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Albany Institute
From the Author

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,
AND A TREATISE ON MATHEMATICAL CRYSTALLOGRAPHY
AND THE DRAWING OF FIGURES OF CRYSTALS.

ILLUSTRATED BY NUMEROUS WOOD CUTS AND FOUR COPPER PLATES.

BY JAMES D. DANA, A. M.

Member of the Soc. Cæs. Nat. Cur. of Moscow, the Soc. Philomathique of Paris,
the American Academy of Arts and Sciences at Boston, etc.

"*Hæc studia nobiscum peregrinantur, rusticantur.*"

THIRD EDITION,
REWRITTEN, REARRANGED, AND ENLARGED.

NEW YORK AND LONDON:
PUBLISHED BY GEORGE P. PUTNAM.

1850.

A.

THOMAS J. STAFFORD, PRINTER,
NEW HAVEN, CONN.

PREFACE.

This Treatise, in the present edition, has undergone so various and extensive alterations, that few of its original features will be recognized. The science of Mineralogy has made rapid progress in the six past years; chemistry has opened to us a better knowledge of the nature and relations of compounds; and philosophy has thrown new light on the principles of classification. To change is always seeming fickleness. But not to change with the advance of science, is worse; it is persistence in error: and, therefore, notwithstanding the former adoption of what has been called the "Natural History System," and the pledge to its support given by the author, in supplying it with a Latin Nomenclature, the whole system, its classes, orders, genera, and Latin names, have been rejected; and even the trace of it, which the synonymy might perhaps rightly bear, has been discarded. The system has subserved its purpose in giving precision to the science, and displaying many of the natural groupings which chemistry was slow to recognize. But there are errors in its very foundation which make it false to nature in its most essential points: and in view of the character of these errors, we are willing it should be considered a relic of the past.

Yet science is far from being ready with an acceptable substitute. Most *chemical* systems have been more artificial than the "Natural" system; and doubts now hang over some of the principles of chemistry that are widest in their influence on classification. In view of the difficulties on either side, it was a point long questioned, whether to venture upon a classification that might be deemed most accordant with truth among the many doubts that surround the subject; or to adopt one less strict to science, that might serve the convenience of the student for easy reference, and for the study of Mineralogy in its economical bearings, while at the same time it should exhibit many natural relations, and inculcate no false affiliations or distinctions of species. The latter alternative has been adopted:—the classification is offered simply as a convenient arrangement, and not an exhibition of the true affinities of species in the highest sense of the term. Among the silicates, however, it will be perceived that the groupings in the main are natural groupings; and throughout the work, special care has been taken to inculcate, as far as possible, the true relations of species, both by remarks, and by an exhibition of them in tables.

The system of classification which has been set aside for the arrangement adopted, is presented in a tabular form in the latter part of the volume, and it is recommended as the preferable plan for arranging a cabinet; since it groups together species that are fundamentally alike—that is, alike in chemical and crystallographic characters—and prominently exhibits the various cases of isomorphism and polymorphism among minerals.

Special effort has been used to give completeness to the chemical descriptions of species, while, at the same time, crystallography has not been neglected. In the latter department, a Mathematical chapter has been added, after Naumann's system—the system generally adopted in Germany, and recommended by its simplicity; and a second on the Drawing of Figures of Crystals. On the other side, the number of chemical analyses introduced has been increased fourfold, so that the student will have before him a full registry, in most cases, of all mineral analyses hitherto made that are worthy of confidence. Chemical formulas have been given, and also the various opinions of different authors, where the constitution of a species is still in doubt. The most recent investigations in foreign Works and Journals, as far as they have reached this country, have been examined, and the Treatise is therefore posted up to the hour of its leaving the press. About one hundred new species have been added to the science since the appearance of the preceding edition.

