz.
2. Arnsdorf, G.=3·11,	47·15	38·43	7·03	3·29	0·43	8·11,	Ramm.
3. " "	48·00	36·26	6·33	5·48	*undetermined*,		Ramm.

In two other trials, the alumina was found to be 36·62 and 36·89 per cent. Rammelsberg's analyses correspond nearly to $(\dddot{\text{Al}}^5\dddot{\text{P}}^3+\dot{\text{R}}^5\dddot{\text{P}}^3)+(\text{Al}^2\text{F}^3+\text{RF})$, R standing for lithium and sodium; Rose writes the formula $(2\dot{\text{R}}^3\dddot{\text{P}}+2\dddot{\text{Al}}\dddot{\text{P}})+(\text{Al}^2\text{F}^3+\text{Al}^2\text{O}^3)$.

In a matrass yields water, which at a high heat is acid and corrodes the glass. B.B. fuses easily with intumescence and becomes opaque white on cooling. With borax and salt of phosphorus forms a transparent colorless glass. When moistened with sulphuric acid, the flame is bluish-green. In a fine powder, dissolves easily in sulphuric acid, more slowly in muriatic.

Occurs at Chursdorf and Arnsdorf, near Penig in Saxony, where it is associated with tourmaline and garnet in granite: also at Arendal, Norway.

The name is from αμβλυς, *blunt*, and γονυ, *angle*.

HERDERITE, *Haid.* Allogonit, *Breit.*

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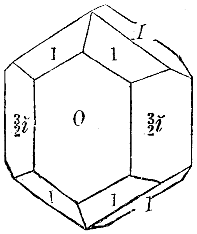


Trimetric. *I* : *I*=115° 53′, *O* : 1ĭ=145° 51′; *a* : *b* : *c*=0·6783 : 1 : 1·5971. Observed planes as in the annexed figure, with also 3, 4 and 6ĭ.

O : 1=141° 19′. 1 : 1 (mac.) 141° 17′.
O : 3=112° 35′. 1 : 1 (brach.)=116° 3′.
O : $\frac{3}{2}$ĭ=147° 30′. *O* : *I*=90°.

Cleavage: *I* interrupted. Surfaces *I* and 1 very smooth, and delicately lined parallel to their edge of intersection.

H.=5. G.=2·985. Lustre vitreous, inclining to subresinous. Streak white. Color various shades of yellowish and greenish-white. Translucent. Fracture small conchoidal. Very brittle. Index of refraction 1·47.

Composition.—Probably, according to trials by Turner and Plattner, an anhydrous phosphate of alumina and lime with fluorine. B.B. fuses with difficulty to a white enamel; becomes blue with cobalt solution. Dissolves when finely powdered in muriatic acid.

Very rare at the tin mines of Ehrenfriedersdorf in Saxony. Resembles the asparagus variety of apatite.

Named after Baron von Herder, director of the Saxon mines.

CARMINITE. Carmine Spar. Carminspath, *Sandberger*, Pogg. lxxx, 391.

Trimetric? In clusters of fine needles; also in spheroidal forms with a columnar structure. Cleavage parallel to the faces of a rhombic prism.

H.=2·5. Lustre vitreous, but cleavage pearly. Color carmine to tile-red; powder reddish-yellow. Translucent. Brittle.

Composition.—Probably an anhydrous arsenate of lead and iron.

B.B. on charcoal fuses easily to a steel-gray globule, giving out arsenical vapors; with soda, a globule of lead, and with borax an iron reaction. Heated in a glass tube, no change. Soluble in nitric acid.

From Horhausen in Saxony, with Beudantite in quartz and brown iron ore.

ROMEINE, *Damour*, Ann. des Mines, [3], xx, 247, [5], iii, 179. Romeit.

Dimetric. In octahedrons; basal angle, according to Dufrénoy, 110° 50′—111° 20′; angle over the summit 68° 10′—69° 10′. Occurs in groups of minute crystals.

Scratches glass. G. in grains 4·714; in powder 4·675. Color hyacinth or honey-yellow.

Composition.—$\dot{R}^3$, SbO^3, SbO^5 Damour. Analysis by Damour, (loc. cit.): O 15·82. Sb 62·18, Fe 1·31, $\dot{M}n$ 1·21, $\dot{C}a$ 16·29, $\ddot{S}i$ *sol* 0·96, insol. 1·90=99·67, or Sb O^5 40·79, Sb O^3 36·82, $\dot{F}e$ 1·70, $\dot{M}n$ 1·21, $\dot{C}a$ 16·29, $\ddot{S}i$ 0·96, insol. 1·90=99·67.

B.B. fuses to a blackish slag. With borax affords a colorless glass in the inner flame, a violet in the outer. In acids insoluble.

Romeine was found at St. Marcel in Piedmont, in small nests or veins in the gangue which accompanies manganese, consisting in part of feldspar, epidote, quartz, brown iron ore, and greenovite. It is named after Romé de l'Isle.

2. HYDROUS PHOSPHATES AND ARSENATES.

The hydrous phosphates are arranged in the order of the oxygen ratio, commencing with the species which have proportionally the most acid. Among them, two groups may be recognized:

1. Vivianite Group.—Containing Vivianite, Cobalt Bloom, and probably Symplesite and Köttigite, (oxygen ratio 3 : 5), with also Pharmacolite, (oxygen ratio 2 : 5), which is homœomorphous with Vivianite. Monoclinic, with perfect clinodiagonal cleavage.
2. Olievnite Group.—Containing Olivenite and Libethenite. Trimetric, (oxygen ratio 4 : 5).

	$\dot{R}+\dddot{\bar{R}}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{A}s$	$\dot{H}$	
Thrombolite,	1½	5	3	$\dot{C}u^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}^2+6\dot{H}$.
Stercorite,				$\dot{N}a\ NH^4O\overset{\cdot\cdot\cdot\cdot\cdot}{P}+9\dot{H}$.
Struvite,				$\dot{M}g^2NH^4O\overset{\cdot\cdot\cdot\cdot\cdot}{P}+12\dot{H}$.
Haidingerite,	2	5	4	$\dot{C}a^2\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+4\dot{H}$.
Pharmacolite,	2	5	6	$\dot{C}a^2\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+6\dot{H}$.
Vivianite,	3	5	8	$\dot{F}e^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}+8\dot{H}$.
Erythrine,	3	5	8	$\dot{C}o^3\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+8\dot{H}$.
Nickel Green,	3	5	8	$\dot{N}i^3\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+8\dot{H}$.
Köttigite,	3	5	8	$\dot{R}^3\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+8\dot{H}$.
Symplesite.				
Scorodite,	3	5	4	$\dddot{\bar{F}}e\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+4\dot{H}$.
Libethenite,	4	5	1	$\dot{C}u^4\overset{\cdot\cdot\cdot\cdot\cdot}{P}+\dot{H}$.
Olivenite,	4	5	1	$\dot{C}u^4(\overset{\cdot\cdot\cdot\cdot\cdot}{A}s,\overset{\cdot\cdot\cdot\cdot\cdot}{P})+\dot{H}$.
Conichalcite,	4	5	1½	$\dot{R}^4(\overset{\cdot\cdot\cdot\cdot\cdot}{A}s,\overset{\cdot\cdot\cdot\cdot\cdot}{P})+1\frac{1}{2}\dot{H}$.
Euchroite,	4	5	7	$\dot{C}u^4\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+7\dot{H}$.
Arseniosiderite,				$\overset{\cdot\cdot\cdot\cdot\cdot}{A}s$, $\dddot{\bar{F}}e$, Ca, $\dot{H}$.
Pharmacosiderite,	4	5	6	$\dot{F}e^3\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+\dddot{\bar{F}}e^3\overset{\cdot\cdot\cdot\cdot\cdot}{A}s^2+18\dot{H}$.
Beudantite,				
Wavellite,	4	5	6	$\dddot{\bar{A}}l^4\overset{\cdot\cdot\cdot\cdot\cdot}{P}^3+18\dot{H}+\frac{1}{3}AlF^3$.

	$\dot{\mathrm{R}}+\dddot{\overline{\mathrm{R}}}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}, \overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$	$\dot{\mathrm{H}}$	
CHILDRENITE,	5 :	5 :	5	$(\dot{\mathrm{R}}^3, \dddot{\overline{\mathrm{Al}}})^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}^3+15\dot{\mathrm{H}}$.
ERINITE,	5 :	5 :	2	$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+2\dot{\mathrm{H}}$.
CORNWALLITE,	5 :	5 :	5	$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+5\dot{\mathrm{H}}$.
PHOSPHOCHALCITE,	5 :	5 :	$2\frac{1}{2}$	$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\frac{1}{2}\dot{\mathrm{H}}$.
EHLITE, TAGILITE,				
TYROLITE,	5 :	5 ;	10	$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+10\dot{\mathrm{H}}[+\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$.
DELVAUXENE,	6 :	5 :	24	$\dddot{\overline{\mathrm{Fe}}}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+24\dot{\mathrm{H}}$.
BERAUNITE,				
DUFRENITE,	6 :	5 :	$2\frac{1}{2}$	$\dddot{\overline{\mathrm{Fe}}}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\frac{1}{2}\dot{\mathrm{H}}$.
APHANESITE,	6 :	5 :	3	$\dot{\mathrm{Cu}}^6\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+3\dot{\mathrm{H}}$.
CHALCOPHYLLITE,	6(8?) :	5 :	12	
LIROCONITE,				$\dot{\mathrm{Cu}}, \dddot{\overline{\mathrm{Al}}}, \overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}, \overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}, \dot{\mathrm{H}}$.
URANITE,	7 :	5 :	8	$(\dot{\mathrm{Ca}}, \dot{\mathrm{Cu}})^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\dddot{\overline{\mathrm{U}}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+16\dot{\mathrm{H}}$.
CARPHOSIDERITE,				
PLUMBORESINITE.				
HYDROUS PHOSPHATE OF ALUMINA AND LIME.				
CASTELNAUDITE.				

Sulphato-phosphates.

PITTICITE,	$\dddot{\overline{\mathrm{Fe}}}^2\dddot{\mathrm{S}}^3+2\dddot{\overline{\mathrm{Fe}}}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+24\dot{\mathrm{H}}$?
DIADOCHITE,	$2\dddot{\overline{\mathrm{Fe}}}\dddot{\mathrm{S}}^2+\dddot{\overline{\mathrm{Fe}}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}^2+36\dot{\mathrm{H}}$.

THROMBOLITE, *Breit.*

Amorphous.

H.=3—4. G.=3·38—3·40. Lustre vitreous. Color emerald, leek, or dark green. Opaque. Fracture conchoidal.

Composition.—$\dot{\mathrm{Cu}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}^2+6\dot{\mathrm{H}}$?—Phosphoric acid 45·1, oxyd of copper 37·8, water 17·1. Analysis (approximate) by Plattner, (J. f. pr. Ch. xv, 321):

Phosphoric acid 41·0, Oxyd of copper 39·2, Water 16·8=97·0.

B.B. Colors the flame blue and then green. On charcoal, fuses easily to a black globule, and finally yields a bead of copper. With boracic acid and iron, gives the reaction of phosphoric acid. In a matrass yields water and becomes black.

Retzbanya, Hungary, in limestone.

STERCORITE, *Herapath*. Microcosmic Salt. Salt of Phosphorus.

In crystalline masses and nodules. G. = 1·6151. Lustre vitreous. Color white, stained yellowish-brown. Transparent. Fragile. Not efflorescent. Easily soluble in hot and cold water.

Composition.—$\dot{Na}\ NH^4O\ \overset{\cdot\cdot\cdot\cdot\cdot}{P}+9H=\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 34·05, NH^4O 12·40, $\dot{Na}$ 14·92, $\dot{H}$ 38·63. Analysis by T. J. Herapath, (Quart. J. Chem. Soc. April, 1849):

$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 34·325, Am 7·680, $\dot{Na}$ 15·752, $\dot{H}$ 42·243=100.

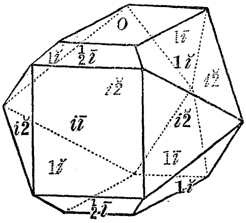
Mixed with about 9 per cent. of impurities, consisting of organic matters along with chlorid of sodium, carbonate of lime, carbonate of magnesia, phosphate of lime, sand, &c. B.B. intumesces, blackens, and gives off water and ammonia, and afterwards fuses to a transparent, colorless glass, soluble in boiling water.

Found in guano at the island of Ichaboe on the western coast of Africa.

This species is identical with the *Salt of Phosphorus*, used as a flux in blowpipe analysis.

STRUVITE, *Ulex*, Afv. K. V. Ac. Förh. iii, 32, Ann. Ch. Pharm. lxvi, 41. Guanite, *E. F. Teschemacher*, Phil. Mag. [3], xxviii, 546.

556 A



Hemihedral, two opposite sides having unlike planes. $I:I$=101° 42′, $O:1\bar{i}$= 132° 32′; $a:b:c$=1·0900: 1: 1·2283. Observed planes as in the annexed figure. $O:1\breve{i}$=138° 25′, $O:\frac{1}{2}\bar{i}$=151° 25′, $O:i\bar{i}$ =90°, $i2:i\breve{2}$ (ov. $i\bar{i}$)=63° 8′, $1\breve{i}\ 1\breve{i}$ (ov. O) =96° 50′, $\frac{1}{2}\bar{i}:\frac{1}{2}\bar{i}$ (ov. $i\bar{i}$)=57° 10′. Cleavage: O, perfect. Twins: face of composition $i\bar{i}$.

H.=2. G.=1·65—1·7. Color slightly yellowish to brown; white. Lustre vitreous. Translucent; sometimes opaque. Brittle. Tasteless, being but very slightly soluble.

Composition.—$NH^4O\ \dot{Mg}^2\ \overset{\cdot\cdot\cdot\cdot\cdot}{P}+12\dot{H}$=Phosphoric acid 29·9, magnesia 16·3, NH^4O 10·6, water 44·0=100. Ulex obtained, (v. Leonh. 1851, 51):

$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{Mn}$	Am, $\dot{H}$
28·56	13·46	3·06	1·12	53·76

B.B. falls to powder, giving off water and ammonia, and fuses to a colorless glass which becomes an enamel on cooling. Dissolves readily in acids.

Found in guano from Saldanha Bay, coast of Africa, imbedded in patches of crystals; also under an old church in Hamburg, where quantities of cattle dung existed in the soil, above a bed of peat which contained the crystals. This salt forms when a tribasic phosphate and a salt of ammonia are dissolved together, and a salt of magnesia is added to the mixture.

The dimensions of the crystals are nearly those of barytes, if $1\bar{i}$ be taken as $\frac{2}{3}\bar{i}$.

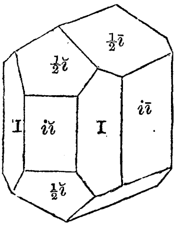
HAIDINGERITE, *Turner*, Brewster's Journal, iii, 303.

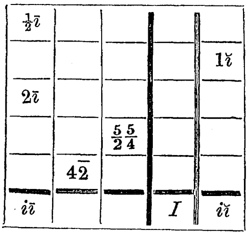
Trimetric. $I:I$=100° (80° over $i\breve{i}$), $O\ 1\bar{i}$=148° 16′; $a:b:c$= 0·595 : 1 : 1·1918. $\frac{1}{2}\bar{i}:\frac{1}{2}\bar{i}$ (top)=146° 53′, $1\breve{i}:1\breve{i}$=126° 58′, $I:i\bar{i}$= 140°, $I:i\breve{i}$=130°. Cleavage $i\breve{i}$ highly perfect. Mostly in minute crystals aggregated into botryoidal forms and drusy crusts.

H.=1·5—2·5. G.=2·848. Lustre vitreous. Streak white.

Color white. Transparent—translucent. Sectile; thin laminæ slightly flexible.

556 B





Observed Planes.

Composition.—$\dot{C}a^2\ddot{\ddot{A}}s+4\dot{H}$=Arsenic acid 55·55, lime 27·05, water 17·39. Turner (Brewster's Journal, iii, 308) obtained, Arsenate of lime 85·681, and water 14·319. Dissolves easily in nitric acid. B.B. like pharmacolite.

Supposed to be from Baden or Joachimstahl, according to R. P. Greg, Jr., who possesses the only specimen that has been observed. It is associated with pharmacolite.

PHARMACOLITE, Brewster's Edinb. J., 1822, iii, 302. Arsenate of Lime. Chaux Arseniatée, *H.* Arsenikblüthe, in part, *Werner.* Picropharmacolite.

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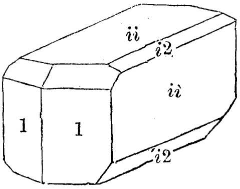

Monoclinic. *I* : *I*=111° 6′, *i*2 : *i*2 =141° 8′, *ii* : *i*2=109° 26′, *ii* : *ii*=90°, 1 : 1=117° 24′, *ii* : 1=121° 28′, *ii* : 1 =95° 46′, *ii* on edge (1 : 1)=83° 14′. Cleavage *ii* eminent. One face (1) often obliterated by the extension of the other. Surfaces *ii* and *i*2 usually striated parallel to their mutual intersection. Rarely in crystals; commonly in delicate silky fibres or acicular crystallizations, in stellated groups. Also botryoidal and stalactitic, and sometimes massive.

H.=2—2·5. G.=2·64—2·73. Lustre vitreous; on *ii* inclining to pearly. Color white or grayish; frequently tinged red by arsenate of cobalt. Streak white. Translucent—opaque. Fracture uneven. Thin laminæ flexible.

Composition.—$\dot{C}a^2\ddot{\ddot{A}}s+6\dot{H}$=Arsenic acid 51·1, lime 24·9, water 24·0. Analyses by Klaproth, (Beit. iii, 277), John, (Chem. Unters. ii, 221), and Rammelsberg, (Pogg. Ann. lxii, 150):

	$\dot{C}a$	$\ddot{\ddot{A}}s$	$\dot{H}$
1. Wittichen,	25·00	50·54	24·46=100, Klaproth.
2. Andreasberg,	27·28	45·68	23·86=96·82, John.
3. Glüksbrunn,	23·59	51·58	23·40, $\dot{C}o$, $\dddot{\bar{F}}e$, 1·43=100, R.

The cobalt in the last is attributed to a mixture with cobalt bloom. Turner obtained for a specimen of unknown locality, (Brewst. J. iii, 306), Arsenate of lime 79·01, water 20·99=100.

B.B. in the outer flame fuses to a white enamel, and in the inner flame on charcoal gives the smell of arsenic, fusing to a bluish bead, and tinging the flame blue. Easily soluble in acids. Insoluble in water.

Found with arsenical ores of cobalt and silver. Crystals have been found at Wittichen, Baden; also in botryoidal or globular groups at St. Marie aux Mines in the Vosges; at Andreasberg in the Hartz, and at Riechelsdorf and Bieber in Hessia; at Glücksbrunn in Thuringia; at Joachimstahl in Bohemia.

This species was named, in allusion to its containing arsenic, from *φαρμακον, poison.*

The *Picropharmacolite* of Stromeyer from Riechelsdorf, (Gilb. Ann. lxi, 185), contains, Lime 24·646, arsenic acid 46·971, magnesia 3·223, oxyd of cobalt 0·998, water 23·977=99·815, affording the formula $(\dot{\text{C}}\text{a}, \dot{\text{M}}\text{g})^5\ddot{\text{A}}\text{s}^2+12\dot{\text{H}}$, Ramm.; but it is probably impure pharmacolite.

This species, viewing the form as above, is remotely homœomorphous with cobalt bloom and vivianite.

VIVIANITE. Phosphate of Iron. Blue Iron Earth. Mullicite, *Thom.* Fer Phosphaté, *H.* Blaue Eisenerz, *Wern.* Eisenblau. Fer azuré, *H.* Glaukosiderit, Eisenphyllit.

Monoclinic. $C=71°\,25'$, $I:I=111°\,12'$, $O:1i=145°\,33'$; $a:b:c=1{\cdot}002:1:1{\cdot}3843$.

ii : 1*i*=125° 47′. *ii* : *i*3=167° 7′. *ii* : 1*i*=90°.

ii : -1*i*=144° 20′. 1 : 1 (front)=119° 10′. *i*3 : *i*3=154° 14′.

ii : *I*=145° 36′. 1 : 1*i*=149° 35′. ½ : ½(front)=140°52′.

Surface *ii* smoth, others striated. Cleavage *ii* highly perfect; *ii* and ½*i* in traces. Often reniform and globular. Structure divergent, fibrous or earthy; also incrusting.

H.=1·5—2. G.=2·661. Lustre, *ii* pearly or metallic-pearly; other faces vitreous. Color blue to green, deepening by exposure; usually green when seen perpendicularly to the cleavage face, and blue transversely; the two colors mingled, producing the ordinary dirty blue color. Streak bluish-white, soon changing to indigo-blue; color of the dry powder, liver-brown. Transparent—translucent; opaque on exposure. Fracture not observable. Thin laminæ flexible. Sectile.

O			
⅓*i*			
		½	⅓*i*
1*i*		1	1*i*
2*i*			
ii	*i*3	*I*	*ii*
1*i*		−1	1*i*
		−½	

Observed Planes; add 33.

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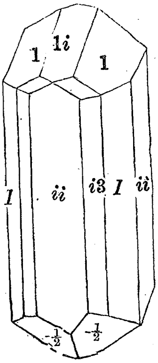

Composition.—$\dot{\text{F}}\text{e}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}+8\dot{\text{H}}$=Phosphoric acid 28·3, protoxyd of iron 43·0, water 28·7, when colorless, being isomorphous with *Cobalt Bloom;* but changes readily, owing to oxydation of part of the iron; analysis afforded Rammelsberg $6(\dot{\text{F}}\text{e}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}+8\dot{\text{H}})+(\ddot{\cancel{\text{F}}}\text{e}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}^2+8\dot{\text{H}})$

Analyses: 1, Vogel, (Gilb. Ann. lix, 174); 2, Stromeyer, (Unters. 274); 3, 4, Rammelsberg, (Pogg. lxiv, 410); 5, Brandes, (Schw. J. xxxi, 77); 6, Thomson, (Min. i, 452); 7, W. Fisher, (Am. Jour. Sci. [2], ix, 84):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$	$\dot{\text{F}}\text{e}$	$\ddot{\cancel{\text{F}}}\text{e}$	$\dot{\text{H}}$
1. Bodenmais,	26·4	41·0	——	31·0 =9·84, Vogel.
2. St. Agnes, Cornwall,	31·18	41·23	——	27·48=99·89, Stromeyer.
3. N. Jersey, *Mullicite,*	28·40	33·91	12·06	——[a] } Ramm. [a] Undetermined.
4. " "	——[a]	33·98	12·06	27·49 }
5. Hillentrup,	30·32	43·78	——	25·00, $\ddot{\text{A}}\text{l}$ 0·7, $\ddot{\text{S}}\text{i}$ 0·02=99·82, B.
6. *Mullicite,*	26·06	46·31	——	27·14=99·51, Thomson.
7. Delaware,	27·17	44·10	——	27·95 Silica 0·10=99·32, Fisher.

Rammelsberg has distinguished that part of the iron in the mineral is often peroxyd. Other analyses, probably of this species more or less impure, have afforded, 1 Berthier, (Ann. d. Mines, xii, 303); 2, Segeth, (J. f. pr. Chem. xx, 256); 3, Klaproth, (Beit. iv, 12); 4, Berthier, (loc. cit.):

			$\overset{\cdot\cdot}{\dot{\ddot{\text{P}}}}$	$\dot{\text{Fe}}$	$\dot{\text{H}}$
1.	*Blue iron Earth,*	Alleyras,	23·1	43·0	32·4, $\dddot{\bar{\text{A}}}\text{l}$ 0·6, $\dddot{\bar{\text{M}}}\text{n}$ 0·3=99·4, Berth'r.
2.	" "	Kertsch,	24·95	48·79	26·26=100, Segeth.
3.	" "	Eckartsberga,	32·0	47·5	20·0 =99·5, Klaproth.
4.	*Anglarite,*	Anglar,	27·3	56·0	16·5 =99·8, Berthier.

The anglarite corresponds to the formula $\dot{\text{Fe}}^4 \overset{\cdot\cdot}{\dot{\ddot{\text{P}}}} + 4\dot{\text{H}}$.

A vivianite from New Zealand afforded R. Pattison, (Phil. Mag. [3], xxv, 495),

Phos. iron 62·80, water 28·40, organic matter 2·80, silica 5·20=99·20.

B.B. decrepitates, loses color, and becomes opaque; if pulverized, it fuses to a dark brown or black scoria, which affects the magnetic needle. Heated in a glass tube, it yields pure water. Dissolves in dilute nitric and sulphuric acids.

It occurs associated with magnetic and common iron pyrites in copper and tin veins; also in narrow veins with gold, traversing gray-wacke; occasionally, it is met with in trap rocks. The friable and crystallized varieties occur in clay, and are sometimes associated with bog iron ore.

At St. Agnes in Cornwall, transparent indigo crystals have been found, 1 in. in diameter and 2 long, on magnetic pyrites; at Bodenmais, and the gold mines of Vöröspatak in Transylvania, in crystals; on the promontory of Kertsch in the Black Sea, in large indistinct crstals in the interior of shells. The earthy variety, sometimes called *blue iron earth* or *native Prussian blue*, (*fer azuré*), occurs in Greenland, Syria, Carinthia, Cornwall, &c. The friable varieties in bog iron ore in several peat swamps in the Shetland Isles, at Ballagh in the Isle of Man, accompanying sometimes the horns of the elk and deer, and near an old slaughter-house in Edinburgh.

Fine translucent dark blue crystals of Vivianite, are met with at Imleytown, New Jersey. At Allentown, Monmouth Co., N. J., it occurs in considerable abundance, both crystallized in nodules and earthy, imbedded in bog iron ore, and associated with clays; also at Mullica Hill, Gloucester Co., N. J., (the *mullicite* of Thomson), in cylindrical masses consisting of divergent fibres or acicular crystals. At Franklin, N. J., this species is occasionally found. It often fills the interior of belemnites and other fossils, in the ferruginous sand formation; also (see analysis 7 above) 4 miles west of Cantwell's Bridge, in the green sand of Delaware, in fine large crystals which are colorless when first obtained, evidently as Fisher observed, containing only protoxyd of iron. At Harlem, N.Y., vivianite in crystals accompanies stilbite and feldspar in the fissures of gneiss. It occurs in the north part of Somerset and Worcester Cos., Maryland; with bog ore in Stafford Co., Virginia, and eight or ten miles from Falmouth, with gold and galena; also near Cape Henlopen, Sussex Co., Delaware; with limonite at Vandreuil, Canada East, abundant.

ERYTHRINE, *Beud.* Cobalt Bloom. Prismatic Red Cobalt, *J.* Red Cobalt Ochre. Arseniate of Cobalt. Cobalt Mica Kobaltblüthe, *Haus.* Cobalt Arseniaté, *H.*

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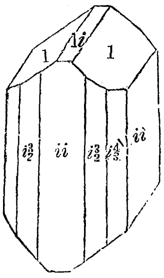

Schneeberg.

Monoclinic. $C=70°\ 54'$, $I : I=111°\ 16'$, $O : 1i =146°\ 19'$: $a : b : c=0·9747 : 1 : 1·3818$. Observed planes: as in the annexed figure, together with $3i$ and $\frac{3}{2}i$ between ii and $1i$.

$ii : ii=90°$. $ii : i\frac{3}{2}=155°\ 5'$. $i\frac{4}{3}\ i\frac{4}{3}=94°\ 12'$. $ii : 1i=124°\ 51'$. $ii : i\frac{4}{3}=137°\ 6'$. $ii : 1=120°\ 48'$. $1i : 1=149°\ 12'$. $i\frac{3}{2} : i\frac{3}{2}\ 130°\ 10'$. $1 : 1=118°\ 24'$. Surface ii and $1i$ vertically striated. Cleavage: ii highly perfect, ii and $1i$ indistinct. Also in globular and reniform shapes, having a drusy surface and a columnar structure: sometimes stellate. Also pulverulent, incrusting.

H.=1·5—2·5; the lowest on *ii*. G.=2·948.
Lustre of *ii* pearly; other faces, adamantine, inclining to vitreous; also dull and earthy. Color crimson and peach-red, sometimes pearl or greenish-gray; red tints incline to blue, perpendicular to cleavage face. Streak a little paler than the color; the dry powder deep lavender-blue. Transparent—subtranslucent. Fracture not observable. Thin laminæ flexible in one direction. Sectile.

Composition.—$\dot{\mathrm{Co}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}+8\dot{\mathrm{H}}$=Arsenic acid 38·43, oxyd of cobalt 37·55, water 24·02; $\dot{\mathrm{Co}}$ often partly replaced by $\dot{\mathrm{Fe}}$, $\dot{\mathrm{Ca}}$ or $\dot{\mathrm{Ni}}$. Analyses: 1, Bucholz, (Gehlen's Jour. [2], ix, 308): 2, Laugier, (Mem. d. Mus. d'hist. n. ix, 233); 3, 4, 5, Kersten, (Pogg. lx, 251):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}$	$\dot{\mathrm{Co}}$	$\dot{\mathrm{H}}$
1. Riechelsdorf,	37·	39·	22· =98 Bucholz.
2. Allemont,	40·0	20·5	24·5, $\dot{\mathrm{Ni}}$ 9·2, $\dddot{\overline{\mathrm{Fe}}}$ 6·1=100·3, Laugier.
3. Schneeberg	38·43	36·52	24·10, $\dot{\mathrm{Fe}}$ 1·01=100·06, Kersten.
4. "	38·30	33·42	24·08, " 4·01=99·81, Kersten.
5. "	38·10	29·19	23·90, $\dot{\mathrm{Ca}}$ 800=99·19, Kersten.

Yields water alone in a matrass and becomes bluish or green. B.B. on charcoal, gives an arsenical odor, and fuses in the inner flame to a dark-gray bead of arsenical cobalt. With the fluxes a cobalt reaction. Dissolves easily in the acids.

The *earthly cobalt bloom*, of a peach blossom color, (Kobaltbeschlag), is shown by Kersten to be cobalt bloom, with some free arsenous acid. He obtained,

	$\dddot{\overline{\mathrm{As}}}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}$	$\dot{\mathrm{Co}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{H}}$
1. Schneeberg,	51·00	19·10	16·60	2·10	11·90=100·70,
2. Annaberg,	48·10	20·00	18·30	——	12·13=98·53,

with a trace of nickel, lime, and sulphuric acid, (Pogg. lx, 262).
Occurs at Schneeberg in Saxony, in micaceous scales, stellularly aggregated. Brilliant specimens, consisting of minute aggregated crystals, are met with at Saalfeld in Thuringia; also at Riechelsdorf in Hessia; Wolfach and Wittichen in Baden; Modum in Norway. The earthy peach-blossom varieties have been observed at Allemont in Dauphiny, in Cornwall, and at the lead mine of Tyne Bottom, near Alston, in Cumberland. A perfectly green variety occurs at Platten in Bohemia, and sometimes red and green tinges have been observed on the same crystals. Occurs also on the north shore of Lake Superior at Prince's Mine on calcite.
Cobalt bloom, when abundant, is valuable for the manufacture of smalt.

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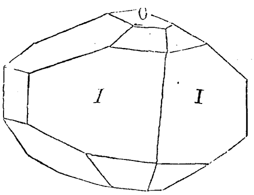

Roselite.—The *Roselite* of Levy is probably a variety of cobalt bloom; and Kersten suggests that it may be identical with the variety in the third of his analyses above, which contains lime, an element detected by Children in Roselite. The form is given by Levy as here figured. Haidinger makes it a twin with composition parallel to *ĭĭ*.
Trimetic; *I*: *I*=132° 48′. *O* : 1*ĭ*=158° 2′. Cleavage distinct and brilliant, parallel to *ĭĭ*. It is deep rose-red, with the lustre vitreous, and H.=3.

Its only known locality is at Schneeberg in Saxony, where it has been found in small quantities on quartz.

Lavendulan, (Breithaupt, J. f. pr. Chem. x, 505).—Amorphous, with a greasy lustre, inclining to vitreous. H.=2·5—3. G.=3·014, Breithaupt. Color lavender blue. Streak paler blue. Translucent. Fracture conchoidal.
Contains, according to Plattner, Arsenic and the oxyds of cobalt, nickel and copper, with water. Fuses easily before the blowpipe, coloring the flame deep blue,

and yielding a globule which becomes crystalline on cooling. On charcoal yields an arsenical odor. With the fluxes gives the reaction of cobalt. Occurs at Annaberg in Saxony, with cobalt and iron ores.

ANNABERGITE, *Haid.* Nickel Green. Nickelocker. Nickleblüthe. Nickel Arseniaté, *H.*

Monoclinic. In capillary crystals; also massive and disseminated.

Soft. Color fine apple-green. Streak greenish-white. Fracture uneven, or earthy.

Composition.—$\dot{\mathrm{Ni}}^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{As}}}+8\dot{\mathrm{H}}$=Arsenic acid 38·41, oxyd of nickel 37·59, water 24·00=100. Analyses: 1, Berthier, (Ann. Ch. Phys. xiii, 52); 2, Stromeyer, (Schw. J. xxv, 220); 3, 4, 5, Kersten, (Pogg. lx, 251):

	$\overset{\cdot\cdot\cdot}{\ddot{\mathrm{As}}}$	$\dot{\mathrm{Ni}}$	$\dot{\mathrm{Co}}$	$\dot{\mathrm{H}}$
1. Allemont,	36·8	36·2	2·5	25·5=100, Berthier.
2. Riechelsdorf,	36·97	37·35	——	24·32, $\ddot{\mathrm{Fe}}$ 1·13, $\dddot{\mathrm{S}}$ 0·23=100, S.; some $\dot{\mathrm{Co}}$ with $\dot{\mathrm{Ni}}$.
3. Schneeberg,	38·30	36·20	1·53	23·91, $\dot{\mathrm{Fe}}$ trace=99·94, Kersten.
4 "	38.90	35·00	——	24·02, " 2·21=100·13, Kersten.
5 "	37·21	36·10	*trace*	23·92, " 1·10, $\overset{\cdot\cdot\cdot}{\ddot{\mathrm{As}}}$ 0·52=98·85, Kersten.

B.B. darkens in color or becomes dull yellow; on charcoal gives out the odor of arsenic, and in the inner flame of the blowpipe yields a metallic button; nickel reaction with the fluxes. This species is propably isomorphous with cobalt bloom.

Occurs on white nickel at Allemont in Dauphiny, and is supposed to result from the decomposition of this ore; also at Kamsdorf, near Saalfeld, at Annaberg, at Riechelsdorf, and other mines of nickel ores. It has been occasionally observed associated with copper nickel in the cobalt mine at Chatham, Connecticut.

KÖTTIGITE, *D.* Zinkarseniat, *Otto Köttig*, J. f. pr. Chem. xlviii, 183, 1849, and *Naumann*, ib. 256.

Monoclinic, according to Naumann, and isomorphous with cobalt bloom. Massive, or in crusts with crystalline surface and fibrous structure. Cleavage: perfect in one direction.

H.=2·5—3. G.=3·1. Lustre of surface of fracture silky. Color light carmine and peach-blossom red, of different shades. Streak reddish white. Translucent to subtranslucent.

Composition.—$(\dot{\mathrm{Zn}}, \dot{\mathrm{Co}}, \dot{\mathrm{Ni}},)^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{As}}}+8\dot{\mathrm{H}}$, or analogous to cobalt bloom. Analysis by Köttig, (loc. cit.):

$\overset{\cdot\cdot\cdot}{\ddot{\mathrm{As}}}$ (by loss) 37·17, $\dot{\mathrm{Zn}}$ 30·52, $\dot{\mathrm{Co}}$ 6·91, $\dot{\mathrm{Ni}}$ 2·00, $\dot{\mathrm{Ca}}$ *trace*, $\dot{\mathrm{H}}$ 23·40=100.

In a matrass yields water and becomes pale smalt blue. B.B. on charcoal in the outer flame changes color and fuses to a pearl, gives out fumes of arsenic, and leaves a slag of oxyd of zinc. Gives a cobalt and nickel reaction. In dilute acids easily dissolved.

Occurs with smaltine at the cobalt mine Daniel, near Schneeberg. The color is owing partly to the arsenate of cobalt in the mineral.

SYMPLESITE, *Breithaupt*, J. f. prakt. Chemie, x, 501.

Monoclinic; in form resembling Cobalt Bloom. Cleavage perfect parallel with the larger lateral face. In minute prismatic crystals; also aggregated.

H.=2·5, nearly. G.=2·957. Lustre of cleavage face pearly; elsewhere vitreous. Color pale indigo, inclined to celandine-green;

sometimes between leek and mountain-green. Streak bluish-white. Subtransparent to translucent.

Composition.—Supposed to be an arsenate of the protoxyd of iron. Heated in a glass tube, it turns brown, and loses 25 per cent. of water. On charcoal it gives off an alliaceous odor, turns black without melting, and is then magnetic.

Occurs at Lobenstein in Voigtland, with cobaltic pyrites and spathic iron.

SCORODITE. Neoctese, *Beud.* Martial Arseniate of Copper, *P.* Cupreous Arseniate of Iron, *Bournon.* Skorodit, *Breit.*

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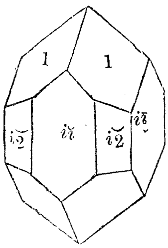

Trimetric. $I : I = 98° 2'$, $O : 1\bar{i} = 132° 20'$; $a : b : c = 1{\cdot}0977 : 1 : 1{\cdot}1511$. Observed planes as in the annexed figure, with also I, and another pyramid $\frac{1}{2}$. $\breve{i}2 : \breve{i}2 = 120° 10'$, $i\breve{i} : \breve{i}2 = 150° 5'$, $1 : 1$ (pyr.)$=$ 114° 34′ and 103° 5′, (bas.)$=$110° 58′, $\frac{1}{2} : \frac{1}{2}$ (pyr.)$=$ 134° 38′ and 127° 18′, (bas.)$=$72° 2′. Cleavage: $\breve{i}2$ imperfect, $i\breve{i}$ and $i\bar{i}$ in traces.

H.=3·5—4. G.=3·1—3·3. Lustre vitreous—subadamantine and subresinous. Color pale leek-green or liver-brown. Streak white. Subtransparent—translucent. Fracture uneven.

Composition.—$\dddot{\bar{\mathrm{F}}}\mathrm{e}\,\dddot{\mathrm{A}}\mathrm{s}+4\,\dot{\mathrm{H}}$=Arsenic acid 49·8, peroxyd of iron 34·7, water 15·5. Analyses: 1, Berzelius, (K. V. Ac. H. 1824, 350, and Jahresb. v, 205); 2, Boussingault, (Ann. Ch. xli, 337); 3—6, Damour, (Ann. Ch. Phys. [3], x, 412):

	$\dddot{\mathrm{A}}\mathrm{s}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{H}}$	$\dddot{\mathrm{P}}$	
1. Brazil, *Neoctese,*	50·78	34·85	15·55	0·67,	$\dot{\mathrm{C}}\mathrm{u}$ *trace*=101·85, Berzelius.
2. Popayan,	49·6	34·3	16·9	——,	$\dot{\mathrm{P}}\mathrm{b}$ 0·4=101·2, Boussingault.
3. Vaulry, *gn. cryst.*	50·95	31·89	15·64	——,	=98·48, Damour. G.=3·11
4. Cornwall, *blue cryst.*	51·06	32·74	15·68	——,	=99·48, "
5. Saxony, *bluish,*	52·16	33·00	15·58	——,	=100·74, "
6. Brazil, *Neoctese,*	50·96	33·20	15·70	——,	=98·86, " G.=3·18

B.B. on charcoal gives out an alliaceous odor, and fuses to a reddish-brown or black scoria, which acts upon the magnet when all the arsenic is expelled. No action with nitric acid, cold or hot; but easily dissolved with muriatic acid.

A brown variety occurs in the granitic mountains of Schwarzenberg in Saxony, associated with arsenical pyrites, and at Löling, near Huttenberg in Carinthia, along with leucopyrite; also at Chanteloube, near Limoges. A leek-green scorodite is found in the Cornish mines, coating cavities of ferruginous quartz. Minas Geraes, in Brazil, and Popayan have afforded some fine specimens.

The *Neoctese,* from Brazil, is shown by Descloizeaux and Damour to be identical with Scorodite, (Ann. Ch. Phys. [3], x, 403).

Occurs in minute crystals and druses of leek-green, grass-green, and greenish-white colors, near Edenville, N. Y., with arsenical pyrites, iron sinter, &c., in white limestone.

Named from *σκοροδον, garlic,* alluding to the odor before the blowpipe.

An *Iron-sinter,* (Eisensinter, Arsenik-sinter), from Nertschinsk, analyzed by Hermann, is an amorphous scorodite. Hermann obtained, (J. f. pr. Ch. xxxiii, 95), $\dddot{\mathrm{A}}\mathrm{s}$ 48·05, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 36·41, $\dot{\mathrm{H}}$ 15·54=100.

It forms an ochreous crust upon beryl, topaz, and quartz crystals.

Altered Forms.—Scorodite occurs altered to Limonite.

LIBETHENITE. Phosphate of Copper. Cuivre Phosphaté, *H.* Phosphatischer Olivenchalcit, *Br.*

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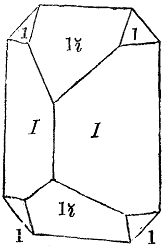

Trimetric. $I : I=92° 20'$, $O : 1\bar{i}=143° 50'$; $a : b : c=0·7311 : 1 : 1·0416$. Observed planes as in the annexed figure, with also the prismatic planes $i\bar{2}$. $1\breve{i} : 1\breve{i}$ (top)$=109° 52'$, $1 : 1=$(ov. $1\breve{i}$) $=118° 12'$ (adj.)$=120° 56'$, (ov. I)$=90° 46'$, $I : 1=135° 23'$. Cleavage: diagonal ($i\bar{i}$, $i\breve{i}$) very indistinct. Also globular or reniform, and compact.

H.=4. G.=3·6—3·8. Lustre resinous. Color olive-green, generally dark. Streak olive-green. Translucent to subtranslucent. Fracture subconchoidal—uneven. Brittle.

Composition.—$\dot{\mathrm{C}}\mathrm{u}^4\bar{\ddot{\mathrm{P}}}+\dot{\mathrm{H}}$=Phosphoric acid 29·7, oxyd of copper 66·5, water 3·8, =100. Analyses: 1, Berthier, (Ann. d. Mines, viii, 334); 2, Kühn, (Ann. d. Ch. u. Pharm. li, 154); 3, Hermann, (J. f. pr. Chem. xxxvii, 175); 4, Berthier, (loc. cit.):

		$\bar{\ddot{\mathrm{P}}}$	$\dot{\mathrm{C}}\mathrm{u}$	$\dot{\mathrm{H}}$
1.	Libethen, *cryst.*,	28·7	63·9	7·4=100, Berthier.
2.	" "	29·44	66·94	4·05=100·43, Kühn.
3.	" "	28·61	65·89	5·50=100, Hermann.
4.	" *massive*,	22·8	64·8	9·0, $\ddot{\mathrm{C}}$ 1·0, $\bar{\dddot{\mathrm{F}}}\mathrm{e}$ 1·6=99·2, Berthier.

The first analysis by Berthier is identical with Rhodius's analysis of Ehlite, on page 426=$\dot{\mathrm{C}}\mathrm{u}^4\bar{\ddot{\mathrm{P}}}+2\dot{\mathrm{H}}$.

B.B. fuses very easily to a brownish globule, which, by further action, acquires a reddish-gray color and metallic lustre, and ultimately yields at its centre a globule of metallic copper. Soluble in nitric acid, and also in ammonia.

Occurs in cavities in quartz, associated with copper pyrites at Libethen, near Neusohl, in Hungary; at Rheinbreitenbach, on the Rhine; in Bolivia, S. A., with malachite; in a brick red matrix, in Chili; also in small quantities near Gunnislake in Cornwall; and in the Ural.

OLIVENITE. Prismatic Arseniate of Copper, *Bournon.* Pharmakochalzit, *Haus.* Olivenerz, *W.*

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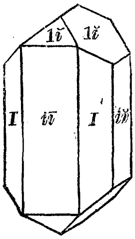

Trimetric. $I : I=92° 30'$, $O : 1\bar{i}=144° 14'$; $a : b : c=0·72 : 1 : 1·0446$. Observed planes as in the figure. $1\breve{i} : 1\breve{i}$ (top)$=110° 50°$, ($110° 47'$, Descl.), $i\breve{i} : 1\breve{i}=124° 35'$, $i\bar{i} : I=136° 15'$. Cleavage: I and $1\breve{i}$ in traces. Also globular and reniform, indistinctly fibrous, fibres straight and divergent, rarely promiscuous; also curved lamellar and granular.

H.=3. G.=4·1—4·4; 3·913, Wood Arsenate. Lustre adamantine—vitreous; of some fibrous varieties pearly. Color various shades of olive-green, passing into leek-, siskin-, pistachio, and blackish-green; also liver- and wood-brown. Streak olive-green—brown. Subtransparent—opaque. Fracture when observable, conchoidal—uneven. Brittle.

Composition.—$\dot{\mathrm{C}}\mathrm{u}^4(\ddot{\mathrm{A}}\mathrm{s},\ddot{\mathrm{P}})+\dot{\mathrm{H}}$ (the arsenic to the phosphoric acid as 3 : 1)=Arsenic acid 31·7, phosphoric acid 6·6, oxyd of copper 58·4, water 3·3=100, and isomorphous with libethenite. Analyses: 1, Kobell, (Pogg. xviii, 249); 2, 3, Richardson, (Thom. Min. i, 614); 4, Hermann, (J. f. pr. Ch. xxxiii, 291); 5, Damour, (Ann. Ch. Phys. [3], xiii, 404); 6, Thomson, (Min. i, 615); 7, Hermann, (loc. cit.):

			$\ddot{\mathrm{A}}\mathrm{s}$	$\ddot{\mathrm{P}}$	$\dot{\mathrm{C}}\mathrm{u}$	$\dot{\mathrm{H}}$
1.	Cornwall, *cryst.*		36·71	3·36	56·43	3·50=100, Kobell.
2.	" "		39·9	—	56·2	3·9=100, Richardson.
3.	" "		39·80	—	56·65	3·55=100, Richardson.
4.	" "	G.=4·135,	33·50	5·96	56·38	4·16=100, Hermann.
5.	" "	G.=4·378,	34·87	3·43	56·86	3·72=98·88, Damour.
6.	" *fibrous,*		40·61	—	54·98	4·41=100, Thomson.
7.	" "	G.=3·913,	40·50	1·00	51·03	8·83, $\ddot{\mathrm{F}}\mathrm{e}$ 3·64=100, Hermann.

The fibrous is the *wood-arsenate*, (*Holzkupfererz*), a variety from Cornwall, presenting a soft velvet-like surface, and a siskin or greenish-gray color.

B.B. in the forceps affords a brown crystalline bead; on charcoal fuses with a kind of deflagration, and yields arsenical fumes and a white brittle metallic globule, which, as it cools, becomes covered with a red scoria. Dissolves in nitric acid, and also in ammonia.

The crystallized varieties occur disposed on, or coating, cavities of quartz, at the Cornwall mines; also in inferior specimens at Alston Moor, in Cumberland. Found at Camsdorf and Saalfeld in Thuringia, in the Tyrol, the Bannat, in Siberia, Chili, and other places.

CONICHALCITE. Konichalcit, *Breit.* and *Plattn.*, Pogg. Ann. lxxvii, 139.

Reniform and massive.

H.=4·5. G.=4·123. Color pistachio-green, inclining to emerald-green; streak the same. Subtranslucent. Brittle. Fracture splintery.

Composition.—$(\dot{\mathrm{C}}\mathrm{u}, \dot{\mathrm{C}}\mathrm{a})^4 (\ddot{\mathrm{P}}, \ddot{\mathrm{A}}\mathrm{s})+1\frac{1}{2}\dot{\mathrm{H}}$, with some vanadic acid replacing (?) part of the phosphoric, the copper and lime in equal proportions, the arsenic to the other acids as 2 : 1. Closely allied to olivenite and volborthite. Analysis by Fritzsche, (loc. cit):

$\ddot{\mathrm{A}}\mathrm{s}$ 30·68, $\ddot{\mathrm{P}}$ 8·81, $\ddot{\mathrm{V}}$ 1·78, $\dot{\mathrm{C}}\mathrm{u}$ 31·76, $\dot{\mathrm{C}}\mathrm{a}$ 21·36. $\dot{\mathrm{H}}$ 5·61.

Probably from Hinajosa de Cordova, in Andalusia, Spain.

EUCHROITE, *Breithaupt.*

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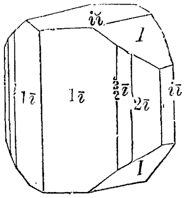

Trimetric. $I : I$=92° 8′, $O : 1\bar{i}$=148° 40′; $a : b : c$=0·6088 : 1 : 1·038. Observed planes as in the annexed figure. $1\bar{i} : 1\bar{i}$=117° 20′, $i\breve{i} : 1\bar{i}$=121° 20′, $i\breve{i} : \frac{3}{2}\bar{i}$=132° 24′, $i\breve{i} : 2\bar{i}$=140° 36½′, $2\bar{i} : 2\bar{i}$ (ov. $i\breve{i}$)=101° 13′. Cleavage: I and $1\bar{i}$. Faces $1\bar{i}$ vertically striated.

H.=3·5—4. G.=3·389. Lustre vitreous. Color bright emerald or leek-green. Transparent—translucent. Fracture small conchoidal—uneven. Rather brittle.

Composition.—$\dot{\mathrm{C}}\mathrm{u}^4\ddot{\mathrm{A}}\mathrm{s}+7\dot{\mathrm{H}}$=Arsenic acid 34·15, oxyd of copper 47·15, water 18·70 =100. Analyses: 1, Turner, (Edinb. Phil. J. iv, 301); 2, 3. Kühn, (Ann. d. Ch. u. Pharm. li, 128); 4, Wöhler, (ib. 285):

	$\ddot{\text{A}}\text{s}$	$\dot{\text{C}}\text{u}$	$\dot{\text{H}}$
1. Libethen,	33·02	47·85	18·80=99·67, Turner.
2. "	34·42	46·97	19·31=100·70, Kühn.
3. "	32·42	46·99	19·31=, $\dot{\text{C}}\text{a}$ 1·12=99·84, Kühn.
4. "	33·22	48·09	18·39=99·70, Wöhler.

In the matrass loses water, becomes yellowish-green and friable. B.B. on charcoal is reduced in an instant with a kind of deflagration, leaving a globule of malleable copper, with white metallic particles disseminated throughout the mass.

Occurs in quartzose mica slate at Libethen in Hungary, in crystals of considerable size, having much resemblance to dioptase. Its name is derived from *ευχροα, beautiful color.*

If the prism $2\bar{\imath}$ were made the fundamental vertical prism in euchroite, then *I* : *I* would equal 101° 13′, and $1\bar{\imath}$: $1\bar{\imath}$(top)=87° 52′, nearly as in wolfram and hopeite. The cleavage is not in accordance with this view.

ARSENIOSIDERITE, *Dufrénoy.* Arsenocrocite.

In fibrous concretions of a yellowish-brown and somewhat golden color, resembling cacoxene; the fibres large and easily separate between the fingers; when rubbed in a mortar the powder adheres to the pestle.

H.=1—2. G.=3·520, Duf., 3·88, Ramm. Lustre silky. Powder yellowish-brown, rather deeper in color than that of yellow-ochre.

Composition.—$\ddot{\text{A}}\text{s}^5$, $\dddot{\text{F}}\text{e}^7$, $\dot{\text{C}}\text{a}^6$, $\dot{\text{H}}^{13}$, (Rammelsberg from his analysis)=Arsenic acid 40·52, peroxyd of iron 39·37, lime 11·88, water 8·23. Analyses: 1, Dufrénoy, (Ann. d. M. [4], ii, 343, 182); 2, Rammelsberg, (2d Supp. 20, and Pogg. lxviii, 508):

	$\ddot{\text{A}}\text{s}$	$\dddot{\text{F}}\text{e}$	$\dddot{\text{M}}\text{n}$	$\dot{\text{C}}\text{a}$	$\dot{\text{K}}$	$\dot{\text{H}}$
1.	34·26	41·31	1·29	8·43	0·76	8·75, $\dddot{\text{S}}\text{i}$ 4·04=98·84, Dufrénoy.
2.	39·16	40·00	——	12·18	——	8·66=100, Rammelsberg.

The arsenic in Rammelsberg's analysis was determined by the loss. His results give no very simple formula. Dufrénoy's correspond to $\ddot{\text{A}}\text{s}^3$, $\dddot{\text{F}}\text{e}^5$, (or $\dddot{\text{F}}\text{e}^6$), $\dot{\text{C}}\text{a}^3$, $\dot{\text{H}}^9$. The mineral appears from the analyses to vary in constitution. Taking the mean of the two, after reducing Dufrénoy's to a percentage rate, the silica and loss excluded, gives—

A. Mean result,	$\ddot{\text{A}}\text{s}$ 37·65	$\dddot{\text{F}}\text{e}$ 41·79	$\dddot{\text{M}}\text{n}$ 0·68	$\dot{\text{C}}\text{a}$ 10·53	$\dot{\text{K}}$ 0·40	$\dot{\text{H}}$ 8·94.
B. Oxygen ratio,	13·09	12·54	0·21	3·00	0·03	7·94.

From this we obtain very nearly the oxygen ratio 25 : 24 : 6 : 15, and the ratio of constituents $\ddot{\text{A}}\text{s}^5$, $\dddot{\text{F}}\text{e}^8$, $\dot{\text{C}}\text{a}^6$, $\dot{\text{H}}^{15}$, which affords the formula $\dot{\text{C}}\text{a}^6\ddot{\text{A}}\text{s}+4\dddot{\text{F}}\text{e}^2\ddot{\text{A}}\text{s}+15\dot{\text{H}}$ =Arsenic 37·86, peroxyd of iron 42·14, lime 11·11, water 8·89.

According to Fournet, arseniosiderite is essentially cacoxene with the phosphoric acid replaced by arsenic acid, and having the corresponding formula $\dddot{\text{F}}\text{e}^4\ \ddot{\text{A}}\text{s}^3+18\dot{\text{H}}$; but this exceeds the proportion of water by nearly one half, and does not take into account the lime.

B.B. fuses to a black enamel, with a feeble arsenical odor developed on adding soda. Dissolves readily in hot nitric or muriatic acid.

This species occurs in a manganese bed at Romanêche in the Department of Saone et Loire, France.

PHARMACOSIDERITE, *Haus.* Cube Ore. Würferlerz, *W.* Fer Arseniaté, *H.* Siderite. Beudantite, *Levy.*

Monometric; tetrahedral. Observed planes *O*, 1, 2, *I*; f. 1, 53, etc. Cleavage: cubic; imperfect. *O* sometimes striated parallel to its edge of intersection with plane 1, (f. 53); planes often curved. Rarely granular.

H.=2·5. G.=2·9—3. Lustre adamantine, not very distinct. Color olive-green, passing into yellowish-brown, bordering sometimes upon hyacinth-red and blackish-brown; also passing into grass-green and emerald-green. Streak olive-green—brown, yellow, pale. Subtranslucent. Rather sectile. Pyroelectric.

Composition.—$\dot{\mathrm{F}}\mathrm{e}^3\ \overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}+\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}^2+18\,\dot{\mathrm{H}}=(\dot{\mathrm{F}}\mathrm{e}^3,\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e})^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}^3+18\,\dot{\mathrm{H}}$=Arsenic acid 40·4, peroxyd of iron 28·1, protoxyd of iron 12·6, water 18·9; according to G. Rose probably $\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}^3+18\dot{\mathrm{H}}$. Analysis by Berzelius, (K. V. Ac. H. 1824, p. 354):

$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{u}$	$\dot{\mathrm{H}}$
40·20	2·53	39·20	0·65	18·61, gangue 1·76=102·95.

Exposed to a gentle heat, it becomes red; a higher temperature causes intumescence, but drives off little or no arsenic, and leaves a red powder. B.B. copious arsenical fumes are emitted on charcoal, and a metallic scoria is obtained in the reducing flame which acts on the magnetic needle.

Cube ore was formerly obtained at the mines of Huel Gorland, Huel Unity, and Carharrack in Cornwall, coating cavities in quartz, with ores of copper; now found in quartz at Burdle Gill in Cumberland, in small brilliant crystals; also in Australia; at St. Leonard in France; and at Schneeberg and Schwarzenberg in Saxony.

Beudantite, *Levy*. This mineral from Horhausen, Nassau, has been referred to Cube ore, but Brooke gives reason for believing it distinct. Form according to Levy, rhombohedral; $R : R$=86° 30′, but faces not even. Black and opaque. Percy obtained in two imperfect analyses, (Phil. Mag. [3], xxxvii, 161):

$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\dddot{\mathrm{S}}$	$\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{P}}\mathrm{b}$	$\dot{\mathrm{H}}$
9·68	1·46	12·31	42·46	24·47	8·49
13·60	*undet.*	12·35	37·65	29·52	8·49

Unless containing largely of impurities, it must be distinct from the above. Rammelsberg deduces the formula $\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}^4\ \overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}+8\dot{\mathrm{H}}$.

Altered Forms.—Cube ore has been observed altered to Psilomelane, Limonite, ($\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}^2\dot{\mathrm{H}}^3$), Red Iron Ore, ($\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}$).

WAVELLITE. Subphosphate of Alumina. Devonite. Alumine Phosphatée, *H.* Lasionite, *Fuchs.*

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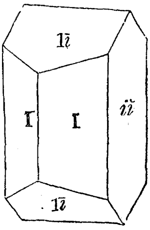

Trimetric. $I : I$=126° 25′, $O : 1\bar{i}$=143° 23′; $a : b : c$=0·7431 : 1 : 1·4943. Observed planes as in the annexed figure, with also 1, $2\breve{2}$ and $\breve{i}\tfrac{4}{3}$ 1 : I=129° 47′, 1 : 1 (mac.) 146° 28′, (brach.) 110° 20′ and (bas.) 79° 34′, $2\breve{2} : 2\breve{2}$ (pyr.) 117° 53′, 118° 33′, (bas.) 93° 7′, $i\breve{i} : \breve{i}\tfrac{4}{3}$=123° 57′. Cleavage: I rather perfect: also brachydiagonal. Usually in hemispherical or globular concretions, having a radiated structure.

H.=3·25—4. G.=2·337, (Barnstaple), Haidinger; 2·3616, (Irish variety), Richardson. Lustre vitreous, inclining to pearly and resinous. Color white, passing into yellow, green, gray, brown, and black. Streak white. Translucent. Index of refraction 1·52.

Composition.—$(\overset{\cdot\cdot\cdot}{\bar{\mathrm{A}}}\mathrm{l}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}^3+18\dot{\mathrm{H}})+\tfrac{1}{3}\,\mathrm{Al\,F}$=Alumina 33·8, phosphoric acid 34·9, aluminium 1·5, fluorine 3·1, water 26·6=100. Sonnenschein's analysis corresponds nearly to $\overset{\cdot\cdot\cdot}{\bar{\mathrm{A}}}\mathrm{l}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}^2+12\dot{\mathrm{H}}$.

Analyses: 1, 2, Fuchs, (Schweig. xxiv, 121); 3, Berzelius, (Schw. J. xxvii, 63), 4—7, Erdmann, (Schweig. lxix, 154); 8, Hermann, (J. f. pr. Chem. xxxiii, 288); 9, Sonnenschien (J. f. pr. Chem. liii, 344):

	$\dddot{\overline{\mathrm{Al}}}$	$\overset{:\cdot:}{\mathrm{P}}$	$\dot{\mathrm{H}}$	HF	$\dddot{\overline{\mathrm{Fe}}}$	
1. Devonshire,	37·20	35·12	28·00	——	—	=100·32, Fuchs.
2. "	37·16	34·84	28·00	——	—	=100 Fuchs.
3. "	35·35	33·40	26·80	2·06	1·25,[a]	$\dot{\mathrm{Ca}}$ 0·50=99·39, Berzelius.
4, Strigis, *blue,*	36·60	34·06	27·40	*trace*	1·00	=99·06, Erd.
5. " *green, yellow,*	36·39	33·28	27·10	*trace*	2·69	=99·46, Erd.
6. " *brown,*	34·90	31·55	24·01	*trace*	2·21.	$\dddot{\mathrm{Si}}$ 7·30=99·97, Erd.
7. " *black,*	35·39	32·46	24·00	*trace*	1·5	$\dddot{\mathrm{Si}}$ 6·65=100, Erd.
8 Zbirow,	36·39	34·29	26·34	F 1·69	1·20	=98·91, Herm.
9 Allendorff,	35·76	32·16	28·32	*trace*		$\dot{\mathrm{Ca}}$ 0·86, $\dddot{\mathrm{Si}}$ 2·70=98·80, Sonn.

[a] With peroxyd of Manganese.

Hermann obtained much less fluorine than Berzelius, and gives a different formula. But Berzelius remarks that this ingredient may easily fall short.

B.B. whitens and intumesces, but is infusible; gives the reaction of phosphorus. In a matrass yields water, and acts on glass from the hydrofluoric acid present.. Reduced to powder, and heated with sulphuric acid, it gives off a vapor which corrodes glass.

Wavellite was first discovered in a tender clay slate near Barnstaple, in Devonshire, by Dr. Wavell. It has since been found at Clonmel and Cork, Ireland; in the Shaint isles of Scotland, at Zbirow in Bohemia; at Frankenberg and Langenstriegis, Saxony; Diensberg near Giessen, Hesse Darmstadt; on brown iron ore in the Jura limestone at Amberg in Bavaria, (the Lasionite of Fuchs); in a Manganese mine at Weinbach near Weilburg in Nassau, (Genth); at Villa Rica, Minas Geraes, Brazil.

In the United States reported as found near Saxton's River, Bellows Falls, N. H.; also at the slate quarries of York Co., Pa., near the Susquehannah; found at Washington mine, Davidson Co., N. C., with actinolite, pyrites and native silver.

A Wavellite containing oxyd of lead occurs at Rosières in stalactites, as detected by Berthier.

CACOXENE. Kakoxen, *Steinmann.*

Occurs in radiated tufts of a yellow or brownish yellow color. H.=3—4. G.=3·38. Becomes brown on exposure.

Composition.—Supposed to be an iron-wavellite. $(\dddot{\overline{\mathrm{Fe}}}, \dddot{\overline{\mathrm{Al}}})^4\overset{:\cdot:}{\mathrm{P}}{}^3+18\dot{\mathrm{H}}$, but doubtful. Analyses: 1, Steinmann, (Leonh. Orykt. 750); 2, Holger, (Baumg. Zeits. viii, 129); 3, Richardson, (Thomson's Min., i, 476):

	$\dddot{\overline{\mathrm{Al}}}$	$\dddot{\overline{\mathrm{Fe}}}$	$\overset{:\cdot:}{\mathrm{P}}$	$\dot{\mathrm{Ca}}$	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{H}}$ and HF
1. Zbirow,	10·01	36·32	17·86	0·15	8·90	25·95=99·19, Steinmann.
2. "	11·29	36·83	9·20	——	3·30	18·98, with $\dot{\mathrm{Mg}}$ 7·58, $\dot{\mathrm{Zn}}$ 1·23, $\dddot{\mathrm{S}}$11·29,H.
3. "	——	43·1	20·5	1·1	2·1	30·2, with $\dot{\mathrm{Mg}}$ 0·9=97·9, Rich.

The differences are supposed to be due to impurities. Steinmann's analysis of wavellite was made on a specimen from Zbirow, and has the composition of true cacoxene. B.B. acts like wavellite, except that it affords the reaction of iron.

It occurs at the Hrbeck mine, near Zbirow in Bohemia, along with an earthy brown iron ore, in the graywacke formation.

CHILDRENITE, *Levy.*

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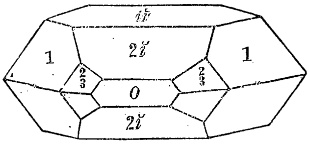

Trimetric. $I : I=111°\ 54'$, $O : 1\bar{\imath}=136°\ 26'$; $a : b : c=0{\cdot}9512 : 1 : 1{\cdot}4798$. Observed planes as in the annexed figure, with also $\frac{3}{2}\breve{\frac{3}{2}}$. $O : 2\breve{\imath}=127°\ 53'$, $O : 1=131°\ 4'$, $O : \frac{2}{3}=142°\ 35'$, $O : i\breve{\imath}=90°$, $1 : 1$ (mac.) $130°\ 4'$, (brach., or over $2\breve{\imath}$,) $102°\ 41'$, (bas.) $97°\ 52'$, $2\breve{\imath} : 2\breve{\imath}$ (ov. O)$=75°\ 46'$, B. and M. Cleavage: $i\breve{\imath}$, imperfect.

H.=5. G.=3·18—3·24; 3·184, Kengott. Lustre vitreous, inclining to resinous. Color yellow and pale yellowish-brown, also yellowish-white, and brownish-black. Streak white, yellowish. Translucent. Fracture uneven. In a matrass much water.

Composition.—$(\dot{\mathrm{R}}^3, \ddot{\bar{\mathrm{A}}}\mathrm{l})^5 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}{}^3+15\dot{\mathrm{H}}$, with the protoxyds to the alumina as 4 : 3= Phosphoric acid 27·8, alumina 14·4, protoxyd of iron 31·3, protoxyd of manganese 8·9, water 17·6=100. In the formula, the oxygen ratio for the bases and phosphoric acid is 15 : 15; Rammelsberg's analysis, (Pogg. lxxxv, 435), which follows, affords 14·4 : 15.

$\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 28·92 $\ddot{\bar{\mathrm{A}}}\mathrm{l}$ 14·44 $\dot{\mathrm{F}}\mathrm{e}$ 30·68 $\dot{\mathrm{M}}\mathrm{n}$ 9·07 $\dot{\mathrm{M}}\mathrm{g}$ 0·14 $\dot{\mathrm{H}}$ 16·98=100·23, Rammelsberg.

B.B. color of flame bluish-green; with the fluxes reactions of iron and manganese. Soluble in muriatic acid after long ignition.

Occurs in crystals and crystalline coats, on spathic iron, pyrites or quartz, and sometimes with apatite near Tavistock in Devonshire; on slate at Crinnis in Cornwall.

If the dome $2\breve{\imath}$ be made the fundamental vertical prism, then *I* : *I*=104° 14′, $1\bar{\imath}$: $1\bar{\imath}$ (top)=73°, $1\breve{\imath}$: $1\breve{\imath}$ (ib.)=87° 14′; the cleavage macrodiagonal; *a* : *b* : *c*=1·3514 : 1 : 1·2853.

ERINITE, *Haid.*

In mammillated crystalline groups, concentric in structure and fibrous, and rough from the terminations of very minute crystals; the concentric layers compact, and often easily separable. Traces of cleavage in one direction.

H.=4·5—5. G.=4·043. Lustre almost dull, slightly resinous. Color fine emerald-green, slightly inclining to grass-green. Streak green, paler than the color. Subtranslucent—nearly opaque. Brittle.

Composition.—$\dot{\mathrm{C}}\mathrm{u}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}+2\dot{\mathrm{H}}$=Arsenic acid 34·7, oxyd of copper 59·9, water 5·4=100. Analyses, (approximative), by Turner, (Ann. Phil. [2], 1828, iv, 154):

$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}$ 33·78, $\dot{\mathrm{C}}\mathrm{u}$ 59·44, $\dot{\mathrm{H}}$ 5·01, $\ddot{\bar{\mathrm{A}}}\mathrm{l}$ 1·77=100.

Erinite occurs associated with other arsenates of copper, in the county of Limerick, Ireland, whence its name.

CORNWALLITE.—Zippe thus names an arsenate of copper from Cornwall, which afforded Lerch, as mean of two analyses, (Ramm. 4th Supp. 122): $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}$ 30·21, $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 2·16, $\dot{\mathrm{C}}\mathrm{u}$ 54·61, $\dot{\mathrm{H}}$ 13·02=100, leading to the formula $\dot{\mathrm{C}}\mathrm{u}^5 \overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}+5\dot{\mathrm{H}}$. G.=4·166; H.=4·5. It occurs amorphous of a blackish or verdigris-green color, and is associated with olivenite.

PHOSPHOCHALCITE, *Kobell.* Pseudomalachite. Hydrous Phosphate of Copper Dihydrite, *Herm.* Kupferdiaspore, *Kühn.* Lunnite, *Bernhardi.*

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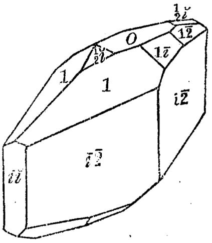

Trimetric; hemihedral, producing monoclinic forms. *I* : *I*=109° 28′, *O* : $1\bar{\imath}$=146° 18½′; *a* : *b* : *c*=√2 : 1 : 0·6667. Observed planes as in the annexed figure. $i\bar{2}$: $i\bar{2}$=141° 4′ and 38° 56′, 1 : 1=117° 49′, *O* : $\frac{1}{2}\breve{\imath}$=166° 34′, $1\bar{\imath}$: $1\bar{2}$=168° 46′. Cleavage: $i\breve{\imath}$ imperfect. Also reniform or massive; indistinctly fibrous, and having a drusy surface.

H.=4·5—5. G.=4—4·4. Lustre adamantine, inclining to vitreous. Color dark emerald, verdigris, or blackish-green, often darker at the surface. Streak green, a little paler than the color. Translucent—subtranslucent. Fracture small conchoidal—uneven. Brittle.

Composition.—$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\frac{1}{2}\dot{\mathrm{H}}$ (Nos. 2 and 4,)=Phosphoric acid 24·3, oxyd of copper 68·0, water 7·7=100. $\dot{\mathrm{Cu}}^6\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+3\dot{\mathrm{H}}$ (Kühn), (Nos. 5, 6, 8,)=Phosphoric acid 21·1, oxyd of copper 70·9, water 8·0. Analyses: 1, Arfvedson, (Jahresb. iv, 143); 2—4, Hermann, (J. f. pr. Chem. xxxvii); 5–7, Kühn, (Ann. d. Ch. u. Pharm. xxxiv, 218, and li, 124); 8, Rhodius, (Pogg. lxii, 369):

		$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{H}}$
1. Rheinbreitenbach,		24·70	68·20	5·97=98·87, Arfvedson.
2. Nischne Tagilsk,	G.=4·25,	23·75	68·75	7·50=100, Hermann.
3. " *Dihydrite,*	G.=4·4,	25·30	68·21	6·49=100, Hermann.
4. Rheinbreitenbach,	G.=4·4,	24·55	67·25	8·20=100, Hermann.
5. "		21·52	68·74	8·64=98·90, Kühn.
6. Hirschberg, Voigtland,		20·87	71·73	7·40=100, Kühn.
7. " *Kupferdiaspore,*		24·13	69·61	6·26 (or loss)=100, Kühn.
8. Libethen, Rheinbreitenbach,		20·4	70·8	8·4=99·6, Rhodius.

The compound $\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\dot{\mathrm{H}}$ of Kühn, (Nos. 7, 3, 1), is named *Prasin* by Breithaupt. The *Dihydrite* is here included.

B.B. fuses readily to a small vesicular metalloidal globule. Dissolves without effervescence in nitric acid; more readily if heated.

Phosphochalcite occurs in veins traversing graywacke slate at Virneberg, near Rheinbreitenbach, on the Rhine, and is associated with quartz and other ores of copper; also at the other localities above enumerated; also in Cabarras Co., N. C.

EHLITE, *Breithaupt.*—This mineral is near phosphochalcite and also libethenite. It is described as occurring in reniform or botryoidal shapes. Structure radiating, foliated. Also amorphous. Cleavage perfect in one direction. H.=1·5—2. G.=3·8—4·27. Lustre pearly. Color verdigris to emerald-green. Streak paler. *Composition.*—$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+3\dot{\mathrm{H}}$=Phosphoric acid 24·0, oxyd of copper 66·9, water 9·1. Rhodius's analyses gives $\dot{\mathrm{Cu}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\dot{\mathrm{H}}$=Phosphoric acid 28·6, oxyd of copper 64·1, water 7·3=100.

Analyses: 1, Bergemann; 2, Hermann, (J. f. pr. Chem. xxxvii); 3, Rhodius, (Ann. d. Chem. u. Pharm. lxii, 371):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{H}}$
1. Ehl,	24·93	65·99	9·06=99·98, Bergemann.
2. Nischne Tagilsk,	23·14	66·86	10·00=100, Hermann.
3. Ehl,	28·9	63·1	7·3=99·3, Rhodius. G.=4·27.

The title of the mineral to the rank of a distinct species is yet uncertain.

TAGILITE, *Hermann.*—Occurs at Nischne Tagilsk in reniform masses on brown iron ore. Structure fibrous and earthy. H.=3. G.=3·5. Color emerald-green to mountain green. *Composition.*—$\dot{\mathrm{Cu}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+3\dot{\mathrm{H}}$=Phosphoric acid 27·7, oxyd of copper 61·8, water 10·5=100. Analyses by Hermann, (J. f. pr. Chem. xxxvii),

$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{H}}$	$\overset{\cdot\cdot\cdot}{\mathrm{Fe}}$
26·44	61·29	10·77	1·50=100.
26·91	62·58	10·71	——=100.

TYROLITE, *Haid.* Copper Froth. Cupriferous Calamine, *P.* Zinc Hydraté Cuprifère, *Levy.* Kupferschaum. Pharmacosiderite. Kupaphrite, *Shepard.*

Trimetric. Observed planes, *O*, *ĭĭ*, *I*. Cleavage: *O*, perfect. Usually reniform, massive; structure radiate foliaceous, surface drusy.

H.=1—2. G.=3·02—3·098. Lustre: *O* pearly; other faces vitreous. Color pale apple-green and verdigris-green, inclining to sky-blue. Streak a little paler. Translucent—subtranslucent. Fracture not observable. Very sectile. Thin laminæ flexible.

Composition.—$\dot{\mathrm{C}}\mathrm{u}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}+10\,\dot{\mathrm{H}}+\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$ (?)=Arsenic acid 25·4, oxyd of copper 43·8, water 19·8, carbonate of lime 11·0=100. The carbonate of lime may be an impurity. Analysis by Kobell, (Pogg. xviii, 253):

Falkenstein, Tyrol, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{A}}\mathrm{s}$ 25·01 $\dot{\mathrm{C}}\mathrm{a}$ 43·88 $\dot{\mathrm{H}}$ 17·46 $\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$ 13·65=100.

B.B. decrepitates briskly, throwing off fine fragments which tinge the flame green, blackens, and fuses to a steel-gray globule, not crystalline on its surface. On charcoal emits moisture quietly, and after a long continuance of the blowpipe heat, swells a little from the extrication of the vapor of arsenic. With soda, an imperfectly fluid mass is obtained, which contains a white metallic nucleus. Soluble in acids evolving carbonic acid.

This mineral usually occurs in the cavities of calamine, calc spar, or quartz, accompanied by other ores of copper, appearing in small aggregated and diverging fibrous groups of a pale-green color, and possessing a delicate silky lustre. It has been observed in the Bannat; at Posing and Libethen in Hungary; Nertschinsk in Siberia; Falkenstein and Schwatz in the Tyrol; Saalfeld in Thuringia; Riechelsdorf in Hessia; Schneeberg in the Erzgebirge.

Rammelsberg suggests that this species may be related to Aurichalcite; the latter has a yellowish-green color and may thus be distinguished.

DELVAUXENE, *Dumont.* Delvauxit.

Massive and earthy, with a yellowish-brown, brownish-black, or reddish color.

H.=2·5. G.=1·85. Waxy; dull. Opaque to translucent on the edges.

Composition.—$\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+24\,\dot{\mathrm{H}}$=Phosphoric acid 15·9, peroxyd of iron 35·8, water 48·3=100. $\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+18\dot{\mathrm{H}}$, Delvaux. Analyses: 1, 2, Dumont, (L'Institut, No. 276); 3, Delvaux, (Bull. Acad. Brux. 1838, 147):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{H}}$
1. *Reddish brown,*	16·04	34·20	49·76=100.
2. *Brownish black,*	16·57	36·62	46·81=100.
3.	18·20	40·44	41·13=99·77

B.B. changes color, decrepitates, and fuses to a gray magnetic globule.

From Berneau, near Visé in Belgium. It is supposed to be a mechanical mixture.

Beraunite, *Breit.*, is supposed to be a hydrous phosphate of peroxyd of iron. Occurs foliated and radiated, with one perfect cleavage and one imperfect; hyacinth-red or reddish-brown; streak reddish ochre-yellow. B.B. fuses and colors the flame bluish-green. Soluble in muriatic acid. Found in limonite near Beraun in Bohemia; also near Kertsch, Crimea. It is *altered Vivianite*, (Breit.)

DUFRENITE, *Brongn.* Green Iron Ore. Kraurite, *Br.* Grüneisenstein, *M.*

Trimetric. $I:I$ about 123°. Cleavage: brachydiagonal. Radiated fibrous, with a drusy surface.

H.=3·5—4. G.=3·2—3·4. Lustre silky, weak. Color dull leek-green, blackish-green; alters on exposure to yellow and brown. Streak siskin-green. Subtranslucent.

Composition.—$\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}}\mathrm{e}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\tfrac{1}{2}\dot{\mathrm{H}}$=Phosphoric acid 28·0, peroxyd of iron 63·1, water 8·9 =100. Analyses: 1, Karsten, (Arch. f. Bergb. u. Hütt. xv, 243); 2, Vauquelin, (Ann. Ch. Phys. xxx, 202):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$	$\overset{\cdot\cdot\cdot}{\bar{\text{F}}\text{e}}$	$\overset{\cdot\cdot\cdot}{\bar{\text{M}}\text{n}}$	$\dot{\text{H}}$	
1. Siegen,	27·72	63·45	——	8·56	=99·73, Karsten.
2. Haute Vienne,	27·85	56·20	6·76	9·29	=100, Vauquelin.

B.B. Fuses easily to a slag. Occurs in Saxony and Haute Vienne, France.

Melanchlor, Fuchs, (J. f. prakt. Ch. xvii, 171).—This is a phosphate of iron from Rabenstein, containing in 100 parts, 38·9 peroxyd and 3·87 protoxyd of iron, besides protoxyd of manganese and 9 to 10 per cent. of water. The name alludes to its blackish-green color.

APHANESITE, *Beud.* Abichite, *Haid.* Klinoclas, *Breit.* Strahlerz, *Hoff.* Strahlenkupfer. Siderochalcit, *Br.* Cuivre Arseniaté Ferrifère, *H.*

Monoclinic; $C=80°\ 30'$, $I:I$ (front)$=56°$ (side) 124°. Observed planes as in the annexed figures. $O:-\frac{3}{2}i=99°\ 30'$, $O:1i=123°\ 48'$. Cleavage: basal, highly perfect. Also massive, hemispherical; structure radiated fibrous.

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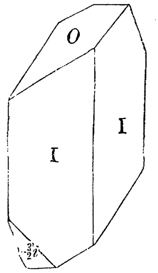

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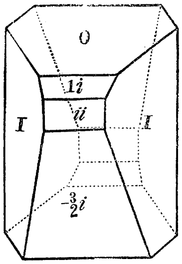


H.=2·5—3. G.=4·19—4·36. Lustre: *O* pearly; elsewhere vitreous to resinous. Color dark verdigris-green, inclining to blue; also dark blue. Streak verdigris-green. Subtranslucent. Not very brittle.

Composition.—$\dot{\text{C}}\text{u}^6\overset{\cdot\cdot\cdot\cdot\cdot}{\text{As}}+3\dot{\text{H}}=\dot{\text{C}}\text{u}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\text{As}}+3\dot{\text{C}}\text{u}\ \dot{\text{H}}$=Arsenic acid 30·2, oxyd of copper 62·7, water 7·1=100. Analyses: 1, Rammelsberg, (2d Supp. 78); 2, Damour, (Ann. Ch. Phys. [3], xiii):

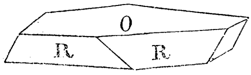
		$\overset{\cdot\cdot\cdot\cdot\cdot}{\text{As}}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$	$\dot{\text{C}}\text{u}$	$\dot{\text{H}}$	$\overset{\cdot\cdot\cdot}{\bar{\text{F}}\text{e}}$	
1. Cornwall,	G.=4·258–4·359,	29·71	0·64	60·00	7·64	0·39,	$\dot{\text{C}}\text{a}$ 0·50, $\overset{\cdot\cdot\cdot}{\text{S}}\text{i}$ 1·12=100, R.
2. “	G.=4·312,	27·09	1·50	62·80	7·57	0·49	=99·44, Damour.

B.B. deflagrates, fuses readily, and emits arsenical fumes. Soluble in acids.

Occurs in Cornwall, with other salts of copper. The crystals usually present a very dark blue color and brilliant lustre, but are rarely recognizable, being aggregated in diverging groups, or disposed in extremely minute individuals, in cavities of quartz. Hence the name *aphanesite*, from *’αφανης*, *unmanifest.* Also found in the Erzgebirge.

CHALCOPHYLLITE, Br. Copper Mica. Kupferglimmer, *W.* and *L.* Kupferphyllit, *Br.* Tamarite.

570



Rhombohedral. $R:R=69°\ 48'$, $O:R=108°\ 44'$; $a=2{\cdot}5536$. Observed planes: R, 2, O,$-\frac{1}{2}$, I. $\frac{1}{2}:\frac{1}{2}=88°\ 46'$, $O:\frac{1}{2}=124°\ 9'$. Cleavage: *O* highly perfect, which plane is sometimes triangularly striated. Also foliated massive, and in druses.

H.=2. G.=2·4—2·66. Lustre: of *O* pearly; of other faces, vitreous or subadamantine. Color emerald or grass-green to verdigris-green. Streak somewhat paler than the color. Fracture scarcely observable. Sectile.

Composition.—$\dot{\mathrm{Cu}}^6\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+12\dot{\mathrm{H}}$, Damour=Arsenic acid 24·9, oxyd of copper 51·7, water 23·4. From Chenevix's analysis, $\dot{\mathrm{Cu}}^8\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+12\dot{\mathrm{H}}$=Arsenic acid 21·31, oxyd of copper 58·71, water 19·98.—From Hermann's analysis, $\dot{\mathrm{Cu}}^8\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+23\dot{\mathrm{H}}$=Arsenic acid 18·02, oxyd of copper 49·61, water 32·37.—Analyses: 1, Chenevix, (Phil. Trans. 1801); 2, Hermann, (J. f. pr. Ch. xxxiii, 294); 3, 4, Damour, (Ann. Ch. Phys. [3], xiii, 404):

		$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{H}}$
1. Cornwall,		21·	58·	21=100, Chenevix.
2. "	G.=2·435,	17·51	44·45	31·19, $\dot{\mathrm{Fe}}$ 2·92, $\overset{\cdot\cdot\cdot}{\bar{\mathrm{A}}\mathrm{l}}$ and $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 3·93=100, H.
3. "	G.=2·659,	19·35	52·92	23·94, $\overset{\cdot\cdot\cdot}{\bar{\mathrm{A}}\mathrm{l}}$ 1·80, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 1·29=99·30, Dam.
4. "	"	21·27	52·30	22·58, $\overset{\cdot\cdot\cdot}{\bar{\mathrm{A}}\mathrm{l}}$ 2·13, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 1·56=99·84, "

B.B. decrepitates, loses color and transparency; on charcoal emits arsenical fumes, and fuses to a black globule, after forming a black spongy scoria; with soda affords copper. Soluble in acids and ammonia.

The copper mines of Tingtang, Huel Gorland, and Huel Unity, near Redruth, are its principal localities in Cornwall. Occurs also crystallized in iron ore, at Sayda in Saxony; in minute crystals at Herrengrund in Hungary; Moldawa in the Bannat.

Taking ½ *R* as the fundamental rhombohedon, then *R* : *R*=88° 46′, and *a*=1·7768.

Altered Forms.—Found altered to Chrysocolla.

LIROCONITE. Octahedral Arseniate of Copper. Linsenerz, *Wern.* Linsenkupfer, *Haus.* Cuivre Arseniaté Octaèdre Obtus, *H.* Chalcophacite, *Glocker.*

Trimetric. *I* : *I*=119° 20′; 119° 9′, Descl.; $1\bar{i}$: $1\bar{i}$=72° 22′. Observed planes as in the annexed figure. Cleavage lateral, but obtained with difficulty. Rarely granular.

H.=2—2·5. G.=2·882, Bournon; 2·926, Haid.: 2·985, Hermann; 2·964, Damour. Lustre vitreous, inclining to resinous. Color and streak sky-blue—verdigris-green. Fracture imperfectly conchoidal, uneven. Imperfectly sectile.

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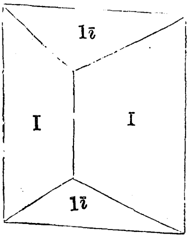

Composition.—25 $\dot{\mathrm{Cu}}$, 5 $\overset{\cdot\cdot\cdot}{\bar{\mathrm{A}}\mathrm{l}}$, 6 $(\frac{5}{6}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+\frac{1}{6}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}})$, 75 $\dot{\mathrm{H}}$; [$=5\,\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+\overset{\cdot\cdot\cdot}{\bar{\mathrm{A}}\mathrm{l}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+75\,\dot{\mathrm{H}}$]. Analyses: 1, T. Wachtmeister, (K. V. Ac. H. 1832, 80); 2, Hermann, (J. f. pr. Ch. xxxiii, 296); 3, 4, Damour, (Ann. Ch. Phys, [3], xiii, 404):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\dot{\mathrm{Cu}}$	$\overset{\cdot\cdot\cdot}{\bar{\mathrm{A}}\mathrm{l}}$	$\dot{\mathrm{H}}$
1. Cornwall,	20·79	3·61	35·19	8·03	22·24, $\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}\mathrm{e}}$ 3·41, $\overset{\cdot\cdot\cdot}{\mathrm{Si}}$ 4·04, gangue 2·95=100·26, [Wacht.
2. "	23·05	3·73	36·38	10·85	25·01, " 0·98=100, Hermann.
3. "	22·22	3·49	37·18	9·68	25·49=98·06, Damour.
4. "	23·40	3·24	37·40	10·09	25·44=98·47, "

The above constitution, as far as the proportion of the bases and acids is concerned, is deduced by Rammelsberg from Wachtmeister's and Damour's analyses. Hermann's gives 20 $\dot{\mathrm{Cu}}$, 5 $\overset{\cdot\cdot\cdot}{\bar{\mathrm{A}}\mathrm{l}}$, 6$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$, 60 $\dot{\mathrm{H}}$.

B.B. loses color and transparency, emits arsenical fumes, and on charcoal becomes a black, friable scoria, containing some metallic globules. With borax a green globule, and a partial reduction. Dissolves in nitric acid without effervescence.

Crystals occasionally an inch in diameter; usually quite small. Occurs with various ores of copper, pyrites, and quartz, at Huel Gorland and Huel Unity, in Cornwall; also in minute crystals at Herrengrund in Hungary, and in Voigtland.

URANITE. Uran Mica. Uranglimmer. Uranoxyd, *Haus.* Urane Oxydé, *H.* Uranphyllit.

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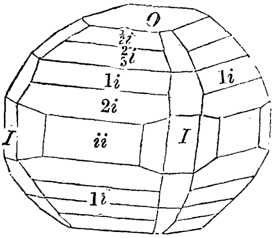


Dimetric. *O* : 1*i*=128° 35′; *a*=1·2534. Observed planes as in the annexed figure; *O* : $\frac{1}{2}i$=147° 56′, *O* : $\frac{2}{3}i$=140° 7′, *O* : 2*i*=111° 45′. Cleavage: basal, highly perfect. Surface *O* smooth, *ii* rough.

Lustre of *O* pearly, of other faces subadamantine. Transparent—subtranslucent. Fracture not observable. Sectile. Laminæ brittle and not flexible.

VAR. 1. URANITE. Lime-Uranite. Kalk-Uranit. Autunite.

H.=2—2·5. G.=3·05—3·19. Color citron to sulphur-yellow.

Composition.—$\dot{C}a^{2}\overset{.....}{\bar{P}}+\overset{...}{\bar{U}}^{4}\overset{.....}{\bar{P}}+16\dot{H}$=Phosphoric acid 15·7, oxyd of uranium 62·7, lime 6·1, water 15·5=100. Analysis by Berzelius, (Jahresb. xxii, 212):

$\overset{.....}{\bar{P}}$	$\overset{...}{\bar{U}}$	$\dot{C}a$	$\dot{M}g$ and $\dot{M}n$	$\dot{B}a$	$\ddot{S}n$	$\dot{H}$
15·20	61·73	5·88	0·20	1·57	0·06	15·48=100·12.

B.B. fuses to a blackish mass like pitchblende. A yellow solution in nitric acid.

Uranite is found with other ores of uranium, associated with silver, tin, and iron ore.

Occurs in the Siebengebirge in the hornstone of a trachytic range; at Johanngeorgenstadt and Eibenstock; at Lake Onega, Wolf Island, Russia; also near Limoges and at St. Symphorien near Autun. Occurs sparingly at the Middletown feldspar quarries, associated with columbite and pitchblende, in minute tabular crystals and thin scales of light green and lemon yellow colors; also in minute crystals at Chesterfield, Mass., on the quartz or albite, and sometimes in the red centres of tourmalines, and at Ackworth, N. H., straw-yellow and light green; also in a gneiss quarry on the Schuylkill near Philadelphia, about a quarter of a mile above the suspension bridge.

VAR. 2. CHALCOLITE. Copper-Uranite, Kupfer-Uranit. Torberite.

H.=2—2·5. G.=3·5—3·6. Color emerald and grass-green, and sometimes leek, apple, and siskin-green. Streak somewhat paler than the color.

Composition.—$\ddot{C}u^{2}\overset{.....}{\bar{P}}+\overset{...}{\bar{U}}^{4}\overset{.....}{\bar{P}}+16\dot{H}$, or same as above, with copper in place of lime =Phosphoric acid 15·1, oxyd of uranium 61·2, oxyd of copper 8·4, water 15·3=100. Analyses: 1, Berzelius, (loc. cit): 2, Werther, (J. f. pr. Ch. xliii, 334):

	$\overset{.....}{\bar{P}}$	$\overset{...}{\bar{U}}$	$\ddot{C}u$	$\dot{H}$
1.	15·57	61·29	8·44	15·05=100·45, Berzelius.
2.	14·34	59·03	8·27	15·39, $\ddot{S}i$ 0·49, Earthy substance 0·41, Werther.

B.B. fuses to a black mass, coloring the flame bluish-green. Gives with borax a green glass, which becomes reddish-brown in the reduction flame. In nitric acid a yellowish green solution.

Gunnis Lake formerly afforded splendid crystallizations of this species, and also Tin Croft and Huel Buller, near Redruth and elsewhere in Cornwall. Found also at Johanngeorgenstadt, and Eibenstock and Schneeberg in Saxony; in Bohemia at Joachimstahl and Zinnwald; in Belgium at Vielsalm.

CARPHOSIDERITE. Karphosiderit, *Breithaupt.*

In reniform masses, and incrustations.

H.=4—4·5. G.=2·49—2·5. Lustre resinous. Streak yellowish, glimmering. Color pale and deep straw-yellow. Feel greasy.

Composition.—Contains oxyd of iron, phosphoric acid, and water, with small quantities of manganese and zinc. B.B. turns red, and yields a magnetic bead. Dissolves readily with borax, and fuses with salt of phosphorus to a black scoria.

This species occurs in fissures in mica slate, and was first distinguished by Breithaupt, among some specimens from Labrador. It resembles oxalate of iron. The name alludes to the color, and is from *καρφος, straw, σιδηρος, iron.*

PLUMBO-RESINITE. Gummispath, *Br.* Plomb hydro-alumineux, *H.* Plomb-gomme, *Laumont.* Bleigummi *of the Germans.*

Reniform or globular shapes, with a columnar structure; also compact massive.

H.=4—4·5. G.=6·3—6·4; 4·88, Dufrénoy. Lustre resinous. Color yellowish and reddish-brown; also yellowish-white. Streak uncolored. Translucent. Resembles in color and appearance gum-arabic. Fracture conchoidal, splintery.

Composition.—$\dot{\mathrm{Pb}}\ddot{\bar{\mathrm{Al}}}^2+6\dot{\bar{\mathrm{H}}}$, Berzelius; $\dot{\mathrm{Pb}}^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}+6\ddot{\bar{\mathrm{Al}}}\,\dot{\bar{\mathrm{H}}}$, Damour. Analyses: 1, Berzelius, (Schw. J. xxvii, 65); 2, Dufrénoy, (Ann. Ch. Phys. lix, 440); 3, Damour, (Ann. D. Mines, [3], xvii, 191);

	$\dot{\mathrm{Pb}}$	$\ddot{\bar{\mathrm{Al}}}$	$\dot{\bar{\mathrm{H}}}$	$\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}$	
1. Huelgoet,	40·14	37·00	18·80	—,	$\dddot{\mathrm{S}}$ 0·20 $\dot{\mathrm{Ca}}\,\ddot{\bar{\mathrm{Fe}}}\,\ddot{\bar{\mathrm{Mn}}}$ 1·80, $\dddot{\mathrm{Si}}$ 0·6=98·54, Berz.
2. Nussière,	37·51	34·23	16·13	—,	$\dot{\mathrm{Pb}}^3\,\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}$ 7·79, quartz, &c., 2·11=97·77, Duf.
3. Huelgoet,	35·10	34·32	18·70	8·06,	$\ddot{\bar{\mathrm{Fe}}}$ 0·20, $\dddot{\mathrm{S}}$ 0·30, PbCl 2·27, $\dot{\mathrm{Ca}}$ 0·8=99·75, D.

B.B. decrepitates and parts with water. On charcoal, forms an enamel, partly fusing. With borax a colorless glass is obtained; a reduction of the ore is not effected. Concentrated muriatic acid decomposes the powdered plumbo-resinite.

Occurs in clay slate at Huelgoet, near Poulaouen, in Britanny, associated with galena, blende, iron pyrites, and pyromorphite; also in a lead mine at Nussière, near Beaujeu; at Roughten Gill, Cumberland; at Mine La Motte, Missouri. It resembles some varieties of mammillated blende.

An earthy mineral of allied characters, and of modern origin, afforded Berthier, (Ann. d. Mines, [3], xix, 669), $\dot{\mathrm{Pb}}$ 10·0, $\dot{\mathrm{Cu}}$ 3·0, $\ddot{\bar{\mathrm{Al}}}$ 23·0, $\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}$ with trace of $\ddot{\mathrm{As}}$ 25·5, $\dot{\bar{\mathrm{H}}}$ and organic matters 38·0=99·5.

It is from the mine Rosières near Carmeaux. Berzelius observes that it is a hydrous mixture of phosphate of alumina $\ddot{\bar{\mathrm{Al}}}^4\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}^3$, and phosphate of lead, $\dot{\mathrm{Pb}}^3\overset{\cdot\cdot\cdot}{\ddot{\mathrm{P}}}$.

HYDROUS PHOSPHATE OF ALUMINA AMD LIME, *Damour.*

Compact, of a pale or dark brick-red color. Scratches glass feebly. G.=3·194.

Composition.—Supposed by Damour to be a hydrophosphate of alumina and lime. B.B. in a tube gives considerable water; and in a platinum crucible at a red heat loses 12·70 per cent. of water.

Found in rolled pebbles with the diamond sand of Bahia. L' Institut, 1853, 78.

CASTELNAUDITE, *Damour*, L' Institut, 1853, 78.

Trimetric? In imperfect crystals, and irregular grains. A pyramid observed, the two larger opposite faces of which meet at 96° 35′, the two smaller at 98° 20′, and adjacent faces mutually inclined 124° 23½′, Descloizeaux. Cleavage in two directions, affording a rectangular prism, but whether oblique or not, not ascertained. H. above fluor. Scratched by a steel point. Lustre greasy, adamantine. Color grayish-white to pale yellow.

Composition.—Probably a hydrous phosphate of yttria.

B.B. whitens, but infusible; with borax dissolves, and gives a colorless pearl, which becomes white and opaque in the oxydating flame; dissolves with extreme slowness in salt of phosphorus, giving a colorless globule unless the glass is saturated, when it becomes milky. Soluble in heated concentrated sulphuric acid.

From the diamond sands of Bahia, Brazil.

PITTICITE, *Haus.* Iron Sinter. Diarsenate of Iron. Eisensinter. Arseneisensinter. Eisenpecherz. Gänseköthigerz. Chenocoprolite.

Reniform and massive. H.=2—3. G.=2·2—2·5. Lustre vitreous, sometimes greasy. Color yellowish and reddish-brown, blood-red and white. Streak yellow—white. Translucent—opaque.

Composition.—Analysis affords varying results. 1, Stromeyer, (Gilb. Ann. lxi, 181); 2, Laugier, (Ann. Ch. xxx, 325); 3, Kersten, (Schw. J. liii, 176); 4, 5, Rammelsberg, (Pogg. lxii, 139); 6, ib. (5th Suppl. 102):

	$\ddot{A}s$	$\dddot{S}$	$\dddot{\bar{F}}e$	$\dddot{\bar{M}}n$	H
1. Freiberg,	26·06	10·14	33·10	0·64	29·26=99·09, Stromeyer.
2. "	20·	14·	35·	*trace*	30· =99, Laugier.
3. "	30·25	——	40·45	——	28·50=99·20, Kersten.
4. Seiglitzstollen,	24·67	5·20	54·66	——	15·47=100, Ramm.
5. "	28·45	4·36	58·00	——	12·59=100, Ramm.
6. Schwarzenberg,	26·70	13·91	34·85	——	24·54=100, Ramm.

Stromeyer's analysis corresponds to $\dddot{\bar{F}}e^3\ddot{A}s^2+\dddot{\bar{F}}e\dddot{S}^2+30\dot{H}$; No. 4, gives $5\dddot{\bar{F}}e^2\ddot{A}s+3\dddot{\bar{F}}e^2\dddot{S}+40\dot{H}$, Rammelsberg; 6 gives $\dddot{\bar{F}}e^2\dddot{S}^3+2\dddot{\bar{F}}e\ddot{A}s+24\dot{H}$, Rammelsberg. Acts before the blowpipe like scorodite.

Occurs in old mines near Freiberg and Schneeberg in Saxony, and elsewhere. An ore on Hopkins' farm near Edenville, N. Y., is referred by Beck to this species.

Gänseköthigerz (Chenocoprolite, or Ganomatite) has been shown to be an impure iron sinter, containing some silver and arsenate of cobalt; it is a result of decomposition, and not a distinct mineral.

DIADOCHITE, *Breit.*, J. f. pr. Chem. x, 503. Phosphoreisensinter, *Ramm.*

Reniform or stalactitic; structure curved lamellar.

H.=3. G.=2·035. Lustre resinous, inclining to vitreous. Color yellow or yellowish-brown. Streak uncolored. Fragile; fracture conchoidal.

Composition.—$\dddot{\bar{\mathrm{F}}}\mathrm{e}^{3}\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}{}^{2}+2\dddot{\bar{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{S}}{}^{2}+36\dot{\mathrm{H}}$=Phosphoric acid 13·90, sulphuric acid 15·62, peroxyd of iron 38·94, water 31·54=100. Analyses by Plattner, (Ramm. 1st Supp. 45): $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$ 14·811, $\dddot{\mathrm{S}}$ 15·145, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 39·690, $\dot{\mathrm{H}}$ 30·344=100.

Considered by Rammelsberg as near Iron Sinter, (Pitticite), with phosphoric acid in place of arsenic acid. In a matrass yields much water. B.B. colors the flame green, intumesces and fuses on the edges to a black scoria somewhat magnetic. With the fluxes gives the reaction of iron.

From alum slate near Gräfenthal and Saalfeld in Thuringia.

3. NITRATES.

NITRE. Nitrate of Potash. Saltpetre. Kalisalpeter.

Trimetric. *I* : *I*=118° 50′, *O* : 1ĭ=130° 8′; *a* : *b* : *c*=1·1861 : 1 : 1·692. 1ĭ : 1ĭ (top)=109° 57′, 2ĭ : 2ĭ (ib.)=71° at 19° C, and 71° 44′ at 100° C, B. and M. Generally in thin crusts, silky tufts, and delicate acicular crystallizations.

H.=2. G.=1·937. Lustre vitreous. Streak and color white. Subtransparent. Brittle. Taste saline and cooling.

Composition.—$\dot{\mathrm{K}}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$=Potash 46·6, nitric acid 53·4. Klaproth obtained for an African specimen, (Beit. i, 317), Nitrate of potash 42·55, sulphate of lime 25·54, chlorid of calcium 0·20, carbonate of lime 30·40=98·60.

Deflagrates vividly on burning coals, and detonates with combustible substances. Dissolves easily in water;, not altered by exposure.

Found generally in minute needle-form crystals, and crusts on the surface of the earth, on walls, rocks, &c. It forms abundantly in certain soils in Spain, Egypt and Persia, especially during hot weather succeeding rains. Also manufactured from soils where other nitrates (nitrate of lime or soda) form in a similar manner, and beds called *nitriaries* are arranged for this purpose in France, Germany, Sweden, Hungary, and other countries. Refuse animal matter, also, putrified in calcareous soils gives rise to the nitrate of lime. Old plaster, lixiviated, affords about 5 per cent. of nitre. In India it is obtained in large quantities for the arts.

In Madison county, Kentucky, it is found scattered through the loose earth, covering the bottom of a large cave. Also in other caverns in the western part of the United States.

NITRATINE, *Haid.* Nitrate of Soda. Soda Nitre. Soude Nitratée, *H.* Natron Salpeter, *Leonh.*

Rhombohedral. *R* : *R*=106° 33′; *a*=0·8276. Cleavage: rhombohedral, perfect. In efflorescences; also massive, granular.

H.=1·5—2. G.=2·09—2·29; 2·290, (Tarapaca), Hayes. Lustre vitreous. Color white; also, reddish-brown, gray, and lemon-yellow. Transparent. Rather sectile. Fracture indistinctly conchoidal. Taste cooling. Crystals strongly doubly refracting.

Composition,—$\dot{N}a\overset{\cdot\cdot\cdot\cdot\cdot}{N}$=Nitric acid 63·5, and soda 36·5. Hochstetter obtained from the Chilian nitratine, (v. Leonh. 1846, 235), $\dot{N}a\ \overset{\cdot\cdot\cdot\cdot\cdot}{N}i$ 94·291, Na Cl 1·990, $\dot{K}\ddot{S}$ 0·239, $\dot{K}\ \overset{\cdot\cdot\cdot\cdot\cdot}{N}$ 0·426, $\dot{M}g\ \overset{\cdot\cdot\cdot\cdot\cdot}{N}$ 0·858, insol. 0·203, $\dot{H}$ 1·993. Deflagrates on charcoal with less violence than nitre, causing a yellow light, and also deliquesces. Dissolves in three parts of water at 60° F.

In the district of Tarapaca, northern Chili, the dry pampa for 40 leagues, at a height of 3,300 feet above the sea, is covered with beds of this salt several feet in thickness, along with gypsum, common salt, glauber salt, and remains of recent shells, the last indicating the former presence of the sea. (Am. Jour. Sci. xxxix, 375, J. H. Blake).

In 1837, 150,900 quintals of this salt refined were shipped from Yquique. It is also used for the manufacture of nitric acid and nitre.

A. A. Hayes obtained for masses collected by Mr. Blake, Nitrate of soda 64·98, sulphate of soda 3·00, common salt 28·69, iodids 0·63, shells and marl 2·60=99·90.

$O : \frac{2}{3}2$ in Nitratine equals nearly $O : \frac{2}{3}$ in Apatite.

NITROCALCITE, *Shep.* Nitrate of Lime. Kalksalpeter, *Haus.*

In efflorescent silken tufts and masses. Color white or gray. Taste sharp and bitter.

Composition.—$\dot{C}a\overset{\cdot\cdot\cdot\cdot\cdot}{N}+\dot{H}$=Lime 30·7, nitric acid 59·4, water 9·9. On burning coals it slowly fuses with a slight detonation, and dries. Very deliquescent before, but not after being desiccated by heat.

It occurs in silky efflorescences, in many limestone caverns, as those of Kentucky. The salt forms in covered spots of earth where the soil is calcareous, and is extensively used in the manufacture of saltpeter. According to Hausmann, a large part of the so-called nitre in nature is this salt.

VI. CARBONATES.

I. ANHYDROUS CARBONATES.

1. CALCITE GROUP.—Rhombohedral. $R : R$=105°—108°.

CALCITE,	$\dot{C}a\ \ddot{C}$.	CHALYBITE,	$\dot{F}e\ \ddot{C}$.
PLUMBOCALCITE,	$(\dot{C}a, \dot{P}b)\ddot{C}$.	"	$(\dot{F}e, \dot{M}g, \dot{M}n)\ddot{C}$.
MAGNESITE,	$\dot{M}g\ \ddot{C}$.	OLIGON SPAR,	$(\frac{3}{5}\dot{F}e+\frac{2}{5}\dot{M}n)\ddot{C}$
DOLOMITE,	$(\frac{1}{2}\dot{C}a+\frac{1}{2}\dot{M}g)\ \ddot{C}$.	DIALLOGITE,	$\dot{M}n\ \ddot{C}$.
"	$(\frac{2}{3}\dot{C}a+\frac{1}{3}\dot{M}g)\ \ddot{C}$, etc.	"	$(\dot{M}n, \dot{F}e, \dot{C}a)\ \ddot{C}$.
GURHOFIAN,	$(\frac{3}{4}\dot{C}a+\frac{1}{4}\dot{M}g)\ \ddot{C}$.	SMITHSONITE,	$\dot{Z}n\ \ddot{C}$.
CONITE,	$(\frac{1}{4}\dot{C}a+\frac{3}{4}\dot{M}g)\ \ddot{C}$.	"	$(\dot{Z}n, \dot{F}e, \dot{M}n)\ \ddot{C}$.
ANKERITE,	$(\frac{1}{2}\dot{C}a+\frac{1}{2}(\dot{F}e, \dot{M}g))\ddot{C}$.		
BREUNNERITE,	$(\frac{1}{2}\dot{M}g+\frac{1}{2}\dot{F}e)\ \ddot{C}$.		
MESITINE,	$(\frac{2}{3}\dot{M}g+\frac{1}{3}\dot{F}e)\ \ddot{C}$.		

2. ARAGONITE GROUP.—Trimetric. $I : I = 116°—119°$.

ARAGONITE,	$\dot{Ca}\,\ddot{C}$.	BROMLITE,	$(\frac{1}{2}\dot{Ca}+\frac{1}{2}\dot{Ba})\ddot{C}$
WITHERITE,	$\dot{Ba}\,\ddot{C}$.	MANGANOCALCITE,	$\dot{Mn}\,\ddot{C}$.
STRONTIANITE,	$\dot{Sr}\,\ddot{C}$.	CERUSITE,	$\dot{Pb}\,\ddot{C}$.

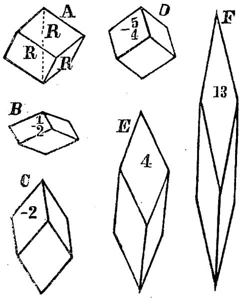
3. BARYTOCALCITE GROUP.—Monoclinic.

BARYTOCALCITE, $(\frac{1}{2}\dot{Ca}+\frac{1}{2}\dot{Ba})\ddot{C}$.

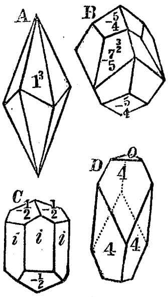
CALCITE. Calcareous Spar. Carbonate of Lime. Marl, Agaric Mineral, Anthraconite, Aphrite, Argentine, Chalk, Inolite, Marble, Oolite, Ostreocolla, Peastone, Slate Spar, Travertine, Tufa. Kalkspath. Kohlensäurer Kalk. Chaux carbonatée, Prunnerite. Strontiano-calcite, *Genth.*

Rhombohedral. $R : R = 105°\ 5'$, $O : R = 135°\ 23'$; $a = 0{\cdot}8543$.

573



574



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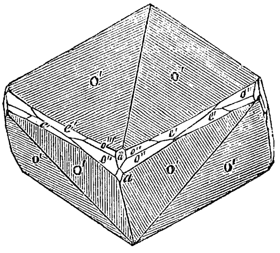
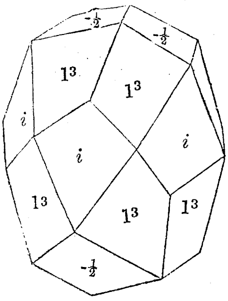
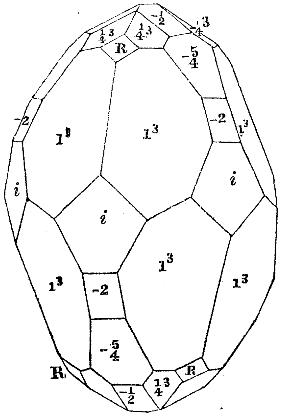


St. Lawrence Co., N. Y.

576

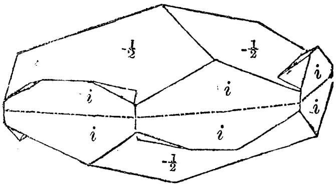


577



Derbyshire.

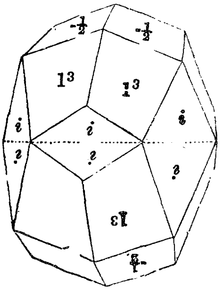
578



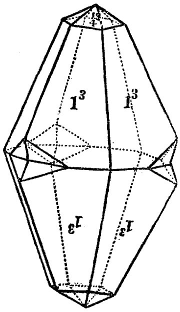
Alstonmoor.