In the department of American Mineralogy, no pains have been spared to render the Work as complete as the nature of the case admitted. And here the Author would gratefully acknowledge the valuable assistance he has received from various sources. He would especially mention his indebtedness to Dr. C. T. Jackson, for information upon the minerals of the Michigan Copper region, with Analyses of Telluric Bismuth of Virginia, and Chrysocolla, Apophyllite, and Analcime of Michigan, besides a description of Vermiculite, and an Analysis of this species in his laboratory by R. Crossley; also to Mr. Crossley, for an Analysis of Algerite and Schorlomite;—to J. E. Teschemacher of Boston, for observations on many species, including the Crystallized Black Copper Ore and a Vanadate from the Lake Superior region;—to A. A. Hayes of Boston, for the blowpipe characters of Pyrrhite, and facts relating to Red Zinc Ore, and some other minerals;—to M. Adolph Schlieper, now of Lowell, Mass., for an Analysis of a Volcanic Labradorite, and the Cummington Manganese Spar;—to J. C. Booth of Philadelphia, for Analyses carried on in his laboratory of Emerylite, Euphyllite, Marmolite, an Iridescent Pyrites, a supposed Allanite, and other investigations, performed by T. H. Garrett, J. D. Darrack, Ch. Hartshorne;—to Wm. S. Vaux and T. F. Seal of Philadelphia, and L. White Williams of Westchester, Pa., for much important information on the localities and minerals of Pennsylvania and Delaware; to H. Wurtz of New York for Analyses of Brucite and Nemalite, besides a new species he has named Melanolite; to Hon. T. L. Clingman of North Carolina for a catalogue of the North Carolina minerals; to D. D. Owen and J. G. Norwood for an account of the minerals of Wisconsin, and other parts of the West;—to B. Silliman, Jr., for Analyses of Emerylite, and other species, and for aid in the optical examination of the American Micas, besides help of various kinds in the progress of the Work;—to H. Erni, assistant chemist in the Yale Laboratory, for Analyses of Danburite, Euphyllite, and a Feldspar;—to W. J. Craw of the same laboratory, for Analyses of Emerylite, W. H. Brewer, for Analyses of Hudsonite, Vauxite, and a mica, (Margarodite), G. J. Brush, for Analyses of Williamsite, Deweylite and an Opal, J. B. Bunce, for an Analysis of Wollastonite;—to T. S. Hunt, for a catalogue of the mineral localities of Canada, and a description of the new species, Nickel Vitriol;—to Dr. F. B. Hough, for a catalogue of the localities of Northern New York, and a notice of the Capillary Pyrites of Antwerp;—to O. P. Hubbard, for facts relating to the minerals of New Hampshire.

With so many Collaborators, the Work must bear some evidence of progress in American Mineralogy. The persons here mentioned are independent of those whose publications have appeared during the past six years—among whom we cannot properly leave unnoticed the names of C. U. Shepard, J. D. Whitney of Boston, Wolcott Gibbs of New York, B. Silliman, Jr., J. E. Teschemacher, T. S. Hunt, F. Alger of Boston, L. C. Beck,—and W. Fisher, J. S. Kendall and G. J. Dickinson of Prof. Booth's Laboratory; whose labors among American Minerals will be found reported under the species Schorlemite, Brookite, Ozarkite, Zircon, Gibbsite, Allophane, Boltonite, Unionite, Albite, Kyanite, Nuttalite, Serpentine, Algerite, Sodalite, Davyne, Brucite, Tetradymite, Garnet, Vivianite, Chondrodite, Pectolite, Wollastonite, Coracite or Pitchblende, Azorite, Chromic Iron, Black Copper, Pyroxene, Hornblende, Chladnite, and Shepardite. If we cannot number many new species, we may claim that our knowledge in numerous cases has been rendered more precise. Some species of uncertain titles have been restored to credit, while others have been stripped of their seeming claims.

Among foreign laborers on American species, we should make honorable mention of M. Hermann, who has analyzed the Manganese spar of

Stirling and Cummington, Gibbsite, Jeffersonite, Columbite, Pennite, and the so-called Troostite;—also of Prof. H. Rose, whose labors on Columbite are well known;—also of Rammelsberg, Delesse, Marignac, Damour, and Kerndt, to whom the science is indebted for analyses or descriptions of American Bismutite, Brookite (Arkansite), Schorlomite, Washingtonite, Chrysoberyl, and Wolfram.

In the preparation of this edition, and especially the elaboration of its Chemical part, the Author has availed himself freely of the Chemical Mineralogy—"Handwörterbuch des Chemischen Theils der Mineralogie"—of Rammelsberg, and its biennial Supplements, in which all that is published respecting the composition of minerals is posted up with a fullness, discrimination, and erudition, that leaves little for another hand. The tables of Analyses are, to a great extent, only another arrangement of the very valuable Work of this distinguished Chemist and Mineralogist. The various Foreign Scientific Periodicals and Transactions have also been consulted, both of Britain, France, Germany, and Russia, and every care has been taken to insure correctness and accuracy. Many facts of very recent date, that were received through new publications, or as private communications from different contributors to the Work, subsequent to the printing of the earlier part of the volume, are contained in an Appendix; and the reader will find it of use to him to add to the descriptions of species in the body of the volume, the number of the page in the Appendix where the mineral is again treated of.