The secondary planes or forms include thirty-six different rhombohedrons, seventy-nine scalenohedrons, seven pyramids, and four prisms, besides the basal plane 0*R*. The most of the forms occur only in combination.*

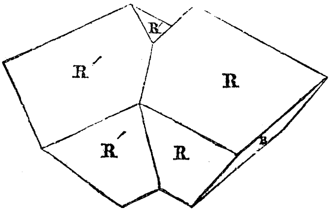
579



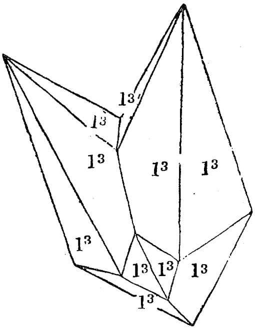
580



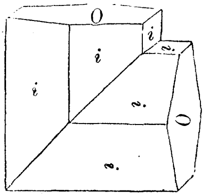
581



582



583



Cleavage: rhombohedral, highly perfect, (see p. 109). Twins: f. 578, composition basal, simple form like f. 574C; f. 580 the same, simple form like f. 574A; f. 579 the same, in the form of f. 576; f. 581 composition lateral; f. 582 face of composition –2, in a scalene dodecahedron, (f. 574A); f. 583, face of composition *R*. Imperfect crystallizations, structure fibrous, both coarse and fine; sometimes lamellar; often granular, coarse or impalpable; also stalactitic.

H.=2·5—3·5. G.=2·508—2·778. Pure crystals, according to Beudant, (Ann. Ch. Ph. xxxviii, 398), 2·7213 to 2·7234; fibrous, lamellar and stalactitic, 2·70 to 2·52, but when pulverized 2·729—2·7233. Lustre vitreous—subvitreous—earthy. Color usually white; also various pale shades of gray, red, green, or yellow; also brown and black, when impure. Streak white or grayish. Transparent—opaque. The transparent varieties exhibit strong double refraction. Fracture usually conchoidal, but obtained with difficulty when the specimen is crystallized.

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* The list of planes and angles here given is from an article by Zippe, Denkschr. Wien. Akad. iii, cited in Liebig and Kopp's Jahresb. for 1851, p. 817.

ANGLES OF RHOMBOHEDRONS:

R is a face of the fundamental rhombohedron 1*R*; *R′* the particular rhombohedron below in each line; *O* the basal plane:

	Term. Edge.		$O:R$		$R:R'$			Term. Edge.		$O:R$		$R:R'$	
	°	′	°	′	°	′		°	′	°	′	°	′
$\frac{1}{4}$	156	2	166	9	149	14	$-\frac{11}{4}$	71	18	110	14	114	23
$\frac{2}{5}$	142	55	158	28	156	55	$-\frac{5}{2}$	73	15	112	5	112	32
$\frac{1}{2}$	134	57	153	45	161	48	$-\frac{12}{5}$	74	9	112	56	111	41
$\frac{4}{7}$	129	40	150	35	164	48	$-\frac{9}{4}$	76	9	116	16	110	21
1*R*	105	5	135	23	180		−2 (f. C)	78	51	116	52	107	45
$\frac{7}{4}$	82	56	120	5	164	42	$-\frac{13}{8}$	85	26	121	58	102	39
$\frac{5}{2}$	73	15	112	5	156	42	$-\frac{11}{7}$	86	36	122	49	101	58
3	69	24	108	40	153	7	$-\frac{3}{2}$	88	18	124	6	100	2
$\frac{13}{4}$	68	25	107	20	151	57	$-\frac{7}{5}$	90	55	125	58	98	39
4 (f. 573E)	65	50	104	17	148	54	$-\frac{5}{4}$ (f. D)	95	28	129	2	95	35
$\frac{17}{4}$*	65	6	103	24	148	1	$-\frac{6}{5}$	97	10	130	11	94	48
$\frac{9}{2}$	64	42	102	42	147	19	$-\frac{8}{7}$	99	14	131	35	93	2
13 (f. F)	60	36	94	27	139	4	$-\frac{7}{8}$	111	13	139	12	85	25
16	60	20	93	38	138	15	$-\frac{4}{5}$	115	7	141	43	82	54
−11	60	50	95	19	129	18	$-\frac{2}{3}$	123	10	146	40	77	57
−8	61	33	97	48	127	25	$-\frac{3}{5}$	127	39	149	23	75	14
−5	63	51	101	28	123	9	$-\frac{1}{2}$ (f. B)	134	57	153	45	70	52
−4	65	50	104	17	120	20	$-\frac{1}{4}$	156	2	166	9	58	38
$-\frac{7}{2}$	67	26	106	9	118	28	$-\frac{1}{5}$	160	42	168	50	55	47

ANGLES OF SCALENOHEDRONS:

	Longer E.		Shorter E.		Mid. E.			Longer E.		Shorter E.		Mid. E.	
	°	′	°	′	°	′		°	′	°	′	°	′
${\frac{1}{10}}^{7}$	154	37	145	55	61	36	1^{5}	134	28	109	1	150	44
${\frac{1}{5}}^{13}$	130	16	121	14	131	19	$1^{\frac{17}{3}}$	132	41	110	3	154	5
${\frac{1}{4}}^{3}$ (f. 577)	159	24	138	5	64	54	1^{7}	130	10	111	39	158	53
${\frac{1}{4}}^{5}$	146	10	128	15	93	20	1^{9}	127	50	113	21	163	30
${\frac{2}{5}}^{2}$	164	1	130	37	67	41	1^{11}	126	26	114	24	166	28
${\frac{2}{5}}^{3}$	152	40	123	35	90	20	1^{12}	125	47	114	50	167	35
${\frac{1}{2}}^{\frac{5}{3}}$	166	57	125	53	69	16	1^{13}	125	30	115	12	168	32
${\frac{4}{7}}^{\frac{3}{2}}$	169	5	122	37	69	45	${\frac{5}{4}}^{\frac{13}{9}}$	165	59	95	27	105	24
${\frac{5}{8}}^{\frac{7}{5}}$	170	29	120	14	71	5	${\frac{7}{5}}^{\frac{9}{7}}$	170	0	91	34	103	21
${\frac{7}{10}}^{\frac{9}{7}}$	172	30	116	59	72	1	${\frac{8}{5}}^{3}$	142	53	100	55	145	28
$1^{\frac{19}{15}}$	171	43	102	55	88	16	2^{3}	142	30	99	58	149	21
$1^{\frac{7}{5}}$	168	1	102	21	94	1	${\frac{16}{7}}^{2}$	153	2	91	12	137	48
$1^{\frac{3}{2}}$	165	33	102	6	97	57	${\frac{5}{2}}^{2}$	152	54	90	46	139	12
$1^{\frac{5}{3}}$	161	53	101	55	103	52	${\frac{8}{3}}^{\frac{5}{2}}$*	146	31	95	12	147	38
$1^{\frac{7}{4}}$	160	13	101	56	106	34	$3^{\frac{25}{9}}$	143	50	97	28	151	51
$1^{\frac{9}{5}}$	159	17	101	57	108	7	$4^{\frac{3}{2}}$	162	23	80	10	133	19
1^{2}	155	50	102	11	113	45	4^{2}	152	29	88	57	144	29
$1^{\frac{7}{3}}$	151	7	102	52	121	34	4^{3}	141	51	98	40	155	39
1^{3} (f. 574A)	144	24	104	38	132	58	${\frac{11}{2}}^{\frac{19}{11}}$?	157	14	83	55	140	40
$1^{\frac{13}{3}}$	136	47	107	48	146	28	$10^{\frac{17}{15}}$?	134	3	66	44	125	4

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* From Rossie Crystals, St. Lawrence Co., N. Y.

	Longer E.		Shorter E.		Mid. E.			Longer E.		Shorter E.		Mid. E.	
	°	′	°	′	°	′		°	′	°	′	°	′
$\frac{1}{2}7^{23}_{17}$?	166	10	71	36	132	37	$-\frac{8}{7}{}^{2}$	155	7	99	26	119	6
-8^{5}_{4}	169	39	71	18	129	3	-1^{4}_{3} ?	169	56	102	36	91	13
-5^{7}_{5}	164	59	76	54	132	1	-1^{5}_{3} ?	161	53	101	55	103	52
$-\frac{7}{3}{}^{5}_{3}$	159	4	87	37	130	45	-1^{7}_{3}, 1^{3}, 1^{13}_{3}, 1^{5} same as + 1^{7}_{3}, 1^{3}, 1^{13}_{3}, 1^{5}.						
-2^{3}_{2}	163	11	86	6	122	32	$-\frac{4}{5}{}^{3}$	145	15	107	38	124	39
-2^{5}_{3}	159	20	88	18	127	29	$-\frac{2}{3}{}^{7}_{3}$	154	7	111	54	103	4
-2^{2}	153	16	92	9	135	19	$-\frac{1}{2}{}^{7}_{3}$	157	5	120	26	88	9
-2^{5}_{2} ?	146	53	96	22	143	34	$-\frac{1}{2}{}^{3}$	149	43	117	23	102	25
-2^{3}	142	30	99	58	149	21	$-\frac{1}{2}{}^{4}$	142	32	115	17	117	50
-2^{4}	139	36	106	25	163	24	$-\frac{1}{2}{}^{13}_{3}$?	140	44	114	57	121	39
$-\frac{7}{4}{}^{25}_{21}$?	172	40	84	45	112	20	$-\frac{1}{2}{}^{5}$	138	23	114	34	128	30
$-\frac{5}{3}{}^{17}_{15}$?*	174	44	85	32	102	31	$-\frac{1}{2}{}^{9}$	129	10	115	5	150	0
$-\frac{3}{2}{}^{5}_{2}$?	147	31	98	32	137	33	$-\frac{1}{2}{}^{13}$	126	1	116	4	158	59
$-\frac{8}{5}{}^{9}_{4}$?	150	15	96	22	135	6	$-\frac{1}{3}{}^{5}_{3}$	170	16	140	18	50	12
$-\frac{7}{5}{}^{3}_{2}$ †	164	8	92	46	111	46	$-\frac{2}{7}{}^{5}$	144	6	124	56	100	47
$-\frac{5}{4}{}^{9}_{4}$?	151	6	99	6	127	40	$-\frac{1}{5}{}^{3}$	162	35	144	45	54	6
$-\frac{5}{4}{}^{7}_{5}$	167	6	95	15	103	40	$-\frac{1}{5}{}^{7}$	141	41	128	7	99	58
$-\frac{5}{4}{}^{9}_{5}$	158	8	96	51	117	8	$-\frac{1}{8}{}^{5}$	158	19	147	13	56	6

Basal angle of Pyramids: $\frac{2}{3}2$, 59° 20′; $\frac{5}{3}2$, 109° 50′; 22, 119° 20′; $\frac{8}{3}2$, 132° 36′; 42, 147° 23; $\frac{14}{3}2$, 151° 50′; 62, 157° 56′.

Composition.—$\dot{\text{Ca}}\ddot{\text{C}}$=Carbonic acid 44·0 and lime 56·0; often with some carbonate of magnesia or iron. The colored varieties often contain as impurities, small portions of oxyd of iron, silica, magnesia, alumina, bitumen, &c. Gibbs found in a specimen from the Calamine mines of Altenberg, 4·074 oxyd of zinc, with 0·849 magnesia, 0·512 protoxyd of iron. A variety called *plumbocalcite* from Leadhills, contains, according to Delesse, 97·61 carbonate of lime, and 2·34 carbonate of lead, with 0·05 of water. Johnston found in the same from Wanlockhead, Scotland, 7·8 per cent. of carbonate of lead. *Natrocalcite* includes pseudomorphs after Gay-lussite from Sangerhausen, in which Marchand found (J. f. pr. Ch. xlvi, 95) $\dot{\text{Ca}}\ddot{\text{C}}$ 94·37, $\bar{\dddot{\text{Al}}}$ $\bar{\dddot{\text{Fe}}}$ 1·15, $\dot{\text{Ca}}\dddot{\text{S}}$ 2·02, $\dot{\bar{\text{H}}}$ 1·34, gangue 1·10=99·98. A variety contains barytes and has been named *neotype* by Breithaupt; G.=2·82—2·83. Carrara marble afforded Kæppel, (J. f. pr. Ch. lvii, 324), $\dot{\text{Ca}}\ddot{\text{C}}$ 98·7654, $\dot{\text{Mg}}\ddot{\text{C}}$ 0·9002, $\ddot{\text{Si}}$ 0·0059, $\bar{\ddot{\text{P}}}$ and loss 0·0902, $\bar{\dddot{\text{Fe}}}$, $\bar{\dddot{\text{Mn}}}$, and $\bar{\dddot{\text{Al}}}$ 0·0825, quartz sand 0·1558=100.

A variety containing carbonate of iron, white but turning brown on exposure, afforded T. S. Hunt (communicated to the author) $\dot{\text{Ca}}\ddot{\text{C}}$ 93·90, $\dot{\text{Fe}}\ddot{\text{C}}$ 4·64 (to 4·35), $\dot{\text{Mg}}\ddot{\text{C}}$ 1·59=100·13; G.=2·715; H.=3; loc. doubtful. Iodine has been found in certain fossiliferous limestones, as at Gouzon, by Lembert, (J. de Pharm., [3], xix, 240).

B.B. infusible; loses, however, carbonic acid, gives an intense light, and ultimately is reduced to pure lime, or *quicklime.* Effervesces with borax, and produces with a larger quantity a clear glass, which becomes somewhat angular on cooling. With cobalt solution affords a black or grayish-black unmelted mass. Many granular limestones phosphoresce with a yellow light when pulverized and thrown on a heated shovel. Acids produce a brisk effervescence.

Calcite appears under a very great variety of forms and aspects, and, consequently, was distributed by the earlier mineralogists into several distinct species. These now constitute varieties.

Iceland spar includes transparent calc spar; the best specimens come from Iceland. *Satin spar* is a fibrous variety, having a satin lustre. *Oolite* consists of minute spherical grains resembling the roe of a fish; it is so called from *ωον, an egg.* The *Peastone,* or *Pisolite,* differs from oolite in the larger size of its particles; these particles are composed of concentric laminæ. *Chalk* is a massive opaque earthy variety, usually white, soft, and without lustre; *Agaric Mineral,* or *Rock Milk,* is

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* From Rossie Crystals, St. Lawrence Co., N. Y. † Fig. 574B, Bergen Hill, N. J.

a loose friable variety, deposited from waters containing carbonate of lime in solution; it is found about lakes whose waters are impregnated with lime; also in fissures in limestone and in limestone caverns; it is called *calcareous tufa*, if so hard as not to be friable. *Prunnerite* is grayish violet, from Faroe. *Marble* includes all the imperfectly crystalline and earthy varieties which admit of a high polish. The *Stinkstone*, *Swinestone*, or *Anthraconite*, which is found columnar, granular, and compact, of various shades, emits a fetid odor when struck with a hammer. *Stalactites* are pendant masses of limestone, formed in limestone caverns by the percolation of water, holding lime in solution, through their rocky roofs; the water which drops to the floor from the roof also evaporates, and forms a layer of limestone over the floor, which is called *Stalagmite;* and both stalactites and stalagmites when polished are often called *Alabaster* in France. *Argentine* possesses a silvery-white lustre, a slaty structure, and contains a little silica. *Slate spar* and *aphrite* are similar varieties. *Marl* is a mixture of clay and carbonate of lime. The *Fontainbleau Limestone* is an aggregate of secondary rhombohedrons, containing, mechanically mingled, a large proportion of sand. A similar variety is found on the African coast between Sandanha Bay and Ichaboe Island, in great quantities in the sand; they contain fifteen to twenty per cent. of sand.

Strontianocalcite of Genth., (Proc. Ac. Phil. vi, 114), is opaque, white, and crystallizes like calcite; form uneven, globular, the globules terminating in acute rhombohedrons, (4R, 65° 50′), H.=3·5. A crimson flame before the blowpipe and affords some strontia.

Granular limestone includes common statuary and architectural marble, having a texture something like loaf sugar. *Compact limestone* has a compact texture, usually an even surface of fracture, and dull shades of color.

Hydraulic limestone is an impure limestone. The French varieties contain two or three per cent. of magnesia, and ten to twenty of silica and alumina, (or clay). The varieties in the United States contain twenty to forty per cent. of magnesia, and twelve to thirty per cent. of silica and alumina. A variety worked extensively at Rondout, N. Y., afforded Professor Beck (Min.-N. Y., p. 78) Carbonic acid 34·20, lime 25·50, magnesia 12·35, silica 15·37, alumina 9·13, peroxyd of iron 2·25. Oxyd of iron is rather prejudicial to it than otherwise.

The *Cipolin* marbles of Italy are white with shadings or zones of green talc. The *Bardiglio* is a gray marble having a whitish basis with crowded dark cloudings; from Corsica. The *Sienna* is yellow with cloudings, and *Brocatello di Sienna* has clouds of bluish red or purplish shades. *Portor* is a Genoese marble of deep black color with veinings of yellow; the best is from Porto-Venese. *Bird's-eye marble* is a compact limestone with crystalline points disseminated through it. *Ruin marble* is yellowish with brown shadings or lines representing castles, towers, and cities in ruins; the markings are due to infiltrated oxyd of iron or manganese. *Shell marble* contains scattered fossil shells; *crinoidal* or *encrinital* includes joints of encrinites of a disk-shape; *madreporic* marble is made up of fossil corals, and has a stellate surface when polished. *Fire marble* or *lumachelle* is a dark brown shell marble, having brilliant fire or chatoyant reflections from within. *Languedoc marble* is of a light red color, with lighter spots due to corals. The *marble of Sarancolin* in the Pyrenees is deep red mixed with gray and yellow, and some transparent spots. *Alabaster* has been brought largely from Chili and Algiers.

Marl contains often forty to fifty per cent. of lime.

This species, in some form, is very generally diffused. England and France contain extensive strata of chalk. Italy, from her Carrara beds, and Greece, from the Pentelican quarries, have provided the world with statuary marble. The greater part of the middle and western sections of the United States are underlaid with strata of limestone, and white or granular limestone occurs in various portions of the Eastern States.

Andreasberg in the Hartz is one of the best European localities of crystallized calcite; there are other localities in the Tyrol, Styria, Carinthia, Hungary, Saxony, Hesse Darmstadt (at Auerbach), Hesse Cassel, Norway, France, and in England in Derbyshire, Cumberland, Cornwall, Scotland; in Iceland. In Iceland a single rhombohedron (*R*) over six yards long and three high has been observed.

The most interesting localities of calcite in the United States, both as regards size of crystals and form, exist in St. Lawrence and Jefferson Counties, N. Y., especially at the Rossie lead mine; the crystals are highly modified, (f.575, $\frac{4^3}{7^2}$ (o'), i (a), $\frac{17}{4}$ (a''), $\frac{8^5}{3^2}$ (o''), 1^3 (e), and are often transparent even when large; one gigantic crystal, nearly transparent, in the cabinet of Yale College, weighs 165 pounds; they are often covered in part by crystals of galena. At the natural dam two miles from Gouverneur, in the same vicinity, good crystals are obtained; also at the Wilson vein in Gouverneur, and the Jepson vein in Rossie. At the Paris ore bed in Gouverneur fine geodes occur in specular iron. In Jefferson County, near Oxbow, on the land of Mr. Benton, large crystals sometimes as clear within as Iceland spar, have been obtained from a decomposing limestone. The rose and purple varieties are very beautiful. Some large crystals weigh a hundred pounds and upwards. Four miles south of Oxbow, in Antwerp, there is a vein of calc spar and lead, which affords beautiful cleavage masses of white, purple, and brownish shades. Interesting crystals are also procured here. In Essex Co., N. Y., town of Moriah, on Mill Brook, near Port Henry, crystals of calc spar occur in white limestone. Dog tooth spar (f. 574A, 1^3 and also 1^3. -2) occurs in Niagara County, near Lockport, with pearl spar, celestine, selenite, and anhydrite; also in Onondaga County, near Camillus, along the railroad. Good crystals are found in Herkimer County, a mile south of Little Falls, in the bed of a small stream; in Lewis County, at Leyden and Lowville, and at the Martinsburg lead mine; and on the western bank of Dry Sugar River, near Boonville, Oneida County, (f. 574C.) In *Maine*, at Thomaston, lenticular and prismatic crystals are common. In crystals (*i*2. $-\frac{1}{2}$. *I*, short or long, and 1^3. *R*) at Middletown, Ct. Lead Mine. In *New Jerssy*, at Bergen, fine crystallizations of yellow calc spar occur with datholite, &c., in trap, (f. 574B). At Franklin, a pink variety is met with, and good cleavage specimens may be obtained. In Nova Scotia, Partridge island affords a wine-colored calc spar, and other interesting varieties. In *Pennsylvania*, Iceland Spar in York County. In splendid crystals at Lake Superior Copper Mines, especially the Minnesota, the crystals often containing scales of native copper. *Argentine* occurs near Williamsburg and Southampton, Mass., and at the iron mines of Franconia, N. H. *Agaric mineral* covers the sides of a cave at Watertown, N. Y. *Stalactites* of great beauty occur in the celebrated Wier's cave, Virginia, and the large caves of Kentucky. Fine specimens are also found in the many caverns of Scoharie, N. Y., of which Ball's cave is the most famous. *Fibrous* carbonate of lime occurs in New York in considerable abundance at Camillus and Scoharie, (near the barytes locality), and of a fine satin lustre near De Long's Mill, St. Lawrence County.

Corals of which large reefs are formed in tropical regions, consist mainly of carbonate of lime. B. Silliman, Jr., obtained for a recent species of Madrepora, (Dana's Report on Zoophytes, and also Amer. Jour. Sci. [2], i, 189), Carbonate of Lime 94·807, phosphates and fluorids, &c., 0·745, organic matter 4·448. And the deposit of phosphates and fluorids afforded the per-centage—$\ddot{\text{S}}\text{i}$ 12·5, $\dot{\text{C}}\text{a}$ 7·5, $\dot{\text{M}}\text{g}$ 4·2, MgF 26·62, CaF 26·34, $\dot{\text{M}}\text{g},\dddot{\ddot{\text{P}}}$ 8·00, $\ddot{\bar{\text{A}}}\text{l}$ and $\bar{\text{F}}\text{e}$ 14·84. Other analyses gave similar results.

The material of the common marbles is either granular or compact limestone. These rocks when burnt form quicklime. A fine compact limestone is employed in lithography, and that from Solenhofen in Bavaria, is most noted. Calc spar is also used as a flux for smelting ores.*

Hydraulic limestone appears to owe its peculiar qualities to the clay present, which is very uniformly and intimately mingled, and is therefore in the best condition to combine with the lime in the formation of a cement.

ALTERED FORMS.—Calcite occurs altered to Dolomite, Calamine, Spathic Iron, Malachite, Gypsum, Smithsonite, Heavy Spar, Fluor, Limonite, Göthite, Red Iron Ore, Minium, Meerschaum, Chlorite, Quartz, Chalcedony, Garnet, Feldspar, Pyrolusite, Hausmannite, Manganite, Marcasite, Galena, Blende. The change to *Dolomite*, as Bischof explains, may take place through bicarbonate of magnesia in solution; to *Spathic Iron* ($\dot{\text{F}}\text{e}\ddot{\text{C}}$) through sulphate of iron in solution, forming sulphate of lime and carbonate of iron; or by carbonated waters containing bicarbonate of iron, which slowly dissolve Calcite, while the carbonate of iron takes its place, forming a pseudomorph by substitution; to *Smithsonite* ($\dot{\text{Z}}\text{n}\ddot{\text{C}}$) through sulphate of zinc in solution, and also by the substitution process just mentioned; to *Calamine*($\dot{\text{Z}}\text{n}^3\ddot{\text{S}}\text{i}+1\frac{1}{2}\dot{\text{H}}$) probably by a change first to $\dot{\text{Z}}\text{n}\ddot{\text{C}}$ and then to the silicate, through alkaline silicates in solution, or by a process of substitution, the $\dot{\text{C}}\text{a}\ddot{\text{C}}$ being dissolved away

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* For various analyses of limestones, see Rammelsberg's Handw. der Min. and Supplements, Kengott's Min. Forschungen for 1844–1849, and 1850–1851, and Lieb. and Kopp's Jahresbericht.

by carbonated waters, and silicate of zinc replacing it, or by incrustation of the calcite before its removal by carbonic acid or otherwise; to *Malachite* through a solution of sulphate of copper, which forms carbonate of copper and sulphate of lime; to *Gypsum* or *Anhydrite* through the action of sulphuric acid, which acid is produced by the oxydation of sulphuretted hydrogen or otherwise, thus forming sulphate of lime; to *Quartz* by waters containing alkaline silicates, which afford free silica; to *Fluor*, *Limonite*, and other species, by the removal of the $\dot{C}a\ddot{C}$ by waters which hold carbonic acid or alkaline silicates, and at the same time contain the ingredients forming the replacing mineral. *Limonite* or *Red Iron Ore* might result from the decomposition of pyrites in the vicinity.

MAGNESITE. Carbonate of Magnesia. Baudisserite. Breunnerite. Rhomb Spar. Giobertite, *Beudant*. Talkspath, *Hartmann*.

Rhombohedral. $R : R=107° 29'$, $O : R=136° 56'$; $a=0·8095$. Cleavage: rhombohedral, perfect. Also massive; granular, or fibrous, and sometimes in radiating groups; also very compact.

H.=3·5—4·5. G.=2·8—3. Lustre vitreous; fibrous varieties sometimes silky. Color white, yellowish or grayish-white, brown. Transparent—opaque. Fracture flat conchoidal.

Composition.—$\dot{M}g\ddot{C}$=Magnesia 47·6, carbonic acid 52·4. Analyses: 1, 2, Stromeyer, (Untersuch. 119); 3, Rammelsberg, (Handw. 397); 4, 5, Scheerer, (Nyt. Mag. f. Nat. iv, 342, and Pogg. lxxx, 313):

	$\dot{M}g$	$\ddot{C}$	$\dot{H}$	$\dot{C}a$
1. Salem,	47·89	51·83	——	0·28=100·00, Str.
2. Baumgarten, *Giobertite*,	48·36	50·22	1·39	$\dot{M}n$ 0·21=99·18, Str.
3. Frankenstein,	48·004	51·996	——	——=100·00, Ramm.
4. Arendal, G.=3·068,	46·93	52·57	——	$\dot{F}e$ 0·87=100·37, Scheer.
5. Snarum,	47·296	51·447	0·470	$\dot{F}e$ 0·786=100, Scheerer.

Guyton Morveau found fourteen per cent. of silica in the magnesite of Castellamonte. T. S. Hunt found in the magnesite of Sutton, C. E., $\dot{M}g\ddot{C}$ 83·35, $\dot{F}e\ddot{C}$ 9·02, mixed silica 8·03=100·40, (Logan's Rep. Canada, 1848, 88). Other analyses, Brunner, (Pogg. lxv, 292); C. v. Hauer, (Jahrb. der k. k. Reichs. iii, 154, Lieb. and K. Jahres. 1852, 896).

Dissolves slowly, with little effervescence, in nitric or dilute sulphuric acid. Infusible before the blowpipe.

Magnesite is found with serpentine and other magnesian rocks. It occurs at Hrubschitz in Moravia, at the Gulsen mountains in Styria, at Baumgarten in Silesia, at Baudissero in Piedmont, and at Valecas in Spain. In the United States at Bolton, Mass., in indistinctly fibrous masses, traversing white limestone; at Lynnfield, Mass. coating serpentine; at Barehills, near Baltimore, Md.; in Pennsylvania, in crystals at West Goshen, Chester Co., and near Texas, Lancaster Co.; in talcose slate, in Sutton and Bolton, Canada East; in Canton Upata, Venezuela, near Mission Pastora, looking like porcelain in the fracture, as observed by N. S. Manross.

DOLOMITE. Bitter Spar. Pearl Spar. Magnesian Limestone. Gurhofite, Gurhofian. Brown Spar. Bitterkalk, Bitterspath, Braunspath, Rautenspath. Miemite. Conite. Tharandite. Ankerite.

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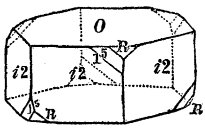


Rhombohedral. $R : R=106° 15'$, $O : R=136° 8\frac{1}{2}'$; $a=0·8322$. Observed planes: O, R, 4, -2, $-\frac{1}{2}$, $i2$, 1^3, 1^5 (hemihedral). $O : i2=90°$, $O : 4=104° 35'$, $O : 2=117° 29'$, $O : \frac{1}{2}=154° 20'$, $\frac{1}{2} : \frac{1}{2}=135° 57'$, $2 : 2=79° 36'$. $R : R$ varies between 106° 10′ and 106° 20′. An increase of 100° C diminishes the angle 4′. Cleavage: R perfect.

Faces *R* often curved, and secondary planes usually with horizontal striæ. Twins: similar to f. 581, page 436. Also in imitative shapes; also amorphous, granular, coarse or fine, and grains often slightly coherent.

H.=3·5—4. G.=2·85—2·92, dolomite; 2·95—3·1, ankerite. Lustre vitreous, inclining to pearly in some varieties. Color white, reddish, or greenish-white; also, rose-red, green, brown, gray, and black. Subtransparent to translucent. Brittle.

Composition.—($\dot{C}a$, $\dot{M}g$) $\ddot{C}$. $\dot{C}a\ddot{C}+\dot{M}g\ddot{C}$ corresponds to $\dot{C}a\ddot{C}$ 54·35 and $\dot{M}g\ \ddot{C}$ 45·65. Analyses: 1, Klaproth; 2, Pelletier, (Ann. Ch. Phys. xiv, 192); 3, Kühn, (Ann. Ch. Pharm. lix, 363); 4, Göbel, (Pogg. xx, 536); 5, Suckow, (J. pr. Chem. viii, 408); 6, Laugier, (Mem. du M. d'hist. Nat. xix, 142); 7, R. E. Rogers and M. H. Boyé, (Jour. Frank. Inst. March, 1840); 8, Rammelsberg, (2d Supp. 25); 9, Scheerer, (Pogg. lxv, 283); 10, Beck, (Rep. Min, N. Y. p. 254); 11, Rammelsberg, (Handw. i, 95); 12, Klaproth; 13, Wackenroder, (Schw. lxv, 41); 14, Abich, (Geol. Beob. iv); 15, Kühn, (loc. cit.); 16, 17, 18, Klaproth; 19, 20, Kühn, (loc. cit.); 21, John, (Schw. J. 6, 13); 22, Schrötter, (Baumg. Zeits. viii, 1); 23—25, Berthier, (T. d. Ess. i, 494); 26, 27, J. Roth, (J. f. pr. Ch. lviii, 82); 28, H. Hirzel, (Lieb. u. Kopp. 1850, 759, from Zeits. f. Pharm. 1850, 24); 29, T. S. Hunt, (communicated to the author):

		$\dot{C}a\ddot{C}$	$\dot{M}g\ddot{C}$	$\dot{F}e\ddot{C}$
1.	Zillerthal, *cryst.*	52·	45·	——$\ddot{\bar{F}}e$ 3·00=100, Klap.
2.	Traversella, G.=2·629,	51·00	44·32	4·68=100, Pelletier.
3.	*Tharandite,*	54·76	42·10	4·19=101·05, Kühn.
4.	Scheidama, *Dolomite,*	53·50	41·50	1·50, insol. 2·75=99·25, G.
5.	Jena, *trp. cryst.*	55·2	44·7	—— =99·9, Suckow.
6.	La Spezzia, *Dol.*	55·36	41·30	—— $\ddot{\bar{F}}e$ 2·0, $\ddot{S}i$ 0·5=99·16, Laug.
7.	New Jersey, *Dol.*	56·11	42·54	—— $\ddot{\bar{A}}l$, $\ddot{\bar{F}}e$, $\ddot{\bar{M}}n$ 0·15, insol. 0·04, $\dot{H}$ 0·48=99·32, R. and B.
8.	Thuringia, *Rauhkalk,*	55·62	49·40	0·56=98·58, Rammelsberg.
9.	Gulbransdal, Norway,	55·88	40·47	2·81=99·16, Scheerer.
10.	Lockport, N. Y. *Pearl spar,*	59·00	39·50	1·50=100, Beck,
11.	Kolosoruk, *cryst.*	61·00	36·53	2·74=100·27, Rammelsberg.
12.	Glücksbrun, *fib.*	60·00	36·50	4·00=100·50, Klap.
13.	Liebenstein,	63·88	33·24	0·91, $\dot{M}n\ddot{C}$ 0·07=98·10, Wack.
14.	Sorrento, Italy,	65·21	34·79	—— =100, Abich.
15.	Bohemia,	61·30	32·20	6·27=99·77, Kühn.
16.	Hall, *cryst.*	68·0	25·5	1·0 $\dot{H}$ 2·0 clay 2·0=98·50, Klap.
17.	Taberg, *cryst.*	73·	25·	—— $\ddot{\bar{F}}e$ 2·25=100·25, Klap.
18.	*Gurhofian,*	70·50	29·50	—— =100, Klap.
19.	Bohemia,	77·63	18·77	3·67=100·07, Kühn.
20.	Kolosoruk, *cryst.*	85·84	10·39	5·53=101·76, Kühn.
21.	Meissner, *Conite,*	28·0	67·4	3·5 =98·9, John.
22.	Styria, *Ankerite,*	50·11	11·85	35·31 $\dot{M}n\ddot{C}$ 3·08=100·35, Schrötter.
23.	" "	51·1	25·7	20·0 " 3·0 =99·8, Berthier.
24.	Corniglion, *Ankerite,*	50·9	29·0	18·7 " 0·5 =99·1, Berthier.
25.	Villefranche, "	60·9	30·3	6·0 " 3·0 =100·2, Berthier.
26.	Monte Somma,	57·25	42·75	—— =100, Roth. G.=2·72.
27.	Mexico, brown spar,	53·18	34·35,	($\dot{F}e$,$\dot{M}n$)$\ddot{C}$ 10·46, $\dot{H}$ 1·22, FeS^2 0·22, Roth.
28.	Traversella, *Brossite,*	52·71	33·46	$\dot{F}e\ddot{C}$ 11·13, $\dot{M}n\ddot{C}$ 2·84=100·14, Hirzel.
29.	Roxbury, Vt.,	53·90	44·04	" 3·05=100·99, T. S. Hunt. G.=2·856.

The carbonate of lime and carbonate of magnesia in the above analyses occur in the following proportions:—

In analyses 1 to 9, a ratio of 1 : 1. The same has been obtained by Garrett for a dolomite from Texas, Pa., (Am. J. Sci. [2], xv, 334). In analyses 10 to 14, a ratio of 3 : 2;—in 15 to 17, 2 : 1;—in 18, 3 : 1;—in 19, 5 : 1;—in 20, 1 : 3;—in 21, 3 : 1; or these latter are partly simple dolomite, and partly dolomitic calcite, (dolomite and calcite mixed). No. 26 corresponds to 46·82 per cent. of dolomite and 53·18 of dolomitic lime.

No. 23, (Ankerite), gives the formula $\dot{Ca}\ddot{C}+(\frac{2}{5}\,[\dot{Fe}, \dot{Mn}]+\frac{3}{5}\,\dot{Mg})\,\ddot{C}$.
No. 24, " " " " $\dot{Ca}\ddot{C}+(\frac{1}{3}\,\dot{Fe}+\frac{2}{3}\,\dot{Mg})\,\ddot{C}$.
No. 25, " " " " $\dot{Ca}\ddot{C}+(\dot{Mg}, \dot{Fe})\,\ddot{C}$.
No. 27, " " " " $\dot{Ca}\ddot{C}+(\dot{Mg}, \dot{Fe}, \dot{Mn}),\,\ddot{C}$.

A reddish bitter spar from Przibram afforded Gibbs (Pogg. lxxi, 564) 4 to 5 per cent. of *oxyd of cobalt,* as follows:

1.	$\ddot{C}$ 45·12	$\dot{Ca}$ 31·72	$\dot{Mg}$ 16·63	$\dot{Co}$ 5·17	$\dot{Fe}$ 1·36=100,
2.	45·37	31·86	17·37	4·34	1·16=100,

affording the formula $\dot{Ca}\ddot{C}+(\dot{Mg}, \dot{Fe}, \dot{Co})\,\ddot{C}$. G.=2·921.

Soluble in the acids, but more slowly than calcite. B.B. acts like calcite; some varieties darken and increase in hardness.

The name *Dolomite* is applied to white crystals, and to the granular varieties. *Pearl* spar includes rhombohedral crystallizations with curved faces and a pearly lustre. When the crystals are not curved, and have a brown or reddish-brown color, they are called *Brown spar*: this variety contains 5 to 10 per cent. of oxyd of iron or oxyd of manganese. *Ankerite* contains still more iron; $R:R$=106° 12′. *Gurhofian* is a compact snow-white subtranslucent variety, so named from a locality of it at Gurhof, in Lower Austria. The Traversella dolomite (anal. 28) has been called *Brossite*: R=106° 20′.

Granular dolomite constitutes extensive beds in various regions. Crystalline and compact varieties are often associated with serpentine and other magnesian rocks. Pearl spar occurs in geodes in compact limestones and other stratified rocks. Rhomb spar is found in Salzburg, the Tyrol, and at Miemo in Tuscany, whence the name *Miemite* was derived. Brown spar and Pearl spar are obtained at Schemnitz in Hungary, Kapnik in Transylvania, at Freiberg in Saxony, in the lead mines at Alston in Derbyshire, and at other places in Devonshire. The Ankerite is from Styria and elsewhere.

Roxbury, Vt., affords large yellow transparent crystals of the rhomb spar variety imbedded in talc. A coarse cleavable variety occasionally presenting perfect crystals is associated with white talc in calc spar, at Smithfield, R. I. White hexagonal crystals (f. 584) occur at Hoboken, N. J. The pearl spar variety is abundant in geodes at Lockport, Niagara Falls, and Rochester, N. Y., accompanying calc spar, celestine, and gypsum; also at Glen's Falls. Massive dolomite forms extensive beds in Litchfield Co., Conn., in the southwestern towns of Massachusetts, in Vermont, in various parts of New York, Pennsylvania, New Jersey, Maryland, &c. Crystallized dolomite occurs in rhombohedrons at the quarantine, Richmond Co., N. Y., and at Hoboken, N. J. Brown spar occurs at Warwick, N. Y. and at the Parish ore bed, St. Lawrence County, N. Y. A variety resembling *Gurhofite* is found on Hustis's farm, Phillipstown, N. Y. It has a semi-opaline appearance, and a fracture nearly like porcelain.

Dolomite is generally supposed to be injurious as a manure for soils, on account of its magnesia; but this is not so, unless used after calcination, before it is fully air-slaked. The lime it affords when burnt, makes a more durable cement than common limestone. The rock is generally less firm or more friable than pure granular limestone, and therefore not as good for building stone. This species was named in honor of Dolomieu.

ALTERED FORMS.—Dolomite occurs altered to Spathic Iron, Calamine, Steatite, Limonite, Red Iron Ore, Göthite, Pyrolusite, and Quartz, and by processes similar to those explained under Calcite.

BREUNNERITE, *Haid.* Bitter Spar and Brown Spar, *in part.* Mesitine Spar. Talkspath. Magnesitspath. Mesitinspath. Pistomesite.

Rhombohedral. $R:R$=107° 23′, $O:R$=136° 52′; a=0·81135. Observed planes: R, $-\frac{1}{2}$. $\frac{1}{2}:\frac{1}{2}$=136° 54′. Cleavage: rhombohedral, perfect. Crystals often imbedded. Also massive, granular, and fibrous.

H.=4—4·5. G.=3—3·63. Colorless, whitish, yellowish, often brown on exposure. Transparent to subtranslucent. Brittle.

Composition.—$(\dot{\mathrm{Mg}}, \dot{\mathrm{Fe}}, \dot{\mathrm{Mn}})\ddot{\mathrm{C}}$. $\dot{\mathrm{Mg}}\ddot{\mathrm{C}}+\dot{\mathrm{Fe}}\ddot{\mathrm{C}}$=Carbonate of magnesia 42·0, carbonate of iron 58·0. Analyses: 1, 2, Stromeyer, (Gött. gel. Anz. 1827, and Schw. J. li); 3, Brooke (Ann. Phil. N. Ser. v, 382): 4, 5, Stromeyer, (loc. cit.); 6, Fritzsche, (Pogg. lxx, 146); 7, Stromeyer; 8, Fritzsche, (loc. cit.); 9, Gibbs, (Pogg. lxxi, 566); 10, v. Hauer, (Jahrb. k. k. geol. Reichsanst. iii, 1852, 154):

			$\dot{\mathrm{Mg}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Fe}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Mn}}\ddot{\mathrm{C}}$
1.	Hall, Tyrol,	10 : 1	89·70	8·02	2·44 C 0·11=100·27, Stromeyer.
2.	St. Gothard,	10 : 1	87·78	10·54	0·90=99·22, Stromeyer.
3.	Tyrol,	8 : 1	86·05	13·15	——=99·20, Brooke.
4.	Zillerthal,	8 : 1	84·79	13·82	0·69=99·30, Stromeyer.
5.	Fassathal,	6 : 1	82·89	16·97	0·78=100·64, "
6.	*Pistomesite*, G=3·415,	1 : 1	44·96	55·27	——=100·23, Fritzsche.
7.	*Mesitine*, Piedmont,	1 : 1	42·72	57·24	——=99·96, with some $\dot{\mathrm{Mn}}\ddot{\mathrm{C}}$, Strom.
8.	"	2 : 1	58·68	39·38	——$\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$ 2·30=100·36, Fritzsche.
9.	" Piedmont,	2 : 1	56·14	43·36	——$\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$ 0·29=99·89, Gibbs.
10.	Semmering, *white*,	10 : 1	89·22	5·10	——$\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$ 3·89, $\dddot{\mathrm{Si}}$ 1·29, v. Hauer.

In the above the proportion of the magnesian carbonate to the rest, is given in the first column. Other analyses by A. Patera, (Fr. d. Nat. ii, 227 and 297, *R* : *R*=107° 20′), Völkel, (v. Leonh. 1849, 701); Joy, (Rammelsberg's 5th suppl., 161). The mesitine spar occurs in lenticular forms, and the first five above in the primary rhombohedron with the faces not curved.

B.B. gives an iron-reaction, becoming black, and sometimes magnetic. Dissolves very slowly in muriatic acid, when pulverized.

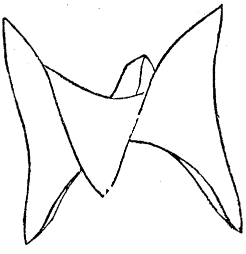
Occurs in chlorite slate at St. Gothard; also at the Zillerthal, and at Hall and elsewhere in the Tyrol. The mesitine is from Traversella in Piedmont. Includes much of the so-called brown spar.

CHALYBITE, *Gl.* Spathic Iron. Carbonate of Iron. Sparry Iron. Siderite, *Haid.* Siderose, *Beud.* Brown Spar. Stahlstein. Sphærosiderite. Clay Iron Stone. Eisenspath and Spatheisenstein. Junkerite, *Dufrénoy.* Oligonspath.

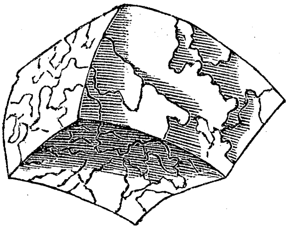
Rhombohedral. $R : R=107°$, $O : R=136° 37'$; $a=0{\cdot}81715$. Observed planes: rhombohedral 1, 4, -5, -2, $-\frac{1}{2}$; scalenohedral 1^3; pyramidal $\frac{4}{3}2$; prismatic I, $i2$; and basal O. The faces often curved, as below.

$O : 2=117° 53'$. $\frac{1}{2} : \frac{1}{2}=136° 34'$. $4 : 4=66° 18'$.
$O : \frac{4}{3}2=132° 30'$. $i : R=133° 23'$. $i2 : 1^3=155° 45'$.

585



586



Cleavage: rhombohedral, perfect. Twins: plane of composition $-\frac{1}{2}$. Also in botryoidal and globular forms, (*sphærosiderite*), occasionally in silky fibrous masses; often cleavable massive with cleavage planes undulate; also coarse or fine granular.

H.=3·5—4·5. G.=3·7—3·9. Lustre vitreous—pearly. Streak white. Color ash-gray, yellowish-gray, greenish-gray, also brown, and brownish-red, rarely green; and sometimes white. Translucent—subtranslucent. Fracture uneven. Brittle.

Composition.—$\dot{Fe}\ddot{C}$=Carbonic acid 37·93, and protoxyd of iron 62·07. But often containing some oxyd of manganese, magnesia, and also lime, or equivalent to ($\dot{Fe}$, $\dot{Mn}$, $\dot{Ca}$, $\dot{Mg}$,) $\ddot{C}$.

Analyses: 1—6, Karsten, (Karst. Arch. ix, 220); 7, Stromeyer, (Untersuch.); 8, 9, 10, Berthier, (Ann. d. Mines, viii, 887); 11, Thomson, (Min. i, 445); 12, Magnus, (Pogg. x, 145); 13, Klaproth, (Beit. vi, 315); 14, Stromeyer, (Untersuch.); 15, Schnabel, (Ramm. 3d Supp. 112):

		$\ddot{C}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Mg}$	$\dot{Ca}$	
1.	Babkowsky, *black*,	36·61	57·91	1·51	*trace*	0·59	gangue 0·60=97·22, K.
2.	Styria, *white*,	34·62	50·23	2·54	1·60	0·83	" 9·73=99·55, K.
3.	Hackenburgh, *white*,	38·64	50·41	7·51	2·35	——	" 0·32=99·23, K.
4.	Siegen, *yellowish*,	38·90	50·72	7·64	1·48	0·40	" 0·48=99·62, K.
5.	" "	38·85	47·20	8·34	3·75	0·63	" 0·95=99·72, K.
6.	Müsen, *white*,	39·19	47·96	9·50	3·12	——	=99·77, Karsten.
7.	Stolberg,	38·22	48·20	7·07	1·84	0·67,	$\dot{H}$ 0·25=96·25, Stromeyer.
8.	Allevard, Isère,	41·8	42·8	——	15·4	——	=100, Berthier.
9.	Autun,	40·4	45·2	0·6	12·2	——	=98·4, Berthier.
10.	Vizelle, Isère,	42·6	43·6	1·0	12·8	——	=100, Berthier.
11.	Durham, Eng.,	35·90	54·57	1·15	——	3·18,	Aq. 2·63=97·43, Thomson.
12.	Ehrenfried. *Oligon*,	38·35	36 81	25·31	——	——	=100·47, Magnus.
13.	Hanau, *Sphærosid.*	34·00	63·75	0·75	0·25	——	=98·75, Klaproth.
14.	" "	38·04	59·63	1·89	——	0·20	=99·91, Stromeyer.
15.	Siegen,	38·22[a]	43·59	17·87	0·24	0·08	=100, Schnabel.

[a] With some water.

Of the above, Nos. 9 and 10, from Autun and Vizelle, correspond to the formula $2\,\dot{Fe}\,\ddot{C}+\dot{Mg}\,\ddot{C}$; that from Ehrenfriedersdorf, No. 12, (called *Oligon Spar* by Breithaupt), $2\,\dot{Mn}\,\ddot{C}+3\,\dot{Fe}\,\ddot{C}$; that from Stolberg, (No 7)=$4\dot{Fe}\,\ddot{C}+\dot{Mn}\,\ddot{C}$.

A green variety from Altenberg afforded F. Monheim, (J. f. pr. Chem. xlix, 318), $\dot{Fe}\,\ddot{C}$ 64·04, $\dot{Mn}\,\ddot{C}$ 16·56, $\dot{Ca}\,\ddot{C}$ 20·22, $\dddot{Si}$ 1·10=101·92, corresponding to $8\,\dot{Fe}\,\ddot{C}+2\,\dot{Mn}\,\ddot{C}+3\dot{Ca}\,\ddot{C}$; it resembles the calamine called Kapnite.

In a brownish-black crystallized spathic iron from Wolch, Rosengarten found, (Ramm. 3d Supp. 112):

$\ddot{C}$ with $\dot{H}$ 35·12, $\dddot{\overline{Fe}}$ 11·30, $\dot{Fe}$ 43·83, $\dot{Mn}$ 7·31, $\dot{Mg}$ 2·44=100.

The spathic iron of Plymouth, Vt., according to T. G. Clemson, (Am. J. Sci. xxiv, 170), and another from Neudorf, according to Peischel, (Ramm. 1st Supp. 139), contained

$\dot{Fe}\ddot{C}$ 74·28	$\dot{Mg}\,\ddot{C}$ 16·40	$\dot{Mn}\,\ddot{C}$ 6·56	$\dddot{\overline{Fe}}$ 0·30	undec. 1·40=98·94, Clemson.
79·34	7·60	8·69	——	$\dot{Ca}\,\ddot{C}$ 5·43=101·06, Peischel.

B.B. blackens, giving off carbonic acid, and ultimately an oxyd of iron is obtained, which is attractable by the magnet. Alone infusible. Colors borax green; dissolves with difficulty in nitric acid, and scarcely effervesces, unless previously pulverized. Exposure to the atmosphere darkens its color, rendering it often of a blackish-brown, or brownish-red color.

Chalybite occurs in many of the rock strata, in gneiss, mica slate, clay slate, and in connection with the coal formation. It is often associated with metallic ores. At Freiberg it occurs in silver mines. At Cornwall it accompanies tin. It is also found accompanying copper and iron pyrites, galena, vitreous copper, &c. In New York according to Beck, it is almost always associated with specular iron. Occasionally it is to be met with in trap rocks as *spherosiderite*.

In the region in and about Styria and Carinthia, this ore forms extensive tracts in gneiss, which extend along the chain of the Alps on one side into Austria, and on the other into Saltzburg. At Harzgerode in the Hartz, it occurs in fine crystals in gray-wacke; also in Cornwall, Alston Moor, and Devonshire.

The *Spherosiderite* occurs in greenstone at Hanau, Steinheim and Dransberg, and many other places. Clay iron stone, which is a siliceous or argillaceous carbonate of iron, occurs in coal beds near Glasgow; also at Mouillar, Magescote, &c., in France, etc.

At Roxbury, Conn., an extensive vein occurs in quartz, traversing gneiss; also at Plymouth, Vt., and at Sterling, Mass. In small quantities it occurs at Monroe, Conn., at Lane's mine; also in rhombohedral crystals in New York, at the Sterling ore bed in Antwerp, Jefferson Co., and at the Rossie iron mines, St. Lawrence Co.; at Fentress and Harlem mines, North Carolina. The argillaceous carbonate in nodules and beds is abundant in the coal regions of Pennsylvania, and many parts of the west.

This ore is employed very extensively for the manufacture of iron and steel.

The *Junkerite* of Dufrénoy is shown by Breithaupt (Pogg. lviii, 278, 1843) to be common spathic iron.

Altered Forms.—Spathic iron becomes brown or brownish-black on exposure, owing to a peroxydation of the iron and its passing to *Limonite*, ($\ddot{\bar{F}}e^2\dot{H}^3$); and by a subsequent loss of water, it may pass to *Red Iron ore* or *Specular Iron*, ($\ddot{\bar{F}}e$), or to *magnetite*, ($\dot{F}e\,\ddot{\bar{F}}e$), the last at times a result of deoxydation of $\ddot{\bar{F}}e$ by organic substances. It also changes by substitution or through the action of alkaline silicates, to *quartz*.

DIALLOGITE, *Beud.* Carbonate of Manganese. Brown Spar, *in part.* Red Manganese. Manganspath, *Werner.* Rhodochrosite.

Rhombohedral. $R : R = 106° 51'$, $O : R = 136° 31\frac{1}{2}'$; $a = 0·8211$. Observed planes, R, O $i2$, $-\frac{1}{2}$, $-\frac{7}{2}$. Form like f. 573A. Cleavage: R, perfect. Also globular and botryoidal, having a columnar structure, sometimes indistinct. Also granular massive; occasionally impalpable.

H.=3·5—4·5 G.=3·4—3·6; 3·592, var. from Kapnik. Lustre vitreous inclining to pearly. Color shades of rose-red, brownish. Streak white. Translucent—subtranslucent. Fracture uneven. Brittle.

Composition.—$\dot{M}n\ddot{C}$=Manganese 61·80, carbonic acid 38·20; or coming under the general formula ($\dot{M}n$, $\dot{C}a$, $\dot{F}e$, $\dot{M}g$) $\ddot{C}$. Analyses; 1, Berthier, (Ann. d. Mines, vi, 593); 2, 3, 4, Stromeyer, (Gött, gel. Anz. 1833, p. 1081); 3, Kersten, (J. f. pr. Ch. xxxvii, 163); 6, 7, R. Kane, (Phil. Mag. Jan. 1848); 8, Gruner, (Ann. d. M., [3], xviii, 61):

		$\dot{M}n\ddot{C}$	$\dot{F}e\ddot{C}$	$\dot{C}a\ddot{C}$	$\dot{M}g\ddot{C}$	
1.	Freiberg,	89·2	7·3	8·9	1·6	=100, Berthier.
2.	"	73·703	5·755	13·080	7·256,	$\dot{H}$ 0·046=99·840, Strom.
3	Kapnik,	89·914	——	6·051	3·304,	" 0·435=99·700, Strom.
4.	Nagyag,	86·641	——	10·581	2·431,	" 0·310=99·963, Strom.
5.	Voigtsberg,	81·42	3·10	10·31	4·28,	$\dot{H}$ 0·33=99·44, Kersten. G.=3·553.
6.	Ireland,	74;55	15·01	*trace*	——,	clay 0·33, org. matters and loss 10·11, K.
7.	"	79·94	11·04	2·43	——,	clay 0·37, org. matters and loss 6·22, K.
8.		97·1	0·7	1·0	0·8,	$\ddot{\bar{M}}n$ 0·1=99·7, Gruner.

B.B. changes to gray, brown, and black, and decrepitates strongly; infusible alone. With glass of borax fuses readily to a violet-blue bead. Effervesces strongly with warm nitric or muriatic acid. On exposure to the air, changes to brown. and some bright rose-red varieties become paler.

Diallogite occurs commonly in veins along with ores of silver, lead, and copper, and with other ores of manganese.

It is not uncommon in the Saxon mines; it occurs also at Nagyag and Kapnik in Transylvania, near Elbingerode in the Hartz, &c. At Glendree, in the County of Clare, Ireland, it forms a layer, two inches thick below a bog, and has a yellowish-gray color, (analyses 6, 7).

It has been observed in a pulverulent form, coating triplite, at Washington, Conn., on the land of Joel Camp.

WISERITE, *Haid.*—This is a hydrated carbonate of manganese, considered a variety of diallogite. It is from Gonzen, near Sarganz in Switzerland.

ALTERED FORMS.—Quartz pseudomorphs occur near Klein-Voigtsberg.

SMITHSONITE, *Beud.* Calamine, *in part.* Zinkspath, *L.* Carbonate of Zinc. Kapnite, *Breit.* Galmey, *in part.*

Rhombohedral. $R : R=107° 40'$, $O : R=137° 3'$; $a=0{\cdot}8062$. Observed planes: the rhombohedrons, R, $-\frac{1}{2}$, -2, $-\frac{7}{2}$, -5. $\frac{1}{2} : \frac{1}{2}=137° 7'$, $2 : 2=80° 33'$, $\frac{7}{2} : \frac{7}{2}=68° 14'$, $5 : 5=64° 17'$. $O : \frac{1}{2}=155° 2'$; R generally curved and rough. Cleavage: R perfect. Also reniform, botryoidal or stalactitic shapes, and in crystalline incrustations; also granular, and sometimes impalpable, occasionally earthy and friable.

H.=5. G.=4—4·45; 4·45, Levy; 4·42, Haidinger. Lustre vitreous, inclining to pearly. Streak white. Color white, often grayish, greenish, brownish-white, sometimes green and brown. Subtransparent—translucent. Fracture uneven—imperfectly conchoidal. Brittle.

Composition.—$\dot{Zn}\,\ddot{C}$=Carbonic acid 35·19, oxyd of zinc 64·81=100; but often containing carbonate of iron, manganese or lime. Analyses: 1, 2, Smithson, (Nicholson's J. vi, 76); 3, Kobell, (J. f. pr. Ch. xxviii, 480); 4—8, Monheim, (Ramm. 3d Supp. 131, and J. f. pr. Ch. xlix, 382):

		$\ddot{C}$	$\dot{Zn}$	
1.	Somersetshire,	35·2	64·8=100,	Smithson.
2.	Derbyshire,	34·8	65·2=100,	Smithson.

		$\dot{Zn}\ddot{C}$	$\dot{Fe}\ddot{C}$	$\dot{Mn}\ddot{C}$	$\dot{Ca}\ddot{C}$	$\dot{Mg}\ddot{C}$	
3.	Nertschink,	96·00	2·03	——	——	——	$\dot{Pb}\ddot{C}$=1·12=99·15, Kobell
4.	Altenberg,	60·35	32·31	4·02	1·90	0·14,	Calamine 2·49=101·11, Monheim.
5.	“	55·89	36·46	3·47	2·27	——	“ 0·41=98·50, Monheim.
6.	“	84·92	1·58	6·80	1·58	2·84,	“ 1·85=99·57, Monheim.
7.	Herrenberge,	85·78	2·24	7·62	0·98	4·44,	$\ddot{Si}$ 0·09, $\dot{H}$ *tr*=101·15, Monheim.
8.	“	74·42	3·20	14·98	1·68	3·88,	“ 0·20 “ 0·56=98·92, Monheim.

1, G.=4·334; 4, G.=4·15; 5, G.=4·04; 6, G.=4·20; 7, G.=4·03; 8, G.=2·98.

Other analyses by E. Schmidt, (J. f. pr. Ch. li, 257); Wandesleben, (Jahrb. pr. Pharm. xxiv, 357, Lieb. and K. 1852, 897).

The variety containing more than fifteen per cent. of protoxyd of iron is called *Kapnite* by Breithaupt; according to this mineralogist, it has $R : R=107° 7'$.

B.B. loses transparency, but does not melt; carbonic acid is driven off, and oxyd of zinc is obtained or passes off in white flakes. Dissolves with effervescence in nitric acid.

Smithsonite is found both in veins and beds, especially in company with galena and blende; also with copper and iron. It usually occurs in calcareous rocks, and is generally associated with Calamine.

Fine specimens of Smithsonite are obtained at Nertschinsk in Siberia; one variety has a dark brown color, and contains cadmium; another is of a beautiful bright green. Other localities are Dognatzka in the Bannat of Temeswar in Hungary; Bleiberg and Raibel in Carinthia; Altenberg, near Aix la Chapelle. Concentric botryoidal groups are met with in the Mendip hills and at Wanlockhead, in Dumfreisshire.

In the United States, Smithsonite is found occasionally at the lead mines of Missouri, and Wisconsin, though the ore is mostly *silicate* of zinc. Mine Hill, near the Franklin furnace, New Jersey, the Perkiomen lead mine, Pennsylvania, and the lead mine at Brookfield, Conn., afford it in small quantities. At Franklin it occurs only in a pulverulent form, and results from the decomposition of red zinc ore.

ALTERED FORMS.—Smithsonite changes though the action of alkaline silicates, to Calamine ($\dot{Z}n^3\ddot{S}i+\frac{1}{2}\dot{H}$); or becomes incrusted with silica and forms quartz pseudomorphs. It is also sometimes replaced by Limonite or Göthite.

ARAGONITE. Eisenbluth, *W.* Igloite. Flos ferri. Needle Spar. Tarnowitzit. Aragonspath.

Trimetric. $I:I=116° \; 10'$, $O:1\bar{i}=130° \; 50'$; $a:b:c=1{\cdot}1571:1:1{\cdot}6055$.

$O:1\bar{i}=130° \; 50'$. $O:2\breve{2}=118° \; 25'$. $2\breve{i}:2\breve{i}=110° \; 30'$.
$O:1=126° \; 15'$. $O:\frac{1}{2}\breve{i}=160° \; 11'$. $1\breve{i}:1\breve{i}=71° \; 34'$.
$O:1\breve{2}=137° \; 15'$. $O:1\breve{i}=144° \; 13'$. $I:i\breve{i}=121° \; 55'$.

O			
			$\frac{1}{2}\breve{i}$
$1\bar{i}$	1	$1\breve{2}$	$1\breve{i}$
			$\frac{3}{2}\breve{i}$
		$2\breve{2}$	$2\breve{i}$
			$3\breve{i}$
			$5\breve{i}$
			$6\breve{i}$
$i\bar{i}$	I		$i\breve{i}$

Observed Planes.

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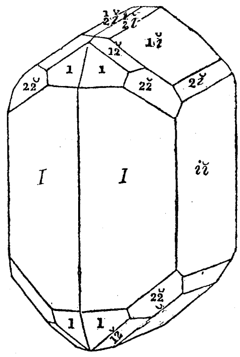

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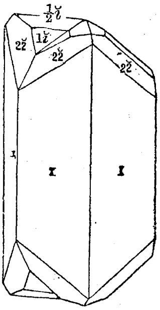


Cleavage: I, imperfect; $i\breve{i}$ distinct, $1\breve{i}$ imperfect. Twins: plane of composition I; hexagonal prisms, and also f. 227, 236. 237, p. 149, 151, and f. 588. Also globular, reniform, and coralloidal shapes; sometimes columnar, composed of straight or divergent fibres.

H.=3·5—4. G.=2·931, Haidinger; 2·927, Biot; 2·945—2·947, small crystals, and others when pulverized, Beudant. Lustre vitreous, sometimes inclining to resinous on surfaces of fracture. Color white; also gray, yellow, green, and violet; streak uncolored. Transparent—translucent. Fracture subconchoidal. Brittle.

Composition.—$\dot{C}a\ddot{C}$, like calcite,=Carbonic acid 44·0, lime 56·0. Analyses: 1—4, Stromeyer; 5, 6, Nentwich, (Versamml. ung. Naturf., Neusohl, 1846); 7, Böttger, (Pogg. Ann. xlvii, 497); 8, Stieren, Arch, f. Pharm., [2], lxii, 31):

	$\dot{C}a\ddot{C}$	$\dot{S}r\ddot{C}$	$\dot{P}b\ddot{C}$	$\dot{H}$	$\ddot{\bar{F}}e^{2}\dot{H}^{3}$	
1. Brisgau,	97·0963	2·4609	——	0·4102	——	=99·9674, St.
2. Nertschinsk,	97·9834	1·0933	——	0·2578	——	=99·3345, St.
3. Eschwege,	96·1841	2·2390	——	0·3077	0·2207	=98·9515, St.
4. Aussig,	98·00	1·0145	——	0·2139	0·1449	=99·3733, St.
5. Herrengrund, G.=2·93,	98·62	0·99	——	0·17	$\ddot{\bar{F}}e$ 0·11	=99·89, N.
6. Retzbanya, G.=2·86,	99·31	0·06	——	0·33	$\dot{C}u\ddot{C}$ 0·19	=99·89, N.
7. *Tarnowitzite*,	95·940	——	3·859	0·157	——	=99·956, B.
8. Papenberg,	97·39	2·22	——	——	——	$\dot{H}$ 0·39=100, S.

Delesse finds in the aragonite of Herrengrund, near Neusohl, Hungary, no strontia, and 0·13 per cent. of water. A Thurnberg variety afforded E. Riegel, (Jahrb. pr. Pharm. xxiii, 348), 2·2 per cent. of carbonate of strontian. A fibrous variety from Dufton in Cumberland, afforded 4·25 per cent. of $\dot{M}n\ddot{C}$.

When aragonite is heated, it falls to powder. It is phosphorescent on red hot iron, and soluble with effervescence in nitric and muriatic acid.

The most common repositories of aragonite are beds of gypsum, beds of iron ore, (where it occurs in coralloidal forms, and is denominated *flos-ferri*, '*flower of iron*'), basalt, and trap rock; occasionally it occurs in lavas. It is often associated with copper and iron pyrites, galena, and malachite. It is forming at an old mine in Monte Vasa, Italy, at a temperature below the boiling point of water.

This mineral was first discovered in Aragon, Spain, (whence its name), at Molina and Valencia, near Migranilla, in six-sided prisms, with gypsum, imbedded in a ferruginous clay. It has since been obtained in compound hexagonal prisms at Bilin, in Bohemia, in a vein traversing basalt; at Breisgau in Baden; at Baumgarten and Tarnowitz in Silesia; at Leogang in Salzburg, Austria; in Waltsch, Bohemia, and many other places. The *flos-ferri* variety is found in great perfection in the Styrian mines, coating cavities and even caves of considerable extent, and associated with spathic iron. At Dufton, a silky, fibrous variety, called *satin spar*, occurs traversing shale in thin veins, generally associated with pyrites. In Buckinghamshire, Devonshire, &c., it occurs in stalactitic forms in caverns, and of snowy whiteness at Leadhills in Lanarkshire. The variety *tarnowitzite* (analysis 7 above) corresponds to plumbocalcite, under calcite. Kersten found in another specimen 2·19 of carbonate of lead. An aragonite deposited in stalactites, etc., at the Carlsbad Springs, called *Sprudelstein*, contains 0·69 per cent. of fluorid of calcium and a trace of arsenic.

Aragonite in fibrous and other forms occurs in Serpentine at Hoboken, (it has been called magnesite).

Flos-ferri occurs sparingly at Lockport, N. Y., coating gypsum in geodes; at Edenville, N. Y., lining cavities of mispickel and cube ore; at the Parish ore bed, Rossie, N. Y.; and at Haddam, Conn., in thin seams between layers of gneiss. A coralloidal aragonite occurs at New Garden, in Chester Co., Pennsylvania.

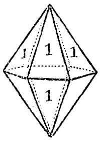
Altered Forms.—Aragonite may undergo similar changes with calcite. It also passes to calcite, through paramorphism. Pseudomorphs of copper after aragonite are reported from Bolivia.

WITHERITE, *Werner*. *Withering*, Phil. Trans. 1784, p. 293. Carbonate of Barytes. Barolite.

Trimetric. $I:I=118^\circ\ 30'$, $O:1\bar{\imath}=128^\circ\ 45'$; $a:b:c=1{\cdot}246:1:1{\cdot}6808$. Observed planes, I, $\frac{1}{4}$, $\frac{1}{2}$, 1, $\frac{3}{2}$, 2. $O:1=124^\circ\ 35\frac{1}{2}'$, $I:1=145^\circ\ 24\frac{1}{2}'$, $I:2=160^\circ\ 58\frac{1}{2}'$, $I:\frac{3}{2}=155^\circ\ 18\frac{1}{2}'$, $I:\frac{1}{2}=125^\circ\ 57\frac{1}{2}'$, $I:\frac{1}{4}=109^\circ\ 55\frac{1}{2}'$, $1:1$ (mac.)$=130^\circ\ 13'$, (brach.)$=89^\circ\ 57'$, (bas.) $110^\circ\ 49'$. Twins: all the annexed figures, composition parallel to I, (probably, as represented in f. 234 or 237, p. 151); reëntering angles sometimes observed. Cleavage: I distinct; also in globular, tuberose, and botryoidal forms; structure either columnar or granular: also amorphous.

H.=3—3·75. G.=4·29—4·35. Lustre vitreous, inclining to resinous, on surfaces of fracture. Color white, often yellowish, or grayish. Streak white. Subtransparent—translucent. Fracture uneven. Brittle.

589



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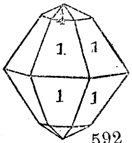

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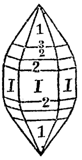

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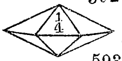

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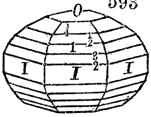

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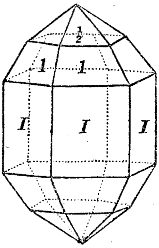

Composition.—$\dot{\mathrm{Ba}}\ddot{\mathrm{C}}$=Carbonic acid 22·33, baryta 77·67. B.B. decrepitates, and melts easily to a translucent globule, which becomes opaque white on cooling. On charcoal boils violently, becomes caustic and is absorbed. Dissolves with effervescence in dilute nitric or muriatic acid.

The *Sulphato-carbonate of baryta* of Thomson, (Min. i, 106), from Bromley Hill, Cumberland, is only a mixture.

Witherite occurs at Alston Moor in Cumberland, associated with galena, in veins traversing the coal formation; in splendid crystals sometimes transparent, and occasionally six inches long, at Fallowfield in Northumberland. The fibrous translucent variety occurs at Anglesark, in Lancashire. Tarnowitz in Silesia; Szlana, Hungary; Leogang in Saltzburg; Peggau in Styria; Barnaoul, Russia, in the Altai; some places in Sicily; and the mine of Arqueros, near Coquimbo, Chili, are other localities.

For several of the above figures the author is indebted to R. P. Greg, Jr., who observes that all the supposed simple crystals are compound.

ALTERED FORMS.—Witherite is altered to Heavy Spar ($\dot{\mathrm{Ba}}\dddot{\mathrm{S}}$) through the action of sulphate of lime in solution at the ordinary temperature, or by the action of other sulphates in solution, or of water containing sulphuric acid.

STRONTIANITE. Carbonate of Strontian. Strontites. Strontiane Carbonatée, *H.* Emmonite, *Thomson.*

Trimetric. $I : I$=117° 19′, $O : 1\bar{i}$=130° 5′; $a : b : c$=1·1883 : 1 : 1·6421. Observed planes: octahedrons $\frac{1}{2}$, ^{4}, 1, $\frac{3}{2}$, 2, 3, 4, 8; domes $\frac{1}{2}\bar{i}$, $1\breve{i}$, $\frac{3}{2}\breve{i}$, $2\breve{i}$, $4\breve{i}$, $6\breve{i}$, $8\breve{i}$, $12\breve{i}$.

$O : \frac{1}{2}\bar{i}$=149° 17′. $O : 1\breve{i}$=144° 6′. 1 : 1 (mac.)=130° 1′.
$O : \frac{1}{2}$=145° 11′. $1\breve{i} : 1\breve{i}$ (bas.)=71° 48′. 1 : 1 (brach.)=92° 11′.
O : 1=125° 43′. $2\breve{i} : 2\breve{i}$ (bas.)=110° 44′. 1 : 1 (bas.)=108° 35′.

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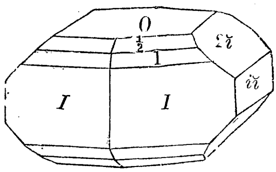

Twins: like those of aragonite. O usually striated, parallel to the shorter diagonal. Cleavage: I nearly perfect, $\breve{i}\breve{i}$ in traces. Also in columnar globular forms; fibrous and granular.

H.=3·5—4. G.=3·605—3·713. Lustre vitreous; inclining to resinous on uneven faces of fracture. Color asparagus green, apple-green; also white, gray, yellow, and yellowish-brown. Streak white. Transparent—translucent. Fracture uneven. Brittle.

Composition.—$\dot{S}r\ddot{C}$=Carbonic acid 29·81, and strontia 70·19.

Thomson found the two varieties from Strontian to contain 6 to 8·64 per cent. of $\dot{C}a\ddot{C}$; and another from the United States, named by him *Emmonite*, in honor of Prof. Emmons, affords 12·5 per cent. of $\dot{C}a\ddot{C}$. Similar specimens come from Clausthal, and from Hamm in Westphalia. Schnabel found in the latter 7·89 per cent. equivalent to 1 $\dot{C}a\ddot{C}$ to 8 $\dot{S}r\ddot{C}$. (Ramm. 4th Suppl, 215; also 5th Suppl., 231). The former contains five to eight per cent. of $\dot{C}a\ddot{C}$.

B.B. melts on the edges and then swells out, emitting a brilliant light, and in the reducing flame strongly heated gives the flame a reddish tinge: assay gives an alkaline reaction.

Effervesces with nitric and muriatic acids. Paper wet with the solution in these acids and dried, burns with a red flame.

Strontianite occurs at Strontian in Argyleshire, in veins traversing gneiss, along with galena and heavy spar, in stellated and fibrous groups, rarely in perfect crystals. Yorkshire, England; Giant's Causeway, Ireland; Clausthal, in the Hartz; Bräunsdorf, Saxony; Leogang in Saltzburg, Austria, are other localities.

In the United States it occurs at Scoharie in granular and columnar masses, and also in crystals, forming nests or geodes often large in the hydraulic limestone, associated with heavy spar, iron pyrites, and calc spar. At Muscalonge Lake a massive and fibrous variety of a white or greenish-white color, is sometimes the matrix of fluor spar. Chaumont Bay and Theresa, in Jefferson Co., N. Y., are other localities. Massive strontianite has been found by Mr. James Heron, at Warwick, N. Y.

Barystrontianite from Stromness, in *Orkney*, consists of

$\dot{S}r\ddot{C}$ 62·6, $\dot{B}a\dddot{S}$ 27·5, $\dot{C}a\ddot{C}$ 2·6, and oxyd of iron 0·1.

It is supposed to be a mechanical mixture.

ALTERED FORMS.—Strontianite is altered to Celestine in the same way as Witherite to Heavy Spar.

BROMLITE, *Johnston*, Phil. Mag. vi, 1, and xi, 45. *Thomson*, ibid. x, 373, and Rec. of Gen. Sci. i, 373. *Delesse* and *Descloizeaux*, Ann. Ch. Ph. [3], xiii, 425. Alstonite, *Breithaupt*. Bicalcareo-carbonate of barytes, *Thomson*.

Trimetric. $I : I$=118° 50′ (Descl.), $O : 1\bar{i}$=128° 39′; $a : b : c$ =1·2504 : 1 : 1·6920. Observed planes: octahedrons 1, 2; domes, $1\breve{i}$, $2\breve{i}$; with I. $O : 1\breve{i}$=143° 32½′, $1\breve{i} : 1\breve{i}$ (bas.)=72° 55′, $2\breve{i} : 2\breve{i}$ (bas.)=111° 50′, 1 : 1 (mac.)=130° 27′, 1 : 1 (brach.)=89° 40′. Twins: double six-sided pyramids, with angles 122° 30′, and 142°; reëntering angle 178° 51′. Cleavage: I and O rather indistinct.

H.=2·5. G.=3·718, Thomson; 3·706, Johnston. Lustre vitreous. Color snow-white. Translucent. Fracture granular and uneven.

Composition.—$\dot{B}a\ddot{C}+\dot{C}a\ddot{C}$, like Barytocalcite=Carb. baryta 66·3, carb. lime 33·7:

	$\dot{B}a\ddot{C}$	$\dot{C}a\ddot{C}$	$\dot{S}r\ddot{C}$	$\dot{M}n\ddot{C}$	$\dddot{S}i$	$\dot{\bar{M}}n$
1.	60·63	30·19	——	9·18	——	——=100, Thomson.
2.	62·156	30·290	6·641	——	——	——=99·087, Johnston.
3.	65·31	32·90	1·10	——	0·20	0·16=99·67, Delesse.

Discovered by Johnston in the lead mine of Fallowfield, near Hexham, Northumberland; and afterwards at Bromley Hill, near Alston, whence the name *Bromlite*, given by Thomson.

MANGANOCALCITE, *Breit.*

In rhombic prisms like Aragonite, and closely related to that species. Cleavage lateral, also brachydiagonal.

H.=4—5. G.=3·037. Lustre vitreous. Flesh-red to dull reddish-white. Translucent.

Composition.—Same general formula as Diallogite. Analysis by Rammelsberg, (Pogg. lxviii, 511):

$\dot{Mn}\,\ddot{C}$ 67·48, $\dot{Fe}\,\ddot{C}$ 3·22, $\dot{Ca}\,\ddot{C}$ 18·81, $\dot{Mg}\,\ddot{C}$ 9·97=99·48.

Thomaite.—This name has been given to a carbonate of iron, said to have a prismatic form. G.=3·10. Lustre pearly. An analysis by Meyer afforded $\ddot{C}$ 33·39, $\dot{Fe}$ 53·72, $\dot{Mn}$ 0·65, $\dot{Mg}$ 0·43, $\dot{Ca}$ 1·52, $\ddot{\bar{Al}}$ 4·25, $\ddot{Si}$ 6·04=100. From the Siebengebirge. *Leonh. u. Bronn's Jahrbuch,* 1845, 200.

CERUSITE, *Haid.* White Lead Ore. Carbonate of Lead. Ceruse. Weissbleierz. Iglesiasite. Bleierde, *Wern.*

Trimetric. $I : I$=117° 13′, $O : 1\breve{i}$=130° 9½′: $a : b : c$=1·1852 : 1 : 1·6388.

			O			
$\frac{1}{3}\bar{i}$			$\frac{1}{3}$			
$\frac{1}{2}\bar{i}$			$\frac{1}{2}$			$\frac{1}{2}\breve{i}$
			1			$1\breve{i}$
		$2\bar{2}$		$2\breve{2}$		$2\breve{i}$
						$3\breve{i}$
						$4\breve{i}$
$i\bar{i}$	$i\bar{\frac{5}{3}}$		I		$i\breve{3}$	$i\breve{i}$

Observed Planes.

$O : 1$=125° 46′.
$O : \frac{1}{2}\breve{i}$=149° 21′.
$O : 1\breve{i}$=144° 8′.
$O : 2\breve{i}$=124° 40′.
$I : i\breve{i}$=121° 24′.
$i\breve{i} : 2\breve{i}$=145° 20′.
$i\breve{i} : \frac{1}{2}\breve{i}$=109° 53′.
$2\breve{i} : 2\breve{i}$ (bas.)=110° 40′.
$1\breve{i} : 1\breve{i}$ (bas.)=71° 44′.
$\frac{1}{2}\breve{i} : \frac{1}{2}\breve{i}$ (bas.)=39° 45′.
$i\breve{3} : i\breve{3}$ (ov. $i\breve{i}$)=122° 43′.
1 : 1 (mac.)=130°.
1 : 1 (brach.)=92° 19′.
1 : 1 (bas.)=108° 28′.

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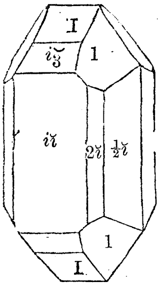

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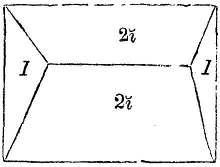

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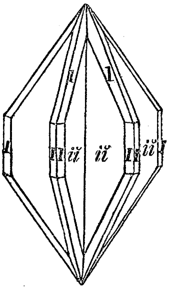


Cleavage: I often imperfect; $2\breve{i}$ hardly less so. Twins: f. 233, 598, often stellated; plane of composition I. Rarely fibrous; often granularly massive and compact.

H.=3—3·5. G.=6·465—6·480; some earthy varieties as low as 5·4. Lustre adamantine, inclining to vitreous or resinous; sometimes pearly; sometimes sub-metallic, if the colors are dark. Color white, gray, grayish-black, sometimes tinged blue or green by some of the salts of copper; streak uncolored. Transparent—subtranslucent. Fracture conchoidal. Very brittle.

Composition.—$\dot{P}b\ \ddot{C}$=Carbonic acid 16·5, oxyd of lead 83·5=100. Analyses: 1, Bergemann, (Chem. Unters. Bleib. 167, 175); 2, J. A. Phillips, (Qu. J. Ch. Soc. iv, 175); 3, 4, John, (Schw. iv, 227, xxxii, 114, 117); 5, Bergemann; 6, Kersten:

	$\ddot{C}$	$\dot{P}b$	
1. Eifel,	16·49	83·51=100, Bergemann.	
2. Durham,	16·05	83·56=99·61, Phillips.	
2. Eschweiler, *earthy,*	16·62	81·34	1·75, $\dot{C}a$ and $\ddot{\bar{F}}e$ 0·29=100, John.
4. Kall, *earthy,*	15·81	77·07	6·32 “ “ 0·80=100, John.
5. “ “ *red,*	$\dot{P}b\ \ddot{C}$ 94·233, $\dot{H}$ 2·566, quartz 1·07, $\ddot{\bar{F}}e$ and $\ddot{\bar{A}}l$ 2·2, Berg.		
6. Sardinia, *Iglesiasite,*	“	92·10, $\dot{Z}n\ \ddot{C}$ 7·02, Kersten; G.=5·9.	

B.B. decrepitates, becomes yellow, then red, and finally, with care, on charcoal a globule of lead may be obtained; dissolves readily, and with effervescence, in dilute nitric acid.

Occurs at Leadhills and Wanlockhead in Scotland, with other ores of lead in Silurian slate; in beautiful crystals at Johanngeorgenstadt; at Nertschinsk and Beresof in Siberia; near Bonn on the Rhine; at Clausthal in the Hartz; at Bleiberg in Carinthia; and at Mies and Przibram in Bohemia; in England, at Alston Moor, Keswick, and particularly in Cornwall, where, in the mine of St. Minvers, it occurs in exceedingly delicate crystals; in heart-shaped macles at Seven-Churches, Wicklow Co., Ireland; in pseudomorphs, imitating Anglesite and Leadhillite, at Leadhills.

Fine crystals have been obtained in Pennsylvania, at Phenixville; also at the Perkiomen lead mines, near Philadelphia. Also occurs at Valle's Diggings, Jefferson Co., Missouri, and in other mines of the West; at Brigham's mines, near the Blue Mounds; as an incrustation, at Southampton, Mass.; sparingly at the lead mines of St. Lawrence Co., N. Y.; fine crystals are obtained at Austin's mines, Wythe Co., Virginia, and especially at King's Mine, in Davidson Co., N. C.

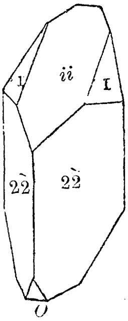
Altered Forms.—Cerusite occurs altered to pyromorphite, or phosphate of lead; probably through the action of waters holding phosphate of lime in solution; also to Galena (PbS) through the action of sulphuretted hydrogen, and Minium by oxydation: also to Breunnerite, Malachite and Chrysocolla.

BARYTOCALCITE, *Brooke,* Ann. Phil. viii, 114, 1824.

Monoclinic. $C=73° 52'$, $I : I=106° 54'$ $O : 1\grave{i}=149°$; $a : b : c=0·81035 : 1 : 1·29583$. $O : 1\grave{i}=147° 34'$, $O : \grave{i}\grave{i}=106° 8'$, $\grave{i}\grave{i} : 1\grave{i}=138° 34'$, $\grave{i}\grave{i} : \grave{i}\grave{2}=124°$, $2\grave{2} : 2\grave{2}$ (over $6\grave{6}$) $=95° 8'$, $6\grave{6} : 6\grave{6}$ (adj)$=146° 6'$. Cleavage: I, perfect, O, less perfect; also massive.

H.=4. G.=3·6363—3·66. Lustre vitreous, inclining to resinous. Color white, grayish, greenish, or yellowish. Streak white. Transparent—translucent. Fracture uneven.

599



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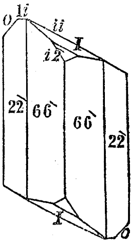

Composition.—$\dot{\mathrm{Ba}}\ddot{\mathrm{C}}+\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$=Carbonate of baryta 66·3, carbonate of lime 33·7=100. Analyses: 1, Children, (Ann. Phil. viii, 115): 2, Delesse, (Ann. Ch. Ph. [3], xiii, 425):

	$\dot{\mathrm{Ba}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$	$\dddot{\mathrm{Si}}$
1.	65·9	33·6	—=99·5
2.	66·20	31·89	0·27=98·36

B.B. alone, infusible, but gives a yellowish green color to the flame. With borax, or salt of phosphorus, fuses to a transparent glass. The glass with borax has a hyacinth color, but loses the tinge in the oxydating flame.

Occurs at Alston Moor in Cumberland. Fig. 600 is from Brooke and Miller.

II. HYDROUS CARBONATES.

CARBONATE OF AMMONIA,	$\mathrm{NH^4O\ddot{C}^2}+\dot{\mathrm{H}}$.	AZURITE,	$2\dot{\mathrm{Cu}}\ddot{\mathrm{C}}+\dot{\mathrm{Cu}}\dot{\mathrm{H}}$.
TRONA,	$\dot{\mathrm{Na}}^2\ddot{\mathrm{C}}^3+4\dot{\mathrm{H}}$.	AURICHALCITE,	$2(\dot{\mathrm{Cu}}, \dot{\mathrm{Zn}})\ddot{\mathrm{C}}+3\dot{\mathrm{R}}\dot{\mathrm{H}}$.
THERMONATRITE,	$\dot{\mathrm{Na}}\ddot{\mathrm{C}}+\dot{\mathrm{H}}$.	BURATITE,	
NATRON,	$\dot{\mathrm{Na}}\ddot{\mathrm{C}}+10\dot{\mathrm{H}}$.	ZINC BLOOM,	$\dot{\mathrm{Zn}}\ddot{\mathrm{C}}+\dot{\mathrm{Zn}}^2\dot{\mathrm{H}}^3$.
GAY-LUSSITE,	$(\dot{\mathrm{Na}}, \dot{\mathrm{Ca}})\ddot{\mathrm{C}}+2\frac{1}{2}\dot{\mathrm{H}}$,	EMERALD NICKEL,	$\dot{\mathrm{Ni}}\ddot{\mathrm{C}}+2\dot{\mathrm{Ni}}\dot{\mathrm{H}}^3$.
LANTHANITE,	$\dot{\mathrm{La}}\ddot{\mathrm{C}}+3\dot{\mathrm{H}}$	REMINGTONITE,	
HYDROMAGNESITE,	$\dot{\mathrm{Mg}}^4\ddot{\mathrm{C}}^3+4\dot{\mathrm{H}}$.	LIEBIGITE.	
MALACHITE,	$\dot{\mathrm{Cu}}^2\ddot{\mathrm{C}}+\dot{\mathrm{Cu}}\dot{\mathrm{H}}$.	BISMUTITE.	

RICARBONATE OF AMONIA.

In crystals, having two brilliant cleavages meeting at 112°. G.=1·45. H.=1·5. Yellowish to white.

Composition.—$\mathrm{NH^4O\ddot{C}^2}+\dot{\mathrm{H}}=\mathrm{N\dot{H}^4O}$ 32·91, carbonic acid 55·69, water 11·40=100.

From guano deposits on the coast of Africa and Patagonia, and the Chinca Islands; forms a bed several inches thick in the lowest parts of the guano deposits of Patagonia.

TRONA. Sesquicarbonate of Soda. Prismatic Natron, *J.* Urao.

Monoclinic. *O* : *ii*=103° 15′. Cleavage : *ii* perfect. Often in fibrous masses consisting of a congeries of minute crystals.

H.=2·5—3. G.=2·11. Lustre vitreous, glistening. Color gray, or yellowish white. Translucent. Taste alkaline. Not altered by exposure to a dry atmosphere.

Composition.—$\dot{\mathrm{Na}}^2\ddot{\mathrm{C}}^3+4\dot{\mathrm{H}}$=Carbonic acid 40·2, soda 37·8, water 22·0. Analysis by Klaproth, (Beit. iii, 83), Carbonic acid 38, soda 37, water 32·5, sulphate of soda 2·5=100.

To this species belongs the urao, found at the bottom of a lake in Maracaibo, S. A., a day's journey from Merida. The specimen analyzed by Klaproth came from the province of Suckenna, two days' journey from Fezzan, Africa. It is found at the foot of a mountain, forming a crust varying from the thickness of an inch to that of the back of a knife. Efflorescences of trona occur near the Sweetwater river, Rocky Mountains, mixed with sulphate of soda and common salt.

THERMONATRITE, *Haid.*

Trimetric. In rectangular tables, with beveled sides. One vertical prism of 83° 50′, another of 121° 56′, and a brachydome of 107° 50′. Usual as an efflorescence.

H.=1—1·5. G.=1·5—1·6. Lustre vitreous. Colorless.

Composition.—$\dot{\mathrm{N}}\mathrm{a}\ddot{\mathrm{C}}+\dot{\mathrm{H}}$=Soda 50·0, carbonic acid 35·5, water 14·5. Beudant obtained in two analyses:

	$\dot{\mathrm{N}}\mathrm{a}\ddot{\mathrm{C}}$	$\dot{\mathrm{H}}$	$\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}$	NaCl and other ingredients.
1. Debreczin,	73·6	13·8	10·4	2·2=100
2. Egypt,	74·7	13·5	7·3	3·1, Earthy matter 4·1=100.

This is the more common salt in nature, natron changing to it, on efflorescing. It occurs at the various localities of natron.

NATRON. Carbonate of Soda. Soude Carbonatée. Natürliches Mineral Alkali, *W.*

Monoclinic: *C*=58° 52, *I* : *I*=76° 28′, *O* : 1ì=140° 9½′. Cleavage *O* distinct; *ìi* imperfect; *I* in traces.

H.=1—1·5. G.=1·423. Vitreous to earthy. White, sometimes gray or yellow, owing to impurities. Taste alkaline.

Composition.—$\dot{\mathrm{N}}\mathrm{a}\ddot{\mathrm{C}}+10\dot{\mathrm{H}}$=Carbonic acid 26·7, soda 18·8, water 54·5. Wackenroder found in the Debreczin Natron, $\dot{\mathrm{N}}\mathrm{a}\,\ddot{\mathrm{C}}$ 89·84, Na Cl 4·34, $\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}$ 1·63, $\dot{\mathrm{N}}\mathrm{a}\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 1·46, $\dot{\mathrm{K}}\dddot{\mathrm{S}}$ 0·03, $\dot{\mathrm{M}}\mathrm{g}\ddot{\mathrm{C}}$ 0·24, $\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$ 0·24, $\dddot{\overline{\mathrm{F}}}\mathrm{e}$ and $\dddot{\mathrm{S}}\mathrm{i}$ 0·42, $\dot{\mathrm{N}}\mathrm{a}\,\dddot{\mathrm{S}}\mathrm{i}$ 1·61, $\dddot{\mathrm{S}}$ 0·15.—Effervesces strongly with nitric acid.

Occurs at the soda lakes of Egypt, at Debreczin in Hungary, at Vesuvius, Etna, and in various parts of Africa, Asia, and America. This is the *nitre* of the Bible.

GAY-LUSSITE, *Boussingault.*

Monoclinic. *C*=78° 27′, *I* : *I*=68° 50′.
O : 2ì=130° 21′. *O* : *I*=96° 30′. 1ì : 1ì=109° 30′.
O : ìi=101° 33′. *O* : 1ì=125° 15′. 1 : 1=110° 30′.
O : 1=136° 39′.

Cleavage: *I* perfect; *O* less so.

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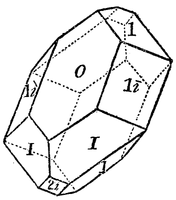


H.=2—3. G.=1·92—1·99. Lustre (obtained by fracture) vitreous. Streak grayish. Color yellowish-white. Translucent. Exhibits double refraction. Fracture conchoidal. Extremely brittle. Not phosphorescent by friction or heat.

Composition.—$\dot{\mathrm{N}}\mathrm{a}\ddot{\mathrm{C}}+\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}+5\dot{\mathrm{H}}$=Carbonate of soda 35·9, carbonate of lime 33·8, water 30·3=100. Analysis by J. B. Boussingault, (Ann. Ch. Phys., vii, [3], 488, 1843),

$\dot{\mathrm{N}}\mathrm{a}\ddot{\mathrm{C}}$ 34·5 $\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$ 33·6, $\dot{\mathrm{H}}$ 30·4, Clay 1·5=100.

Heated in a matrass, the crystals decrepitate and become opaque. With the fluxes it behaves like carbonate of lime; dissolves in nitric acid, with a brisk effervescence; partly soluble in water, and reddens turmeric.

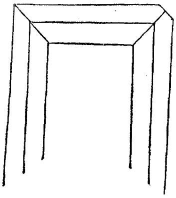
This mineral is abundant at Lagunilla, near Merida, in Maracaibo. Its crystals are disseminated at the bottom of a small lake, in a bed of clay, covering *urao.* The natives call it *clavos* or *nails*, in allusion to its crystalline form. It was named by Boussingault, in honor of Gay-Lussac. Also found near Sangerhausen in Thuringia.

Altered Forms.—Crystals altered to calcite, have been called *Natrocalcite.*

LANTHANITE, *Haid.* Carbonate of Cerium. Carbocérine, *Beudant.* Ceroxydul kohlensaures, *Berz.*, *Ramm.*

Trimetric. $I : I = 93° \; 30' - 94°$, Blake. In thin four-sided plates or minute tables, with beveled edges, as in the annexed figures. Also fine granular or earthy.

602



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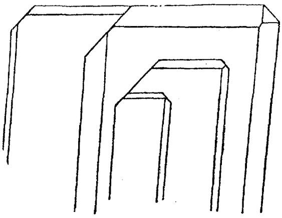

H.=2·5—3. G.=2·666, (?) Blake. Lustre dull or pearly. Color grayish-white, faint pink, or yellowish.

Composition.—$\dot{L}a\ddot{C}+3\dot{H}$=Lanthana 52·94, carbonic acid 21·11, water 25·95. Analysis by J. L. Smith, of American specimen, (Am. J. Sci., [2], xvi, 230):

$\dot{L}a$ (with ox. didymium) 54·90 $\ddot{C}$ 22·58 $\dot{H}$ 24·09=101·57.

Blake obtained, $\dot{L}a$ 54·27, 54·93, 54·64, $\ddot{C}$ 19·13, $\ddot{C}+\dot{H}$ (by ign.) 45·07, 45·36.

Hisinger found in a Swedish specimen, probably impure, $\dot{L}a$ 75·7, $\ddot{C}$ 10·8, $\dot{H}$ 13·5, whence the formula $\dot{L}a^3\ddot{C}+3\dot{H}$.

B.B. infusible; but whitens and becomes opaque, silvery and brownish, with borax, a glass slightly bluish, reddish, or amethystine on cooling; with salt of phosphorus, a glass bluish amethystine while hot, red cold, the bead becoming opaque when but slightly heated and retaining a pink color. Effervesces in the acids. In a matrass affords water.

Found coating cerite at Bastnäs, Sweden; also in silurian limestone with the zinc ores of the Saucon valley, Lehigh Co., Pa., in masses consisting of aggregated minute tables.

HYDROMAGNESITE, *Kobell.* Hydrocarbonate of Magnesia, *Thomson.* Lancasterite, *in part*, *Silliman.*

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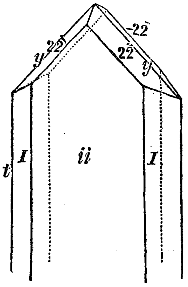

Monoclinic. $C = 82°-83°$, $I : I = 87° \; 52'$ to 88°, $O : 2\grave{\imath} = 137$; $a : b : c$ =(nearly)0·455 : 1 : 1·0973. Observed planes as in the annexed figure. $2\grave{2} : -2\grave{2}$ (adj.)=$143\frac{1}{2}°$ to 145°, $\dot{\imath}\grave{\imath} : 2\grave{2}$ = $113\frac{1}{2}°$ to 112°, $\dot{\imath}\grave{\imath} : -2\grave{2}$ =105°. Culminant angle between edges y, y (or $2\grave{\imath} : 2\grave{\imath}$)=94°, edge t on edge y (or $\dot{\imath}\grave{\imath} : 2\grave{\imath}$)=133°. Crystals small, usually acicular or bladed, and tufted. Also amorphous, or as chalky crusts.

H. of crystals 3·5. G.=2·145—2·18, Smith and Brush. Lustre vitreous to silky or subpearly; also earthy. Color and streak white. Brittle.

Composition.—$\dot{Mg}^4\ddot{C}^3+4\dot{H}$, or $3(\dot{Mg}\ddot{C}+\dot{H})+\dot{Mg}\dot{H}$=Magnesia 43·9, carbonic acid 36·3, water 19·8=100. Analyses: 1, Waltershausen, (K. V. Ac. H. 1827, 17): 2, Kobell, (J. f. pr. Ch. iv, 80); 3, 4, Smith and Brush, of crystalline varieties, (Am. J. Sci. [2], xv, 214):

	$\ddot{C}$	$\dot{Mg}$	$\dot{H}$	$\dddot{Si}$	
1. Hoboken,	36·82	42·41	18·53	0·57	$\dddot{\bar{F}}e$ 0·27, earthy matter 1·39 =99·99, Walt.
2. Negroponte,	36·00	43·96	19·68	0·36	=100, Kobell.
3. Texas, Pa., Wood's Mine,	36·69	43·20	19·43	——	Fe and Mn *tr.*=99·72, S. & B.
4. " Low's Mine,	36·74	42·30	20·10	——	" " *tr.*=99·14, "

B.B. infusible; yields moisture, and finally becomes pure magnesia. Effervesces and dissolves in acids.

Occurs at Hrubschitz, in Moravia in serpentine; in Negroponte near Kumi; in the United States, crystallized with serpentine and brucite, near Texas, Lancaster Co., Penn., at Wood's and Low's mines; also in a similar way at Hoboken, N. J., in acicular crystals like natrolite; at the latter place in earthy crusts. The Brucite of Hoboken sometimes changes on exposure to an earthy hydromagnesite.

The above angles and figure were taken by the author from a crystal one-fiftieth of an inch broad, in which the summit planes were smooth and brilliant, the prismatic striated. The rhombic prism in one crystal gave the angles 95° 20′ and 84° 50′; but other crystals gave different results, and no constant value was obtained. The species is isomorphous with Wollastonite, (p. 156).

The *Lancasterite* of Silliman, (Am. J. Sci. [2], ix, 226), is shown by Smith and Brush to be a mixture of Brucite and Hydromagnesite.

HYDRODOLOMITE. (Dolomite sinter, *Kobell*, J. pr. Ch. **xxxvi**, 304, Hydromagnocalcit, *Ramm.*) A hydromagnesite having part of the magnesia replaced by lime. Occurs in sinter-like globular or stalactitic masses yellowish and white, and earthy. *Composition*, $3[(\dot{Mg}, \dot{Ca})\ddot{C}+\dot{H}]+\dot{Mg}\dot{H}$, Ramm. Kobell obtained, Lime 25·22, magnesia 24·28, carbonic acid 33·10, water 17·40=100. From Somma, in isolated masses.

PREDAZZITE, Petzholdt. A kind of bitter spar mixed with Brucite, from Predazzo in the Southern Tyrol. H.=3·5. G.=2·634. J. Roth obtained, (J. f. pr. Chem. lii, 346):

	$\ddot{C}$	$\dot{Ca}$	$\dot{Mg}$	$\dddot{\bar{F}}e$, $\dddot{\bar{A}}l$	$\dddot{Si}$	$\dot{H}$
1.	27·45	33·53	23·27	2·88	3·28	10·26=100·67.
2.	33·35	46·67	14·54	0·48		6·96=100.

Analysis 1, corresponds to $\dot{Ca}\,\ddot{C}+\dot{Mg}\dot{H}$; 2, to $2\dot{Ca}\ddot{C}+\dot{Mg}\dot{H}$.

Brucite occurs in plates in the Predazzite, and hence the water.

Pennite of Hermann (*Hydronickelmagnesite* of Shepard) is a carbonate of lime and magnesia, containing two per cent. or less of carbonate of nickel, with some water. It occurs in incrustations having a surface of minute spherules; color pale green to whitish. Hermann obtained $\ddot{C}$ 44·54, $\dot{Ca}$ 20·10, $\dot{Mg}$ 27·02, $\dot{Ni}$ 1·25, $\dot{Fe}$ 0·70, $\dot{Mn}$ 0·40, $\dddot{\bar{A}}l$ 0·15, $\dot{H}$ 5·84=100. Occurs with emerald nickel, into which it graduates, and also with chromic iron, at Texas, Lancaster Co., Pa.; and according to Mr. Heddle, at Swinaness in Unst, Shetland.

HYDROCALCITE. Hydrous Carbonate of Lime, *Scheerer*, Ann. der Ph. u. Ch. lxviii, 381. Hydrokonit, *Haus.*

In small rhombohedral crystals, and forming an incrustation on wood under water.

Composition.—$\dot{Ca}\ddot{C}+5\dot{H}$=Carbonate of lime 52·4, and water 47·6. Exposed to the air, the water passes off and it becomes anhydrous. The crystals contain one per cent. of organic matter. By the action of absolute alcohol, it loses two equivalents of water.

A blue limestone from Vesuvius analyzed by Klaproth, (Beit. v, 91), has the formula $2\dot{Ca}\ddot{C}+\dot{Ca}\dot{H}^2$, consisting of Lime 58·00, carbonic acid 28·50, water 11·00, earthy impurities 2·25=99·75.

MALACHITE. Green Carbonate of Copper. Cuivre Carbonaté Vert, *H.* Mountain Green. Atlaserz.

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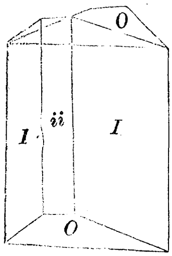

Monoclinic; *C*=61° 49′. *I* : *I*=103° 42′. Observed planes as in the annexed figure, with sometimes *ii*. *I* : *ii*=141° 51′. Cleavage: basal, highly perfect; clinodiagonal less distinct. Twins: plane of composition, *ii*. Usually massive or incrusting, with surface tuberose, botryoidal, or stalactitic, and structure divergent; often delicately compact fibrous, and banded in color; frequently granular or earthy.

H.=3·5—4. G.=3·7—4·008. Lustre adamantine, inclining to vitreous; fibrous varieties often silky; often dull and earthy. Color bright green. Streak paler green. Translucent—subtranslucent—opaque. Fracture subconchoidal, uneven.

Composition.—$\dot{C}u^2\ddot{C}+\dot{H}$=Carbonic acid 19·9, protoxyd of copper 71·9, water 8·2. Analyses: 1, Klaproth, (Beit. ii, 287); 2, Vauquelin, (Ann. du Mus. xx, 1); 3, Phillips, (Jour. Royal Inst. iv, 276):

1.	$\ddot{C}$ 18·0	$\dot{C}u$ 70·5	$\dot{H}$ 11·5=100, Klaproth.
2.	21·25	70·10	8·75=100·10, Vauquelin.
3.	18·5	72·2	9·3=100, Phillips.

B.B. like Azurite.

Green malachite usually accompanies the other ores of copper. Perfect crystals are quite rare. The fibrous variety occurs abundantly in Siberia, at Chessy in France, in the old mine at Sandlodge, in Shetland; the compact occurs at Schwartz in the Tyrol; also in Cornwall, and in Cumberland. Crystals occur at Grimberg, near Siegen in Germany. At the copper mines of Nischne Tagilsk, belonging to M. Demidoff, a bed of malachite was opened which yielded many tons of malachite; one mass measured at top 9 feet by 18; and the portion uncovered contained at least half a million pounds of pure malachite. Also in handsome masses on the west coast of Africa.

Neat specimens occur with vitreous copper at Cheshire, Connecticut; at Schuyler's mines, and still better at New Brunswick, New Jersey; between Newmarket and Taneytown, Md., east of the Monocacey; also in the Catoctin Mountains, Md.; in the Blue Ridge, in Pennsylvania, near Nicholson's Gap; near Morgantown, Berk's County, Penn., in good specimens; at the Perkiomen and Phenix lead mines, Pa.; and at the copper mines of Wisconsin; at Mineral Point, and elsewhere.

Green malachite admits of a high polish, and when in large masses, is cut into tables, snuff boxes, vases, &c.

Mysorin.—Massive. G.=2·62. Soft. Color blackish-brown, when pure; usually green or red, from mixture with malachite and red oxyd of iron. Fracture conchoidal.

Composition, according to Thomson, (Min. i, 601), Carbonic acid 16·70, oxyd of copper 60·75, peroxyd of iron (mechanically mixed) 19·50, silica 2·10, loss 0·95. Gives no water in a glass tube. Occurs at Mysore, in Hindostan. May be an impure malachite.

Lime-Malachite. (Kalk-malachit, *Zincken*).—Massive, reniform, botryoidal; structure fibrous and foliated.

H.=2·5. Lustre silky. Color verdigris-green.

From Zincken's trials it is a hydrous carbonate of copper, with some carbonate and sulphate of lime and iron. From Lauterberg in the Hartz.

AZURITE, *Beud.* Blue Copper. Blue Carbonate of Copper. Blue Malachite. Chessy Copper. Kupferlasur, *W.* Chessylite, *B. and M.* Lasurite, *Haid.*

Monoclinic. $C=87° 39'$; $I : I=99° 32'$, $O : 1\grave{i}=138° 41'$; $a : b : c=1{\cdot}039 : 1 : 1{\cdot}181$.

$O : I=91° 48'$
$O : ii=92° 21'$.
$O : 1i=132° 43'$.
$O : 1=125° 8'$.
$O : 2=108° 35'$.
$O : -1=127° 28'$.
$1 : 1$ (front)$=116° 7'$.
$-1 : -1$ " $=118° 16'$.
$ii : 1i=134° 56'$.
$ii : \frac{1}{2}i=115° 35'$.
$1\grave{i} : 1\grave{i}$ (bas.)$=82° 38'$.
$2\grave{i} : 2\grave{i}$ (bas.)$=120° 46'$.
$i2 : i2=134° 8'$.
$i\frac{3}{2} : i\frac{3}{2}=121° 10'$.
$i\grave{2} : i\grave{2}=118° 50'$.
$ii : 2i=153° 51'$.
$ii : I=139° 46'$

O							
					$\frac{2}{5}2$		$\frac{2}{5}\grave{i}$
				$\frac{2}{3}$			$\frac{2}{3}\grave{i}$
						$\frac{3}{4}\grave{3}$	
					$\frac{4}{5}\grave{2}$		
$1i$				1			$1\grave{i}$
					$\frac{4}{3}\grave{2}$		
$2i$		22		2			$2\grave{i}$
	44				$4\grave{2}$		
ii		$i2$	$i\frac{3}{2}$	I	$i\grave{2}$		$i\grave{i}$
$-2i$				-2	$-2\grave{2}$		
					$-\frac{4}{3}\grave{2}$		
$-1i$				-1			

Observed Planes. Add $\frac{1}{8}i$, $\frac{1}{6}i$, $\frac{1}{2}i$, $\frac{3}{2}i$, $3i$, $-\frac{1}{2}i$.

Cleavage: $2\grave{i}$ rather perfect; ii less distinct, I in traces. Also massive and presenting imitative shapes, having a columnar composition; also dull and earthy.

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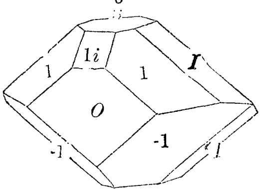

H.=3·5—4·25. G.=3·5—3·831. Lustre vitreous, almost adamantine. Color various shades of azure-blue, passing into Berlin-blue. Streak blue, lighter than the color. Transparent—subtranslucent. Fracture conchoidal. Brittle.

Composition.—$2\dot{C}u\ddot{C}+\dot{C}u\dot{H}$ [$=(\dot{C}u, \dot{H})^2\ddot{C}$]=Carbonic acid 25·6, protoxyd of copper 69·2, water 5·2. Analyses: 1, Phillips, (Jour. Roy. Institution, iv, 276); 2, Vauquelin, (Ann. du Mus. xx, 1):

1. Chessy,	$\ddot{C}$ 25·46	$\dot{C}u$ 69·08	$\dot{H}$ 5·46=100, Phillips.
2. "	25·0	68·5	6·5=Vauquelin.

In a matrass yields water and blackens. B.B. on charcoal fuses, and affords a globule of copper, and in the forceps the flame is green. Borax is colored green. It dissolves with effervescence in the acids, and also in ammonia.

Azurite occurs in splendid crystallizations, at Chessy, near Lyons, whence it derived the name *Chessy Copper*. It also occurs in fine crystals in Siberia; at Moldawa, in the Bannat; at Wheal Buller, near Redruth, in Cornwall; at Porto Cabello, S. A.; also in small quantities at Alston Moor, and Wanlockhead, &c.

This mineral occurs in indifferent specimens at the Perkiomen lead mine, associated with galena, blende, and white lead ore; also near Nicholson's gap, in the

Blue Ridge, Penn., and near Sing Sing, N. Y.; near New Brunswick, N. J., in crystals coating red shale at Cornwall, Pa.

When abundant, azurite is a valuable ore of copper. When ground to an impalpable powder, it forms a blue paint of a bright tint; but it is of little value as a pigment, on account of its liability to turn green.

ALTERED FORMS.—Azurite occurs altered to Malachite, through the addition of carbonic acid.

AURICHALCITE, *Böttger*, Pogg. xlviii, 495. Green Calamine, *Patrin*.

In acicular crystals forming drusy incrustations; also columnar and granular; also laminated.

H.=2. Lustre pearly. Color verdigris-green. Translucent.

Composition.—$2(\dot{Zn}, \dot{Cu})\ddot{C}+3(\dot{Zn}, \dot{Cu})\dot{H}$, G. Rose=Oxyd of copper 29·2, oxyd of zinc 44·7, carbonic acid 16·2, water 9·9. Analyses: 1, 2, Böttger, (loc. cit.); 3, Connel:

	$\dot{Zn}$	$\dot{Cu}$	$\dot{Ca}$	$\ddot{C}$	$\dot{H}$	
1. Altai,	45·839	28·192	——	16·056	9·951	=100·057, Böttger.
2 "	45·620	28·357	——	16·077	9·933	= 99·987, Böttger.
3. Matlock,	42·7	32·5	*trace*	27·5		=102·07, Connel.

B.B. in a matrass gives out water, which has neither acid nor alkaline reaction, and the green crystals become brownish-black. In the outer flame, the color becomes darker, but it does not fuse; in the reduction flame, forms a slag without melting, yellow while hot, and white on cooling. With borax and salt of phosphorus, intumesces and affords a green glass. With equal quantities of soda and borax; becomes reduced, affording a globule of copper in a slag of zinc oxyd. Soluble in muriatic acid with effervescence.

Aurichalcite occurs at Loktefskoi, at a copper mine of the Altai, where it is associated with calc spar and brown iron ore, sometimes forming a drusy covering upon these minerals; also near Kleopinski, (Patrin's *green calamine*), in cavities; at Retzbanya in Hungary; also at Matlock, in Derbyshire, of a pale-green color, laminated structure and pearly lustre, and at Roughten-Gill in Cumberland.

BURATITE, *Delesse*, Ann. Ch. Phys. 3d ser. xviii, 478.

In radiated acicular crystals or plumose aggregations. Color verdigris-green. G.=3·32.

Composition.—$(\frac{1}{2}\dot{Zn}+\frac{1}{3}\dot{Cu}+\frac{1}{6}\dot{Ca})^2\ddot{C}+\dot{H}$. Perhaps a mechanical mixture, the lime being carbonate of lime. Analysis by Delesse, (loc. cit.):

$\ddot{C}$ 21·45, $\dot{Zn}$ 32·02, $\dot{Cu}$ 29·46, $\dot{Ca}$ 8·62, $\dot{H}$ 8·45=100.

Associated with calamine at Loktefskoi in the Altai Mountains; said to occur also at Chessy, near Lyons; at Campiglia in Tuscany; Framont in Tyrol. Closely related to aurichalcite and probably the same species. The Chessy ore afforded $\ddot{C}$ 19·88, $\dot{Zn}$ 41·19, $\dot{Cu}$ 29, $\dot{Ca}$ 2·16, $\dot{H}$ 7·62=99·85.

ZINC BLOOM, *Smithson*. Dicarbonate of Zinc. Zinconise, *Beud.* Zinkblüthe.

Earthy incrustations, and reniform.

H.=2—2·5. G.=3·58—3·6. Lustre dull. Color white, grayish or yellowish. Streak shining. Opaque.

Composition.—$\dot{Zn}^3\ddot{C}+3\dot{H}$ or $\dot{Zn}\ddot{C}+\dot{Zn}^2\dot{H}^3$=Carbonic acid 12·89, oxyd of zinc 71·28, water 15·83. Analysis by Smithson, (loc cit.), $\ddot{C}$ 13·50, $\dot{Zn}$ 69·38, $\dot{H}$ 15·10=97·98.

EMERALD NICKEL, *Silliman, Jr.*

Incrusting, and often small stalactitic or minute mammillary, and sometimes appearing prismatic with rounded summits. Also massive, compact.

H.=3—3·25. G.=2·57—2·693. Lustre vitreous. Color emerald-green; streak paler. Transparent—translucent. Brittle.

Composition.—$\dot{\mathrm{N}}\mathrm{i}^3\,\ddot{\mathrm{C}}+6\dot{\mathrm{H}}$(or $\dot{\mathrm{N}}\mathrm{i}\,\ddot{\mathrm{C}}+2\dot{\mathrm{N}}\mathrm{i}\,\dot{\mathrm{H}}^3$)=Carbonic acid 11·66, oxyd of nickel 59·72, water 28·62; often containing magnesia in place of part of the oxyd of nickel. Analyses: 1, B. Silliman, Jr., (Am. J. Sci. [2], vi, 248); 2, Smith and Brush, (ib. xvi, 52):

1.	$\dot{\mathrm{N}}\mathrm{i}$ 58·811,	$\ddot{\mathrm{C}}$ 11·691,	$\dot{\mathrm{H}}$ 29·498.	
2.	56·82	11·63	29·87,	$\dot{\mathrm{M}}\mathrm{g}$ 1·68.

In a matrass yields water, and loses color. With borax affords a transparent bead of a dark yellow or reddish color when hot, and nearly colorless when cold. In the inner flame the bead is gray from the presence of particles of metallic nickel. Dissolves easily with effervescence in heated dilute muriatic acid.

Occurs on chromic iron at Texas, Lancaster Co., Pa., associated with serpentine; also at Swinaness in Unst, Shetland.

REMINGTONITE. *J. C. Booth*, Am. J. Sci. [2], xiv, 48.

A rose-colored incrustation, softy and earthy; opaque. Streak pale rose-colored.

Composition.—A hydrous carbonate of cobalt, but precise composition not ascertained. Dissolves in muriatic acid with a slight effervescence, making a green solution, the color due to iron. Cobalt reaction with borax.

Occurs as a coating on thin veins of serpentine, which traverse hornblende and epidote, at a copper mine near Finksburg, Carroll Co., Maryland.

ZIPPEITE. Uranochre. Uranblüthe. Uraconise, *Beud.*

Earthy and pulverulent. Color sulphur-yellow, citron-yellow to brownish or reddish-yellow. Opaque.

Composition.—Probably $\ddot{\bar{\mathrm{U}}}$ with water and some carbonic acid. It dissolves in acid, yielding a yellow solution, which affords a brown precipitate with prussiate of potash. Heated gently it becomes orange-yellow. In the reducing flame changes to green, but does not fuse.

Accompanies pitchblende in Cornwall, at Joachimstahl in Bohemia, and at Symphorien in France. At the Callington tin mine, Cornwall, it has been observed in masses of considerable size, which were said to be quite free from carbonic acid. It is found sparingly with columbite and uranite at the feldspar quarry near Middletown, Ct.

LIEBIGITE, *J. L. Smith*, Am. J. Sci. [2], v, 336, and xi, 259.

In mammillary concretions, or thin coatings: cleavage apparent in one direction.

H.=2—2·5. Lustre of fracture vitreous. Color beautiful apple-green. Transparent.

Composition.—$\ddot{\bar{\mathrm{U}}}\ddot{\mathrm{C}}+\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}+20\dot{\mathrm{H}}$=Carbonic acid 11·1, oxyd of uranium 36·3, lime 7·1, water 45·5; or 2 $\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}+\ddot{\bar{\mathrm{U}}}^2\ddot{\mathrm{C}}+36\mathrm{H}$, Ramm. =$\ddot{\mathrm{C}}$ 9·02, $\ddot{\bar{\mathrm{U}}}$ 39·12, $\dot{\mathrm{C}}\mathrm{a}$ 7·67, H 44·19 =100. Analysis by J. L. Smith, (loc. cit.):

$\ddot{\bar{\mathrm{U}}}$ 38·0, $\dot{\mathrm{C}}\mathrm{a}$ 8·0 $\ddot{\mathrm{C}}$ 10·2, $\dot{\mathrm{H}}$ 45·2.

In a matrass yields much water, and becomes yellowish-gray. At redness it blackens, without fusing, and on cooling *returns to an orange-red* color. At a higher heat it blackens, and remains so on cooling. With borax it gives a yellow glass in the outer flame, and a green glass in the inner. Tested for vanadic acid, but none found. Dissolves readily in dilute acids with violent effervescence, and affords a yellow solution, with the reaction of uranium and lime.

Occurs with Medjidite on pitchblende, near Adrianople, Turkey; also at Johanngeorgenstadt and Joachimstahl. Dr. Smith states that both the lime and uranium of this salt are derived from the pitchblende.

A related mineral from Elias mine near Joachimstahl, has been examined by Vogl and J. Lindacker, (Jahrb. k. k. R., iv, 1853, 221). It occurs in scaly aggregations on pitchblende, and has a siskin-green color, and a pearly lustre on a cleavage face; subtransparent to translucent; H.=2·5—3·0. B.B. on charcoal infusible; with borax and salt of phosphorus, the reaction of uranium. Dissolves with effervescence in sulphuric acid, a white deposit being thrown down; solution in sulphuric and muriatic acids, green, in nitric acid, yellow.

Composition according to J. Lindacker, (loc. cit.), $\ddot{U}\ddot{C}+\dot{Ca}\ddot{C}+5\dot{H}$. Analysis: $\ddot{C}$ 24·18, $\ddot{U}$ 37·03, $\dot{Ca}$ 15·55, $\dot{H}$ 23·24=100.

VOGLITE, *Haidinger*. Uran-kalk-kupfer-Carbonat, *Vogl*.

In aggregations of crystalline scales. Scales rhomboidal somewhat like gypsum, with angles of 100° and 80°, Haid.

Lustre pearly. Color emerald-green to bright grass-green. Dichroic.

Composition.—$2\ddot{U}\ddot{C}+\dot{Ca}\ddot{C}+\dot{Cu}^3\ddot{C}^2+14\dot{H}$, Lindacker, from his analysis, (Jahrb. k. k. R. iv, 1853, 221):

$\ddot{C}$ 26·41, $\ddot{U}$ 37·00, $\dot{Ca}$ 14·09, $\dot{Cu}$ 8·40, $\dot{H}$ 13·90=100.

B.B. in a tube yields water; on charcoal does not fuse; in the platinum forceps colors the flame green, especially after wetting the assay with some muriatic acid; with borax in oxydation flame, a pearl, which is green while hot, and brown and opaque on cooling. Dissolves easily in dilute muriatic acid.

From the Elias mine near Joachimstahl, implanted on pitchblende.

BISMUTITE, *Breit.*, Pogg. liii, 627. Wismuthoxyd Kohlensaures. Bismuthite, *Nicol.* Wismuthspath. Carbonate of Bismuth. Agnesite.

In implanted acicular crystallizations, (pseudomorphous); also incrusting, or amorphous.

H.=4—4·5; 3·5, specimens that have lost their lustre. G.=6·86—6·909, Breit.; 7·670, from South Carolina, Rammelsberg. Vitreous when pure; sometimes dull. Color white, mountain-green and dirty siskin-green; occasionally straw-yellow and yellowish-gray. Streak greenish-gray to colorless. Subtranslucent—opaque. Brittle.

Composition.—According to Plattner's examinations, (Pogg. liii, 727), it is a carbonate of bismuth, containing some iron and copper, (perhaps a carbonate of each), and also sulphuric acid. Melts on a burning coal, and is reduced with effervescence to a metallic globule, covering the coal at the same time with white oxyd of bismuth. Dissolves in muriatic acid, affording a deep yellow solution.

Rammelsberg examined specimens from South Carolina, probably of this species, and obtained the formula, $3(\dddot{Bi}\ddot{C}+\dot{H})+\dddot{Bi}\dot{H}$ $(=\dddot{Bi}^4\ddot{C}^3\dot{H}^4)$=Oxyd of bismuth 90·28, carbonic acid 6·29, water 3·43=100. Analysis, (Pogg. lxxvi, 564, 1849):

$\dddot{Bi}$ 90·00, $\ddot{C}$ 6·56, $\dot{H}$ 3·44=100.

In a matrass yields water. B.B. decrepitates, darkens in color, becoming brownish-yellow, and fuses easily to a glass. On charcoal affords bismuth. With salt of phosphorus becomes dull yellow, and forms a colorless pearl, containing floating silica. Dissolves in nitric acid, and the solution is clouded on the addition of water.

Bismutite occurs at Schneeberg and Johanngeorgenstadt, with native bismuth, and near Hirschberg in Russian Voigtland, with brown iron ore, native bismuth, and bismuth glance. Also in the gold district of Chesterfield, S. C., in porous yellowish masses, sometimes reddish from oxyd of iron. Surface of fracture white and vitreous. It resembles somewhat electric calamine. It is supposed to proceed from native bismuth.

III. CARBONATES WITH CHLORID OR FLUORID.

PARISITE, $\dot{R}\ddot{C}+RF$? CERASINE, $Pb\ddot{C}+PbCl$.

PARISITE, *L. di Medici-Spada.* Mussonite, *Duf.*

Hexagonal. In elongated double six-sided pyramids, with truncated apex; basal angle 164° 58′, pyramidal 120° 34′. Cleavage: basal, very perfect.

H.=4·5. G.=4·35. Vitreous; cleavage face pearly or resinous. Color brownish-yellow; streak yellowish-white.

Composition.—$8\dot{R}\ddot{C}+2CaF+\dot{R}\dot{H}^2$, in which $\dot{R}$=Protoxyd of cerium, lanthanum and didymium, *Bunsen.* Perhaps $\dot{R}\ddot{C}+RF$ with $\dot{C}e\dot{H}$ as impurity, *Ramm.* Analyses by Bunsen, (Ann. d. Ch. u. Pharm. liii, 147):

	$\ddot{C}$	$\dot{C}e$ (with $\dot{L}a$ and $\dot{D}$)	$\dot{C}a$	$\dot{H}$	CaF
1.	23·51	59·44	3·17	2·38	11·51
2.	23·64	60·26	3·15	2·42	10·53

Yields on heating, carbonic acid and water, and becomes brownish, but does not fuse. A clear glass with borax, yellow while hot, and colorless cold. Dissolves slowly with effervescence in muriatic acid.

From the emerald mines of the Musso valley, New Grenada.

CERASINE, *Beud.* Corneous Lead. Murio-Carbonate of Lead. Chloro-Carbonate of Lead, *Thomson.* Plomb Chloro-Carbonaté, *Duf.* Bleihornerz. Phosgenite, *Breit.* Hornblei, *Haus.*

Dimetric. *O* : 1*i*=132° 40′; *a*=1·0847. Observed planes, as in the annexed figure, with also 22 and *i*2.

O : 1=123° 6′. *I* : 1=146° 54′.
O : 22=112° 24′. 1 : 1 (pyr.)=107° 21′.
O : *I*=90°. *I* : *ii*=135°.

Cleavage: *I* and *ii* bright; also basal.

H.=2·75—3. G.=6—6·3; 6·305, Ramm. Lustre adamantine. Color white, gray, and yellow. Streak white. Transparent—translucent. Rather sectile.

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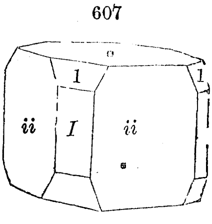

Composition.—$PbCl+\dot{P}b\ddot{C}$=Chlorid of lead 51, carbonate of lead 49=100. Analysis by Klaproth, corrected by Berzelius, (Beit. iii, 141, Schw. J. xxii, 281):

Oxyd of lead 85·5, Muriatic acid 14·0, Carbonic acid 6·0=105·5.

Dr. R. A. Smith obtained from a specimen from near Matlock, Chlorid of lead 51·784, carbonate of lead 48·215=99·999; and Rammelsberg from the same, 50·93 of the former, to 47·45 of the latter, (Pogg. lxxxv, 141).

B.B. melts readily to a yellow globule, which on cooling becomes white and crystalline. On charcoal lead is obtained. Dissolves with effervescence in nitric acid.

At Crawford, near Matlock, in Derbyshire, where some of the crystals were two or three inches long; very rare in Cornwall; in minute crystals at a lead mine near Elgin in Scotland. Some crystals recently obtained at Crawford, sold for fifteen to twenty pounds sterling each.

VII. OXALATES.

Whewellite.

Oxalite, $2\dot{\mathrm{F}}\mathrm{e}\,\dddot{\mathrm{C}}+3\dot{\mathrm{H}}$.

Conistonite, $\dot{\mathrm{C}}\mathrm{a}\,\dddot{\mathrm{C}}+7\dot{\mathrm{H}}$.

WHEWELLITE, *B. and M.* Oxalate of Lime, *H. T. Brooke*, Phil. Mag. xvi, 449. Oxacalcite, *Shepard.*

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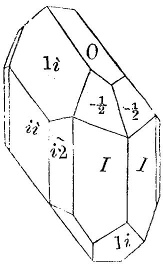

Monoclinic. *C*=72° 41′, *I* : *I*=100° 36′, *O* : 1*i*=127° 25′; *a* : *b* : *c*=1·5745 : 1 : 1·1499. Observed planes as in the annexed figure. *O* : *I*=103° 14′, *O* : 1*i*=109° 28′, *O* : $-\frac{1}{2}$=141° 6′, *I* : *ii*=129° 42′. Cleavage parallel with *O*; less perfect parallel with *I*, and the longer diagonal. All the planes bright except *I* and $-\frac{1}{2}$, which are vertically striated. Twins: composition face 1*i*.

H.=2·5—2·75. Lustre like sulphate of lead. Very brittle. Fracture conchoidal.

This species, an Oxalate of lime, was observed by Brooke in crystals from a tenth to a fourth of an inch broad on calc spar; the locality of the spar is not known.

OXALITE, *Haus.* Oxalate of Iron. Humboldtine, *Mariano de Rivero,* Ann. de Ch. et de Ph. xviii, 207. Eisen-resin, *Breithaupt.*

In capillary forms; also botryoidal and in plates, or earthy; structure fibrous or compact.

H.=2. G.=2·13—2·489. Dull or slightly resinous. Color yellow. Fracture uneven, earthy. Acquires negative electricity by friction, when insulated.

Composition.—$2\dot{\mathrm{F}}\mathrm{e}\dddot{\mathrm{C}}+3\dot{\mathrm{H}}$=Protoxyd of iron 41·40, oxalic acid 42·69, water 15·91 =100. Analysis by Rammelsberg, (Pogg. xlvi, 283):

$\dot{\mathrm{F}}\mathrm{e}$ 41·13, Oxalic acid 42·40, (loss) 16·47=100.

Mariano de Rivero obtained, Oxalic acid 46·14, and protoxyd of iron 53·86. Rammelsberg (Pogg. liii, 631, 1841) has confirmed his former analysis and shown that the iron is all protoxyd.

Blackens in the flame of a candle, and becomes attractable by the magnet. B.B. on charcoal yields a vegetable odor, and is decomposed, becoming at first yellow, then black, and finally red.

It occurs at Kolosoruk, in Bohemia, and in the opinion of Rivero, has resulted from the decomposition of succulent plants; also in brown coal at Gross-Almerode, in Hessia; and according to T. S. Hunt, at C. Ipperwash, Canada, in shales; soft, earthy, sulphur yellow, (Logan's Report, 1850).

CONISTONITE, *R. P. Greg, Jr.*, Am. J. Sci. [2], xvii, 333, 440, 1854.

Trimetric. Observed angles, (Greg): $I : I=97^\circ\ 5'$, $1\bar{\imath} : 1\bar{\imath}$ (top) $=86^\circ\ 30'$, $1\breve{\imath} : 1\breve{\imath}$ (top)$=96^\circ\ 50'$, $I : 1\breve{\imath}=117^\circ\ 30'$, $1\bar{\imath} : 1\breve{\imath}=121^\circ\ 0'$. Faces I brightest. Cleavage none.

H.=2. G.=2·052. Lustre vitreous. Colorless. Transparent to translucent. Slightly sectile. Fracture small conchoidal, uneven.

Composition.—$\dot{\mathrm{Ca}}\,\ddot{\bar{\mathrm{C}}}+7\dot{\mathrm{H}}$, M. F. Heddle, who obtained in his analysis, Oxalic acid 28·017, lime 21·055, soda and magnesia 0·822, water 49·155=99·049.

Soluble without effervescence in muriatic or nitric acid. Heated gives off water and carbonic oxyd, and is converted into a carbonate, and then effervesces with acids.

From the copper mine near Coniston in Cumberland. Largest crystals not more than one-eighth of an inch across, and in general form not unlike the double four-sided crystals of Edingtonite.

THIERSCHITE, *Liebig*, Ann. d. Ch. u. Pharm. lxxxvi, 113, April, 1853.

An oxalate of lime, occurring as a grayish, warty, and somewhat opaline incrustation, about a line thick, on the marble of the Parthenon, Athens. A complete analysis has not yet been made. Its origin is attributed to the action of some kind of vegetation on the marble. It is probably identical with whewellite.

V. RESINS—ORGANIC COMPOUNDS.

AMBER. Yellow Mineral Resin, *M.* Bernstein *of the Germans.* Succin, *H.* Succinite, *Breit.* Succinum. Ηλεκτρον. Λυγκουριον. Lyncurion, *Demostr.*

In irregular masses, without cleavage.

H.=2—2·5. G.=1·081. Lustre resinous. Color yellow, sometimes reddish, brownish, and whitish, often clouded. Streak white. Transparent—translucent.

Composition.—$C^{10} H^{8} O$=Carbon 78·96, hydrogen 10·51, oxygen 10·52. Analyses: 1, Drapier: 2, Schrötter, (Pogg. Ann. lix, 64):

	C	H	O	Ca	$\dddot{\bar{\text{A}}}\text{l}$	$\ddot{\text{Si}}$	Total.
1.	80·99	7·31	6·73	1·54	1·10	0·63	97·90.
2.	78·824	10·228	10·9				100·00.

Burns readily with a yellow flame, emitting an agreeable odor, and leaves a black shining carbonaceous residue. Fuses at 287° C. Becomes electric by friction. Soluble in alcohol.

Amber occurs abundantly on the Prussian coast of the Baltic; occurring from Dantzig to Memel, especially between Pillau and Dorfe Gross-Hubnicken. It occurs also on the coast of Denmark and Sweden; in Gallicia, near Lemberg, and at Miszau; in Poland; in Moravia, at Boskowitz, etc.; in the Urals, Russia; near Christiania, Norway; in Switzerland, near Bâle; in France, near Paris in clay, in the department of the Lower Alps, with bituminous coal, also in the department of l' Aisne, de la Loire, du Gard, du Bas Rhin. In England, near London, and on the coast of Norfolk, Essex, and Suffolk. It also occurs in various parts of Asia. Also near Catania, on the Sicilian coast, sometimes of a peculiar blue tinge. At Hasen Island in Greenland, it also occurs in brown coal.

It has been found in various parts of the Green sand formation of the United States, either loosely imbedded in the soil, or engaged in marl or lignite, as at Gay Head or Martha's Vineyard, near Trenton and also at Camden in New Jersey, and at Cape Sable, near Magothy river in Maryland.

The vegetable origin of amber is now fully ascertained. This is inferred both from its native situation with coal, or fossil wood, and from the occurrence of insects encased in it. Of these insects, some appear evidently to have struggled after being entangled in the then viscous fluid, and occasionally a leg or wing is found some distance from the body, which had been detached in the effort to escape. Göppert has named the tree yielding it *Pinites succinnifer.*

Amber was early known to the ancients, and called *ηλεκτρον*, *electrum,* whence, on account of its electrical susceptibilities, we have derived the word *electricity.* It was called by some Lyncurium, though this name was applied, as is supposed, also to Tourmaline, another mineral of remarkable electrical properties; also succinum, because of its supposed vegetable origin, as stated by Pliny, "quod arboris *succum,* prisci nostri credidere."

Amber is extensively employed for ornamental purposes, though not of high value. In the royal museum at Berlin, there is a mass weighing fourteen pounds. Another in the kingdom of Ava, India, is nearly as large as a child's head; it is intersected by veins of carbonate of lime, from the thickness of paper to one twentieth of an inch.

It is used in the manufacture of a varnish, and for obtaining succinic acid and oil of amber, which it affords at a low temperature.

COPALINE, *Hausmann.* Fossil Copal, Highgate Resin, *Aikin, Jameson.*

Like the resin Copal in hardness, color, lustre, transparency, and difficult solubility in alcohol. Emits a resinous odor when broken.

Composition.—$C^{40}H^{32}O$. Analysis by Johnston, (Phil. Mag. xiv, 87, 1839):

Carbon 85·408, Hydrogen 11·787, Oxygen 2·669, Ashes 0·136=100.

Volatilizes in the air by a gentle heat, and burns easily with a yellow flame and much smoke. Slightly acted upon by alcohol.

Comes from the blue clay of Highgate Hill, near London, from whence it is called Highgate resin.

Another resin, resembling the fossil copal in external appearance, has been examined by Johnston, and found to consist of Carbon 85·133, hydrogen 10·853, ashes 3·256=99·242, or nearly C^4H^3. It occurs in the form of flattened drops or coatings on calc spar, on the walls of a dyke of trap, at the old lead mine in Northumberland, called *Settling Stones.* Color pale yellow to deep red, with a pale green opalescence. G.=1·16–1·54. Hard, but brittle. Does not melt at 400° F., but burns in the flame of a candle with an empyreumatic odor. Insoluble in water and nearly so in alcohol.

A pale honey-yellow resin from the East Indies, is described by Kengott, (Min. Unters. ii, 81, 153). H.=2. Streak white. G.=1·053. Heated, fuses to a clear fluid, burns with a yellow light and aromatic smell, and is consumed without residue. But little soluble in alcohol, and largely in concentrated sulphuric acid. Duflos found it to contain C 85·73, H 11·50, O 2·77=100, or near the Highgate resin.

MIDDLETONITE, *J. F. W. Johnston,* Phil. Mag. xii, 261, 1838.

In rounded masses, seldom larger than a pea, or in layers a sixteenth of an inch or less in thickness, between layers of coal.

Brittle. G.=1·6. Lustre resinous. Color reddish-brown by reflected light, and deep red by transmitted; powder light-brown. Transparent in small fragments. No taste or smell. Blackens on exposure.

Composition.—$C^{20}H^{10}+HO$; Carbon 86·437, hydrogen 8·007, oxygen 5·563=100·007, Johnston. Not altered at 400° F., (210° C.); on a red cinder, burns like resin. Boiled in alcohol, ether, or oil of turpentine, the liquid becomes yellow, but dissolves only a mere trace of the resin. Softens and melts in boiling nitric acid, with the emission of red fumes; a brown flocky precipitate falls on cooling. Soluble in cold concentrated sulphuric acid.

Occurs about the middle of the main coal or Haigh Moor seam, at the Middleton collieries, near Leeds; also at Newcastle.

RETINITE. Retinasphaltum, *Hatchett,* Phil. Trans. 1804.

Occurs in roundish masses.

H.=1–2·5. G.=1·135, Hatchett. Lustre often earthy externally, but slightly resinous in the fracture. Color light yellowish-brown, sometimes green, yellow, red or striped. Subtransparent—opaque. Fracture conchoidal. Often flexible and elastic, when first dug up; but it loses this property on exposure.

Composition.—According to Hatchett, (Phil. Trans. 1804, p. 404):

Vegetable resin 55, Bitumen 41, Earthy matter 3=99, H.

Johnston, after drying it at 300° F., obtained, (Phil. Mag. xii, 560, 1838), Resin soluble in alcohol 59·32, insoluble organic matter 27·45, white ash 13·23=100. It takes fire in a candle, and burns with a bright flame and fragrant odor. The insoluble matter, heated in a tube, blackens and gives off an empyreumatic ordor: at a red heat, it burns. The whole is soluble in alcohol, excepting an unctuous residue.

This species was first observed near Devonshire, by Dr. Milles, accompanying Bovey coal. A specimen from Cape Sable, U. S., afforded Troost 55½ parts soluble in alcohol, and 42½ parts insoluble with 1½ per cent. of alumina and oxyd of iron as an ash.

A retinite from Halle afforded Bucholz, (Schweig. J. i, 290), 91 parts soluble in alcohol, and 9 parts insoluble.

SCLERETINITE, *J. W. Mallet*, (Phil. Mag. [4], 4, 261).

In small drops or tears, from the size of a pea to that of a hazel nut.

H.=3. G.=1·136. Translucent in thin splinters. Color black, but by transmitted light reddish-brown; streak cinnamon-brown. Lustre between vitreous and resinous, rather brilliant. Brittle; fracture conchoidal.

Composition.—Analyses by J. W. Mallet, (loc. cit.)

	Carbon	Hydrogen	Oxygen	Ash
1.	76·74	8·86	10·72	3·68
2.	77·15	9·05	10·12	3·68

Affords the ratio $C^{10}H^7O$=Carbon 77·05, hydrogen 8·99, oxygen 10·28, ash 3·68. Taking the number of atoms of carbon at 40, which exists in so many resins, the formula becomes $C^{40}H^{28}O^4$. It is nearest in composition to amber, which contains $C^{40}H^{32}O^4$.

Heated in platinum foil, it swells up, burns like pitch, with a disagreeable empyreumatic smell, and a smoky flame, leaving a coal rather difficult to burn, and finally a little gray ash. In a glass tube, yields a yellowish-brown oily product of a nauseous empyreumatic odor. Insoluble in water, alcohol, ether, caustic and carbonated alkalies or dilute acids; and even strong nitric acid acts slowly.

From the coal measures of Wigan, England.

GUYAQUILLITE, *Johnston*, Phil. Mag. xiii, 1838, 329.

Amorphous.

Yields easily to the knife, and may be rubbed to powder. G.=1·092. Color pale yellow. Lustre not resinous, or imperfectly so.

Composition.—$C^{20}H^{13}O^3$; Carbon 76·665, hydrogen 8·174, oxygen 15·161=100, Johnston. Slightly soluble in water, and largely in alcohol, forming a yellow solution, which is intensely bitter. Begins to melt at 157° F., but does not flow easily till near 212°. As it cools, becomes viscid, and may be drawn into fine tenacious threads. Soluble in cold sulphuric acid, forming a dark reddish-brown solution. A few drops of ammonia put into the alcoholic solution, darken the color and finally change it to a dark brownish-red.

It is said to form an extensive deposit near Guyaquil in South America.

The *Berengelite* of Prof. Johnston is near Guyaquillite. Analysis: C 72·472, H 9·198, O 18·330=$C^{40}H^{31}O^8$. Forms a bitter solution with cold alcohol. On evaporation the resin obtained has a clear red color, and remains soft and viscid at the ordinary temperature. Fracture and lustre resinous. Color dark brown, with a tinge of green. Powder yellow. Odor resinous, disagreeable. Taste a little bitter. It is said to form a lake like that of Trinidad, in the province of St. Juan de Berengela, about one hundred miles from Arica, Peru, and is used at Arica for paying boats and vessels.

PIAUZITE, *Haidinger*, Pogg. Ann. lxii, 275.

An earthy resin of a brownish-black color, occurring massive. Streak yellowish-brown.

H.=1·5; G.=1·220.

Fuses at 315° C. (600° F.), and burns with an aromatic odor and much smoke, leaving 5·96 per cent. of ash. Soluble in ether and caustic potash, also largely in absolute alcohol. Heated in a glass tube a yellowish oily fluid is distilled, having an acid reaction.

From brown coal at Piauze near Neustadt in Carniola.

WALCHOWITE, *Haidinger*.

In yellow translucent masses, often striped with brown. Lustre resinous. Fracture conchoidal. Translucent to opaque.

H.=1·5—2. G.=1·0—1·069; an opaque variety 1·035.

Composition.—$C^{12}H^{9}O$, Schrötter, or $3C^{4}H^{3}+O$, Ramm.=80·41 C, 10·66 H, 8·93 O. Fuses to a yellow oil at 250° C., and burns readily: becomes transparent and elastic at 140° C. Forms a dark brown solution in sulphuric acid; slightly soluble in ether.

In brown coal at Walchow, and formerly called *Retinite*. Boussingault found a similar mineral near Bucaramanga in New Grenada.

BITUMEN. Asphaltum. Petroleum. Mineral Pitch. Bergpech. Bergtheer, *Haus.* Mineral Oil. Naphtha. Erdöl. Steinöl. Maltha. Seneca Oil. Naphte, *Beud.*

Bitumen includes several distinct species, the two prominent of which are Naphtha and Asphaltum.

NAPHTHA, (Steinöl).—Liquid and colorless when pure, with a bituminous odor. G.=0·7—0·84. *Composition.*—$C^{6}H^{5}$. In nature often combined with asphaltum, and containing also parraffine and other substances.

ASPHALTUM.—Solid; black and brownish-black, with a conchoidal brilliant fracture. G.=1—1·2. Odor bituminous. Fuses at 100° C., and burns with a bright flame. An asphaltum from the island of Brazza, Dalmatia, consists, according to Kersten, (J. f. pr. Chem. xxxv, 271), of petrolene (volatile oil) 5·0, brown resin soluble in ether 20·0, asphaltene (bitumen insoluble in alcohol and ether) 74·0, yellow resin soluble in alcohol 1·0=100·0

There are also earthy varieties, called *earthy* and *slaggy* mineral pitch. *Petroleum* is a dark-colored fluid variety, containing much naphtha. *Maltha* or *Mineral tar* is a more viscid variety.

Asphaltum is abundant on the shores of the Dead Sea. It occurs also in reniform stalactitic masses at Matlock in Derbyshire; in granite, with quartz and fluor, at Poldice, in Cornwall; in cavities of chalcedony and calc spar, in Russia, and other places. Naphtha issues from the earth in large quantities in Persia and the Birman empire; at Rangoon there are upwards of five hundred naphtha wells, which afford annually 412,000 hhds. A remarkable lake of bitumen occurs on Trinidad, which is one and a half miles in circumference. The bitumen is solid and cold near the shores, but gradually increases in temperature and softness towards the centre, where it is boiling. The solidified bitumen appears as if it had cooled as the surface boiled in large bubbles. The ascent to the lake from the sea, a distance of three quarters of a mile, is covered with a hardened pitch, on which trees and vegetables flourish, and about Point La Braye the masses of pitch look like black rocks among the foliage. The lake is underlaid by a bed of mineral coal, (Manross).

In the peninsula of Apcheron, on the western shore of the Caspian, naphtha rises in vapor through a marly soil, and is collected by sinking pits several yards in depth, into which the naphtha flows. Near Amians in the state of Parma, is an abundant spring. Near Alfreton, England, naphtha has been discovered.

Petroleum is met with at Kenhawa in Virginia, Scotsville, Ky., Oil Creek in Venango Co., Penn., Duck Creek, in Monroe Co., Ohio, and Liverpool, Ohio. It was formerly collected and sold by the Seneca and other Indians, and is hence called *Seneca* or *Genesee oil.* Also at Inniskillan, Canada West, the inspissated petroleum in some places is two feet deep. (Logan's Geol. Rep. 1852, 90.)

Naphtha affords both fuel and lights to the inhabitants of Badku, on the Caspian. It is also employed in Persia and the Burman empire as a lotion in cutaneous eruptions, and as an embrocation in bruises and rheumatic affections. It is employed for various purposes in the arts, particularly in the manufacture of varnish, and as a substitute for oil in the formation of oil paint, it being preferred on account of its rapid evaporation and drying.

Bitumen, in all its varieties, was well known to the ancients. It is reported to have been employed in the construction of the walls of Babylon, and at Agrigentum it was burnt in lamps, and called Sicilian oil. The Egyptians also made use of it in enbalming. Two ship loads of the Trinidad pitch were sent to England by Admiral Cochrane, but it was found that the oil required to render it fit for use, exceeded in expense the cost of pitch in England, and the project of employing it was therefore abandoned.

Asphaltum is a constituent of the kind of varnish called Japan; it is also made into a cement for lining cisterns, and with ground stone into a material for pavements.

Naphthadil. A substance derived from naphtha. It is black; weak, greasy lustre; copper-brown in fracture. Does not change in the light. Fuses at the same temperature as wax, and burns with a clear flame, (Von Leonh. J. 1846, 84).

IDRIALINE. Idrialite, *Schrötter, Nicol.* Quecksilberbranderz.

Massive, with a greasy lustre, a grayish or brownish-black color, and a blackish streak inclining to red. Opaque. H.=1—1·5. G.=1·4—1·6.

Composition.—According to Bödeeker, C 91·828, H 5·299, O 2·873, (Kengott's Min. Forsch. i, 253); formula $C^{42}H^{14}+O$. The distillation of the bituminous earth at Idria affords a product consisting of C 94·568, H 6·459, with the formula C^3H, which is the radical of the Idrialine. Insoluble in water, and little so in alcohol or ether. Fuses at 400° F.

Occurs mixed with cinnabar at Idria. It is sometimes called, from its combustibility, *quecksilberbranderz* or *inflammable cinnabar.*

PYROPISSITE, Kengott, Min. Forsch., 1850, 1851, p. 148.

Like an earthy brown coal in appearance. G.=0·493—0·522. Color dull yellowish brown, opaque. Streak shining and greasy. Feel greasy. Fracture earthy.

Burns readily with a brownish-yellow flame and a weak aromatic odor. Heated, fuses to an asphaltum-like mass, which is porous, little soluble in alcohol and largely in oil of turpentine. Burns like bitumen. Little soluble in muriatic or nitric acid, and largely so in sulphuric.

Forms a layer six to eight inches thick in brown coal near Weissenfels. According to Marchand, affords on distillation 62 per cent. of paraffine, one pound of the mass giving three cubic feet of illuminating gas.

BREWSTOLINE.

Fluid. Colorless. Transparent. Expands one-fourth its size by an increment of 30° F., or is nearly 32 times more expansible than water, by an increment of 30° of heat at the temperature of 50°.

Occurs in minute cavities in crystals of topaz, chrysoberyl, quartz crystals from Quebec, and amethyst from Siberia, where it was detected by Sir David Brewster.

We have thought proper to recognize this fluid among minerals and name it, although yet imperfectly described. The fluid expands with the heat of the hand. Its refractive power is less than that of water. It was sometimes indurated in the cavity like a resin. On exposure, the fluid undergoes quick motions and changes, and finally leaves a residue of minute particles, which from the moisture of the hand alone, suddenly became fluid again, and extended and contracted as before. This was indefinitely repeated. The residue is volatilized by heat, and dissolves in the acids without effervescence.

CRYPTOLINE.—A *second* fluid was also distinguished in the same crystals that contained the preceding, and often in the same cavities; yet they were not miscible, and remained distinct. On exposure it hardens speedily into a yellowish transparent resin-like substance, not volatilizable by heat, nor soluble in water or alcohol, but rapidly dissolving with effervescence in sulphuric acids. Nitric and muriatic acids also dissolve it. Refraction index nearly that of water. [See further Edinburgh Royal Trans. vol. x; also Am. J. Sci. xii, 214, 1827].

ELATERITE, *Hausmann*. Mineral Caoutchouc. Elastic bitumen. Elastisches Erdharz. Bitume elastique.

In soft flexible masses.

G.=0·9053—1·233, the Derbyshire variety. Lustre resinous. Color blackish-brown, of various shades. Subtranslucent; sometimes presents a brilliant dark orange-red color by transmitted light. Flexible or elastic.

Composition.—Analyses by Johnston, (Brewst. J. xiii, 22, 1838):

Carbon,	85·474	84·385	83·671
Hydrogen,	13·283=98·757	12·576=96·961	12·535=96·206,

showing that it is probably allied to ozocerite and hatchettine. M. Henry (Ann. des M. vii, 269) found 36·75 to 40·10 per cent. of oxygen in his analyses, and the constant loss in Johnston's is supposed by him to have been oxygen. Takes fire readily, and burns with a lively yellow flame, giving out a bituminous odor.

This species was first observed in Derbyshire, at the forsaken lead mine of Odin, by Dr. Lister, in 1673, who called it a subterranean fungus. In 1797, it was accurately described by Hatchett, in the Linnæan Transactions, iv, 146. It has since been found in a coal mine at Montrelais, at the depth of 230 feet; and according to Hausmann, (Handbuch, iii, 273), it occurs at Neufchatel and on the island of Zante. A similar material has been met with at Woodbury, Ct.

SCHEERERITE, *Stromeyer*.

Monoclinic. In loosely aggregated crystalline grains and folia; also in minute acicular crystals, deposited in small cavities in coal.

Soft. G.=0·65, Macaire Prinsep. Lustre pearly or resinous; feebly shining. Color whitish or gray. More or less translucent. Easily frangible. Tasteless. Inodorous. Feel not greasy. At

111° F., (44° C.), according to M. Prinsep, it melts, and in the fused state resembles a fatty oil, and like it penetrates paper; these spots, however, may be removed by heat. On cooling, the mineral crystallizes in four-sided acicular crystals. Its boiling point is at 197½° F.

Composition.—According to Prinsep, (Pogg. Ann. xv, 294), Carbon 73, and hydrogen 24, nearly=$C H^2$. It takes fire easily, and is completely consumed, giving out much smoke and a feeble aromatic odor.

It was found by Capt. Scheerer, in the year 1822, in a bed of brown coal of tertiary age at Uznach, near St. Gallen, in Switzerland.

Branchite, Savi, (Leonh. and Bronn, 1842, 459). A colorless translucent substance resembling Scheererite, from the brown coal of Mount Vaso in Tuscany. It fuses at 75° C. (167° F.), but does not crystallize on cooling. G.=1·00. It dissolves in alcohol.

Tekoretin and Phylloretin, Forchammer, (J. f. pr. Ch. xx, 459). Resins from fossil wood in Denmark. Tekoretin is crystallized; it fuses at 45° C. Dissolves in ether, but little in alcohol, and consists of C 87·19, H 12·81=$C^{10} H^9$. Phylloretin fuses at 86°—87° C. Dissolves easily in alcohol, and appears to have the constitution $C^8 H^5$.

KÖNLITE, *Schrötter,* Pogg. Ann. lix, 37.

Resembles Scheererite. In white crystalline folia and grains. Soft. G.=0·88. Fuses at 114° C., Kraus, 107° ·5 C., Trommsdorff. Very slightly soluble in cold alcohol, more so in hot, and still more so in ether.

Composition.—C 92·429, H 7·571, Schrötter=C^2H. Kraus, (Pogg. xliii, 141), obtained C 92·49, H 7·42, specimen from Uznach; and Trommsdorff, (Ann. d. Pharm. xxi, 126), C 92·429, H 7·571, specimen from Redwitz.

In brown coal at Uznach, and near Redwitz, Bavaria, in the Fitchelgebirge.

FICHTELITE, *Bromeis,* Ann. der Pharm. xxxvi, 304. *Schrötter,* lix, 37.

Resembles the preceding. Fuses readily at 46° C., and becomes crystalline on cooling. Slightly soluble in alcohol, easily so in ether.

Composition.—C 83·9, H 11·1=$C^4 H^3$. Bromeis, (Ann. d. Ch. u. Pharm. xxxvii, 304), obtained carbon 89·3, hydrogen 10·7. Occurs with Könlite in the Fichtelgebirge.

KÖNLEINITE, *Kengott,* Min. Untersuch., ii, 111.

In thin plates, consisting of an aggregate of crystalline scales. Crystals probably orthometric. Perfectly soluble in ether and alcohol; and the solution on the addition of water becomes white and opaque. The ether solution not changed by the addition of alcohol. Wholly soluble in concentrated sulphuric acid, little so in nitric, and not at all in muriatic acid. Partly soluble in ammonia and oil of turpentine. From the brown coal of Fossa, in the Eger valley.

HARTITE, *Haidinger*, Pogg. liv, 261.

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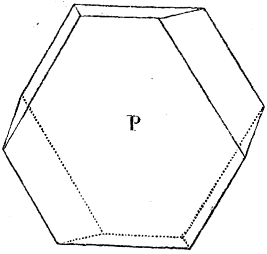

Monoclinic. Angle $I : I$ of oblique rhombic prism about 100°, P : *a* =about 120°. Cleavage only in traces.

H.=1. G.=1·046. Lustre somewhat greasy. Color white. Translucent. Brittle.

Composition.—$C^6 H^5$; Carbon 87·473, hydrogen 12·048, Schrötter. Fuses at 165° F., (74° C.), to a clear fluid, and at a high temperature distills. Dissolves easily in ether, less readily in alcohol, and crystallizes from each on evaporation.

Hartite resembles wax. It is distinguished from Scheererite by its crystallization and the temperature of fusion, as well as action before the blowpipe. It occurs in brown coal at Oberhart in Austria.

HARTINE, *Schrötter*, Pogg. Ann. 1843, liv, 45. Psathyrin, *Glocker*.

Resembles Hartite. Massive, but crystallizes from a naphtha solution in needles of the trimetric system. Color white. Without taste or smell. Pulverizes in the fingers. Fuses at 210° C., and distills at 260° C.

Composition.—$C^{20} H^{17} O^2$. C 78·26, H 10·92, O 10·82, Schrötter. Little soluble in ether.

From the brown coal of Oberhart, Austria.

The *Bogbutter* of *Williamson*, (Butyrite, Glocker), from an Irish peat swamp, contains C 75·05, H 12·56, O 12·39=$C^{33}H^{32}O^3+HO$. It fuses at 51° C., (124° F.), and dissolves easily in alcohol.

IXOLYTE. Ixolyt, *Haidinger*, Pogg. lvi, 345.

Amorphous. Occurs in bituminous coal.

H.=1. G.=1·008. Lustre greasy. Color hyacinth-red. Pulverized in the fingers, it becomes ochre-yellow and yellowish-brown. Thin fragments subtranslucent. Fracture imperfect conchoidal in the purer varieties.

Softens at 76 C., (169° F.), but is still tenacious at 100° C., (212° F.)—whence the name, from ἰξός and λύω, *to dissolve.*

This species closely resembles the Hartite, but differs in the temperature of fusion and other characters. It occurs in a coal bed at Oberhart, near Gloggnitz.

HATCHETTINE, *Conybeare*. Mineral Tallow.

Crystallized and amorphous in thin laminæ, like wax or spermaceti in consistency. G. at 60° F.=0·916. Lustre nacreous. Color white; black and opaque, after long exposure. Transparent. Feel greasy.

Composition.—According to Johnston, (Phil. Mag. xii, 338), Carbon 85·910, hydrogen 14·624=100·534. Melts at 115° F., (46° C.) Heated cautiously it distills over without change. Sparingly dissolves in boiling alcohol, and precipitates again on cooling. Cold ether dissolves a small quantity, and hot ether more largely; the solution on cooling coagulates into a mass of minutely pearly fibres, from which the ether may be separated by agitation or compression.

Occurs with the iron ores of the coal measures in Glamorganshire; also at Rossitz in Moravia; H.=1; G.=0·892, Patera. A variety from Loch Fyne near Inverary, fuses at 117° F., (47° C.) Another allied mineral from Merthyr Tydvil, melts at 170° F., (76° 6, C.)

OZOCERITE. Ozokerit. Erdwachs, *Ramm.*

Like a resinous wax in consistency and translucency; structure sometimes foliated. Color brown or brownish-yellow by transmitted light; leek-green by reflected light. Odor pleasant aromatic. G.=0·94—0·97.

Composition.—According to Magnus, Ann. d. Ch. et de Ph. lv); Schrötter, (Bib. Univ. 1836), and Johnston, (Phil. Mag. xii, 389, 1838):

	Moldavia.	Moldavia.	Urpeth.
Hydrogen,	15·15	13·787	14·06
Carbon,	85·75=100.90, M.	86·204=99·991, S.	86·80=100·86, J.

Fuses at 62° C., (144° F.), Schrötter, 84° C., (183° F.), Malaguti, and boils at 210° C., Schrötter, 300° C., Malaguti. According to Johnston a variety from Urpeth near Newcastle, fuses at 60° C., (140° F.), and boils at 121° C. Distills without apparent decomposition. No change in the strong acids, and very little in hot concentrated alcohol. The Moldavia ozocerite dissolves but slightly in ether, while that from Urpeth dissolves about four-fifths of the whole, which it deposits, on evaporation, in brown flocks, that melt at 102° F. to a yellowish-brown liquid. Three or four substances are supposed to be here included.

Ozocerite was discovered by Meyer in a sandstone in Moldavia, in the vicinity of coal and rock salt. It also occurs in Austria at Gresten near Gaming, and at Truskawiez in Galicia, (a variety fusing at 59° C., and boiling at 300° C.); also at the Urpeth colliery, Newcastle-on-Tyne, England.

CHRISMATINE, *Germar.* Leonh. u. Bronn's Jahrb. 1851, 353.

Color oil-green to yellowish. Shining. Translucent to semi-translucent. Unchanged at 68 to 78° F., but softens at 55 to 60° R.

Burns with flame without smell. Near Ozocerite.

From a red argillaceous sandstone of the coal formation at Wettin near Halle.

DOPPLERITE.

In thin plates or massive. When fresh, brownish-black, with a dull brown streak and greasy subvitreous lustre; and when in thin plates, reddish-brown by transmitted light. G.=1·089. Becomes elastic on exposure to the light.

Composition.—$C^8 H^5 O^5$. According to Schrötter, a homogeneous peaty substance from whose cellulose, two parts of water are removed. Analysis by Schrötter, (Wien. Acad. Ber. 1849, 285):

C 51·63 H 5·34 O 43·03.

Heated to 100° C., loses 78·5 per cent. of water. It resembles a black pitch. On heating the fresh mineral with potash, ammonia is given off.

Near Aussee, in Styria, in peat. The species is named after M. Doppler.

DINITE, *Meneghini*, Gaz. Med. Italiana, Firenze, Toscana, July, 1852.

An aggregation or druse of crystals. Cleavage none. Has the appearance of ice, with a yellow tinge due to a foreign substance. Inodorous. Tasteless. Fragile, and easily reduced to powder.

Insoluble in water; little soluble in alcohol, very soluble in ether, and in sulphuret of carbon. The ethereal solution on standing deposits large crystals of the dinite. Fuses with the warmth of the hand; heated in a close vessel distills over without undergoing any sensible decomposition. When melted it looks like a yellowish oil; crystallizes in large transparent crystals on cooling.

From a lignite deposit, at Lunigiana, Tuscany, where it was found by Prof. Dini.

MELLITE, *H.* Mellilite. Honey Stone. Mellate of Alumina. Honigstein, *Werner*.

Dimetric; octahedral. Pyramidal edge=118° 4′, and basal edge 93° 22′, Haüy; the latter 93° 1′, Breithaupt; 93° 6′, Kupffer. In short octahedrons, and also with the terminal or lateral solid angles or edges truncated. Cleavage octahedral, very indistinct. Also in massive nodules.

H.=2—2·5. G.=1·55—1·65; 1·636—1·642, Kenngott. Lustre resinous, inclining to vitreous. Streak white. Color honey-yellow, often reddish or brownish; rarely white. Transparent—translucent. Fracture conchoidal. Sectile.

Composition.—$\dddot{A}l\,\bar{M}^3+18\dot{H}$=Alumina 14·32, mellic acid 40·53, water 45·15. Analyses: 1, Klaproth, (Beit. iii, 114); 2, Wöhler, (Pogg. vii, 325):

Alumina,	16	14·5
Mellic acid,	46	41·4
Water,	38=100 K.	44·1=100, W.

Whitens in the flame of a candle, but does not take fire. Dissolves in nitric acid; decomposed by boiling water. In a matrass yields water.

Occurs in brown coal at Arten in Thuringia; at Luschitz near Bilin in Bohemia; near Walchow in Moravia.

SUPPLEMENT.

CATALOGUE OF AMERICAN LOCALITIES OF MINERALS.

The following catalogue may aid the mineralogical tourist in selecting his routes and arranging the plan of his journey. Only important localities, affording cabinet specimens, are in general included. The list is an abstract of the fuller information with regard to localities, scattered through the Descriptive part of this Treatise.

For the facts included, the country is especially indebted to the Reports of Prof. Shepard of the Connecticut survey, Profs. Beck, Emmons, and Mather, Messrs. Vanuxem and Hall of New York, Prof. Hitchcock of the Massachusetts, Dr. Jackson of the Maine, New Hampshire, and Rhode Island surveys, Prof. H. D. Rogers of the New Jersey, Prof. W. B. Rogers of the Virginia survey, Profs. Troost and Houghton, and Mr. Owen of the Western States, Prof. C. B. Adams of the Vermont survey, Prof. M. Tuomey of the South Carolina, Messrs. Foster and Whitney of the Lake Superior Region: some distinguished names among the State Geologists are here omitted, as their regions were not mineral regions. The American Journal of Science and Arts, and the Transactions of the various scientific societies of the country, have also contributed essentially to this part of the work: and among the names in these Journals conspicuous in this department, in addition to the above enumerated, I would especially mention Messrs A. Bruce, P. Cleaveland, B. Silliman, W. Meade, G. Gibbs, C. Dewey, J. F. Dana, F. Hall, T. Nutall, H. H. Hayden, J. G. Percival, G. T. Bowen, D. Olmsted, H. Seybert, C. U. Shepard, S. Fowler, T. G. Clemson, J. Delafield, J. Torrey, J. E. Teschemacher, C. B. Hayden, D. D. Owen of Indiana, G. Troost of Tennessee, O. P. Hubbard, B. Silliman, Jr., J. C. Booth, P. P. Tyson, J. Finch, J. B. Crawe, J. Johnson, G. W. Benedict, J. Gebhard, J. D. Whitney, and W. B. Hough. The author would also acknowledge here his indebtedness for many private communications in this department, especially from Prof. B. Silliman, Jr., Messrs. J. E. Teschemacher, and C. T. Jackson, Boston; Thomas F. Seal and Wm. S. Vaux, Philadelphia; L. White Williams, of Westchester, Pa.; Hon. T. L. Clingman, of North Carolina; D. Dale Owen and J. G. Norwood, of Indiana; Dr. F. A. Genth of Philadelphia, J. D. Whitney, and W. P. Blake. The Pennsylvania list is largely prepared from information furnished the author, mostly by Messrs. Williams and Seal; the Minesota and Wisconsin, through contributions by Messrs. Owen and Norwood; the North Carolina, from manuscript catalogues received from the Hon. Mr. Clingman and Dr. Genth.

In the catalogue, the names of those minerals which are obtained in good specimens in the several localities, are distinguished by italics. When the specimens are remarkably good, an exclamation mark (!) is added, or two of these marks (! !) when the specimens are quite unique. The more exact position of localities may in most instances be ascertained by reference to the descriptions of the species in the preceding part of the Treatise.

MAINE.

Mt. Abraham.—*Andalusite*, staurotide.

Albany.—*Beryl ! green and black tourmaline, feldspar, rose quartz.*

Albion.—Iron pyrites.

Aroostook.—Red Hematite.

Bingham.—*Massive pyrites*, galena, blende, andalusite.

Blue Hill Bay.—*Arsenical iron, molybdenite ! galena, apatite ! fluor spar !* black tourmaline, (Long Cove), black oxyd of manganese, (Osgood's farm), rhodonite, bog manganese, wolfram.

Bowdoinham.—*Beryl*, molybdenite.

Brunswick.—*Green mica, garnet ! black tourmaline !* molybdenite.

Buckfield.—*Garnet*, (estates of Waterman and Lowe), iron ore.

Camdage Farm.—(Near the tide mills), molybdenite, (wolfram).

Camden.—*Macle.*

Carmel, (Penobscot Co.)—Gray Antimony.

Corinna.—*Iron pyrites, arsenical pyrites.*

Deer Isle.—*Serpentine, verd antique*, abestus, diallage.

Dexter.—Galena, pyrites, blende, copper pyrites, green talc.

Dixfield.—Native copperas, graphite.

Farmington.—(Norton's ledge), *pyrites*, graphite, bog ore.

Georgetown.—(Parker's island), *beryl !* black tourmaline.

Greenwood.—Graphite, black manganese.

Hartwell.—Staurotide.

Lenox.—Galena, pyromorphite.

Lewiston.—Garnet.

Litchfield.—*Sodalite, cancrinite, nepheline*, zircon.

Lubec Lead Mines.—*Galena, copper pyrites, blende*, pyromorphite, an ore of bismuth.

Madrid.—Gold.

Newfield, (Bond's Mt.)—Mispickel, olive phosphate of iron in botryoidal masses.

Paris.—*Green ! red ! black*, and *blue tourmaline ! mica ! lepidolite !* feldspar, *albite, quartz crystals ! rose quartz, blende.*

Parsonsfield.—*Idocrase ! yellow garnet, pargasite, adularia, scapolite*, galena, blende, copper pyrites.

Perry.—Prehnite and calc spar, (above Loring's cove), quartz crystal, calc spar, analcime, apophyllite, agate, (Gin Cove).

Peru.—*Crystallized pyrites.*

Phipsburg.—*Yellow garnet ! manganesian garnet, idocrase, pargasite, axinite, laumonite !* chabazite, an ore of cerium?

Poland.—Idocrase.

Raymond.—*Magnetic iron, scapolite, pyroxene, lepidolite, tremolite*, hornblende.

Rumford.—*Yellow garnet, idocrase, pyroxene*, apatite, scapolite, graphite.

Sanford, York Co.—*Idocrase !* albite, calc spar, molybdenite, epidote.

Searsmont.—*Andalusite.*

Streaked Mountain.—*Beryl ! black tourmaline, mica, garnet.*

Thomaston.—*Calc spar, tremolite, hornblende*, sphene, arsenical iron, (Owl's head), black manganese, (Dodge's mountain).

Warren.—Galena, blende.

Waterville.—*Crystallized pyrites.*

Windham, (near the bridge).—*Staurotide, spodumene, garnet.*

Woodstock, (New Brunswick).—*Graphite, specular iron.*

NEW HAMPSHIRE.

Acworth.—*Beryl ! ! mica ! tourmaline, feldspar, albite, rose quartz, columbite !*

Alstead.—*Mica ! ! albite, black tourmaline.*

Amherst.—*Idocrase ! yellow garnet*, pargasite, calc spar.

Bartlett.—Magnetic iron, *specular iron*, brown iron ore in large veins near Jackson, (on "Bald face mountain"), *quartz crystals, smoky quartz.*

Bath.—Galena, copper pyrites.

Bellows Falls.—Kyanite, wavellite, near Saxton's river.

Benton.—*Quartz crystals.*

Campton.—*Beryl!*

Canaan.—Gold in pyrites.

Charlestown.—*Staurotide macle, andalusite macle,* bog iron ore.

Cornish.—Gray antimony, antimonial argentiferous gray copper, *rutile in quartz!* (rare).

Eaton, (3 m S. of).—*Galena, blende!* copper pyrites, limonite, (Six Mile Pond).

Franceston.—*Soapstone,* arsenical pyrites.

Franconia.—*Hornblende, staurotide! epidote! zoisite, specular iron, magnetic iron. black* and *red manganesian garnets: mispickel!* (*Danaite*), copper pyrites, molybdenite, prehnite; specimens now hardly obtainable.

Gilford.—(Gunstock Mt.)—Magnetic iron ore, native "lodestone."

Goshen.—*Graphite,* black tourmaline.

Grafton.—*Mica!* (extensively quarried at Glass Hill, 2 m. S. of Orange Summit) *albite!* asparagus stone, blue, green, and yellow *beryls!* (1 m. S. of O. Summit), *tourmaline, garnets.*

Grantham.—*Gray staurotide!*

Hanover.—*Garnet,* a boulder of quartz containing *rutile! black tourmaline, quartz.*

Haverhill.—*Garnet! arsenical pyrites, native arsenic,* galena, blende, iron and copper pyrites, magnetic and white iron pyrites.

Hillsboro', (Campbell's mountain).—*Graphite.*

Hillsdale.—*Rhodonite,* black oxyd of manganese.

Jackson.—Drusy quartz, tin ore, *arsenical pyrites,* native arsenic, fluor spar, apatite, *magnetic iron ore, molybdenite,* wolfram, copper pyrites, arsenate of iron.

Jaffrey.—(Monadnock Mt.)—*Kyanite.*

Keene.—*Graphite, soapstone,* milky quartz.

Landaff.—*Molybdenite,* lead and iron ores.

Lebanon.—*Bog iron ore.*

Lisbon.—*Staurotide,* black and red *garnets, granular magnetic iron ore, hornblende, epidote, zoisite, specular iron.*

Lyme.—Kyanite, (N. W. part), *black tourmaline,* rutile, iron pyrites, copper pyrites, (E. of E. village), *sulphuret of antimony.*

Merrimack.—*Rutile!* (in gneiss nodules in granite vein).

Moultonborough, (Red Hill).—*Hornblende,* bog ore, pyrites, tourmaline.

Newport.—Molybdenite.

Orange.—*Blue beryls!* Orange Summit, chrysoberyl, *mica,* (w. side of mountain.)

Orford.—*Brown tourmaline* (now obtained with difficulty), *steatite, rutile,* kyanite, brown iron ore, native copper, green malachite, galena.

Pelham.—*Steatite.*

Piermont.—*Micaceous iron, heavy spar,* green, white, and brown mica, apatite.

Plymouth.—Columbite, beryl.

Richmond.—*Iolite!* rutile, steatite, iron pyrites.

Saddleback Mt.—Black tourmaline, garnet, spinel.

Shelburne.—*Argentiferous galena, black blende, copper pyrites, iron pyrites,* manganese.

Springfield.—Beryls, (very large, eight inches diameter,) *manganesian garnets!* in mica slate, *albite mica.*

Sullivan.—*Tourmalines,* (black), in quartz, beryl?

Surrey.—Amethyst, calcite.

Swanzey, (near Keene).—*Magnetic iron,* (in masses in granite).

Tamworth, (near White Pond).—Galena.

Unity, (estate of James Neal).—*Copper and iron pyrites, chlorophyllite, green mica, magnetic iron, radiated actinolite,* garnet, *titaniferous iron ore, magnetic iron ore.*

Walpole, (near Bellows Falls).—*Macle.*

Warren.—*Copper pyrites, blende, epidote,* quartz, *iron pyrites, tremolite! galena, rutile, talc,* molybdenite.

Westmoreland, (South part).—*Molybdenite! apatite! blue feldspar, bog manganese,* (north village), quartz, *fluor spar,* copper pyrites, oxyd of molybdenum and uranium.

White Mts., (notch behind "old Crawford's house").—Green octahedral fluor, quartz crystals, black tourmaline, chiastolite.

Wilmot.—*Beryl.*

Winchester.—Pyrolusite, diallogite, psilomelane, magnetic iron ore, granular quartz.

VERMONT.

Addison.—*Iron sand.*

Alburgh.—Quartz crystals on calc spar, iron pyrites.

Athens.—*Steatite, rhomb spar*, actinolite.

Barnet.—Graphite.

Belvidere.—Steatite, chlorite.

Bennington.—*Pyrolusite*, brown iron ore, pipe clay, yellow ochre.

Bethel.—*Actinolite!* talc, chlorite, octahedral iron, *rutile, brown spar in steatite.*

Brandon.—Braunite, pyrolusite, *psilomelane*, limonite, lignite, white clay, statuary marble; fossil fruits in the lignite.

Brattleborough.—Black tourmaline in quartz.

Bridgewater.—*Talc, dolomite, magnetic iron,* steatite, chlorite, gold, native copper, blende, galena, blue spinel, copper pyrites.

Bristol.—*Rutile*, brown hematite, manganese ores.

Brookfield.—*Mispickel, iron pyrites.*

Cabot.—Garnets, staurotide, hornblende, *albite.*

Castleton.—*Roofing slate.*

Cavendish.—Garnet, *serpentine.*

Chester.—*Asbestus.*

Chittenden.—Psilomelane, pyrolusite, brown iron ore, *specular* and *magnetic iron*, galena.

Colchester.—Brown iron ore, iron sand, jasper, alum.

Corinth.—*Copper pyrites*, (has been mined); magnetic iron pyrites.

Coventry.—Manganese spar.

Craftsbury.—Mica in concentric balls.

Dummerston.—Rutile.

Fletcher.—Pyrites, octahedral iron, acicular tourmaline.

Grafton.—The *steatite* quarry referred to Grafton is properly in Athens.

Guilford.—Scapolite.

Hartford.—Calcite, *pyrites! kyanite* in mica slate.

Irasburgh.—Rhodonite, *psilomelane.*

Jay.—*Chromic iron, serpentine*, picrosmine, amianthus.

Lowell.—Picrosmine, amianthus.

Marlboro.—*Rhomb spar, steatite, garnet, magnetic iron.*

Mendon.—Octahedral Iron Ore.

Middlebury.—Zircon.

Middlesex.—Rutile! (exhausted).

Monkton.—*Pyrolusite*, brown iron ore.

Moretown.—*Smoky quartz! steatite*, talc, wad, rutile.

Morristown.—Argentiferous galena.

Mount Holly.—*Asbestus*, chlorite.

New Fane.—*Glassy* and *abestiform actinolite, steatite, green quartz*, (called chrysophrase at the locality), chalcedony, drusy quartz, *garnet, chromic iron, rhomb spar.*

Norwich.—*Actinolite, feldspar, brown spar* in talc.

Pittsford.—*Brown iron ore*, manganese ores.

Plymouth.—Spathic iron, magnetic and specular iron, both in octahedral crystals.

Plympton.—Massive hornblende.

Putney.—Fluor, *brown iron ore, rutile*, and *zoisite* in boulders.

Reading.—*Glassy actinolite* in talc.

Readsboro'.—*Glassy actinolite, steatite.*

Ripton.—*Brown iron ore*, augite in boulders, octahedral iron pyrites.

Rochester.—Rutile, specular iron cryst., *magnetic iron*, in chlorite state.

Roxbury.—*Dolomite, talc*, serpentine, asbestus.

Salisbury.—Brown iron ore.

Sharon.—*Quartz crystals*, kyanite.

Shoreham.—*Iron pyrites.*

Shrewsbury.—Magnetic iron and copper pyrites.

Somerset.—Magnetic iron, native gold.

Stafford.—Magnetic iron and *copper pyrites*, (has been worked), native copper, hornblende.

Starksboro'.—Brown iron ore.

Stirling.—Copper pyrites, talc, serpentine.

Stockbridge.—Mispickel, magnetic iron ore.

Thetford.—Blende, *galena, kyanite;* chrysolite in basalt.

Troy.—*Magnetic iron*, talc, *serpentine*, picrosmine, amianthus, *steatite*, one mile southeast of village of South Troy, on the farm of Mr. Pierce, east side of Missisco, *chromic iron.*

Warren.—Actinolite, magnetic iron ore, wad.

Waterbury.—Mispickel, copper pyrites, *rutile, quartz.*

Waterville.—*Steatite*, actinolite, talc.

Wells River.—Graphite.

Westfield.—*Steatite*, chromic iron, serpentine.

Westminster.—Zoisite in boulders.

Wardsboro'.—*Zoisite.*

Windham.—*Glassy actinolite, steatite.*

Woodbury.—Massive pyrites.

Woodstock.—*Quartz crystals.*

MASSACHUSETTS.

Alford.—Galena, iron pyrites.

Athol.—*Allanite*, fibrolite, (?) *epidote!* babingtonite.

Auburn.—*Masonite.*

Barre.—*Rutile! mica, pyrites, beryl, feldspar, garnet.*

Great Barrington.—*Tremolite.*

Bedford.—*Garnet.*

Belchertown.—Allanite.

Bernardston.—Magnetic oxyd of iron.

Beverly.—Polymignyte, columbite, *green feldspar*, tin ore.

Blanford.—*Marmolite, schiller spar, serpentine, anthophyllite, actinolite! chromic iron*, kyanite, rose quartz in boulders.

Bolton.—*Scapolite! petalite, sphene, pyroxene, nuttalite, diopside, boltonite, petalite*, apatite, magnesite, rhomb spar, *allanite, yttrocerite*, cerium ochre, (on the scapolite), spinel.

Boxborough.—*Scapolite*, spinel, *garnet*, augite, actinolite, apatite.

Brighton.—Asbestus.

Brimfield, (road leading to Warren).—*Iolite*, adularia, molybdenite, mica, garnet.

Carlisle.—*Tourmaline, garnet! scapolite*, actinolite.

Charlestown.—*Prehnite, laumonite*, stilbite, chabazite, quartz crystals.

Chelmsford.—*Scapolite, chondrodite, blue spinel, amianthus!* rose quartz.

Chester.—*Hornblende, scapolite, zoisite, spodumene, indicolite*, apatite—magnetic iron and *chromic iron*, (west part)—stilbite, heulandite, analcime and chabazite.

Chesterfield.—*Blue, green, and red tourmaline, cleavelandite*, (albite), *lithia mica, smoky quartz, microlite, spodumene, kyanite*, apatite, *rose beryl, garnet, quartz crystals, staurotide*, tin ore, *columbite*, erubescite, zoisite, uranite, brookite (eumanite).

Conway.—Pyrolusite, fluor spar, zoisite, *rutile!!* native alum, galena.

Cummington.—*Rhodonite!* cummingtonite (hornblende), white iron pyrites, *garnet.*

Dedham.—Asbestus, galena.

Deerfield.—Chabazite, heulandite, stilbite, amethyst, carnelian, chalcedony, *agate.*

Fitchburg, (Pearl Hill).—*Beryl, staurotide!* garnets, molybdenite.

Foxborough.—*Iron pyrites, anthracite.*

Franklin.—Amethyst.

GOSHEN.—*Lithia mica, albite, spodumene! blue and green tourmaline, beryl, zoisite,* smoky quartz, columbite, tin ore, galena.

GREENFIELD, (in sandstone quarry, half mile east of village).—Allophane, white and greenish.

HATFIELD.—*Heavy Spar,* yellow quartz crystals, galena, blende, copper pyrites.

HAWLEY.—*Micaceous iron,* massive pyrites, magnetic iron, zoisite.

HEATH.—*Pyrites, zoisite.*

HINSDALE.—Brown iron ore, apatite, zoisite.

HUBBARDSTON.—*Massive pyrites.*

LANCASTER.—*Kyanite, chiastolite!* apatite, staurotide, pinite, andalusite.

LEE.—*Tremolite! sphene!* (east part).

LENOX.—Brown hematite, gibbsite, (?)

LEVERETT.—Heavy spar, galena, blende, copper pyrites.

LEYDEN.—*Zoisite, rutile.*

LITTLETON.—Spinel, scapolite, apatite.

LYNNFIELD.—Magnesite on serpentine.

MARTHA'S VINEYARD.—Brown iron ore, amber, selenite, radiated pyrites.

MENDON.—*Mica!* chlorite.

MIDDLEFIELD.—*Glassy actinolite, rhomb spar, steatite, serpentine, feldspar,* drusy quartz, apatite, zoisite, nacrite, chalcedony, *talc!*

MILBURY.—*Vermiculite.*

MONTAGUE.—Specular iron.

NEWBURY.—*Serpentine,* chrysolite, *epidote, massive garnet,* carbonate of iron.

NEWBURYPORT.—*Sepentine, nemalite,* uranite.

NEW BRAINTREE.—*Black tourmaline.*

NORWICH.—*Apatite! black tourmaline, beryl, spodumene! triphyline* (alte red) blende, quartz crystals.

PALMER, (Three Rivers).—*Feldspar,* prehnite, calc spar.

PELHAM.—*Asbestus,* serpentine, *quartz crystals,* beryl, *molybdenite, green hornstone.*

PLAINFIELD.—*Cummingtonite, pyrolusite, rhodonite.*

RICHMOND.—*Brown iron ore, gibbsite!*

ROWE.—Epidote, talc.

SOUTH ROYALSTON.—*Beryl!!* (now obtained with great difficulty), *mica!! feldspar! ilmenite,* allanite. Four miles beyond old loc., on farm of Solomon Heywood, *mica! beryl! feldspar!*

RUSSEL.—Schiller spar (diallage?) *mica,* serpentine, beryl, galena, copper pyrites.

SAUGUS.—Porphyry.

SHEFFIELD.—*Asbestus,* pyrites, native alum, pyrolusite.

SHELBURNE.—Rutile.

SHUTESBURY, (east of Locke's Pond).—*Molybdenite.*

SOUTHAMPTON.—*Galena,* white lead ore, anglesite, molybdate of lead, fluor, heavy spar, copper and iron pyrites, blende, corneous lead, pyromorphite.

STERLING.—*Spodumene, chiastolite, spathic iron, mispickel, blende,* galena, iron and copper pyrites.

STONEHAM.—*Nephrite.*

STURBRIDGE.—*Graphite,* garnet, apatite, bog ore.

TAUNTON, (one mile south).—Paracolumbite.

TURNER'S FALLS, (Conn. River.)—Copper pyrites, prehnite, chlorite, *chlorophæite,* spathic iron, green malachite, magnetic iron sand, anthracite.

TYRINGHAM.—Pyroxene, scapolite.

UXBRIDGE.—Argentiferous galena.

WARWICK.—*Massive garnet, black tourmaline, magnetic iron,* beryl, epidote.

WASHINGTON.—*Graphite.*

WESTFIELD.—*Schiller spar,* (diallage), *serpentine, steatite,* kyanite, scapolite, actinolite.

WESTFORD.—*Andalusite!*

WEST HAMPTON.—Galena, *argentine, pseudomorphous quartz.*

WEST SPRINGFIELD.—*Prehnite,* ankerite, satin spar, celestine, bituminous coal.

WEST STOCKBRIDGE.—*Hematite,* fibrous pyrolusite, spathic iron.

WHATELY.—*Native copper,* galena.

WILLIAMSBURG.—Zoisite, pseudomorphous quartz, apatite, rose and smoky quartz, galena, pyrolusite, copper pyrites.

WILLIAMSTOWN.—*Cryst. quartz.*

WINDSOR.—*Zoisite*, actinolite, *rutile !*

WORCESTER.—*Mispickel,* idocrase, pyroxene, garnet, amianthus, bucholzite, spathic iron, galena.

WORTHINGTON.—*Kyanite.*

ZOAR.—Bitter spar, *talc.*

RHODE ISLAND.

BRISTOL.—*Amethyst.*

CRANSTON.—Actinolite in talc.

CUMBERLAND.—*Manganese, epidote, actinolite,* garnet, titaniferous iron, magnetic iron, red hematite, copper pyrites.

FOSTER.—*Kyanite.*

JOHNSON.—Talc, brown spar.

NEWPORT.—*Serpentine.*

PORTSMOUTH.—*Anthracite,* graphite, asbestus, iron pyrites.

SMITHFIELD.—*Dolomite, calc spar, bitter spar, nacrite,* serpentine (bowenite), tremolite, asbestus, quartz, magnetic iron in chlorite slate, *talc ! !*

WARWICK, (Natic village).—*Masonite,* garnets, graphite.

WESTERLY.—*Ilmenite.*

CONNECTICUT.

BERLIN.—Heavy spar, datholite, blende, quartz crystals.

BOLTON.—Staurotide, copper pyrites.

BRADLEYVILLE, (Litchfield).—Laumontite.

BRISTOL.—*Copper glance, copper pyrites,* heavy spar, *erubescite.* talc, *allophane,* pyromorphite.

BROOKFIELD.—Galena, calamine, *blende,* spodumene, magnetic pyrites.

CANAAN.—*Tremolite* and *augite !* in dolomite.

CHATHAM.—Mispickel, smaltine, chloanthite (chathamite), scorodite, copper nickel, *beryl.*

CHESHIRE.—*Heavy spar ! copper glance cryst.*, erubescite, *green malachite,* kaolin, natrolite, prehnite, chabazite, datholite.

CHESTER.—*Sillimanite !* zircon, epidote.

CORNWALL, near the Housatonic.—*Graphite, pyroxene.*

DANBURY.—*Danburite, oligoclase, moonstone,* brown tourmaline.

FARMINGTON.—*Prehnite, chabazite !* agate, native copper.

GRANBY.—Green malachite.

GREENWICH.—*Black tourmaline.*

HADDAM.—*Chrysoberyl ! beryl ! epidote ! tourmaline ! feldspar, anthophyllite, garnet ! iolite ! oligoclase, chlorophyllite ! automolite, magnetic iron, adularia,* apatite, *columbite !* zircon (calyptolite), *mica, white* and yellow iron pyrites, *molybdenite,* allanite, bismuth, bismuth ochre.

HADLYME.—Chabazite and stilbite in gneiss, with epidote and garnet.

HARTFORD.—*Datholite,* (Rocky Hill quarry.)

KENT.—*Brown iron ore,* pyrolusite, ochrey iron ore.

LITCHFIELD.—*Kyanite* with corundum, apatite and andalusite, *ilmenite,* (washingtonite), copper pyrites.

LYME.—Garnet, sunstone.

MERIDEN.—Datholite.

MIDDLEFIELD FALLS.—Datholite, chlorite, &c., in amygdaloid.

MIDDLETOWN.—*Mica, lepidolite* with green and red tourmaline, *albite, feldspar, columbite ! prehnite, garnet,* beryl, topaz, uranite, apatite, pitchblende; at lead mine, *galena, copper pyrites,* blende, quartz, *calcite,* fluor, iron pyrites, sometimes capillary.

MILFORD.—Sahlite, *pyroxene, asbestus,* zoisite, verd-antique marble, pyrites.

NEW HAVEN.—Serpentine, asbestus, chromic iron, sahlite, stilbite, prehnite.

NORWICH.—*Sillimanite, monazite !* zircon, *iolite,* corundum, feldspar.

OXFORD, near Humphreysville.—Kyanite, copper pyrites.

PLYMOUTH.—Galena, *heulandite*, *fluor.*
ROARING BROOK, (Cheshire).—*Datholite !* calc spar, prehnite, saponite.
READING, (near the line of Danbury).—Pyroxene, *garnet.*
ROXBURY.—Massive *spathic iron*, blende.
SALISBURY.—*Brown iron ore*, ochery iron, *pyrolusite*, triplite.
SAYBROOK.—*Molybdenite*, stilbite, plumbago.
SIMSBURY.—*Copper glance*, green malachite.
SOUTHBURY.—Rose quartz, laumontite, prehnite, calc spar, heavy spar.
SOUTHINGTON.—Heavy spar, datholite, asteriated quartz crystals.
STAFFORD.—Massive pyrites.
STONINGTON.—Stilbite and *chabazite* on gneiss.
THATCHERSVILLE, (near Bridgeport).—Stilbite on gneiss, babingtonite?
TOLLAND.—Staurotide, massive pyrites.
TRUMBULL and MONROE.—*Chlorophane*, *topaz*, *beryl*, diaspore, magnetic pyrites, iron pyrites, *tungstate of lime*, *wolfram*, (pseudomorph of tungsten), rutile, native bismuth, tungstic acid, spathic iron, mispickel, argentiferous galena, blende, scapolite, *tourmaline*, *garnet*, albite, augite, graphic tellurium, (?) *margarodite.*
WASHINGTON.—*Triplite*, *ilmenite !* (Washingtonite of Shepard), diallogite, natrolite, *andalusite* (New Preston), kyanite.
WATERTOWN, near the Naugatuck.—White sahlite, monazite.
WEST FARMS.—Asbestus.
WINCHESTER and WILTON.—Asbestus, garnet.

NEW YORK.

ALBANY CO.—COEYMAN'S LANDING.—Epsom salt.
GUILDERLAND.—*Petroleum.*
WATERVLIET.—*Quartz crystals.*

ALLEGANY CO.—CUBA.—*Petroleum.*

CATTARAUGUS CO.—FREEDOM.—*Petroleum.*

CAYUGA CO.—AUBURN.—Fluor, epsom salt.
CAYUGA LAKE.—Sulphur.
LUDLOWVILLE.—Epsom salt.
SPRINGVILLE.—Nitrogen springs.

CHATAUQUE CO.—FREDONIA.—*Petroleum, carburetted hydrogen.*
LAONA.—Petroleum.

COLUMBIA CO.—ANCRAM LEAD MINE.—Galena, *blende*, *copper pyrites*, heavy spar.
AUSTERLITZ.—*Earthy manganese*, molybdate of lead, copper mica.
HUDSON.—*Selenite !*
LEBANON.—Nitrogen spring.

DUCHESS CO.—DOVER.—*Garnet* (Foss ore bed).
FISHKILL.—*Graphite*, *green actinolite ! talc*, hydrous anthophyllite.
RHINEBECK.—Granular epidote.
UNION VALE.—*Gibbsite*, (at Clove mine).
AMENIA.—Brown hematite.

ESSEX CO.—ALEXANDRIA.—Kirby's graphite mine, *graphite*, *pyroxene*, *scapolite*, sphene.
CROWN POINT.—*Apatite*, (eupyrchroite of *Emmons*), *brown tourmaline !* in the apatite, chlorite, quartz crystals, pink and blue calcite, pyrites; a short distance south of J. C. Hammond's house, *garnet*, *scapolite*, copper pyrites, *aventurine feldspar*, zircon; magnetic iron (Peru).
LEWIS.—*Tabular spar*, *colophonite*, garnet, *labradorite.*
LONG POND.—Apatite, *garnet*, *pyroxene*, idocrase, *coccolite ! ! scapolite*, magnetic iron ore, *blue calc spar.*

McIntyre.—*Labradorite,* garnet, *magnetic iron ore.*

Moriah, at Sandford Ore Bed.—*Magnetic iron,* apatite, *allanite!* actinolite, and feldspar; at Fisher Ore Bed, *magnetic iron,* feldspar, quartz; at Hall Ore Bed, or "New Ore Bed," *magnetite, zircons.*

Newcomb.—*Labradorite,* feldspar.

Port Henry.—*Brown tourmaline, mica, rose quartz, serpentine, green* and *black pyroxene,* hornblende, *cryst. pyrites, magnetic pyrites, adularia. Phlogopite!* at Cheever Ore Bed, with magnetite and serpentine.

Roger's Rock.—*Graphite, tabular spar, garnet, colophonite, feldspar,* adularia, *pyroxene, sphene,* coccolite.

Schroon.—*Calc spar,* pyroxene, *chondrodite.*

Ticonderoga.—*Graphite, pyroxene, sahlite, sphene,* black tourmaline, cacoxene (Mt. Defiance).

Westport.—Labradorite, prehnite.

Willsboro.—*Tabular spar, colophonite,* garnet, *green coccolite,* hornblende.

FRANKLIN CO.—Chateaugay.—Nitrogen springs.

Malone.—*Massive pyrites,* magnetic iron ore.

GENESEE CO.—*Acid springs* containing sulphuric acid.

GREENE CO.—Catskill.—*Calc spar.*

Diamond Hill.—Quartz crystals.

HERKIMER CO.—Little Falls.—*Quartz crystals,* heavy spar, *calc spar,* anthracite.

Middleville.—*Quartz crystals! calc spar,* brown and pearl spar.

Salisbury.—*Quartz crystals!* blende, galena, iron and copper pyrites.

Stark.—Fibrous celestine, *gypsum.*

JEFFERSON CO.—Alexandria.—Hornblende, *orthoclase, tourmaline,* celestine.

Adams.—Fluor, calc tufa, barytes.

Antwerp.—Stirling iron mine, *specular iron, chalcodite, spathic iron, millerite,* nickeliferous iron pyrites, *quartz crystals,* pyrites; at Oxbow, *calc spar!* porous coralloidal heavy spar; near Vrooman's lake, *calc spar!* idocrase, *phlogopite! pyroxene, sphene,* fluor, calcite, pyrites, copper pyrites; also *feldspar, bog iron ore,* scapolite, (farm of David Eggleson), *serpentine,* tourmaline (yellow, rare).

High Island, (in the St. Lawrence).—*Tourmaline.*

Pamelia.—*Agaric mineral,* calc tufa.

Pillar Point.—*Massive heavy spar* (exhausted).

Theresa.—*Fluor, calcite,* specular iron ore, hornblende, *quartz crystals,* serpentine, (associated with the specular iron), celestine, strontianite; the Muscolonge lake locality of fluor is exhausted.

Watertown.—*Tremolite, agaric mineral,* calc tufa, celestine.

[This county adjoins St. Lawrence Co., and the localities of Rossie, Hammond, and Gouverneur, near Oxbow, are in the latter county.]

LEWIS CO.—Diana, (localities mostly near junction of crystalline and sedimentary rocks, and within two miles of Natural Bridge). *Scapolite! tabular spar, green coccolite, feldspar, tremolite,* black pyroxene, sphene, mica, *quartz crystals,* drusy quartz, cryst. pyrites, magnetic pyrites, blue calc spar, serpentine, *rensselaerite,* zircon, graphite, chlorite, specular iron, bog iron ore, iron sand.

Greig.—*Magnetic iron ore,* pyrites.

Lowville.—*Calc spar,* fluor spar, pyrites, galena, blende, calc tufa.

Martinsburgh.—Wad, galena, etc., but mine not now opened.

Watson, Bremen.—Bog iron ore.

MONROE CO.—Rochester.—*Pearl spar,* calc spar, snowy gypsum, fluor, celestine, galena, blende.

MONTGOMERY CO.—Root.—Pearl spar, *drusy quartz, blende.*

Palatine.—*Quartz crystals,* drusy quartz.

NEW YORK CO.—Corlaer's Hook.—Apatite.

Kingsbridge.—*Tremolite, pyroxene, mica, tourmaline,* pyrites, rutile.

Harlem.—Epidote, apophyllite, stilbite, tourmaline, vivianite, lamellar feldspar, mica.

New York.—*Serpentine, amianthus,* actinolite, talc, *pyroxene,* hydrous anthophyllite, garnet, staurotide, molybdenite, graphite.

NIAGARA CO.—Lewiston.—*Epsom salt.*

Lockport.—*Celestine, calc spar, selenite, anhydrite, fluor, pearl spar, blende.*

Niagara Falls.—*Calc spar,* fluor, blende.

ONEIDA CO.—Boonville.—*Calc spar, tabular spar, coccolite.*

Clinton.—Blende, *lenticular argillaceous iron ore;* in rocks of the Clinton Group, strontianite, celestine, the former covering the latter.

ONONDAGA CO.—Camillus.—*Selenite* and *fibrous gypsum.*

Manlius.—*Gypsum* and fluor.

Syracuse.—*Serpentine,* celestine.

ORANGE CO.—Cornwall.—*Zircon, chondrodite, hornblende, spinel, massive feldspar, fibrous epidote,* hudsonite, ilmenite, *serpentine,* boltonite.

Deer Park.—*Cryst. pyrites,* galena.

Monroe.—*Mica! sphene! garnet,* colophonite, *epidote, chondrodite, allanite,* bucholzite, brown spar, boltonite, *spinel,* hornblende, talc, *ilmenite, magnetic pyrites,* common pyrites, chromic iron, *graphite.*

At Wilks and O'Neil Mine in Monroe.—Aragonite, *magnetite,* dimagnetite (pseud?), jenkinsite.

At Two Ponds in Monroe.—*Pyroxene! chondrodite, hornblende, scapolite! zircon, sphene,* apatite.

At Greenwood Furnace in Monroe.—*Chrondrodite, pyroxene! mica, hornblende, spinel, scapolite, biotite!* ilmenite.

At Forest of Dean.—*Pyroxene, spinel,* zircon, scapolite, hornblende, boltonite.

Town of Warwick.

Warwick Village.—*Spinel, zircon, serpentine! brown spar, pyroxene! hornblende! pseudomorphous steatite, feldspar!* (Rock Hill), *ilmenite, clintonite,* tourmaline, (R. H.), *rutile,* sphene, molybdenite, mispickel, *white iron pyrites,* common pyrites, yellow iron sinter.

Amity.—*Spinel, garnet, scapolite, hornblende, idocrase, epidote! clintonite! magnetic iron! tourmaline,* warwickite, *apatite, chondrodite,* ilmenite, *talc! pyroxene!* rutile, *zircon, corundum, feldspar,* sphene, calc spar, serpentine, schiller spar.(?)

Edenville.—*Apatite, chondrodite! hair brown hornblende!* tremolite, *spinel, tourmaline, warwickite, pyroxene, sphene, mica, feldspar, mispickel,* orpiment, *rutile, ilmenite,* scorodite, copper pyrites.

West Point.—*Feldspar, mica,* scapolite, *sphene, hornblende,* allanite.

PUTNAM CO.—Carmel, (Brown's quarry).—Anthophyllite, schiller spar, (?) orpiment, mispickel.

Cold Spring.—Chabazite, mica, sphene.

Patterson.—*White pyroxene! calc spar, asbestus, tremolite,* dolomite, massive pyrites.

Phillipstown.—*Tremolite, amianthus, serpentine, sphene, diopside, green crocolite,* hornblende, *scapolite,* stilbite, mica, laumontite, gurhofite, calc spar, magnetic iron, chromic iron.

Phillips Ore Bed.—Hyalite, *actinolite, massive pyrites.*

RENSSELAER CO.—Hoosic.—Nitrogen springs.

Lansingburgh.—Epsom salt, quartz crystals, *iron pyrites.*

Troy.—*Quartz crystals, iron pyrites, selenite.*

RICHMOND CO.—Rossville.—Lignite, *cryst. pyrites.*

Quarantine.—*Asbestus, amianthus,* aragonite, *dolomite, gurhofite,* brucite, serpentine, *talc.*

ROCKLAND CO.—CALDWELL.—*Calc spar!*
GRASSY POINT.—Serpentine, actinolite.
HAVERSTRAW.—*Hornblende.*
LADENTOWN.—Zircon, red copper ore, green malachite.
PIERMONT.—Datholite, stilbite, apophyllite, stellite, prehnite, thomsonite, calc spar.
STONY POINT.—Kerolite, lamellar hornblende, asbestus.

ST. LAWRENCE CO.—CANTON.—*Massive pyrites, calc spar,* brown tourmaline, *sphene, serpentine,* talc, *rensselaerite,* pyroxene, specular iron, copper pyrites.
DEKALB.—*Hornblende,* heavy spar, *fluor, tremolite, tourmaline,* blende, graphite, pyroxene, quartz (spongy), serpentine.
EDWARDS.—*Brown and silvery mica!* scapolite, apatite, *quartz crystals,* actinolite, tremolite, specular iron, serpentine, magnetite.
FINE.—*Black mica,* hornblende.
FOWLER.—*Heavy spar, quartz crystals! specular iron, blende,* galena, tremolite, chalcedony, bog ore, satin spar, (assoc. with serpentine), iron and copper pyrites, actinolite, *rensselaerite,* (near Somerville).
GOUVERNEUR.—*Calc spar! serpentine! hornblende! scapolite! orthoclase, tourmaline!* idocrase, (one mile south of G.), pyroxene, apatite, *rensselaerite,* serpentine, *sphene,* fluor, *heavy spar* (farm of Judge Dodge), black *mica,* phlogopite, *tremolite!* asbestus, *specular iron,* graphite, idocrase; (near Somerville in serpentine), *spinel,* houghite, scapolite, *phlogopite,* dolomite; three quarters of a mile west of Somerville, *chondrodite,* spinel; two miles north of Somerville, *apatite,* pyrites.
HAMMOND.—*Apatite! zircon!* (farm of Mr. Hardy), *orthoclase, pargasite,* heavy spar, pyrites, purple fluor, dolomite.
HERMON.—*Quartz crystals, specular iron, spathic iron,* pargasite, pyroxene, serpentine, tourmaline, bog iron ore.
MACOMB.—Blende, mica, *galena* (on land of James Averil), sphene.
MINERAL POINT, Morristown.—Fluor, blende, galena, *phlogopite,* (Pope's Mills), heavy spar.
OGDENSBURG.—Labradorite.
PITCAIRN.—Satin spar, associated with serpentine.
POTSDAM.—*Hornblende!*—eight miles from Potsdam on road to Pierrepont, *feldspar, tourmaline, black mica,* hornblende.
ROSSIE, (Iron Mines).—*Heavy spar, specular iron,* corralloidal aragonite in mines near Somerville, limonite, *quartz,* (sometimes stalactitic at Parish iron mine), *pyrites, pearl spar.*
ROSSIE Lead Mine.—*Calc spar, galena, pyrites, celestine,* copper pyrites, *spathic iron!* white lead ore, anglesite.
Elsewhere in ROSSIE.—*Calc spar, heavy spar,* quartz crystals, chondrodite (near Yellow Lake), *feldspar! pargasite! apatite, pyroxene,* hornblende, sphene, zircon, *mica,* fluor, serpentine, automolite, pearl spar, graphite.
RUSSEL.—*Pargasite, specular iron, quartz* (dodec.), calcite, serpentine, rensselaerite, magnetite.

SARATOGA CO.—GREENFIELD.—*Chrysoberyl! garnet, tourmaline! mica, feldspar,* apatite, graphite, aragonite, (in iron mines).

SCOHARIE CO.—BALL'S CAVE, and others.—Calc spar, stalactites.
CARLISLE.—*Fibrous sulphate of baryta, cryst. and fib. carbonate of lime.*
SCOHARIE.—Fibrous celestine, *strontianite! cryst. pyrites!*

SENECA CO.—CANOGA.—*Nitrogen springs.*

SULLIVAN CO.—WURTZBORO'.—*Galena, blende, pyrites, copper pyrites.*

ULSTER CO.—ELLENVILLE.—*Galena,* blende, *copper pyrites! quartz, brookite.*
MARBLETOWN.—Pyrites.

WARREN CO.—CALDWELL.—*Massive feldspar.*
CHESTER.—*Pyrites,* tourmaline, rutile, copper pyrites.

Diamond Isle, (Lake George.)—*Calc spar, quartz crystals.*

Glenn's Falls.—Rhomb spar.

Johnsburg.—*Fluor ! zircon ! ! graphite, serpentine, pyrites.*

WASHINGTON CO.—Fort Ann.—*Graphite.*

Granville.—*Lamellar pyroxene,* massive feldspar, epidote.

WAYNE CO.—Wolcott.—*Heavy spar.*

WESTCHESTER CO. Anthony's Nose.—*Apatite,* pyrites, *calcite !* in very large tabular crystals, grouped and sometimes incrusted with drusy quartz.

Davenport's Neck.—*Serpentine,* garnet, sphene.

Eastchester.—Blende, copper and iron pyrites, dolomite.

Hastings.—*Tremolite, white pyroxene.*

New Rochelle.—*Serpentine,* brucite, quartz, *mica,* tremolite, garnet.

Peekskill.—Mica, feldspar, hornblende, stilbite.

Rye.—*Serpentine, chlorite, black tourmaline,* tremolite, kerolite.

Singsing.—*Pyroxene, tremolite, iron pyrites,* copper pyrites, beryl, azurite, green malachite, white lead ore, pyromorphite, anglesite, vauquelinite, galena, native silver.

West Farms.—Apatite, tremolite, garnet, stilbite, heulandite, chabazite, epidote, sphene.

Yonkers.—*Tremolite,* apatite, calc spar, analcime, *pyrites,* tourmaline.

Yorktown.—*Sillimanite, monazite,* magnetic iron.

NEW JERSEY.

Andover Iron Mine. (Sussex Co).—Willemite, brown garnet.

Allentown, (Monmouth Co.)—Vivianite.

Belville.—Copper mines.

Bergen.—*Calc spar, datholite, thomsonite, pectolite* (called stellite), *analcime, apophyllite, prehnite,* sphene, stilbite, natrolite, heulandite, laumontite, chabazite, pyrites, pseudomorphous steatite imitative of apophyllite.

Brunswick.—Copper mines; *native copper, malachite, mountain leather.*

Bryam.—Chondrodite.

Cantwell's Bridge, Newcastle Co., three miles west.—Vivianite.

Danville, (Jemmy Jump Ridge).—*Graphite,* chondrodite, augite, mica.

Flemington.—*Copper mines.*

Frankfort.—*Serpentine.*

Franklin and Sterling.—*Spinel ! garnet ! rhodonite ! willemite ! franklinite ! red zinc ore ! dysluite ! hornblende, tremolite, chondrodite, white scapolite, black tourmaline, epidote, pink calc spar, mica,* actinolite, augite, sahlite, coccolite, asbestus, *jeffersonite* (augite), calamine, graphite, fluor, beryl, galena, serpentine, honey-colored sphene, quartz, chalcedony, amethyst, zircon, molydenite, vivianite. Also *algerite* in gran. limestone. The zinc ores and franklinite, especially at Sterling Hill in Sterling, the jeffersonite at Mine Hill, in Franklin.

Franklin and Warwick Mts.—*Pyrites.*

Greenbrook.—Copper mines.

Griggstown.—Copper mines.

Hamburgh.—One mile north, *spinel !, tourmaline !, phlogopite, hornblende, &c., limonite,* specular iron.

Hoboken.—Serpentine, *brucite ! nemalite* (or fibrous brucite), aragonite, dolomite.

Hurdstown.—*Apatite,* magnetic pyrites, magnetite.

Imleytown.—Vivianite.

Lockwood.—*Graphite, chondrodite, talc, augite, quartz, green spinel.*

Montville, Morris Co.—Serpentine, *chrysotile.*

Mullica Hill, Gloucester Co.—*Vivianite* lining belemnites and other fossils.

Newton.—*Spinel,* blue and white corundum, (exhausted), *mica, idocrase, hornblende, tourmaline, scapolite,* rutile, pyrites, talc, calc spar, heavy spar, *pseudomorphous steatite.*

Patterson.—*Datholite.*

Schuyler's Mines.—Green malachite, red copper ore, native copper, *chrysocolla.*

Somerville.—*Red copper ore, native copper, chrysocolla,* green malachite, bitumen, (two miles to the northeast).

Sparta.—*Chondrodite! spinel,* sapphire, green talc, graphite, epidote, augite.

Suckasunny, on the Morris canal.—*Brown apatite* in magnetic pyrites.

Trenton.—Zircon, amber, lignite.

Vernon.—*Green spinel, chondrodite, red sapphire, hornblende, pyrites, phlogopite, graphite, limonite,* rutile, sphene, ilmenite, zircon, fluor, margarite.

Woodbridge.—Copper mine.

Note.—From Amity, N. Y., to Andover, N. J., a distance of about thirty miles, the outcropping limestone, at different points, affords more or less of the minerals enumerated as occurring at Franklin. (See Geol. Rep. on N. J., by H. D. Rogers).

PENNSYLVANIA.

ADAMS CO.—Reading.—Molybdenite in quartz, zircon, magnetic iron ore.

BERKS CO.—At Jones's Mines, near Morgantown, *green malachite!* cerusite, *chrysocolla!,* oct. and dodec. magnetic iron, iron pyrites, copper pyrites;—two miles to the northeast, graphite, sphene; at Steel's Mines, *octahedral and micaceous iron ore,* coccolite.

BUCK'S CO.—Opposite New Hope, *tourmaline!*; near Attleboro', at Vanarsdale's limestone quarry, *sahlite,* scapolite, sphene, green coccolite, graphite, green mica.

CARBON CO.—At Mauch Chunk, *cryst. iron pyrites,* selenite.

CHESTER CO.—Birmingham.—Kerolite, amethyst, quartz cryst., serpentine.

E. Bradford.—On Minorcus Hill, green, blue and gray *kyanite,* apatite, allanite; on A. Taylor's farm, sphene, cryst. smoky quartz; on the farms of B. Jones, B. Price, L. Sharpless, and S. Entrikin, amethyst; near Strode's mill, asbestus, magnesite, marmolite, garnet; near T. Hoope's saw mill, *epidote, asbestus;* on Osborn's Hill, sphene, manganesian garnet, wad, tourmaline, actinolite, anthophyllite, feldspar, fetid calcite; near the Black Horse Inn, rutile.

W. Bradford.—Near A. Jackson's limestone quarry, green *kyanite,* rutile, scapolite, iron pyrites; near Marshall's mill, chromic iron, serpentine; at Poor House (limestone) quarry, (called also Baldwin's), four miles north of Unionville, and six west of Westchester, *rutile!* in brilliant acicular crystals; cryst. calc spar, cryst. *dolomite,* zoisite in quartz, *talc* in implanted crystals on dolomite, *chesterlite!* (in fine crystals implanted on dolomite), quartz crystals.

Chester Springs.—*Gibbsite,* in an iron mine; near Coventryville, in Chrisman's limestone quarry, augite, sphene, graphite, *zircon!* in iron ore about half a mile from the village on French Creek.

West Goshen.—Amianthus, asbestus, precious serpentine, cellular quartz, jasper, chalcedony, drusy quartz, chlorite, marmolite, dolomite, cryst. *carb. magnesia! chromic iron! magnetic iron;* near Westchester Water Works, zoisite, (rare, not found now).

Keim's Iron Mine near Knauertown.—*Flos-ferri,* pyroxene, *metaxite, micaceous iron ore, aplome!! actinolite, yellow octahedral pyrites,* copper pyrites in tetrahedrons, *red garnet!* malachite, hornblende (var. byssolite).

Kennet Township.—*Actinolite!* (rare on Gregg's farm), brown tourmaline, brown mica, *epidote,* tremolite, scapolite, aragonite; at Pearce's paper mill, zoisite, epidote, *sunstone;* on R. Lamborne's farm, chabazite in small brownish yellow crystals, (rare), zeolite; at Gause's corner, *epidote.*

Knauertown.—North of Pughtown, graphite, sphene, cryst. magnetic iron; in Chrismard's Iron Mine, zircon.

London Grove.—In Jackson's limestone quarry, *yellow tourmaline!* (rare), fib. tremolite; at Pusey's quarry, rutile, tremolite.

New Garden Township.—At Nevin's limestone quarry, *brown tourmaline!* scapolite, brown and green mica, rutile, *aragonite, kaolin.*

Newlin.—See Unionville, below.

East Marlboro.—*Epidote*, and nearly white *tourmaline*, (rare).

Oxford.—Iron pyrites, garnets.

Nottingham.—At Scott's chrome mine, *chromic iron, foliated talc*, marmolite, serpentine, chalcedony; at the Magnesian Quarry, magnesite, marmolite, serpentine.

Parksburg, (in township of Sadsbury).—In the soil for seven miles along the valley, *rutile !;* northeast of the village, amethyst, tourmaline, epidote, (in a boulder).

Penn.—Garnets, figure stone.

Pennsbury Township.—On Cephas Cloud's farm, *brown garnets !;* J. Dilworth's farm, near Pennsville, *mica ! !* (in six-sided prisms from one quarter to seven inches across); at Harvey's lime quarry, on the Brandywine, *chondrodite;* quarter of a mile above the last, at Wm. Burnett's lime quarry, sphene, diopside, augite, coccolite.

Phenixville.—In Railroad Tunnell, *pearl spar* (exhausted), *dolomite, yellow blende*, iron pyrites; at Wheatley's Mine, *pyromorphite! cerusite!* cryst. quartz, *galena, anglesite! copper pyrites*, heavy spar, *fluor, wulfenite! calamine*, cerasine?, vanadinite?, phosphate of copper, chromate of lead.

Pottstown, near French Cr.—(Elizabeth Mine).—*Iron pyrites !* (in octahedrons), *copper pyrites, magnetite, dark brown garnet*, molybdenite.

Unionville.—One and a half miles northeast, on Serpentine Barrens, *corundum !* massive and cryst. (often in loose crystals and also in albite, the loose crystals mostly covered with a thin coating of steatite, sometimes with gibbsite), talc, *green tourmaline* (with flat or pyramidal terminations), ligniform asbestus, *yellow beryl* (rare), *serpentine*, brucite, *chromic iron*, quartz crystals, *green quartz*, actinolite, *clinochlore* in cryst., diallage, granular albite (H.=7), adularia, *oligoclase*, halloysite, *margarite, euphyllite*, allanite, hematite, chalcedony; half a mile southwest, on T. Webb's farm, *serpentine, chromic iron*, (mas.); two and a half miles southwest, in R. Bailey's lime quarry, fib. tremolite, mussite; *kyanite, margarodite;* two miles southwest, at Pusey's saw mill, *zircon* (cryst. small, loose in the soil, rare), rutile; one mile south, on the farm of Baily and Brothers, bright *yellow* and nearly *white tourmaline !* (rare), *orthoclase* (chesterlite), *albite !* (inaccessible); two miles east, near Marlborough meeting house, *epidote!* (rare), serpentine, acicular black tourmaline in white quartz; one mile west, near Logan's quarry, staurotide, kyanite, yellow tourmaline, (rare); at Edward's lime quarry near the last, purple fluor, *rutile;* four miles west, in limestone quarries of West Marlborough, near Doe River Village, scapolite, rutile, tremolite.

Westchester.—One and a half mile north, *hydromagnesite, clinochlore, brucite*, in serpentine, zircon, two miles west; one and a half mile northwest, pitch-black allanite; B.B. intumesces very readily (G. 2·5); 3 m. south, *clinochlore, phlogopite.*

Willistown.—Magnetic iron, chromic iron, actinolite.

COLUMBIA CO.—At Webb's mine, yellow blende in calc spar; near Bloomburg, cryst. magnetic iron.

DAUPHIN CO.—Near Hummerstown, green garnets, cryst. *smoky quartz*, cryst. feldspar.

DELAWARE CO.—Aston.—Near Village Green, *amethyst, corundum, emerylite*, staurotide, sillimanite, black tourmaline, pearl mica, asbestus, anthophyllite; near Tyson's Mill, garnet, staurotide; at head of Peter's Mill Dam, in a brook, garnet resembling pyrope.

Birmingham.—At Bullock's quarry, zircon, bucholzite, fibrolite, nacrite.

Chester.—*Amethyst*, black tourmaline; in Burk's quarry, *beryl ! ! black tourmaline ! ! feldspar !* manganesian garnet, cryst. pyrites; on Chester Creek, at Carter's, *molybdenite, molybdic ochre*, copper pyrites, *tourmaline, kaolin;* at Little's quarry, brown garnets, tourmaline; near Henvi's quarries, *amethyst* in geodes.

Chichester.—Near Trainer's Mill Dam, beryl, tourmaline, cryst. feldspar, kaolin; on W. Eyre's farm, *tourmaline ! !*

CONCORD.—On Green's Creek, *garnets* resembling pyrope, *bucholzite*, *mica !* in hexagonal prisms, beryl, actinolite, anthophyllite, fibrolite, *rutile !* in capillary crystals in the cavities of cellular rose quartz.

DARBY.—Kyanite, zoisite, (in a boulder); near Gibbon's, garnets, staurotide.

EDGEMONT.—1 m. E. of Edgemont Hall, near the road, rutile in quartz, amethyst, oxyd of manganese, cryst. feldspar.

LEIPERVILLE.—*Beryl !* in granite; in Judge Leiper's Quarries, *beryl*, *tourmaline*, *apatite*, garnet, cryst. feldspar, mica; at Morris's Ferry, *kyanite*, *sillimanite*, *apatite*, *red garnet*, mica; at Hill's Quarries, chabazite, stilbite, zeolite, epidote, sphene, albite, calcite, cryst. pyrites; near Leiper's Church, on the edge of a wood, *andalusite*, apatite, tourmaline, mica, gray *kyanite*.

MARPLE.—*Tourmaline !;* on A. Worrall's farm, *andalusite*, tourmaline; near C. Palmer's Mills, beryl, tourmaline, actinolite, amethyst.

MINERAL HILL.—*Corundum ! aventurine feldspar* (sunstone), chatoyant feldspar (moonstone), *actinolite*, *green coccolite*, *green feldspar !* chromic iron, cryst. green quartz, ferruginous quartz, asbestus, hydrous anthophyllite, *brown garnet !* magnesite, marmolite, bronzite, chalcedony, limonite, labradorite, float stone, red garnet, beryl, serpentine.

PROVIDENCE.—At Blue Hill, serpentine, cryst. green quartz in green talc, asbestus, talc, anthophyllite, *actinolite*, hydrous anthophyllite; on M. Hunter's farm, *amethyst !* (one finely colored crystal found weighing over 7 lbs.), *andalusite*.

RADNER.—Garnets, marmolite, deweylite, serpentine, chromic iron, asbestus, magnesite.

SPRINGFIELD.—*Andalusite;* on Abby Worrall's farm, *tourmaline*, beryl, ilmenite?, garnets; on Fell's Laurel Hill, *beryl*, garnet; near Beattie's Mill, staurotide, apatite; near Lewis's Paper Mill, tourmaline, mica.

HUNTINGTON CO.—Near Frankstown, in the bed of a stream, and on the side of a hill, *fibrous celestine*, abundant.

LANCASTER CO.—Near Texas, in the south part of the county, at Wood's Chrome Mine, *emerald nickel*, *pennite*, *kœmmererite*, millerite, *baltimorite*, *chromic iron*, *marmolite*, picrolite, *hydromagnesite*, brucite, *dolomite*, cryst. magnesite, calcite, serpentine; at Low's Mine, *hydromagnesite*, brucite, *picrolite ! magnesite*, chromic iron, talc, emerald nickel, serpentine, baltimorite; on M. Boice's farm, N. of the village in the soil, *cryst. pyrites !* anthophyllite, marmolite, magnesite; near the Rock Spring, chalcedony, carnelian, moss agate, green tourmaline in talc, titanic iron, cryst. magnetic iron in chlorite; at Reynold's Mine, calcite, *talc*, picrolite; at Gap Mine, *magnetic* pyrites (containing nickel), copper pyrites, actinolite; at Safe Harbor, iron ores; Pequea Valley, 8 m. S. of Lancaster, argentiferous galena (250 to 300 oz. of silver to the ton); 4 m. N. W. of Lancaster, on L. and H. Railroad, *calamine*, galena, blende.

LITTLE BRITAIN.—*Anthophyllite.*

LEBANON CO.—CORNWALL, adjoining Lancaster Co.—*Pyrites !* in cubo-octahedrons, brilliant steel tarnish, native copper, *red copper*, azurite.

LEHIGH CO.—Near Friedensville in the Saucon Valley, *calamine !* (valuable mine), lanthanite, cryst. quartz, malachite, pyrolusite, wad; near Allentown, magnetic iron, pipe iron ore; near Bethlehem, in S. Mountain, *allanite* in syenite.

MONROE CO.—In Cherry Valley, calc spar, chalcedony, cryst. quartz; in Poconoe Valley, near Judge Mervine's, cryst. quartz.

MONTGOMERY CO.—At Perkiomen Copper Mine, azurite, blende, galena, *pyromorphite*, *cerusite*, *molybdate of lead*, *anglesite*, *heavy spar*, calamine, copper pyrites, green malachite, chrysocolla; at Henderson's Marble Quarry, *calc spar;* about one mile N. of Henderson's, in the bank of railroad, cryst. quartz in geodes; at Spring Mills, cacoxene, lepidokrokite, spathic iron; near the Gulf Mills, *limonite*, garnets, chromic iron; in Franconia township,(?) gold.

NORTHUMBERLAND CO.—Opposite Selim's grove, calamine.

NORTHAMPTON CO.—Near Easton, *zircon !!* (exhausted), nephrite, coccolite, tremolite, calamite, pyroxene, sahlite, limonite, magnetic iron, purple calc spar; near Bethlehem, at the South Mountain, allanite, magnetite, epidote, brown garnet, black spinel and tourmaline in syenitic gneiss.

PHILADELPHIA CO.—On the Schuylkill, near foot of inclined plane, *laumontite*, garnet, tourmaline, *mica;* on the Schuylkill, a fourth of a mile from the Suspension Bridge, yellow uranite.

Chesnut Hill.—*Mica, serpentine, dolomite, asbestus,* nephrite, talc, *tourmaline*, sphene, apatite, tremolite.

Germantown.—Mica, apatite, feldspar, beryl, garnet.

Banks of Wissahiccon.—Actinolite, garnet, staurotide.

Frankford.—Garnet, staurotide, iron pyrites.

Conchikocen.—Staurotide, garnet, argillaceous iron ore; near Manyunk Tunnell, stilbite, chabazite (rare in small brownish-yellow crystals).

YORK CO.—*Calc spar* (transparent), *cryst. smoky quartz, cryst. pyrites;* in Slate Quarries near the Susquehannah, *wavellite.*

DELAWARE.

NEWCASTLE CO.—Brandywine Springs, *bucholzite, fibrolite* abundant, sahlite, pyroxene.

Dixon's Feldspar Quarries, 6 miles N. W. of Wilmington, (these quarries have been worked for the manufacture of porcelain), *adularia, albite, beryl, apatite, cinnamon stone!!* (both granular like that from Ceylon, and crystallized, rare), magnesite, serpentine, asbestus, black *tourmaline!* (rare), *indicolite!* (rare), sphene in pyroxene, kyanite.

Dupont's Powder Mills, "hypersthene."

Eastburn's Limestone Quarries, near the Pennsylvania line, *tremolite, bronzite.*

Quarryville.—Garnet, spodumene, fibrolite, sillimanite.

Near Newark on the railroad, sphærosiderite on drusy quartz, jasper, (ferruginous opal), cryst. spathic iron in the cavities of cellular quartz.

Wilmington.—In Christiana quarries, *metalloidal diallage.*

Kennett turnpike, near Centreville, kyanite and garnet.

KENT CO.—Near Middletown, in Wm. Polk's marl pits, *vivianite!*

On Chesapeake and Delaware Canal, retinasphalt, iron pyrites, amber.

SUSSEX CO.—Near Cape Henlopen, vivianite.

MARYLAND.

Baltimore, (Jones's Falls, 1¾ miles from B).—Chabazite (haydenite), heulandite (beaumontite of Levy), pyrites, lenticular carbonate of iron, *mica, stilbite.*

Sixteen miles from Baltimore, on the Gunpowder.—*Graphite.*

Twenty-three miles from B., on the Gunpowder.—*Talc.*

Twenty-five miles from B., on the Gunpowder.—*Magnetic iron, sphene,* pycnite.

Thirty miles from B., in Montgomery Co., on farm of S. Eliot.—Gold in quartz.

Eight to twenty miles north of B., in limestone.—*Tremolite, augite, pyrites,* brown and yellow tourmaline.

Fifteen miles north of B.—*Sky-blue chalcedony* in granular limestone.

Eighteen miles north of B., at Scott's Mills.—*Magnetic iron,* kyanite.

Bare Hills.—*Chromic iron, asbestus, tremolite, talc,* hornblende, serpentine, chalcedony, meerschaum, baltimorite, *copper pyrites,* magnetite.

Cape Sable, near Magothy R.—Amber, pyrites, alum slate.

Carroll Co.—Near Sykesville, Liberty Mines, gold, magnetic iron, *pyrites* (*octahedrons*), *copper pyrites,* linnæite (carrollite), an ore of nickel (not analyzed); at Patapsco Mines, near Finksburg, *erubescite, malachite, linnæite, remingtonite,* magnetic iron, *copper pyrites;* at Mineral Hill Mine, *erubescite,* copper pyrites, ore of *nickel* (see above), gold, magnetic iron.

Cecil Co., north part.—*Chromic iron* in serpentine.

Cooptown, Harford Co.—Olive-colored *tourmaline, diallage, talc* of green, blue, and rose colors, *ligniform asbestus, chromic iron, serpentine.*

Deer Creek.—*Magnetic iron!* in chlorite slate.

Frederick Co.—Old Liberty Mine, near Liberty Town, black copper, malachite, copper glance, specular iron; at Dollyhyde Mine, *erubescite*, copper pyrites, iron pyrites, argentiferous galena in dolomite.

Montgomery Co.—*Oxyd of manganese.*

Somerset and Worcester Cos., north part.—*Bog iron ore, vivianite.*

St. Mary's River.—*Gypsum!* in clay.

VIRGINIA AND DISTRICT OF COLUMBIA.

Albemarle Co., a little west of the Green Mts.—*Steatite, graphite;* galena.

Amherst Co., along the west base of Buffalo ridge.—*Copper ores*, etc.

Augusta Co.—At Weyer's (or Weir's) cave, sixteen mile northeast of Staunton, and eighty-one miles northwest of Richmond, calc spar, and stalactites.

Buckingham Co.—*Gold* at Garnett and Moseley Mines, largely worked, also pyrites, pyrrhotine, calcite, garnet; at the Eldridge Mine (now London and Virginia Mines) near by, and the Buckingham Mines near Maysville, gold, auriferous pyrites, copper pyrites, tennantite, *heavy spar; kyanite, tourmaline, actinolite.*

Chesterfield Co.—Near this and Richmond Co., bituminous coal, native coke.

Culpepper Co., on Rapidan river.—Gold, pyrites.

Franklin Co.—Grayish steatite.

Fauquier Co., Barnet's Mills.—Asbestus; gold mines, *barytes, calcite.*

Fluvanna Co.—Gold at Stockton's Mine; also tetradymite at "Tellurium Mine."

Phenix Copper Mines.—*Copper pyrites*, etc.

Georgetown, D. C.—Rutile.

Goochland Co.—Gold mines, (Moss and Busby's).

Harper's Ferry, on both sides of the Potomac.—Thuringite (owenite), with quartz.

Jefferson Co., at Shepherdstown.—Fluor.

Kenawha Co.—At Kenawha, *petroleum*, brine springs, cannel coal.

Loudon Co.—*Tabular quartz, prase, pyrites, talc, chlorite, soapstone*, asbestus, *chromic iron, actinolite, quartz crystals; micaceous iron*, erubescite, malachite, epidote, near Leesburg, (Potomac Mine).

Louisa Co.—Walton gold mine, gold, pyrites, copper pyrites, argentiferous galena, spathic iron, blende, anglesite; boulangerite, blende (at Tinder's Mine).

Nelson Co.—Galena, copper pyrites, malachite.

Orange Co.—Western part, Blue Ridge, specular iron; gold at the Orange Grove† and Vaucluse gold mines, worked by the "Freehold" and "Liberty" Mining Companies.

Rockbridge Co., three miles southwest of Lexington.—Heavy spar.

Shenandoah Co., near Woodstock.—Fluor spar.

Mt. Alto, Blue Ridge.—Argillaceous iron ore.

Spotsylvania Co., two miles northeast of Chancellorville.—*Kyanite;* Gold mines at the junction of the Rappahannock and Rapidan ("Gardiner" Co.); on the Rappahannock (Marshall Mine); Whitehall Mine, affording also tetradymite.

Stafford Co., eight or ten miles from Falmouth.—Micaceous iron, gold, tetradymite, silver, galena, vivianite.

Washington Co., eighteen miles from Abingdon.—*Rock salt* with *gypsum.*

Wythe Co., (Austin's mines).—*Cerusite, minium, plumbic ochre*, blende, *calamine, galena.*

On the Potomac, twenty-five miles north of Washington City.—*Native sulphur* in gray compact limestone.

NORTH CAROLINA.

Ashe Co.—Malachite, copper pyrites.

Buncombe Co.—Corundum (from a boulder), *margarite*, corundophilite, *garnet*, chromic iron, barytes, *fluor*, rutile, iron ores, oxyd of manganese.

Burke Co.—Gold, monazite, zircon, beryl, *corundum*, *garnet*, sphene, *graphite*, iron ores.

Cabarrus Co.—Phenix mine, gold, barytes, *copper pyrites*, auriferous pyrites, quartz pseudomorph after barytes, tetradymite; Pioneer Mines, *gold*, limonite, pyrolusite, *barnhardtite*, *wolfram*, *scheelite*, tungstate of copper, *wolframine*, diamond, chrysocolla, copper glance, molybdenite, *copper pyrites*, *iron pyrites;* White Mine, needle ore, copper pyrites, barytes; Long and Muse's Mine, argentiferous galena, iron pyrites, copper pyrites, limonite; Boger Mine, tetradymite; Fink Mine, valuable copper ores; Mt. Makins, tetrahedrite? magnetite, talc, blende, pyrites, galena.

Caldwell Co.—Chromic iron,

Chatham Co.—Mineral coal, pyrites.

Cherokee Co.—Iron ores, gold, galena, corundum, rutile.

Davidson Co.—King's now Washington Mine, native silver, cerusite, anglesite, scheelite, pyromorphite, galena, blende, malachite, black copper, *wavellite*, garnet, stilbite. Five miles from Washington Mine, on Faust's Farm, gold, *tetradymite*, oxyd of bismuth and tellurium, copper pyrites, limonite, spathic iron, epidote; near Squire Ward's, gold in crystals, electrum.

Gaston Co.—Iron ores, corundum, margarite. Near Crowder's Mountain (in what was formerly Lincoln Co.), *lazulite*, *kyanite*, *garnet*, graphite; also twenty miles northeast, near south end of Clubb's Mtn., lazulite, kyanite, talc.

Guilford Co.—McCullock copper and gold mine, twelve miles from Greensboro, *gold*, *pyrites*, *copper pyrites* (worked for copper), *quartz*, spathic iron. The North Carolina Copper Co. are working the copper ore at the old Fentress mine.

Henderson Co.—*Zircon.*

Lincoln Co.—Diamond; at Randleman's, *amethyst!*, rose quartz.

Macon Co.—Chromic iron.

McDowell Co.—Brookite, monazite, corundum in small crystals red and white, *zircons*, garnet, beryl, sphene, xenotime, rutile, elastic sandstone, iron ores.

Mecklenberg Co.—Near Charlotte (Rhea and Cathay Mines) and elsewhere, *copper pyrites*, *gold;* chalcotrichite at McGinn's Mine; barnhardtite near Charlotte; pyrophyllite in Cotton Stone Mountain, diamond.

Rowan Co.—Gold Hill Mines, thirty eight miles northeast of Charlotte, and fourteen from Salisbury, gold, auriferous pyrites; ten miles from Salisbury, *feldspar* in crystals.

Rutherford Co.—*Gold*, *graphite*, bismuthic gold, diamond, euclase, *pseudomorphous quartz*, chalcedony, corundum in small crystals, *epidote*, *pyrope*, brookite, zircon, monazite, rutherfordite, samarskite, *quartz crystals*, itacolumite; on the road to Cooper's gap, kyanite.

Stokes and Surrey Cos.—Iron ores, graphite.

Union Co.—Lemmond Gold Mine, eighteen miles from Concord, (at Stewart's and Moore's Mine), gold, quartz, blende, argentiferous galena (containing 29·4 oz. of gold, and 86·5 oz. silver to the ton, Genth), pyrites, some copper pyrites.

Yancey Co.—*Iron ores*, amianthus, *chromic iron.*

SOUTH CAROLINA.

Abbeville Dist.—Oakland Grove, *Gold*, (Dorn Mine), galena, pyromorphite, amethyst, garnet.

Anderson Dist.—At Pendleton, *actinolite*, galena, kaolin, *tourmaline.*

Charleston.—*Selenite.*

Cheowee Valley.—Galena, tourmaline, gold.

Chesterfield Dist.—Gold, (Brewer's mine), talc, chlorite, pyrophyllite, pyrites, native bismuth, carbonate of bismuth, red and yellow ochre, whetstone.

Darlington.—Kaolin.

Edgefield Dist.—Psilomelane.

Greenville Dist.—Galena, phosphate of lead, kaolin, chalcedony in burhstone, beryl, plumbago, epidote, *tourmaline.*

Kershaw Dist.—*Rutile.*

Lancaster Dist.—Gold (Hale's mine), talc, chlorite, kyanite, elastic sandstone, pyrites; gold also at Blackman's mine, Massey's mine, Ezell's mine.

Newberry Dist.—Leadhillite (?).

PICKEN'S DIST.—Gold, manganese ores, kaolin.

RICHLAND DIST.—Chiastolite, novaculite.

SPARTANBURG DIST.—*Magnetic iron ore,* chalcedony, *hematite;* at the Cowpens, *brown hematite, graphite,* limestone, copperas.

SUMTER DIST.—Agate.

UNION DIST.—Fairforest gold mines, pyrites, copper pyrites.

YORK DIST.—Limestones, whetstones, witherite, heavy spar.

GEORGIA.

BURKE AND SCRIVEN COS.—Hyalite.

CLARK CO., near Clarksville.—Gold, xenotime, zircon, rutile, kyanite, specular iron, garnet, quartz.

HABERSHAM CO.—*Gold,* iron and copper pyrites, *galena,* hornblende, garnet, quartz, kaolin, soapstone, chlorite, *rutile,* iron ores, galena, tourmaline, staurotide, zircon.

HALL CO.—*Gold,* quartz, kaolin, diamond.

HANCOCK CO.—Agate, chalcedony.

LUMPKIN CO.—Gold, quartz crystals.

RABUN CO.—Gold, *copper pyrites.*

WASHINGTON CO. near Saundersville.—*Wavellite, fire opal.*

ALABAMA.

BIBB CO., CENTREVILLE.—*Iron ores,* marble, *heavy spar,* coal, cobalt.

TUSCALOOSA CO.—*Coal,* galena, pyrites, vivianite, limonite, calcite, dolomite, kyanite, steatite, quartz crystals, manganese ores.

BENTON CO.—Antimonial lead ore (Boulangerite?)

FLORIDA.

NEAR TAMPA BAY.—Limestone, sulphur springs, chalcedony, carnelian, agate, silicified shells and corals.

KENTUCKY.

MAMMOTH CAVE.—*Gypsum,* in imitative forms, stalactites, nitre, epsom salt.

Near the line between Livingston and Union Cos., galena, copper pyrites.

TENNESSEE.

BROWN'S CREEK.—Galena, blende, heavy spar, celestine.

CARTER'S CO. foot of Roan Mt.—*Sahlite,* magnetic iron.

CLAIBORNE CO.—*Calamine,* galena, smithsonite, chlorite, steatite, and magnetic iron.

COCKE CO., near Brush Creek.—Cacoxene, kraurite, iron sinter, stilpnosiderite, brown hematite.

DAVIDSON CO.—Selenite, with granular and snowy *gypsum,* or alabaster, crystallized and compact *anhydrite, fluor* in crystals? *calc spar* in crystals. Near Nashville, blue *celestine,* (crystallized, fibrous, and radiated), with *heavy spar* in limestone. Haysboro', galena, blende, with heavy spar as the gangue of the ore.

DICKSON CO.—Manganite.

JEFFERSON CO.—*Calamine,* galena, fetid heavy spar.

KNOX CO.—Magnesian limestone.

MAURY CO.—Wavellite in limestone.

MORGAN CO.—Epsom salt, nitrate of lime.

POLK CO., Hiwassee mine, southeast corner of state, near Ocoee river. *Black copper!* copper pyrites, iron pyrites, (mines valuable).

Roan Co., eastern declivity of Cumberlands Mts.—Wavellite in limestone.

Severn Co, in caverns.—Epsom salt, soda alum, saltpetre, nitrate of lime.

Smith Co.—Fluor.

Smoky Mt., on declivity.—Hornblende, garnet, staurotide.

OHIO.

Bainbridge, (Copperas Mt., a few miles east of B.)—Calc spar, heavy spar, iron pyrites, copperas, alum.

Canfield,—*Gypsum!*

Duck Creek, Monroe Co.—Petroleum.

Liverpool.—Petroleum.

Marietta.—Argillaceous iron ore; iron ore abundant also in Scioto and Lawrence Cos.

Poland.—*Gypsum!*

MICHIGAN.

Lake Superior Mining Region.—The four principal regions are Keweenaw Point, Isle Royale, the Ontonagon, and Portage Lake. The mines of Keweenaw Point are along two ranges of elevation, one known as the Greenstone Range and the other as the Southern or Bohemian Range, (Whitney). The copper occurs in the trap or amygdaloid, and in the associated conglomerate. *Native copper! native silver!* copper pyrites, horn silver, gray copper, manganese ores, epidote, *prehnite, laumontite, datholite,* heulandite, *stilbite, analcime,* chabazite, *mesotype,* (Copper Falls mine), *leonhardite,* (ib.), *analcime,* (ib.), *apophyllite,* (at Cliff Mine), *wollastonite,* (ib.), *calc spar, quartz* (in crystals, at Minesota mine), *saponite, black oxyd* of copper, (near Copper Harbor, but exhausted), chrysocolla; on Chocolate river, galena and sulphuret of copper; copper pyrites and native copper at Presqu' Isle. At Albion mine, *domeykite;* at Prince Vein, *amethyst;* at Michipicoten Ids., copper nickel, stilbite, analcime.

Isle Royale, 48° N., 89° W.—*Native copper, epidote,* harmotome (?) *datholite,* wollastonite (exhausted), *pectolite,* chlorastrolite.

ILLINOIS.

Gallatin Co., on a branch of Grand Pierre Creek, sixteen to thirty miles from Shawneetown, down the Ohio, and from half to eight miles from this river.—*Violet fluor spar!* in carboniferous limestone, heavy spar, *galena,* blende, brown iron ore; near Rosiclare, *calcite,* galena, blende; five miles back from Elizabethtown, bog iron; one mile north of the river, between Elizabethtown and Rosiclare, *nitre.*

In Northern Illinois, townships 27, 28, 29, several important mines of *galena.*

Pope Co.—Pyromorphite.

INDIANA.

Limestone Caverns; Corydon Caves, &c.—*Epsom salt.*

In most of the southwest counties, *pyrites, sulphate of iron,* and *feather alum;* on Sugar Creek, pyrites and *sulphate of iron;* in sandstone of Lloyd Co., near the Ohio, *gypsum;* at the top of the blue limestone formation, *brown spar, calc spar.*

MINESOTA.

North Shore of L. Superior, (range of hills running nearly northeast and southwest, extending from Fond du Lac Superieure to the Kamanistiqueia river in Upper Canada).—*Scolecite, apophyllite, prehnite, stilbite, laumontite, heulandite, harmotome,* thomsonite, *fluor spar, sulphate of baryta, tourmaline, epidote,* hornblende, calcareous spar, quartz crystals, iron pyrites, magnetic iron ore, steatite, blende, black oxyd of copper, malachite, native copper, copper pyrites, amethystine quartz, ferruginous quartz, *chalcedony*, *carnelian*, *agate*, drusy quartz, hyalite? fibrous quartz, jasper, prase, (in the debris of the lake shore), dogtooth spar, augite, native silver, spodumene?, arsenite? of cobalt, chlorite; between Pigeon Point and Fond du Lac, near Baptism river, saponite, (thalite), in amygdaloid.

KETTLE RIVER TRAP RANGE.—Epidote, nail-head calc spar, amethystine quartz, calcareous spar, undetermined zeolites, saponite.

STILLWATER.—Blende.

FALLS OF THE ST. CROIX.—Green carbonate of copper, native copper, epidote, nail-head spar.

RAINY LAKE.—Actinolite, tremolite, fibrous hornblende, garnet, iron pyrites, magnetic iron, steatite.

WISCONSIN.

At MINERAL POINT and elsewhere, copper and lead ores, principally silicate and carbonate of copper, copper pyrites, and *galena*, (only the last abundant). Also *pyrites*, *capillary pyrites*, *blende*, *white lead ore*, leadhillite (?), *smithsonite* (carbonate of zinc), anglesite, *heavy spar*, and calc spar.

SANK CO.—Specular iron! malachite, copper pyrites.

MONTREAL RIVER PORTAGE.—Galena in gneissoid granite.

LAC DU FLAMBEAU R.—Garnet, kyanite

BIG BULL FALLS, (near).—Bog iron.

LEFT HAND R., (near small tributary).—Malachite, copper glance, native copper, red copper ore, earthy malachite, epidote, chlorite? quartz crystals.

IOWA.

DU BUQUE LEAD MINES, and elsewhere.—*Galena! calc spar*, black oxyd of manganese; at Ewing's and Sherard's diggings, *calamine!* or smithsonite; at Des Moines, quartz crystals, selenite; Mahoqueta R., *brown iron ore*.

CEDAR RIVER, a branch of the Des Moines.—*Selenite* in crystals, in the bituminous shale of the coal measures; also elsewhere on the Des Moines, gypsum abundant; argillaceous iron ore, spathic iron; copperas in crystals on the Des Moines, above the mouth of Saap and elsewhere, *iron pyrites*, blende.

MISSOURI.

BIRMINGHAM.—Limonite.

JEFFERSON CO., at Valle's Diggings.—*Galena*, *white lead ore*, anglesite, calamine, pyritous copper, blue and green malachite, carbonate of baryta.

MINE A BURTON.—*Galena*, *white lead ore*, *anglesite*, *heavy spar*, calc spar.

DEEP DIGGINGS.—Carbonate of copper, *white lead ore* in crystals, and manganese ore.

MINE LA MOTTE.—*Galena!* malachite, *earthy cobalt* and *nickel*, bog manganese, sulphuret of iron and nickel, *white lead ore* in crystals, caledonite, plumboresinite, wolfram.

PERRY'S DIGGINGS, and elsewhere.—Galena, &c.

Forty miles west of the Mississippi and ninety south of St. Louis, the iron mountains, specular iron, limonite.

ARKANSAS.

BATESVILLE.—In bed of white R., some miles above Batesville, Gold.

OUACHITA SPRINGS.—*Quartz!* whetstones.

MAGNET COVE.—*Brookite! schorlomite*, *elæolite*, magnetic iron, quartz, green coccolite, garnet, apatite.

CALIFORNIA.

Along the Sierra Nevada, *gold*, platinum (rare), iridosmine, molybdenite, molybdine, zircon, magnetic iron; near bay of San Francisco, actinolite, talc, serpentine, jasper, salt, gypsum, (island in the Caquines Straits); ridges of Sierra Azul, south of San José, *cinnabar*. Gold also found in the Umpqua region, Oregon, and the Shasty Mountains.

CANADA.

CANADA EAST.

ABERCROMBIE.—Labradorite.

BAY ST. PAUL.—*Ilmenite!*, apatite, allanite, rutile (or brookite?)

AUBERT.—Gold, iridosmine, platinum.

BOLTON.—*Chromic iron, magnesite*, serpentine, picrolite, steatite, bitter spar, wad.

BOUCHERVILLE.—*Augite* in trap.

BROME.—*Magnetic iron*, copper pyrites, *sphene*, ilmenite, phyllite, sodalite, cancrinite, galena.

CHAMBLY.—Analcime, chabazite and calcite in trachyte.

CHATEAU RICHER.—*Labradorite, ilmenite, hypersthene.*

DAILLEBOUT.—Blue spinel, with clintonite.

GRENVILLE.—*Tabular spar, sphene*, idocrase, calcite, pyroxene, *garnet* (cinnamon stone), *zircon, graphite, scapolite.*

HAM.—Chromic iron in serpentine.

INVERNESS.—*Variegated copper.*

LAKE ST. FRANCIS.—*Andalusite* in mica slate.

LANDSDOWNE.—*Barytes.*

MILLE ISLES.—*Labradorite!* ilmenite, hypersthene, andesine, *zircon.*

MONTREAL.—*Calcite, augite*, sphene in trap.

MORIN.—*Sphene, apatite, labradorite.*

POLTON.—Chromic iron, *steatite*, serpentine, *amianthus.*

ROUGEMONT MTS.—Augite in trap.

ST. ARMAND.—Micaceous iron ore with quartz, epidote.

ST. FRANÇOIS BEAUCE.—Gold, platinum, iridosmine, ilmenite, magnetite, serpentine, chromic iron, soapstone, magnetite, heavy spar.

ST. JEROME.—*Sphene, apatite, chondrodite, phlogopite, tourmaline, zircon*, molybdenite, *magnetic pyrites.*

ST. NORBERT.—Amethyst in greenstone.

STUKLEY.—Serpentine, *verde antique!* schiller spar.

SUTTON.—*Magnetic iron* in fine crystals, *specular iron, rutile*, dolomite, *magnesite*, chromiferous *talc*, bitter spar, steatite.

UPTON.—Copper pyrites, malachite, calcite.

VAUDREUIL.—Limonite, vivianite.

YAMASKA.—Sphene in trap.

CANADA WEST.

BALSAM LAKE.—*Molybdenite*, scapolite, quartz.

BRANTFORD.—Sulphuric acid spring, (4·2 parts of pure sulphuric acid in 1000).

BATHURST.—Heavy spar, *black tourmaline, perthite* (orthoclase), *peristerite* (albite), *bytownite.*

BROME.—Magnetite.

BURGESS.—*Pyroxene*, albite, *mica, sapphire*, sphene, copper pyrites, *apatite, black spinel!* spodumene, (in a boulder).

BYTOWN.—*Calcite, bytownite*, chondrodite, spinel.

CAPE IPPERWASH, Lake Huron.—Oxalite in shales.

CLARENDON.—*Idocrase.*

DALHOUSIE.—Hornblende, dolomite.

DRUMMOND.—Labradorite.

Elmsley.—Pyroxene, sphene, feldspar, *tourmaline.*

Fitzroy.—Amber, brown *tourmaline,* in quartz.

Gœtineau River, Blasdell's Mills.—Calcite, apatite, tourmaline, hornblende, pyroxene.

Grand Calumet Island.—*Apatite, phlogopite ! pyroxene !* sphene, *idocrase ! !* serpentine, tremolite, *scapolite,* brown and black *tourmaline !* pyrites, loganite.

High Falls of the Madawaska.—*Pyroxene !* hornblende.

Hull.—*Magnetite,* garnet, graphite.

Hunterstown.—*Scapolite, sphene,* idocrase, garnet, *brown tourmaline !*

Inniskillen.—Petroleum.

Lac des Chats, Island Portage.—*Brown tourmaline !* pyrites, calcite, quartz.

Lanark.—Raphilite (hornblende), serpentine, asbestus.

Landsdown.—*Barytes !* vein 27 in. wide, and fine crystals.

Madoc.—Magnetite.

Marmora.—Magnetite, chalcolite, garnet, epsomite, specular iron.

McNab.—Specular iron.

New Brunswick, St. John.—*Graphite.*

South Crosby.—Chondrodite in limestone, magnetite.

St. Adele.—Chondrodite in limestone.

Sydenham.—Celestine.

Terrace Cove, Lake Superior.—Molybdenite.

Wallace Mine, Lake Huron.—*Specular iron,* Bruce mines, copper pyrites.

Note.—The rock of the Mississippi valley containing the remarkable deposits of galena, (sometimes regarded as the equivalent of the "Cliff" or "Upper Magnesian" Limestone), is considered by James Hall as between the Hudson River and Trenton Groups of New York in age, and as having no representative in the eastern part of the United States. The sandstones and conglomerates of the Lake Superior copper region in Michigan are referred by Foster and Whitney, Hall, Owen, and Logan to the age of the Potsdam sandstone, or the *lowest Silurian ;* while the copper-bearing red sandstone of Connecticut and New Jersey, is shown by Rogers, Redfield and Hall, to be as recent as the *Liassic* Period.

The metamorphic limestone of northern New York, (St. Lawrence Co., etc.), and north near the bay of Quinté, in Canada, abounding in apatite, scapolite, etc., is referred by T. S. Hunt to the *Azoic System ;* the beds of western Vermont, western Massachusetts, and south eastern New York and New Jersey, (containing in the latter regions especially, chondrodite, spinel, etc.), to the *lower Silurian,* as previously shown by H. D. Rogers and W. W. Mather; those of middle New England, occurring near Milford and New Haven, Ct., and north near Lake Memphremagog, and on the Chaudière in Canada, to the *upper Silurian.* Still a fourth range of the *Devonian Period* is supposed to occur in eastern Massachusetts, and to include the quarries of Bolton, Chelmsford, etc. The intervening micaceous, gneissic and other rocks are of intermediate age; while those of northern New York, the most remote from the carboniferous deposits of Pennsylvania, and Rhode Island, are the most ancient.

APPENDIX.

APPENDIX TO FIRST VOLUME.

Mathematical Crystallography.—P. 75, fifth line from top, the formula ma tan $\frac{1}{2}Z\sqrt{\frac{1}{2}}$ should read $ma=\tan \frac{1}{2}Z\sqrt{\frac{1}{2}}$.

P. 87. In the Monoclinic System, the values of the axes, (the clinodiagonal b being a unit), are readily obtained by the following equations; X being half the front angle of the prism (or half of $I : I$) and X' half the angle above of the clinodome 1-$\breve{\infty}$ (or half of $1\grave{\imath} : 1\grave{\imath}$ over O):

$$c=\text{Tan } X \sin C, \qquad a=\text{Tan } X \div \tan X' = \tan X \cot X'.$$

The proportion $a : b = \sin \mu : \sin \nu$, in the seventeenth line from bottom of this page should be $a : b = \sin \nu : \sin \mu$.

P. 92. The heading *Monoclinic System* should be *Monometric System.*

Atomic Weight of Glucinum.—J. Weeren has obtained for the atomic weight of Glucinum 86·50. Pogg. xcii, 128, 1854.

P. 189. *Homœomorphism.*—In a paper on the relations between Chemical Composition and Crystalline Form, (Paris, 1852), by M. Ladrey, from whom it has been just now received, the author reviews many different classes of compounds, principally minerals, and shows that all or nearly all of the forms may be obtained from fundamental forms, near 90° in angle, by assuming as the fundamental form where necessary, one having some simple relation to that usually so adopted. Relations to the monometric system are thus brought out, and also homœomorphisms independent of composition. In deducing the relations, cleavage, twin composition, and all other points bearing on the actual or potential dimensions of a species, are disregarded; points which are dwelt upon in the chapter on homœomorphism, and which have led the author to a similar general conclusion by a different, and, as we believe, by a more consistent method.

Rammelsberg has published an important paper in Pogg. xci, 321, on the Crystallization of Isomorphous Salts together. In the Ann. de Ch. et de Phys. [3], xxxix, 404, 1853, M. J. Nicklès has a valuable memoir "On Polymorphism."

Pseudomorphs, p. 222.—Add the following to the catalogue. They are mostly from a paper by Prof. Reuss of Prague, (1853):

Hematite	after	Cerusite.	Pyrites	after	Brown Spar.
"	"	Feldspar.	Marcasite	"	Barytes.
Galena	"	Cerusite.	Chalcopyrite	"	Magnetite.
Pharmacolite	"	Realgar.	"	"	Nagyagite.
Garnet	"	Calcite.	Thorite	"	Orthoclase.
Cerusite	"	Calcite.			

P. 250. In the Classification of Minerals, the Fluorids are arranged along side of the Chlorids, where some chemists place them. The element Fluorine appears to be intermediate in character between Oxygen and Chlorine; and it is probably better to make for it a separate division, arranging the species (p. 250) as follows:

III. CHLORIDS, BROMIDS, IODIDS.

1. Calomel Division, &c.—Calomel.

2. Rock Salt Division, &c.—*Rock Salt Group*, Sylvine, Rock Salt, Sal Ammoniac, Kerargyrite, Bromyrite; *Iodyrite Group*, Iodyrite; *Cotunnite Group*, Cotunnite.

IV. FLUORIDS.

I. BINARY COMPOUNDS.—1. *Fluor Group*, Fluor Spar, Yttrocerite; *Fluocerite Group*, Fluocerite. II. DOUBLE BINARY COMPOUNDS, Cryolite, Chiolite.

Then V. OXYGEN COMPOUNDS, and so on.

APPENDIX TO SECOND VOLUME.

1. *New or Unarranged Species.*

BARNHARDTITE, *Genth*, (communicated to the author).—Massive, and of a pale bronze-yellow color, near that of pyrites, but lustre less bright, and tarnishes easily to pinchbeck and pavonine tints. Cleavage none. Streak black, slightly shining.

Composition.—$2\,\bar{Cu}S+Fe^2S^3$. Analyses, by P. Keyser and W. J. Taylor, under the direction of Dr. F. A. Genth:

1. Pioneer Mills,	Sulphur 30·50	Copper 48·40	Iron 21·08,	Keyser.
2. Dan Barnhardt's,	29·40	47·61	22·23, Ag *trace*,	Taylor.

B.B. gives sulphur fumes, and fuses to an iron-black magnetic globule; with the fluxes, reactions of iron, copper, and sulphur.

From a mine on the land of Dan Barnhardt, Cabarras Co., North Carolina; also near Pioneer Mills, and at the Phenix and Vanderberg Mines in the same county, and in the neighborhood of Charlotte in Mecklenburg Co.

CAROLATHINE, *F. L. Sonnenschein*, (J. f. pr. Ch. lx, 268, 1853).—Massive, or in rounded balls. Color honey-yellow to wine-yellow. Subtranslucent. H.=2·5. G.=1·515. Fracture conchoidal.

Composition.—Analysis afforded H 2·41, O 19·39, C 1·33, for the volatile part, (water included) with $\dddot{\bar{Al}}$ 47·25 and $\dddot{Si}$ 29·62 for the fixed. This last corresponds to the formula $\dddot{\bar{Al}}\dddot{Si}^{\frac{2}{3}}$, as in Andalusite. Heated it affords water, which is neutral in its reactions, and decrepitates at a higher temperature, the color becomes darker, and a black shining mass is obtained. B.B. ignites somewhat without flame, and affords the reaction of alumina and silica.

From a bed of mineral coal near Gleiwitz in Upper Silesia. Somewhat resembles Mellite. Named after the Prince of Carolath.

CHALCODITE, *Shepard*. (Shep. Min. 3d. ed. 153).—Chalcodite appears to be near Anthosiderite, (p. 304). It occurs in minute thin laminæ, aggregated in tufts, and forming very short velvety coatings, on hematite; color yellow and brownish-yellow, with a pearly bronze lustre; laminæ tender, flexible. Dissolves easily in hot muriatic acid. B.B. like Anthosiderite. Occurs at the Sterling Iron Mine, Antwerp, Jefferson Co., N. York.

DELANOVITE, *Kenngott*, (Jahrb. k. k. Geol. Reichs., iv, 633).—A reddish amorphous earthy mineral, H.=1—1·5; fracture splintery to earthy; adheres to the tongue; streak reddish, a little shining; B.B. infusible. Analysis by C. von Hauer, (loc. cit):

$\dddot{Si}$ 50·55 $\dddot{\bar{Al}}$ 19·15 $\dot{Ca}$ 0·63 $\dot{Mn}$ 4·40 $\dot{\bar{H}}$ 24·05=98·78.

14·03 per cent. of water was driven off at 100° C. The oxygen ratio for $\dot{R}$, $\dddot{\bar{R}}$, $\dddot{Si}$, $\dot{\bar{H}}$, is nearly 1 : 2 : 6 : 15$=\dot{R}^3\dddot{Si}^2+2\dddot{\bar{R}}\dddot{Si}^2+45\dot{\bar{H}}$, or $(\frac{1}{3}\dot{R}^3+\frac{2}{3}\dddot{\bar{R}})\dddot{Si}^2+15\dot{\bar{H}}$, a composition which suggests that it may have proceeded like Cimolite from the alteration of Augite. From the department of Dordogne, France. Kenngott places it near Montmorillonite.

IODO-BROMID OF SILVER.—M. Louis Sæmann announces by letter to the author, that he has distinguished an iodo-bromid of silver among the minerals of Chili.

LINDACKERITE, *J. F. Vogl*, (Jahrb. k. k. Geol. Reichs., iv, 552).—In oblong rhombohedral tables, probably trimetric, grouped in rosettes and reniform masses. H.=2—2·5; G.=2—2·5. Vitreous; verdigris to apple-green; streak pale-green to white. *Composition.*—$2\dot{Cu}^3\dddot{\bar{As}}+\dot{Ni}^3\dddot{S}+8\dot{\bar{H}}$. Analysis by Lindacker, (loc. cit.): $\dddot{\bar{As}}$ 28·58, $\dddot{S}$ 6·44, $\dot{Cu}$ 36·34, $\dot{Ni}$ 16·15, $\dot{Fe}$ 2·90, $\dot{\bar{H}}$ 9·32=99·73. B.B. on charcoal alliaceous fumes, and fuses to a black mass. With borax and salt of phosphorus a copper reaction. Soluble after long heating in muriatic acid, the solution giving a yellowish brown precipitate with sulphuretted hydrogen.

LÖWEITE.—A yellowish saline mineral, from Ischl, approaching Astrakanite, (p. 379), affording the formula $\dot{M}g\ddot{S}+\dot{N}a\ddot{S}+2\frac{1}{2}\dot{H}$=Sulphuric acid 51·94, magnesia 13·20, soda 20·27, water 14·59=100. Karafiat obtained, (Haid. Ber. Wien, 1846, 266), Sulphuric acid 52·35, magnesia 12·78, soda 18·97, water 14·45, peroxyd of iron and alumina 0·66=99·21. G.=2·376.

MANGAN-VITRIOL, or Sulphate of Manganese.—Announced by Glocker, but imperfectly known.

MENEGHINITE, Bechi, (Am. J. Sci. [2], xiv, 60.—In compact fibrous forms, very lustrous ; H.=2·5. *Composition.*—$PbS+\frac{1}{4}SbS^3$, Bechi, whose analysis afforded (loc. cit.), S 17·522, Sb 19·284, Pb 59·214, Cu 3·540, Fe 0·344=99·904.

From Bottino in Tuscany, where it was obtained by Prof. Meneghini, along with Boulangerite and Jamesonite. The atomic proportions are those of tetrahedrite.

PARACOLUMBITE, *Shepard*, (Proc. Amer. Assoc., iv, 313, and Amer. Jour. Sci. [2], xii. 209).—In grains and short irregular seams, of an iron-black color, with a tinge of purple and a black streak ; lustre imperfectly metallic. H. about 5. B.B. fuses readily to a black glass, which is not magnetic. With borax dissolves rapidly, the glass yellowish-brown while hot, but paler on cooling. Easily attacked by sulphuric acid, and gives reaction for fluorine ; a heavy white precipitate falls, " unmixed with silica." The solution filtered was not rendered milky by boiling ; it was decomposed by ammonia, and the precipitate " of mixed oxyds of uranium and iron was treated with carbonate of ammonia, which dissolved the latter, and showed its proportion to be small when compared with the former." Whence it is stated to consist probably of oxyds of iron and uranium, with some metallic acid not the titanic.

Occurs about a mile southwest of the village of Taunton, Mass., disseminated in very minutes quantities through a very large boulder, lying in a field contiguous to the highway.

PARTSCHIN, *Haidinger*, (Haid. Ber. iii, 440).—Found in grains in small monoclinic crystals, somewhat resembling Monazite. H.=6—6·5 ; G.=4—4·1. Color reddish-brown. Lustre greasy. Fracture splintery.

In sand from Olahpian in Hungary with Rutile, Ilmenite, Zircon, Kyanite. Named after P. Partsch, of the Vienna Museum.

PERCYLITE, *H. J. Brooke*, (Phil. Mag. [3], xxxvi, 131, 1850).—Monometric. In minute cubes; planes *O*, 1, *I*, *i*2. H.=2·5. Color sky-blue ; streak similar.

Composition.—Contains, according to Percy, (loc. cit.), lead, chlorine, and copper, and probably oxygen ; the quantity under analysis was too small for complete results. The examination gave, besides some water, chlorine 0·84, lead 2·66, copper 0·77, corresponding to equal atomic equivalents of these ingredients. Mr. Percy supposes that an equivalent of oxygen should be added, and writes the formula $(PbCl+PbO)+(CuCl+CuO)+Aq$. B.B. by slight heat the blue color changes to emerald-green, and reappears on cooling ; in the outer flame, the flame is green within and blue at the edges ; fuses very easily, and in a tube fumes were given off, but no odors were perceived. On charcoal in the inner flame metallic globules are obtained, which dissolve without residue in dilute nitric acid. With borax in the outer flame, a transparent bluish-green bead is obtained, which in the inner flame becomes turbid and brownish-red.

Accompanies gold in a matrix of quartz and red oxyd of iron, and is said to have come from La Sonora, in Mexico.

PRASOCHROME, *Landerer*.—A result of the alteration of chromic iron on the island Scyro, Grecian Archipelago, forming a dull green incrustation. Contains carbonate of lime colored by oxyd or chrome.

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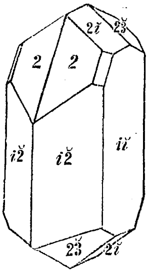

PROSOPITE, *Scheerer*, (Pogg. xc, 315).—Supposed from some qualitative trials on portions that were unaltered, to consist of aluminium, calcium, fluorine, and water. Occurs at the tin mines of Altenberg, in crystals which are mostly altered to Kaolin. Scheerer points out a relation in some angles to Barytes; but the form is in fact very much like that of Datholite, as shown in the angles and in the annexed figure, altered in position from that given by Scheerer; $i\breve{2} : i\breve{2}$=77° to 78°, (76° 44, in Datholite); $\bar{O} : 2\bar{i}$=135°, (same in D.); 2 ; 2=132°, (131° 52′ in D.); $2\breve{i} : 2\breve{i}$ (top)=116½°, (115° 26′ in D.); $2\breve{3} : 2\breve{3}$=119°, (118° 9′ in D.)

Is it possible that the fluorine has been introduced through the process of alteration, and that the mineral is when unaltered, nothing but Datholite? The name is from *προσωπειον, a mask*, and alludes to its deceptive or masked condition.

RIOLITE, *Fröbel*.—A selenid of silver, consisting according to Del Rio, of Silver 57·66, selenium 42·34=$Ag\ Se^2$. Occurs in small hexagonal tables of a lead gray color and malleable, at Tasco in Mexico. Requires further examination. The composition and form would place the species in the *Covelline* Group, p. 54.

STRAKONITZITE, *von Zepharovich*.—A yellowish green steatite-like mineral, forming pseudomorphs at Mutenitz, near Strakonitz in Bohemia, with fluor spar which is partly incrusted with quartz, and also sphene and pyrites in orthoclase and quartz. It is soft with a greasy feel, and G.=1·91. Analysis afforded von Zepharovich, (Jahrb. f. k. k. Reichs., iv, 695):

$\dddot{\text{Si}}$ 53·42 $\ddot{\bar{\text{Al}}}$ 7·00 $\dot{\text{Fe}}$ 15·41 $\dot{\text{Ca}}$ 1·37 $\dot{\text{Mg}}$ 2·94 $\dot{\bar{\text{H}}}$ 19·86.

The powder is pale yellowish, and becomes dull brown on heating.

TELLURIC OCHRE, (Tellurite, *Nicol*, Tellurige Säure, *Petz*).—Occurs with native Tellurium at Facebay and Zalathna in Transylvania, in small yellowish or whitish spherical masses, with a radiated structure; also as an earthy coating. Supposed to be Tellurous acid.

TUNGSTATE OF COPPER.—Announced by Dr. Genth, as occurring at Dr. Cosby's mine near Pioneer Mills, Cabarras Co., North Carolina, along with Wolframine, Wolfram and Scheelite, the last in large, but not very distinct, crystals.

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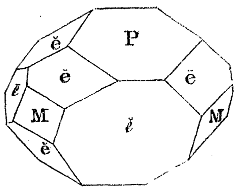

TURNERITE, *Levy*, (Ann. of Phil. xviii, 241).—Monoclinic. M : M=86° 10′, P : M=99° 40′; M : ē=138° 5′; P : ē=133° 50. Cleavage parallel with both diagonals of the prism, one more perfect than the other.

H. above 4. Lustre adamantine. Streak white or grayish. Color yellow or brown. Transparent—translucent.

Composition.—According to Children, it contains alumina, lime, magnesia, and a little iron; and it differs from sphene, of which it has been considered a variety, in containing very little silica and no titanium. It requires further examination, in order to determine its place in the system.

Accompanies quartz, albite, feldspar, crichtonite, and anatase, at Mount Sorel in Dauphiné. It was distinguished by Levy, and named in honor of Mr. Turner, in whose collection it was first found.

URANIUM, BASIC SULPHATE OF, *H. Dauber*, (Pogg. xcii, 251, June, 1854).—Occurs in citron-yellow microscopic, rhombic or hexagonal tables, and in spherical aggregations. An analysis afforded Sulphuric acid 4·0, oxyd of uranium 79·9, water 14·3=98·2, corresponding to $5\dddot{\bar{\text{U}}}$, $1\dddot{\text{S}}$, $15\dot{\bar{\text{H}}}$. Is it a simple chemical compound?

WILSONITE, *T. S. Hunt*, (Logan's Geol. Survey of Canada, 1853).—Massive. Cleavage perfect in two directions at right angles with one another, and giving square prisms; a cross cleavage at right angles with one of those cleavages and inclined 110° to 115° to the other. [According to the examination of fragments by the author, this last cleavage may be only a fracture, a supposition sustained by the wide variation mentioned in the angle of inclination]. H.=3·5. G.=2·765—2·776. Lustre vitreous, shining, occasionally pearly on cleavage surfaces. Color reddish, rose-red to peach-blossom-red. Subtranslucent. Fracture uneven.

Composition.—Analysis by T. S. Hunt:

	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dddot{\overline{\mathrm{Fe}}}$, $\dddot{\overline{\mathrm{Mn}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
	43·55	27·94	0·20	6·50	3·81	8·37	1·45	8·61
Oxygen	23·07	13·05	0·06	1·86	1·52	1·42	0·37	7·65

B.B. whitens, becoming opaque, and losing water; fuses with intumescence to a white enamel. Occurs at Bathurst, C. W., with apatite, calcite, and pyroxene. Some resemblance in appearance to scapolite.

Mineral from Italy, (Sitzungsb. Wien. x, 179).—This mineral substance is probably a mechanical mixture. It is crystalline; light greenish to wine yellow; translucent; shining with a waxy lustre; streak white. H.=5·5. G.=2·969.

Composition.—	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{P}}}$	$\dot{\mathrm{H}}$
	38·42	5·30	34·23	7·72	6·72	6·00.

It affords no probable formula. Wholly soluble in sulphuric acid, and but little attacked by muriatic acid. B.B. on charcoal melts easily to a colorless blebby glass, phosphorescing. With borax easily forms a colorless glass.

Meteoric Minerals.—Several substances occurring in meteorites have been named by C. U. Shepard as minerals, which are imperfectly described and little known. See Am. J. Sci., [2], ii, 377, vi, 402, xv. 363. They are called *Apatoid, Sphenomite,* (so called from Sphene), *Dyslytite, Iodolite, Chladnite, Chantonnite, Schreibersite,* (changed by Haidinger to *Shepardite*), *Hyposulphite of Soda, Hyposulphite of Magnesia,* (Am. J. Sci., ii, 377), *Olivinoid,* (so called because like Olivine), *Howardite,* (ib. vi, 402), *Partschite,* (ib. xv, 366).

2. *Additional notices of described species.*

Amber.—According to Prof. Goeppert, Amber is derived from at least eight species of plants besides the Pinites succinifer. The resin is supposed to have been altered to Amber through fossilization. Prof. Goeppert enumerates 163 species of plants represented by remains in Amber.—*Monatsb. Akad., Berlin,* 1853, *and Am. J. Sci.,* [2], *xviii.*

Anatase, p. 121.—Kenngott obtains for $O : 1$, 111° 42′, $1 : 1$ (pyr.) 97° 51′, $O : 1\bar{i}$ =119° 22′.—*Min. Russl.,* 49.

Berthierite, p. 73.—Specimens from the mine Neue Hoffnung Gottes, near Freiberg, afforded C. v. Hauer (Jahrb. k. k. Geol. Reichs., iv, 635), Sulphur 30·53, iron 10·16, antimony 59·30=99·99.

Bismuthine, p. 33.—An artificial sulphuret of Bismuth afforded G. Rose the following angles: $I : I$=90° 40′, $i\breve{2} : i\breve{2}$=53° 40′ and 126° 20′, $I : i\bar{i}$=135° 20′.—*Pogg. xci,* 402, 1854.

Bole, p. 252.—Analyses by C. von Hauer, (Jahrb. k. k. Geol. Reichs., iv, 634):

	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
1. C. di Bove,	45·64	29·33	8·88	0·60	*trace*	14·27=98·72.
2. N. Holland,	38·22	31·00	11·00	*trace*	*trace*	18·81=99·03.
3. Discovery Id.,	37·12	20·00	22·47	2·99	*trace*	17·62=100·20.

Probably results of alteration of feldspathic or some aluminous mineral.

Sinopite, Hausm. is the Bolus of Sinope; *Stolpenite,* Kenngott, is the bole of Stolpen; *Oropion,* Glocker, is Bergseife, p. 252. The right to a name in each of these so-called species is very questionable.

Calamine, p. 313.—Altenberg crystals of Calamine have been measured by H. Dauber, Pogg. xcii, 245, June, 1854.

Calcite, p. 435.—The Fontainbleau crystals contain, according to Delesse, upwards of fifty per cent. of sand. In one crystal, G.=2·84, he found fifty-seven per cent. of mixed sand; in another sixty-two per cent.; another G.=2·53, sixty-three per cent.; in a less perfectly crystallized spheroidal mass, eighty-three per cent. *Halle Zeitschr*, 1854, 215. F. W. Wimmer describes a crystal of Calcite affording the scalenohedron $-\frac{8}{7}^{\frac{3}{2}}$, *ib.*, 1854, 334.

Catapleiite.—The crystallization of Catapleiite, according to H. Dauber, is hexagonal. The crystals have the edges replaced by the planes 1, 2, 4; *O* : 1=142° 1½′, *O* : 2=122° 38½′, *O* : 4=107° 45½′.—*Pogg.* xcii, 239, *June*, 1854.

Chileite.—Domeyko's vanadate of lead and copper, p. 363, is named Chileite by Kenngott. This is the second species so called, the name being a synonyme under Göthite.

Chloropal, p. 337.—Named *Unghwarite* by Glocker, and regarded as a good species by Kenngott. Occurs amorphous; H=2·5—3; G=2·10—2·16; greenish-yellow; streak greenish-white; lustre weak waxy. B.B. infusible, but becomes brown to black in a glass tube, and gives off water. Muriatic acid takes up the hydrate of iron. Von Hauer obtained in an analysis, (Kenngott's Min. Notizen, ix),

$$\dddot{\text{S}}\text{i}\ 57{\cdot}76 \qquad \dot{\text{F}}\text{e}\ 20{\cdot}86 \qquad \dot{\text{C}}\text{a}\ 1{\cdot}77 \qquad \dot{\text{H}}\ 19{\cdot}78=100{\cdot}17.$$

This result differs considerably from other analyses.

Chrysocolla.—L. Sæmann communicates to the author that he has specimens of Chrysocolla from Chili, which have in the interior the fibrous structure and composition of pure malachite, showing that the whole was once malachite.

In an earthy Chrysocolla-incrustation from Chili, Berthier found sulphuric acid, (analysis p. 310); and in another Kittredge (anal. 11, p. 310) obtained neither carbonic nor sulphuric acid.

The Chrysocolla analyzed by Scheerer, (anal. 8, p. 310), occurs with feldspar, and is supposed to have resulted from the action of sulphate of copper on the feldspar.

Bischof observes (Lehrb. ii, 1885) that silicate of copper may be formed through the action of an alkaline-, lime-, or magnesia-silicate on sulphate or nitrate of copper in solution. He also shows that this silicate is decomposed by carbonated waters, producing carbonate of copper. The silicate is slightly soluble in pure water, and therefore may act in forming the pseudomorphs after carbonate of lead and libethenite, which have been described. Its solubility and formation by the methods stated, account for its occurrence in hydrous silicates, as Allophane. The alkaline silicates are furnished by the decomposing granite, and the sulphate of copper by altered pyritous copper.

Clay and Clayey Earths, Earthy hydrous aluminous Silicates.—Various compounds of this nature are described on pp. 165, 249 to 253, and 337 to 340. The following are others:

Sphragide, Hausm.—A yellowish-gray earth or clay, speckled with red, called Lemnian earth; Λημνια σφραγις of the Greeks; Siegelerde of the Germans. Adheres but little to the tongue, and falls to pieces in water. Analysis by Klaproth, Beit. iv, 333, specimen from Stalimene, the ancient Lemnos.

Fuller's Earth, (Walkerde, *Wern;* Walkthon, *Hausm*).—Earthy with a shining streak; greenish-gray, oil-green, white, yellowish, reddish, red, brown; G.=1·7—2·4; feel either greasy or harsh; adheres a little to the tongue; falls to pieces in water. Analysis by Klaproth, Beit. iv, 338, and Thomson.

Occurs in connection with the chalk, oolite, &c. Found in England at Nutfield near Riegate, in Sussex; near Maidstone, in Kent; Woburn, in Bedfordshire; at Vahls, near Aix la Chapelle; Rosswein, in Saxony; Zwikowetz, in Bohemia; and elsewhere.

Potter's Clay.—Analyses of Potter's Clay by Klaproth, Beit. vi, 281, and by Aubert and Berthier, Dict. Tech. xvii.

Severite.—A variety of halloysite, analysis by Pelletier, Beud. Tr. ii, 36.

Onkosin, Kobell.—In roundish pieces, having an apple-green color; sometimes grayish or brownish; lustre weak, greasy; translucent; H.=2; G.=2·8; fracture fine splintery. Analysis by Kobell, J. f. pr. Chem. ii, 295. From Salzburg. B.B. fuses with intumescence to a white blebby glass; in sulphuric acid soluble, but not in muriatic.

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
1. *Sphragide*, Stalimene,	66·00	14·50	6·00	0·25	0·25	3·50	8·50, Klaproth.
2. *Fuller's Earth*, Riegate,	53·00	10·00	9·75	1·25	0·50	——	24·00, $\dot{\mathrm{K}}$ *trace*, NaCl 0·10, Klap.
3. " " Silesia,	48·50	15·50	6·50	1·50	0·50	——	25·50, Klap.
4. " " Maxton,	57·105	31·850	2·615	——	——	——	7·280, Thom.
5. *Potter's Clay*, Silesia,	61·	27·	1·	——	——	——	11, Klap.
6. " " France,	57·0	37·0	4·0	——	1·7	——	——, [a] Aubert.
7. " " "	60·0	30·0	7·6	——	2·4	——	——, [a] Berthier.
8. *Onkosin*,	52·52	30·88	——	3·82	$\dot{\mathrm{Fe}}$ 0·80	$\dot{\mathrm{K}}$ 6·38	4·60, Kobell.
9. *Severite*,	50·	22·	——	——	——	——	26, Pelletier.

a Water excluded.

Anauxite, Breith.—Anauxite is greenish-white, pearly, granular, with cleavage in one direction; translucent; H.=2·3; G.=2·26. Plattner obtained, (J. f. pr. Ch. xv, 325), 55·7 silica, 11·5 water, with much alumina, a little magnesia and protoxyd of iron. A doubtful if not bad species. From Bilin, in Bohemia.

Clintonite, p. 297.—Two recent analyses of this mineral by G. A. Brush, (communicated to the author, by letter dated München, Aug. 7, 1854), afforded,

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dddot{\bar{\mathrm{Zr}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1.	20·24	39·13	3·27	0·75	13·69	20·84	1·14	0·29	1·04=100·39.
Oxygen,	10·74	18·29	0·98	0·20	3·89	8·34	0·29	0·03	0·92.
2.	20·13	38·68	3·48	0·68	13·35	21·65	1·14	0·29	1·05=100·45.
Oxygen,	10·69	18·07	1·04	0·18	3·80	8·66	0·29	0·03	0·93.

These results of Mr. Brush give for the oxygen ratio of $\dot{\mathrm{R}}$, $\dddot{\bar{\mathrm{R}}}$, $\dddot{\mathrm{Si}}$, 12·55 : 19·47 : 10·74 and 12·78 : 19·29 : 10·69. Adding the oxygen of the protoxyds and peroxyds, the ratio for $\dot{\mathrm{R}}+\dddot{\bar{\mathrm{R}}}$, $\dddot{\mathrm{Si}}$ becomes 32·02 : 10·74 and 32·73 : 10·69, or very closely 3 : 1, while the ratio for the oxygen of the protoxyds and peroxyds is 2 : 3; the former of which ratios, however expressed in a formula, appears to be the characteristic of the species. Kobell's Disterrite afforded the oxygen ratio for $\dot{\mathrm{R}}$, $\dddot{\bar{\mathrm{R}}}$, $\dddot{\mathrm{Si}}$, 11·24 : 21·26 : 10·60, and for $\dot{\mathrm{R}}+\dddot{\bar{\mathrm{R}}}$, $\dddot{\mathrm{Si}}$, 32·50 : 10·60, which gives the same oxygen ratio 3 : 1 nearly for the bases and silica. Both correspond to $(\dot{\mathrm{R}}^3, \dddot{\bar{\mathrm{R}}})\dddot{\mathrm{Si}}^{\frac{1}{3}}+\mathrm{Aq}$, with $\dot{\mathrm{R}}^3 : \dddot{\bar{\mathrm{R}}}$ as 2 : 3 in the Clintonite, and 1 : 2 in the Disterrite. The water is nearly wanting in the Clintonite, according to Brush.

If we regard one third of the peroxyds in Brush's analysis as replacing silica, the oxygen ratio for $\dot{\mathrm{R}}$, $\dddot{\bar{\mathrm{R}}}$, $(\dddot{\mathrm{Si}})$, becomes 12·78 : 12·86 : 17·12; or between the bases and the rest 25·64 : 17·12=3 : 2, giving the formula $(\frac{1}{2}\dot{\mathrm{R}}^3+\frac{1}{2}\dddot{\bar{\mathrm{R}}})(\dddot{\mathrm{Si}}, \dddot{\bar{\mathrm{Al}}})^{\frac{2}{3}}$, which is the formula deduced on pp. 289, 297.

Copper Glance, p. 46.—A crystal weighing half a pound has been found in the mines near Angina, Tuscany. The Mount Catini Mine affords Copper Glance, and also Native Copper, Red Copper, and Copper Pyrites.

Covelline, p. 65.—The Covelline of Leogang, in Salzburg, occurs mostly massive, but affords minute crystals, according to Kenngott, which present faces of two hexagonal pyramids; the acuter pyramid has for its basal edges the angle 155° 24′; and the inclination of a face of this pyramid on one of the other is 150° 24′. Color: indigo-blue, with submetallic somewhat greasy lustre, a little pearly on the cleavage face; streak black; H.=1·5—2. G.=4·636—4·590. Analysis afforded Sulphur 34·30, copper 64·56, iron 1·14.—Kenngott's Min. Notizen, No. ix.

Deweylite, p. 285.—A variety from Fleims (called *Gymnite* by the author, but correctly Deweylite, as this is the earlier name) afforded von Widtermann, (Jahrb. k. k. Geol. Reichs., iv, 525), $\dddot{\mathrm{Si}}$ 40·82, $\dot{\mathrm{Mg}}$ 36·06, water 21·72, $\dddot{\bar{\mathrm{Fe}}}$ 0·42, $\ddot{\mathrm{C}}$ 0·59=99·61, agreeing closely with *Œllacher's* analyses of this mineral from the same locality, (Anal. 4, p. 286).

An earthy variety from the same place affords $\dddot{\mathrm{Si}}$ 49·06, $\dot{\mathrm{Mg}}$ 28·50, $\dot{\mathrm{H}}$ 16·25, $\dddot{\bar{\mathrm{Fe}}}$ 0·69, $\ddot{\mathrm{C}}$ 4·76=99·28, affording the oxygen ratio for $\dot{\mathrm{H}}$, $\dot{\mathrm{R}}$, $\dddot{\mathrm{Si}}$, nearly 3 : 2 : 5.

Eliasite, p. 108.—This species differs widely from Pitchblende in its lower specific gravity and the large proportion of water.

ENARGITE, p. 87.—Crystals of Enargite, which are trimetric, have been measured by H. Dauber. He obtained for $I : I$, 97° 53′. Other observed planes, $i\bar{\imath}$, $i\breve{\imath}$, $\frac{1}{2}\bar{\imath}$, $1\bar{\imath}$, $2\bar{\imath}$, $1\breve{\imath}$, with the pyramids 1 and $\frac{1}{2}$. $O : 1\breve{\imath}$=140° 29′; whence by calculation, $O : 1\bar{\imath}$=136° 37′, $O : \frac{1}{2}\bar{\imath}$=154° 43′, $O : 2\bar{\imath}$=117° 53′, $O : 1$=147° 55′.—*Pogg.* xcii, 237.

FELDSPAR.—M. Scheerer obtains for an albite from Snarum the oxygen ratio for $\dot{\text{R}}$, $\bar{\dddot{\text{R}}}$, $\dddot{\text{Si}}$, 1 : 3 : 11; and as the ratio is intermediate between that of albite and oligoclase, he proposes to call it oligoclase-albite. A feldspar from the zircon-syenite of Norway, analyzed by C. Gmelin, he regards as consisting of 1 of oligoclase, 1 of albite, and 1 of orthoclase; another from the Syenite of Ballons, as composed of 1 of oligoclase and 2 of orthoclase; and the same for another from Plombières, analyzed by Delesse. *Bull. Soc. Geol. de France*, [2], xi, 146.—T. S. Hunt offered some theoretical views on the composition of the Feldspars to the American Association, at the meeting in 1854, at Washington. See Am. J. Sci., [2], xviii, 269.

GABRONITE, Beudant (Traité, ii, 94).—L. Sæmann observes that he has seen in the School of Mines, Paris, truncated square prism of the gabronite, which show that the mineral is Scapolite. (Communicated to the author).

GALENA, p. 39.—A variety in cubes, containing manganese, probably from Hartenrod, near Gladenbach, afforded Sandmann, S 13·80, Pb 83·52, Fe 0·83, Mn 1·20, Ag 0·14=99·49. H.=2·5. G.=7·11. B.B. a strong manganese reaction. *Ann. Ch. u. Pharm.* lxxxix, 364.

GIBBSITE, p. 134.—The Villa Rica (Brasil) Gibbsite afforded von Hauer, Alumina 64·35, water 35·65, phosphoric acid, *a trace*=100.—*Jahrb. f. k. k. Reichs.*, iv, 397.

HEMATITE, p. 113.—Kokscharov has elegantly figured and describes several forms of hematite crystals in his Materialen zur Min. Russlands. Besides the planes enumerated on p. 113, he mentions $\frac{2}{5}^{3}$ as presented by Russian crystals. He obtained for $R : R$ 86°; for $\frac{2}{5}^{3}$, terminal edges 147° 23′ 13″, 111° 40′ 23″, and for the middle (or basal) edge 114° 46′ 20″.

HESSITE, p. 44.—This species, according to Kenngott, (Sitzb. Wien. xi, 20, 1853), is trimetric; the crystals show the faces $i\bar{\imath}$, $i\breve{\imath}$, I, besides another vertical prism undetermined.

HYDROHALITE, *Mitscherlich.*—A hydrous Chlorid of Sodium. Composition $\text{Na Cl}+4\dot{\text{H}}$=Chlorid of Sodium 62·0, water 38·0=100.

HYDROPHILITE, *Glocker.*—A name applied to Chlorid of Calcium.

IDOCRASE, p. 197.—Kohscharov has published an elaborate memoir with many fine figures on the Russian idocrase, in his Min. Russlands, p. 92. From crystals from the Poljakowsk mine he found $O : 1$=142° 46½′. *Jefreinoffite* is a variety of idocrase from Finland, containing according to Ivanoff, $\dddot{\text{Si}}$ 37·41, $\dot{\text{Ca}}$ 34·20, $\bar{\dddot{\text{Al}}}$ 20·00, $\bar{\dddot{\text{Fe}}}$ 4·60, $\dot{\text{K}}$ 1·16, $\dot{\text{Na}}$ 1·70=99·07. It is usually yellowish-brown, but sometimes colorless. Kohscharov's *Min. Russlands*, 116.

ILMENITE, p. 115.—Kokscharov mentions the rhombohedron $\frac{1}{4}$R as occurring in Russian ilmenite. *Min. Russl.* 20.

IODYRITE, p. 95.—Two analyses of this silver ore have afforded J. Lawrence Smith the following results, (communicated to the author by letter, dated Louisville, Ky., Aug. 23, 1854):

Iodine,	52·934	53·109
Silver,	46·521=99·455	46·380=99·489,

with traces of copper and chlorine.

KAOLIN.—The author is indebted for the mode of presenting the analyses of Kaolin, on p. 249, to M. Louis Sæmann of Paris. M. Sæmann observes that the hydrous silicates of alumina proceeding from the decomposition of the feldspars never contain more alumina than silica, and they mostly come under the formula $\ddot{\overline{\text{Al}}}\,\dddot{\text{Si}}+2\dot{\text{H}}$. The species Collyrite, Allophane, Scarbroite, and Miloschine, which contain much less silica, have not proceeded from the decomposition of feldspars, but through sulphates of alumina produced by the alteration of pyrites. The earthy silicates containing two or more equivalents of silica have probably proceeded from the decomposition of aluminous pyroxenes.

Lavendulan, p. 417.—According to trials by J. Lindacker, (Jahrb. k. k. Geol. Reichs., iv, 555), Lavendulan contains oxyd of copper, arsenous acid, and water, with also oxyd of cobalt, lime, and sulphuric acid. It is a result of alteration of different ores, and occurs with arsenates of cobalt and nickel, nickel ochre, copper black, and cobalt pyrites.

Leadhillite, p. 371.—Fig. 1 of Leadhillite, is taken from Mohs, (pl. 13), but altered by the addition (though of reduced size) of the planes wanting through hemihedrism, (the right hand I, $\frac{8}{3}\breve{2}$, $\frac{2}{3}\breve{2}$, $i\breve{2}$), in order to exhibit the relations of the planes.

Leedsite, *Thomson.*—Regarded as a mechanical mixture of sulphates of lime and baryta. Thomson's analysis afforded 71·9 of the former to 28·1 of the latter. From near Leeds, Yorkshire, England.

Leucopyrite, p. 61.—The *Sätersbergite* of Kenngott includes analyses 4 and 5, p. 61.

Limestone for Hydraulic Purposes; Subcarbonate of Lime. — According to Villeneuve, (Bull. Soc. Geol. de France, [2], x, 342), the hydraulic mortar owes its character to the formation of subsalts of lime, magnesia, alumina, or iron, with carbonic acid and silica, that is, salts containing an excess of base. Lime may form a subcarbonate (containing two equivalents of lime and one of acid) which is insoluble, and has hydraulic characters. This subcarbonate contains half an equivalent of water; with the silica a subsilicate forms containing 5 of water; and he observes also that there is a subaluminate with 7½ equivalents of water. These subsalts are stable only below a temperature of 212° F. The virtue therefore of the hydraulic rock depends on the excess of bases or earthy ingredients. M. Delesse has detected a *hydrated subcarbonate of lime* in bone caverns of the Jura beds.

Magnesite.—A specimen from Madras afforded Pfeiffer, (Ann. Ch. u. Pharm. lxxxix, 219), $\ddot{\text{C}}$ 50·64, $\dot{\text{M}}\text{g}$ 46·12, $\dot{\text{C}}\text{a}$ 0·35, $\dot{\text{N}}\text{a}$ 0·42, $\dot{\text{K}}$ 0·67, $\ddot{\overline{\text{Al}}}$ 0·26, $\dddot{\text{Si}}$ 0·23, $\dot{\text{H}}$ 0·16, $\dddot{\overline{\text{P}}}$ and Cl *trace*=98·85.

Mica.—An elaborate paper by Joseph Grailich, on the optical characters of the micas, has recently appeared in the Sitzungsberichte der kais. Akad. der Wissenschaften at Vienna, (vol. xi, p. 46). It contains the following measurements of the optical angles of micas:

1. Angle of Divergence of the Axes small.

1. *Plane of the axes in the line of the shorter diagonal.*—Green in limestone, Vesuvius 0°–1°; dull-green to colorless, ib., 1°; brownish-green. ib., 2°; bluish, ib., 3°; white, from Easton, Pa., 1°–2°; green, ib., 3°–4°; brown, from Upper Hungary, in calcite, 4° 30′; brown in feldspar, from Warwick, 4°–5°; gold yellow, from Baritti, Brazil, 5° 30′; meroxene, from Fassa Valley, 1°–3°.

2. *Angle between the optical axes* 0°.—Dark green mica of Zillerthal; ib. from Norway; dark olive-green, from Kariat; blood-red in thin plates, from Beszterceze, in quartz; from Retzbanya, in calcite with chalcopyrite; dark-green from Goshen, (New York probably), submetallic in lustre; liver-brown, from Anaksirksarklik; black, in thin leaves blood-red, from Leonfelden; dark-greenish, from Kingiktorsoak, Greenland; dull-red, from Magura, in granite; bluish, from Altenberg; black, from Horn, Upper Austria.

3. *Optical axes in the plane of the longer diagonal.*—Brown mica, from Frascati, in six-sided tables, 0°–1°; brown, six-sided pyramids, from Cayuga-lake, N. Y., 1°–2°; hexag. tables, from Pellegrino, Tyrol, in calcite, 0°–1°; blackish-green, from Greenwood Furnace, 0°–1°; sea-green, from Karosulik, 1°–2°; chesnut-brown, from L. Baikal, 1°–2°; liver-brown, in large tables, 5°.

4. *Doubtful as to which diagonal coincides with the plane of the optical axes.*—Brown, from Moravia, 6°; liver-brown, from Gargenberg, Suabia, 5°; dark-brown,

from Eden, Orange Co., N. Y., 2° ; pistachio-green, from Gömör, 2° 30′ ; pinchbeck-brown, from Siberia, 2° 40′, G.=2·582 ; sea-green, from Norway, 2°, G.=2·552 ; chesnut-brown, in granite, 0°–1°.

2. Angle of Divergence above 50°.

1. *Plane of the axes in the line of the shorter diagonal.*—Gray mica, from Kollin, in granite, 50° 12′ ; from Zinnwald and Schlackenwald, in granite, 51° 50′; gray, from the Tyrol, in granite, 52° 12′ ; colorless, from Siberia, 60° 30′.

2. *Plane of the axes in the line of the longer diagonal.*—Greenish-brown, from Arendal, 58° ; yellowish-brown, from Warwick, 59° ; from Airolo, Switzerland, 60° ; from Miask, in yellow feldspar, 62° 50′ ; pale greenish, from Schwarzenbach, 61° 12′; from Nertschinsk, in granite, 65° ; green, from Rothenkopf, Tyrol, 66° ; colorless, from Gloria, Brazil, 66° 36′ ; from Skogbollt, near Kimito, Finland, with red albite, 67° 25′; from Weathersfield,* Connecticut, in coarse-grained granite, G.=2·836, 67° 40′ ; colorless, from Josefs-Alpe, G.=2·713, 69° 10′; pinchbeck-brown, from Trachiros, Cape Goyaz, Brazil, 69° 25′ ; brownish to colorless, from Middletown, Connecticut, G.=2·852, 70°, (No. 6 of Silliman, p. 218) ; from Nulluk, Greenland, 70° 36′; blonde, from Pressburg, Hungary, 70° 40′ ; green, from Kassigiengoyt, Greenland, 71° ; pinchbeck-brown, from Kakunda, Brazil, 71° 25′ ; blonde, from Cam, Bohemia, 71° 40′ ; light-green, from Greenland, 71° 50′; pale-brown, from Minas Geraes, Brazil, 72° 20′; pinchbeck-brown, from Hörlberg, Bavaria, in granite, 72° 25′ ; greenish-yellow, from Chester, Mass., G.=2·827, 72° 30′–73° 30′ ; white, from Zwiesel, Bavaria, 74° ; greenish-white, from Conceiçao, Brazil, 74° ; colorless, from the Ural, 74° ; gray, from Galmeikirchen, Upper Austria, 74° 36′ ; pinchbeck-brown, from Miask, Urals, 75° 25′ ; gray to colorless, from Siberia, G. =2·802, 75°–76° ; colorless, from Pressburg, Hungary, 76° 12′ ; pinchbeck-brown, from Engenhos Corallinhos, Brazil, 64°–65° and 68°–69°.

3. In the following, crystals not well defined, and position of the longer diagonal inferred from the cleavage forms. From Irkutsk, 68° ; from Fogaras, in Transylvania, in granite, 69° ; colorless, from Lobming, Austria, 69° 20′ ; wine-yellow, from Balmarussa, 69° 45′ ; sea-green, from Elfdal, Sweden, 69° 58′ ; silver-gray, from Schlackenwald, Bohemia, 70° ; from Pressburg, 69° 42′ to 72° 24′; from Pojanska, 70°–71° ; from Grobo, Bannat, 70°–70° 36′; from Gömör, Hungary, 70° 24′; from Neuberg, Bavaria, 70° 40′; from Jamaica, 70° 54′; from Wottawa, Bohemia, 71° 15′; from Brazil, 71° 36′ ; from Mursinka, Poland, 71° 50′ ; greenish-yellow, from Utö, Sweden, 72° 50′ ; pale yellowish-green, from Paris, Me, 72° 54′ (No. 41 and 42 of Silliman); from Ronsberg, Bohemia, 73° ; from Skuttrand, Norway, 73° 30′; greenish, from Norway, 74° 10′; pale-green, from Chillon, Switzerland, 74° 24′; yellowish-white, from Zwiesel, Bavaria, 75° 10′; yellowish-green, from Serra de Conceiçao, Brazil, 76°.

4. *Rose-red Lithia Micas.*—From Maine, 74°, (No. 45 of Silliman) ; from Chesterfield, Mass, 75° ; from Siberia, 75° 40′ ; from Rozena, 76° ; from Pennig, Saxony, 76° 30′ ; from Massachusetts, in granite, (Goshen? No. 50 of Silliman), 76° 10′–76° 40′.

From a review of all the observations and the analyses, as far as they have been made, it appears that there are at least two great groups—one including the biotites and phlogopites, the other the muscovites and lepidolites. The line between the last two is not at present distinct either in composition or optical characters. Between the two former there is a difference of composition, according to the analyses made, and, as far as known, the optical angle of the phlogopites is hardly below 5°. Judging from the descriptions of the specimens examined by Grailich, there were but few phlogopites among them. The color and general habit of the phlogopites, as well as their occurrence in granular limestone, will usually distinguish them from either the biotites or muscovites. But more analyses are required to clear up the whole subject of the micas, and especially to ascertain what importance, if any, attaches to the distinction whether the plane of the optical axes lies in the longer or shorter diagonal. M. Grailich shows that, with slight exceptions, the angle increases with the specific gravity in the mica of a given locality. Thus seven micas from Pressburg, Hungary, have respectively the following specific gravities and optical angles :

Specific gravity,	2·714	2·735	2·755	2·782	2·790	2·793	2·796.
Angles,	69·7	70·0	70·5	71·2	72·3	72·4	72·0.

We refer to M. Grailich's paper for his mathematical details.

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* This must be an error, as we know of no mica in granite at Weathersfield.

Mispickel, p. 62.—A variety from near Mühlbach, in Transylvania, afforded von Hauer, Arsenic 45·00, sulphur 21·36, iron 33·52=99·88. *Jahrb. f. k. k. Reichs.*, iv, 400.

Nacrite, Talcite.—Nacrite has the feel of a soft earthy talc, and consists of minute grains or scales, white and pearly, with a greasy feel, much like Pholerite, although anhydrous. Talcite from Wicklow, Ireland, is similar. Analyses: Thomson, (Rec. Gen. Sci. May, 1836), 2, 3, Short and Tennant, (Thom. Min. i, 244):

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Mn}}$	H	
1. Nacrite, Brunswick, Me.,	64·44	28·84	4·43	—	—	—	1·0,	Thomson.
2. Talcite, Wicklow,	46·00	35·20	2·88	9·61		3·94	2·0,	Short.
3. " "	44·55	33·80	7·70	1·30	3·30	2·25	6·25,	Tennant.

Vauquelin's analysis of Nacrite is referred to mica by Rammelsberg. It is anhydrous.

Ottrelite.—Reported as occurring in Tuscany.

Paraluminite, *Steinberg.*—Includes anal. 12, 13, of Websterite, p. 390. A very doubtful species.

Pencatite, *Roth.*—Analysis 1, of Predazzite; but not a good species.

Rocks, (p. 247).—The following are recent analyses of different rocks:

1. *Granite*, from the Valorsin Valley, consisting of quartz, oligoclase, and white or brownish mica: Delesse, Bull. Geol. France, [2], vii, 424.

2. *Red Syenite* of Egypt, consisting of quartz, red orthoclase, white oligoclase, and black mica: Delesse, ib., vii, 484.

3. *Protogine* of Mt. Blanc, consisting of quartz, orthoclase, oligoclase, talc, and mica: Delesse, ib., vi, 230.

4. *Porphyry* of Lessines, having a green base, and the disseminated crystals being oligoclase: Delesse, ib., vii, 310.

5, 6. *Diorites* of the Vosges; 5, from Frondromé, fine crystalline, nearly compact in texture, consisting of feldspar and hornblende; G.=2·945;—6, from Clefcy, consisting of oligoclase, hornblende, and mica; color black; G.=2·902: Delesse.

7. *Granulite* (Weissstein), fine-grained, grayish-white color, from Krems; only 0·70 p. c. soluble in muriatic acid: E. Hornig, Wien. Akad., vii, 583.

8. *Hornblende Slate*, consisting of feldspar and hornblende, with some chlorite; G.=3·008; from Miltitz in Saxony; contains small acicular crystals of hornblende: Bischof, Lehrb. de Geol.

9, 10. *Mica Slate;* 9, grayish, from Libethen in Hungary;—10, ib., from Orawitza, Hungary: Bischof and Kjerulf, Bisch. Lehrb.

11, 12, *Clay Slate;*—11, from Siegen;—12, from Rothwaltersdorf, color bluish-black: Bischof, Lehrb.

13. *Ib.* of violet color and having a silky lustre, from Nerothal, near Wiesbaden; G.=2·822; B.B. fuses on the edges to a gray enamel; muriatic acid decomposes 17·89 p. c., removing a fourth of the silica and alumina, all the peroxyd of iron, nearly all the magnesia, all the lime, and less than one-third of the potash: List, Ann. Ch. u. Pharm., lxxxi, 257. List obtained from this slate the *sericite*, (see p. 223), which is the source of the silky lustre.

14. *Clay Slate* of greenish color from Naurod; G.=2·792; List, ib.

15, 16, 17, 18. *Roofing Slate;*—15, purplish-blue, feebly glimmering lustre; G.=2·884; Lower Silurian, of Kingsey, Canada East;—16, greenish-blue, silky surface; G.=2·711; Upper Silurian from Westburg, C. E.;—17, Welsh roofing-slate, resembling No. 15; G.=2·824;—18, from Angers, France, and resembling No. 16, but more pearly in lustre and somewhat talcose; G.=2·882: T. S. Hunt, Phil. Mag. [4], vii, 237. Part of the iron in 15 and 17 he suggests may be peroxyd.

19. *Variolite* of Durance, in Savoy;—*a*, the base of the rock; G.=2·896—2·934; general appearance somewhat like Euphotide, of a greenish to dark-green color. Contains disseminated spherules, (analysis 19 *b*), which are feldspathic, white or

greenish-white, and often changed to Kaolin; G.=2·923: Delesse, Ann. des M. [4], xvii, 116.

20. *Dolerite* from Meissner, consisting, according to the analysis, of 47·60 Labradorite, and 49·60 Augite: Heusser, Pogg. lxxxv, 298.

21. *Trap*, or Dolerite, from Eskifjord-Bucht, Iceland; *A*, composition of the part soluble in muriatic acid (25·39 p. c.); *B*, of the part insoluble (74·13 p. c.): Damour, Bull. Geol. de France, [2], vii.

22, 23. *Trap;* 22, of Giants Causeway; 23, of Fingal's Cave: A. Streng, in Bunsen's Laboratory, Lieb. u. Kopp., 1852, 953.

24. *Lava*, from Hecla, Iceland, eruption of 1845; *A*, part soluble in muriatic acid (33·25 p. c.); *B*, part insoluble (64·92 p. c.); the feldspar was easily decomposed in acids, and is supposed by the analyst to be Anorthite: Damour, loc. cit.

25. *Lava* of Etna, from the eruption of 1852; consisting, according to the analyst, of about 95 parts of Labradorite and Augite, 2 of Olivine, and 3 of Magnetic Iron: von Hauer, Sitz. Akad. Wien., xi, 87, 1853. (Abich obtained from the lava of 1669, 48·83 Silica and a closely related composition, making the lava to consist of 54·80 of Labradorite, 34·16 augite, 7·98 olivine, 3·08 magnetic iron).

26. *Trachyte*, from Külsbrunnen; G.=2·701: Bischof.

27, 28. *Pozzuolana* from Vesuvius; *A*, part soluble in muriatic acid; *B*, part insoluble: L. Elsner, J. f. pr. Ch., xxxiv, 438.

29. *Trass*, or Rhine Cement; *A*, part soluble in muriatic acid; *B*, part insoluble: L. Elsner, ib., xxxiii, 21.

30. *Clay*, of a reddish fawn-color, from the river à la Graisse, Rigaud, Canada; yields to heated muriatic acid 12·95 p. c. of alumina and peroxyd of iron, 3·97 of lime, and 1·92 of magnesia: T. S. Hunt, Phil. Mag. [4], vii, 238.

For other analyses see Bischof's Lehrb. der Geol., passim; Delesse's papers in the Bull. Geol. de France, [2]; and Ann. des Mines, [4]; Bunsen, on Volcanic Rocks, (a paper of great interest), Pogg., lxxxiii, 197; E. Wolff on porphyrytic rocks, J. f. pr. Chem., xxxiv, 193; Damour, on volcanic rocks of Iceland, Bull. Geol. de France, [2], vii, 83; A. Streng, (paper referred to above); von Waltershausen's "*Vulkanischen Gesteine*," Göttingen, 1853.

		$\ddot{\text{Si}}$	$\ddot{\bar{\text{Al}}}$	$\ddot{\bar{\text{Fe}}}$	$\dot{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	$\dot{\text{H}}$ or ign.
1.	*Granite,*	75·00	12·90	1·10	——	1·26	[by loss 9·34]			0·40, Delesse.
2.	*Red Syenite,*	70·25	16·00	2·50	——	1·60	[" 9·00]			0·65, Delesse.
3.	*Protogine,*	74·25	11·58	2·41	$\ddot{\bar{\text{Mn}}}$ *tr.*	1·08	[" 10·01]			0·67, Delesse.
4.	*Porphyry,*	57·60	25·00		——	3·23	[" 9·92]			4·25 $\ddot{\text{C}}$ incl, Del.
5.	*Diorite,*	48·50	17·10	——	$\dot{\text{Fe}}$16·26	7·99	[6·10]	2·20	1·05	0·80, Delesse.
6.	"	48·90	18·50	——	11·92	5·47	[9·70]	2·35	1·26	1·40, $\dot{\text{Mn}}$ 0·50, D.
7.	*Granulite,*	73·04	8·23	1·35	6·27	1·18	——	——	7·11	—— " 2·33, H.
8.	*Horn. Slate,*	48·65	16·42	18·62	4·69	7·16	2·32	0·89	0·56	0·21 $\ddot{\bar{\text{Mn}}}$ 0·48, B.
9.	*Mica Slate,*	52·01	13·64	19.72	——	0·67	5·42	0·55	5·55	2·49=100·05, B.
10.	"	50·88	26·69	8·48	——	——	1·19	2·72	4·52	4·19=98·67, B.
11.	*Clay Slate,*	50·01	34·74	——	3·73	——	0·87	0·04	7·21	3·27=99·87, B.
12.	"	61·72	19·55	——	8·54	0·55	1·08	——	4·81	3·74=100, B.
13.	"	55·84	15·62	4·86	8·25	1·40	0·50	1·70	6·13	5·19=$\ddot{\text{Ti}}$ 0·51, B.
14.	"	59·93	15·01	1·85	5·62	4·56	1·43	6·08	2·44	2·43=$\ddot{\text{Ti}}$ 0·43^a, B.
15.	*Roofi'g Slate,*	54·80	23·15	——	9·58	1·06	2·16	2·22	3·37	3·90=100·24, H.
16.	"	65·85	16·65	——	5·31	0·59	2·95	1·31	3·74	3·10=99·50, H.
17.	"	60·05	19·70	——	7·83	1·12	2·20	2·20	3·18	3·30=100·03, H.
18.	"	57·00	20·10	——	10·98	1·23	3·39	1·30	1·73	4.40=100·13, H.
19.	*Variolite,* *a.*	52·79	11·76	——	11·07	5·90	9·01	3·07	1·16	4·38 ($\ddot{\text{C}}$ incl), D.
	b.	56·12	17·40	7·79	$\ddot{\bar{\text{Cr}}}$ 0·51	8·74	3·41	3·72	0·24	1·93=99·86, D.
20.	*Dolerite,*	48·00	16·28	——	$\dot{\text{Fe}}$15·55	9·50	3·85	2·01	2·01	2·80(loss incl) H.
21.	*Trap,*	64.28	12·25	——	11·43	3·19	0·45	4·76	1·27	1·09^b=99·52, D.
	" *A,*	13·18		——	8·49	0·63	0·45	——	0·75	——^{b} =25·39.
	" *B,*	51·10	12·25	——	2·94	2·56	——	4·76	0·52	—— =74·13.
22.	*Trap,*	52·13	14·87	——	11·40	10·56	6·46	2·60	0·69	1·19 $\dot{\text{Mn}}$ 0·32, St.
23.	"	47·80	14·80	——	13·08	12·89	6·84	2·48	0·86	1·41 " 0·09, Str.

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$ or ign.
24. *Lava*, Hecla,	54·76	13·61	——	15·60	6·44	1·35	3·41	1·21	0·07[c]=98·17, D.
“ *A*,	16·61	0·16	10·08	——	2·44	1·21	0·99	0·45	—[d] =33·25.
“ *B*,	38·15	13·45	5·53	——	4·00	0·14	2·42	0·76	—[e] =64·92.
25. *Lava*, Etna,	49·63	22·47	——	10·80	9·05	2·68	3·07	0·98	$\dot{\mathrm{Mn}}$0·63, H.
26. *Trachyte*,	64·21	16·98	6·69	——	0·49	0·18	4·41	5·13	1·00=99·09, Bi.
27. *Pozzuolana*,	59·15	21·28	4·76	——	1·90	——	6·23	4·37	—— Na Cl2·56, S.
“ *A*,	10·25	9·01	4·76	——	1·90	——	——	1·50	——=27·42.
“ *B*,	48·90	12·27	——	——	——	——	6·23	2·87	——=70·27.
28. *Pozzuolana*,	59·81	16·36	4·56	——	1·58	——	——	14·16	—— NaCl3·25, R.
“ *A*,	10·25	2·57	4·56	——	——	1·58	——	1·50	——=20·46.
“ *B*,	49·56	13·79	——	——	——	——	——	12·66	——=76·01.
29. *Trass*,	48·94	18·95	12·34	——	5·41	2·42	3·56	0·37	7·66(Am *incl*) E.
“ *A*,	11·50	17·70	11·77	——	3·15	2·15	2·44	0.29	——=49·01.
“ *B*,	37·44	1·25	0·57	——	2·25	0·27	1·20	0·08	——=42·98.
30. *Clay*,	50·81	21·70	5·60	——	5·32	2·62	2·61	2·85	7·75[f] $\dddot{\mathrm{P}}$0·74, H.

a. Add 0·05 oxyd of copper. b. Add titanic acid 0·80. c. Add titanic acid 1·72. d. Add titanic acid 1·24. e. Add titanic acid 0·48. f. Includes 3·25 of carbonic acid.

M. G. von Helmersen has a paper on the conductibility of heat of different rocks, in Pogg. Ann., lxxxviii, 461. Despretz published results on the same subject in the Ann. de Ch. et de Phys., vols. xix and xxxvi; and in the Compt. Rend., xxxv, 1844.

Scorodite, p. 419.—Crystals from Nertschinsk afforded Kokscharov the planes in figure 561, with also $2\bar{\imath}$ and $2\breve{\imath}$. The faces $i\breve{\imath}$ are vertically striated, and 1 are mostly rough.

Seladonite (*Terre Verte*), p. 165.—A green earth accompanying the specular iron of Framont afforded Delesse—

$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
43·50	16·61	8·88	11·83	0·80	6·66	*trace*	3·14	0·69	7·15=99·26

It occurs in pyroxene rocks with garnet, and results as Delesse observes from their decomposition. Boiled in concentrated muriatic acid it is discolored and the silica separates as a powder.

Delesse states that in attacking the mineral with acids, the bases which *resist* the action longest are the *alkalies;* the magnesia, oxyds of iron, and alumina yielding first.

Bischof observes the same fact with mica slate; and it explains why minerals containing alkalies are often attacked by acids with difficulty.—*L' Institut, June* 14, 1854.

Schreibersite, p. 53.—Dr. J. Lawrence Smith finds that the Schreibersite (Patera) is quite common in meteorites, being often mistaken for magnetic pyrites. The following are the results of three analyses, two of them incomplete:

	P	Fe	Ni	Co	Cu	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	Cl
1.	13·92	57·22	25·82	0·32	*tr.*	1·62	1·63	*trace*	0·13=100·66.
2.	14·86	56·04	26·43	0·41	*tr.*	Not estimated.			
3.	14·53	56‘53	28·02	0·28	*tr.*	Not estimated.			

No. 1 was detached in small pieces from the meteorite: No. 2 by dissolving away the iron and separating with great care; the silica, alumina, and lime were almost entirely absent. The mineral, according to Smith, consists of 1 P, 2 Ni, 4 Fe= Phosphorus 15·47, nickel 29·17, iron 55·36=100. (Communicated to the author).

Selbite, Haidinger.—Regarded as a *carbonate of silver*, but probably only a mechanical mixture. Color ash-gray to black. Reported from Wolfach, in Baden, and the Mexican mines where it is called *Plata Azul.*

Serpentine, p. 282.—On supposed pseudomorphs of serpentine after hornblende, pyroxene, and olivine, *Th. Scheerer*, in Pogg. xcii, 287.

Smaltine, p. 56.—The Smaltine containing 11 to 19 per cent. of iron, from Schneeberg in Saxony, (analyses 3, 4, p. 57), is the *Safflorite* of Haidinger, (Handb. bestim. Min. 1845) or Eisenkobaltkies. It is essentially the same mineral in composition with the *Chathamite* of Shepard, (Shepard's Min. 1844).

The Chathamite of a new opening at Chatham, Ct., has been recently analyzed by Dr. F. A. Genth, with the following results, (Rep. Cryst. Palace of N. Y.),

As 70·11	S 4·78	Fe 11·85	Co 3·82	Ni 9·44
67·46 (loss)	5·62	12·92	3·85	10·17

The *Eisenkobaltkies* of Modum, according to Kenngott, is trimetric instead of monometric. It afforded him a vertical prism of 155°, parallel to whose planes cleavage took place; there were also two macrodomes and a brachydome; H.=6·0; color tin-white; streak black. Chathamite has not been observed in crystals.

The name Smaltine is sometimes written *Smaltite.*

Stannite, *Breith.*—Amorphous, of a pale yellowish white color, with little lustre; H.=6·5; G.=3·545; fracture conchoidal. Contains according to Plattner, (Pogg. lxix, 435), Silica, alumina, and 36·5 per cent. of oxyd of tin. B.B. infusible. Probably a mechanical mixture. From Cornwall.

Tannenite, p. 73.—Forms trimetric, according to H. Dauber, the flattened prisms presenting the planes I, $i\bar{\imath}$, $1\bar{\imath}$, $\frac{1}{3}\bar{\imath}$. $i\bar{\imath} : 1\bar{\imath}$=129° 14′, $i\bar{\imath} : \frac{1}{3}\bar{\imath}$=105° 13½′, $I : I$=102° 50½′, $O : 1\bar{\imath}$=140° 46′. [Or doubling the vertical axis, the planes are I, $i\bar{\imath}$, $\frac{1}{2}\bar{\imath}$, $\frac{1}{6}\bar{\imath}$, giving for $O : 1\bar{\imath}$, 131° 28′, and making the dimensions very near those of Anglesite; that is, $I : I$=102° 50½′, $1\bar{\imath} : 1\bar{\imath}$=62° 56′.]—*Pogg.* xcii, 241.

Teratolite, (Eisensteinmark, Terra miraculosa Saxoniæ).—Pale violet, bluish grayish; compact earthy; H.=2·5—3; G.=2·5. *Composition,* $\ddot{\mathrm{S}}\mathrm{i}$ 41·66, $\bar{\ddot{\mathrm{A}}}\mathrm{l}$ 22·85, $\bar{\ddot{\mathrm{F}}}\mathrm{e}$ 12·98, $\bar{\ddot{\mathrm{M}}}\mathrm{n}$ 1·68, $\dot{\mathrm{C}}\mathrm{a}$ 3·04, $\dot{\mathrm{M}}\mathrm{g}$ 2·55, $\dot{\mathrm{K}}$ 0·93, $\dot{\mathrm{H}}$ 14·20, Schüler. From the coal beds, near Zwickau, Saxony.

Tetradymite, p. 21.—The Tetradymite of the "Tellurium Mine," Fluvanna Co., Virginia, affords Dr. F. A. Genth, (communicated to the author by letter dated Philadelphia, August 23, 1854),

Bismuth 53·85, Tellurium 46·67=100·52,

after deducting about a half per cent. of gold and quartz. Only a trace of Selenium was found. This is the same mineral analyzed by Fisher. The mineral of this locality is broad foliated, and occurs in mica slate.

Tetradymite occurs also, according to Dr. F. A. Genth, near Pioneer Mills, Cabarras Co., N. C., at Monroe Mine, in Stafford Co., and at Rogers' Gold Mine.

Tetrahedrite, p. 82.—I, from Mornshausen, near Biedenkopf:—Occurs in a gangue of quartz and barytes in greenstone; H.=4; color light steel-gray; streak dull cherry-red. II, from Stahlberg near Müsen, with spathic iron; H.=4; G.=4·58; streak black, somewhat brownish. Analyses by Sandmann, (each means of two analyses, Ann. Ch. u. Pharm. lxxxix, 364),

	S	Sb	As	Cu	Fe	Zn	Ag	Ni
I.	24·61	25·65	1·65	38·17	1·59	6·28	0·62	*trace*=98·57.
II.	25·52	19·71	4·98	38·41	2·29	6·50	0·69	*trace*, quartz 0·36=98·46.

Schwatzite, Kenngott, includes anal. 20, p. 84; and *Freibergite,* the argentiferous Tetrahedrite or *Polytelite* of *Glocker.*

Thorite, p. 312.—The following method is proposed by Sæmann for distinguishing the species Thorite. The powder is decomposed easily by muriatic acid, especially if heated; after adding some drops of sulphuric acid to the solution, it should be evaporated to dryness; then turn some cold water on the white residue and it dissolves out the sulphate of thoria—a salt which has the property of forming a precipitate in flocks which collect at the bottom of the platinum crucible, and render the liquid gelatinous if the solution is a strong one.—A pseudomorph of thorite (orangite) after orthoclase is described by H. Dauber, Pogg. xcii, 250, June, 1854.

Topaz, p. 259.—According to a recent memoir by H. St. Claire Deville and M. Fouqué, topaz and some other silicates containing fluorine, when highly heated, lose the fluorine as fluorid of silicium. Topaz thus loses 23 per cent. of this fluorid. They arrive at $\bar{\ddot{\mathrm{A}}}\mathrm{l}\,\ddot{\mathrm{S}}\mathrm{i}^{\frac{3}{4}}$ as the formula of topaz, part of the oxygen of the silica being replaced by fluorine. *Compt. Rend.* xxxviii, 317.

It is remarkable that analyses apparently equally trustworthy, recent as well as old, give for *Andalusite* the two formulas $\dddot{\bar{A}}l\,\dddot{S}i^{\frac{2}{3}}$ and $\dddot{\bar{A}}l\,\dddot{S}i^{\frac{3}{4}}$; for *Staurotide* the two $\dddot{\bar{A}}l\,\dddot{S}i^{\frac{1}{2}}$, $\dddot{\bar{A}}l\,\dddot{S}i^{\frac{2}{3}}$; for *Sillimanite*, $\dddot{\bar{A}}l\,\dddot{S}i^{\frac{2}{3}}$ and $\dddot{\bar{A}}l\,\dddot{S}i^{\frac{3}{4}}$, and perhaps others; and now topaz in the present state of chemistry of the species, is divided between $\dddot{\bar{A}}l\,\dddot{S}i^{\frac{2}{3}}$ and $\dddot{\bar{A}}l\,\dddot{S}i^{\frac{3}{4}}$. Moreover Sphene, $(\dddot{\bar{R}})\,\dddot{S}i^{\frac{2}{3}}$ is homœomorphous with Euclase $(\dddot{\bar{R}})\,\dddot{S}i^{\frac{3}{4}}$; and all the above are pleomorphous with Tourmaline, $(\dot{R}^3, \dddot{\bar{R}}, \dddot{B})\,\dddot{S}i^{\frac{3}{4}}$. Kyanite alone appears to give to all recent analysts the same uniform result, $\dddot{\bar{A}}l\,\dddot{S}i^{\frac{2}{3}}$; and the uniformity on this species makes it more incredible that the variations in the case of the other species should be all attributable to errors of analysis.

TOURMALINE, p. 270.—Kenngott has deduced essentially the same formulas for Tourmaline as that given on page 271, except that he writes $B^2\,O^3$ for boracic acid, and regards it as replacing alumina. Min. Notizen, No. ix.

TRIPHYLINE, p. 406.—Altered forms of triphyline are mentioned on page 407. L. Sæmann states that *Melanchlor* (p. 428) is also a result of the alteration of Triphyline, and occurs as an incrustation on unaltered Triphyline; that *Heterosite, Pseudotriplite* and the Norwich mineral are the results of a further change; that *Hureaulite* and *Alluaudite* are connected with Triplite in origin. (*Communicated to the Author.*)

TURQUOIS, p. 405.—The *bone Turquois*, or *Odontolite*, according to L. Sæmann owes its color to a phosphate of iron, as stated by Dufrénoy, (Min. ii, 361). True turquois, when decomposed by muriatic acid gives a fine blue color with ammonia, which is not the case with the odontolite. This mineral has a fine turquois blue color, and a very compact but earthy texture. It is formed along with fossil bones or teeth, being like vivianite connected with organic phosphates in its origin.

VOLGERITE, p. 142.—Cumenge's mineral, p. 142, is named *Cumengite* by Kenngott.

WEISSIGITE, p. 254.—The following are additional particulars respecting this mineral, from a note by M. Jenzsch, communicated to the author by L. Sæmann.—Cleavage parallel to a hemidome pertaining to the brachydiagonal; also in two vertical directions meeting at 118°; also parallel to the macrodiagonal. Crystals small and not very distinct. *Composition,* $\dddot{S}i$ 64·5, $\dddot{\bar{A}}l$ 17·0, $\dot{M}g$ 0·9, $\dot{K}$ 14·6, $(\dot{N}a, \dot{L}i)$, 2·2, ign. 0·8. Insoluble in muriatic acid. From Weissig in Saxony.

The proportion of silica, alumina, and alkalies, differs little from the same in Orthoclase; and is it not that species?

WÖHLERITE, p. 343.—H. Dauber has figured and described a crystal of Wöhlerite, (Pogg. xcii, 242). He gives the crystal the same position as that by the author. Adopting the lettering of f. 494, it contains the planes—

	$i\bar{\imath}$	I	$i\breve{2}$	$i\breve{3}$	$i\breve{\imath}$	$\frac{1}{2}\bar{\imath}$	$\frac{3}{2}\bar{\imath}$	$1\breve{2}$	$\frac{3}{2}\frac{\bar{3}}{2}$	$2\breve{\frac{4}{3}}$
Dauber's lettering,	*a*	*m*	*g*	*h*	*b*	*k*	*d*	*o*	*p*	*i*

All but two of which planes are in Desloizeaux's figure, from which f. 494 was taken, and one of these two, $\frac{3}{2}\bar{\imath}$, is probably the correct symbol for that lettered $1\frac{1}{8}\bar{\imath}$, from Descloizeaux. The angles according to Dauber vary considerably as the faces are not very brilliant; and in fact he makes the brachydiagonal what Descloizeaux makes the macrodiagonal. The latter gives for I on the broad face lettered $i\bar{\imath}$, 135° 27′, whence $I : I = 90° 54′$, while Dauber obtained 134° 51′, giving 89° 42′ for the same $I : I$. Using the lettering of f. 494, the angles obtained are as follows:

Dauber,		Descloizeaux,
	$i\bar{\imath} : \frac{1}{2}\bar{\imath} = 109°\ 28′$.	109° 57′.
	$i\bar{\imath} : 1\breve{2} = 106°\ 54′$.	106° 27′.
	$i\bar{\imath} : \frac{3}{2}\frac{\bar{3}}{2} = 130°\ 45′$.	131° 32′.
	$i\bar{\imath} : i\breve{2} = 116°\ 17′$.	116° 56′.

Dauber's measurements of $I : i\bar{\imath}$ however varied from 134° 21′ to 135° 24′.

WOLKONSKOITE, p. 339.—This species has H.=2—2·5; G.=2·213–2·303, Breithaupt. Analysis by Ivanoff, (Kokscharov's Min. Russl. 145): $\dddot{S}i$ 36·84, $\dddot{\bar{C}}r$ 18·85, $\dddot{\bar{F}}e$ 17·85, $\dddot{\bar{A}}l$ 3·50, $\dddot{\bar{M}}n$ *trace*, $\dot{C}a$ 1·39, $\dot{H}$ 22·46=100·89.

ZINC BLOOM, p. 460.—Occurs with ores of zinc and lead at Bleiberg and Raibel in Carinthia, and has probably resulted from the decomposition of Calamine.

ANNOTATED INDEX TO THE USEFUL METALS AND METALLIC ORES.

GOLD.—*Native Gold,* (p. 7). Distinguished from all minerals it resembles by its flattening under a hammer; its cutting like lead, although considerably harder; its resisting the action of nitric acid, hot or cold; its high specific gravity.

Gold also occurs in *Gold Amalgam,* (p. 15), *Sylvanite,* (p. 64) and *Nagyagite,* (p. 65). Also sometimes in traces in Pyrites, Galena, Chalcopyrite, Native Tellurium.

PLATINUM.—IRIDIUM.—PALLADIUM.—*Native Platinum,* (p. 12), the source of the platinum of commerce, is distinguished by the same tests as gold; and it is mainly on account of its malleability that it occurs in flattened grains or scales. *Platiniridiun* (p. 13) is another ore somewhat harder. *Iridosmine* (p. 19) resembles platinum; but it scratches glass, and gives the reaction of osmium, besides being rather brittle. *Native Palladium,* (p. 14).

SILVER.—The important Silver minerals are: 1, *Native Silver,* (p. 15), sectile and malleable like gold, the only one that has a white color; 2, *Silver Glance* or *Sulphuret of Silver,* (p. 37), blackish lead gray, cutting (unlike the following) nearly like pure lead, cubic in crystallization; 3, *Pyrargyrite* and *Proustite* or Ruby Silver Ore, (pp. 77–78), ruby red to black, always giving a bright red powder; 4, *Freislebenite* or Gray Silver ore, (p. 79), steel gray, rather brittle and powder steel-gray; 5, *Stephanite* or Brittle or Black Silver ore, (p. 86), iron black, and giving an iron black powder; 6, *Kerargyrite* or *Horn Silver,* (p. 92), resembling a dark colored gray or greenish wax, and cutting like wax; 7, *Embolite* or Chloro-bromid of Silver, (p. 93), like the last, but more greenish. These ores yield silver easily, when heated on charcoal. Besides these, *Tetrahedrite* or Gray Copper, (p. 82), is often a valuable silver ore; *Galena,* (p. 39), which, although seldom yielding over seventy-five ounces to the ton, affords a considerable part of the silver of commerce. For other rarer silver ores, see pp. 16, 35, 43, 44, 48, 64, 71, 74, 76, 85, 87, 95.

COPPER.—The more valuable species are: 1, *Native Copper,* (p. 17); 2, *Chalcopyrite* or *Copper pyrites,* (p. 68), of a brass yellow color, scratched easily with the point of a knife blade and giving a greenish black powder; 3, *Barnhardtite,*(p. 500), and *Cuban,* (p. 68), which are similar to the last but paler; 4, *Erubescite* or *Purple Copper,* (p. 38), pale yellowish, with a slight coppery tinge, but tarnishing externally to purple, blue, and reddish tints; easily scratched with a knife blade, and powder grayish; 5, *Copper Glance* or *Vitreous Copper,* (p. 46), of a dark lead-gray color, and powder similar, resembling some silver ores, but yielding copper and not silver, when heated on charcoal; 6, *Tetrahedrite* or *Gray Copper,* (p. 82), of a somewhat paler steel-gray color and powder; 7, *Red Copper,* (p. 101); 8, *Black Copper,* (p. 109, 136); 9, *Malachite* or *Green Carbonate of Copper,* (p. 458), of a bright green color, sometimes earthy in the fracture and sometimes silky; 10, *Azurite* or *Blue Malachite,* (p. 459), of a rich deep blue color, either earthy or vitreous in lustre. All the above are acted on by nitric acid, and the solution deposits a red coating of copper on a strip of polished iron; 11, *Chrysocolla,* (p. 309), a silicate of copper, resembling the Green Carbonate, but paler green, and usually having a close texture, (never fibrous), a smoother surface and somewhat waxy lustre, although occurring usually only as an incrustation; 12, *Atacamite* or Chlorid of Copper, (p. 138), of deeper green than Malachite; 13, *Sulphate of Copper,* in solution, (p. 380). For rarer ores, see pages 36, (arsenical); 43, (selenid); 48, 65, 73, 80, 82, 84, 85, 87, (different sulphur, arsenical and antimonial ores); 309, (silicate); 360, 362, 363, (chromates, vanadate); 375, 380, (sulphates); 412, 420, 421, 425, (phosphates and arsenates).

QUICKSILVER.—The only valuable ore is *Cinnabar,* (p. 48), of a bright red to brownish black color, with always a red powder, and affording fumes of quicksilver when heated on charcoal. There are also Native Quicksilver, (p. 14); Amalgam, (p. 15); Selenid, (p. 52); Chlorid and Iodid, (p. 89, 96). Tetrahedrite (p. 82) sometimes contains this metal.

LEAD.—*Galena* (p. 39) is the only abundant lead ore; it is a lead-gray brittle ore, yielding lead, when heated with charcoal. For other ores see pp. 42, 44, 65, (Selenid and Tellurids); 109, 117, 126, 127, 128, (Oxyds); 359, 361, 362, (Chromate and Vanadate); 348, (Tungstate); 370, 371, 372, 374, 375, 390, (Sulphates), of which Anglesite (p. 370) is the common one; 400, 401, (phosphate and arsenate); 452, (carbonate).

ZINC.—The most important ores are: 1, *Smithsonite* or *Carbonate of Zinc*, (p. 447), and 2, *Calamine* or *Silicate of Zinc*, (p. 313); they are alike in a white, grayish-white, or greenish-white color, commonly a slight waxy lustre and smooth look, (often stalactitic or mammillary), yet sometimes earthy; and a hardness such that the surface is scratched with a knife blade with some little difficulty. They differ in their action with muriatic acid; when the surface is drusy, the silicate shows projections of minute rectangular prisms. *Zincite* or *Red Zinc ore*, (p. 110), is also important; it is bright red and very distinctly foliated. *Blende* or Sulphuret of Zinc, (p. 45), is a common ore, having a yellow to black color and resinous lustre, and distinctly cleavable; the black varieties are sometimes a little metallic in lustre, but the powder is nearly or quite white. For other Zinc Ores, see pp. 127, (oxysulphuret); 156, 189, (silicate); 384, (sulphate); 409, (phosphate); 418, (arsenate); 460, carbonate).

COBALT, NICKEL.—The ores of cobalt of first importance are, *Smaltine*, (p. 56), and *Cobaltine*, (p. 57), both of nearly a tin-white color, with the powder grayish-black, color sometimes verging slightly to gray. The *Black Oxyd of Cobalt*, (p. 136), a kind of bog ore and very impure, is sometimes sufficiently abundant to be valuable. The useful ores of nickel are *Chloanthite* or the nickeliferous smaltine, (p. 56), *Gersdorffite* or *Nickel Glance*, (p. 58), and *Copper Nickel*, (p. 52), the latter distinguished by a pale copper red color. For other ores of *Cobalt*, see pp. 41, 44, 63, 67, (sulphuret or arseniuret); 385, (sulphate); 416, (arsenate); 461, (carbonate); of *Nickel*, 42, 49, (sulphuret); 53, 59, (arsenical or antimonial); 339, (silicate); 386, (sulphate); 418, (arsenate); 461, (carbonate).

MANGANESE.—Common, as *Pyrolusite*, (p. 125), and *Psilomelane*, (p. 135), both black or grayish-black ores, and having little lustre, and a blackish streak or powder, in which last particular they are distinct from the iron ore called Limonite, with which they are often associated, and also from Hematite or Specular Iron. *Wad* (p. 136) is an earthy bog manganese, sometimes abundant and valuable. *Manganite* (p. 130) is abundant in certain mines, but is of little value in the arts, because of its containing so little oxygen, (one third less than Pyrolusite), to which fact Beudant alludes in his name for the species, *Acerdese;* it differs from pyrolusite in its reddish-brown powder. For other manganese ores, see pp. 41, 56, (sulphuret); 53, (arsenical); 117, 118, (oxyds); 167, 186, (silicates); 399, 406, 408, (phosphates); 446, 452, (carbonate).

CHROMIUM.—*Chromic Iron*, (p. 106), a grayish-black little lustrous ore, occurring mostly in Serpentine, is the source of chrome in the arts. For different chromates, see p. 359.

IRON.—The important iron ores are: 1, *Hematite* or *Specular Iron*, (the αιματιτης or *bloodstone* of Theophrastus), (p. 113), characterized by its blood-red powder, and occurring either earthy and red, or metallic and dark steel gray; in the latter condition very hard, a knife point making no impression;—2. *Magnetite*, or *magnetic iron ore*, (p. 105), as hard as the preceding, but having a black powder, and being attractable by a magnet;—3, *Limonite*, called also brown hematite, (p. 131), a softer hydrous ore, affording a brownish yellow powder, earthy or semimetallic in appearance, and often in mammillary or stalactitic forms;—4, *Chalybite*, or *Spathic Iron*, (p. 444), a sparry ore, of grayish, grayish-brown, and brown colors, very distinctly cleavable, turning brown to black on exposure. The common clayey iron ores are impure ores, either of Spathic Iron, Limonite, or Hematite; when the last they are red; when brown, reddish-brown, or yellowish-brown to black, they may be either of the two former. One of the most common ores of iron is *Pyrites* or sulphuret of iron, (p. 54), a pale yellow brass-like ore, hard enough to strike fire with steel, and thus unlike any copper ore, and all similar ores of other metals. *Marcasite* (p. 60) is similar, but is prismatic and often crested in its forms. *Pyrrhotine,* or *Magnetic Pyrites,* (p. 50), is less hard and paler, or more grayish in color. *Leucopyrite* and *Mispickel,* (pp. 61, 62), are white metallic arsenical ores, somewhat resembling ores of Cobalt. *Ilmenite,* or *Titanic Iron,* (p. 115), resembles specular iron closely, but has not a red powder; it is abundant in some regions, but not valued. For other iron ores see pp. 380, 385, 387, 389, (Sulphates); 399, 406–408, 415, 424, 427, 431, (phosphates); 422, (arsenate); 464, (oxalate).

TIN.—The only valuable ore is the *Oxyd of Tin* or *Cassiterite,* (p. 118), a very hard mineral of a dark brown to black color, sometimes gray or grayish-brown, without any metallic appearance; the crystals usually have a very brilliant lustre. Tin also occurs as a sulphuret, (p. 70), and is sparingly found in ores of tantalum, and some other mineral species.

TITANIUM.—The only ore of this metal of any value is Rutile, (p. 120).

ARSENIC.—*Native Arsenic* (p. 22) is one source of arsenic, but it is too rare to be of much avail; also *Orpiment,* (p.32), a sulphur-yellow foliaceous and somewhat pearly mineral, and *Realgar,* (p. 31), bright red and vitreous. Arsenic is mostly derived for the arts from the arsenical ores of iron, cobalt, and nickel.

ANTIMONY.—*Stibnite,* or *Gray Antimony,* (p. 33), is the source of the antimony of commerce. It is a lead gray ore, usually fibrous or in prismatic crystals, and distinguished from a similar ore of manganese by its perfect diagonal cleavage and its easy fusibility. Antimony occurs also in numerous ores of lead and silver, (p. 72), and of nickel, (pp. 53, 59); also as oxyds, 140, 141.

BISMUTH.—*Native Bismuth,* (p. 20), the source of the metal in the arts, is whitish, with a faint reddish tinge, has a perfect cleavage, and is very fusible. For other bismuth ores, see pp. 16, 21, 33, 44, 73, 77, 81, 88; 141, (oxyd); 181, (silicate); 462, (carbonate).

GENERAL INDEX.*

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