The introduction of a table of atomic weights places it in the power of any, who will take the little trouble needed to understand its use, to calculate the results of analyses and test or compare their formulas. To the young student this will be found a most instructive exercise: and the proficient in the Science will appreciate the benefit of having a table of the kind at hand, arranged for easy reference.

The Author is unwilling to close without again acknowledging his obligations for the Scientific aid he has so liberally received during the progress of the Work, and expressing the hope that the Treatise may not prove unworthy of its generous contributors. To expect to satisfy as regards classification, would be the height of folly; for it is a subject on which the widest diversity of opinion exists among the best authorities. The Work will accomplish its end if it contribute to the convenience of the student, and the progress of Mineralogical Science.

New Haven, Conn., May, 1850.

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ABBREVIATIONS,

AND CATALOGUE OF WORKS REFERRED TO IN THIS TREATISE.

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 9, the 10th commencing with July of 1850.

Ann. Chem. u. Pharm.—Annalen der Chemie und Pharmacie, by F. Wöhler and J. Liebig. In monthly numbers of about 180 pages. 4 vols. a year. Vol. lxxiii commenced with 1850.

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 1850, the xxviii volume began.

Ann. Lyc. N. H. New York.—Annals of the Lyceum of Natural History of New York. The 4th volume was completed in 1849.

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., since 1842; with 1850, commenced volume xviii.

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.)

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

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. Since 1846.

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.

Bib. Univ. de 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," by de la Rive, Marignac, Pictet, DeCandolle, Gautier, Plantamour and Favre.

Bost. Jour. Nat. Hist.—Journal of the Boston Society of Natural History, since 1834. *Boston.* vol. vi, in course of publication.

Breit.—Breithaupt.—Handbuch der Mineralogie. 3 vols. *Leipzig.* Vol. iii, in 1847.

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 xviii, for the year 1850.

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 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.* Issued weekly, and forming two volumes annually in thick quarto; since 1835.

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

Duf.—Dufrénoy.—Traité 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. xlviii commenced with the year 1850.

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 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.

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.

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, and the 2d vol. now publishing.

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 appearing at Leipzig twice a month, in parts of 64 pages each, and 3 vols. a year. Commenced in 1834. From 1834 to 1836, (vols. 1 to 9), under Erdmann and Schweigger-Seidel; 1837, (vols. 10, 11, and 12), under Erdmann alone; since under Erdmann and Marchand. The xlix volume commenced with the year 1850.

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

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.* With 1850, commences the xviii volume.

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.*

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 Finlands 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.* Since 1832. Volume xxxvi commenced with the year 1850.

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

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. The lxxix volume was begun with the year 1850. A general index is published for volumes 1 to 60, to the close of 1843.

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 trimonthly, in parts, 96 pages each. Volume iii commenced with April, 1850.

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

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.

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.

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.

W.—Werner.

INTRODUCTION.

1. 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, an exhaling spring, or a volcanic fumarole: the result in both cases is gypsum, identical in chemical, physical, and crystallographic characters. 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 out-door 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.

MINERALOGY:

SUBDIVISIONS OF THE SUBJECT ADOPTED IN THE FOLLOWING TREATISE.

2. 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.

Second, those properties ascertained by the action of chemical reagents and the blowpipe. These, the *Chemical Properties of Minerals*, are considered in Part III.

Next follow:—

Part IV. On *Taxonomy*, or Classification.

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

Part VI. Arrangement of minerals according to a *Chemical Classification*.

Part VII. Classification and Tables for the determination of minerals, or *Determinative 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, therefore, considered only so far as they afford aid in discriminating among minerals, and throw light on the characters of species.

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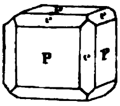

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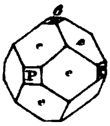

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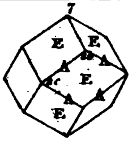

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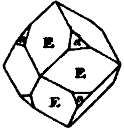

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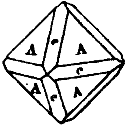

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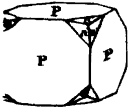

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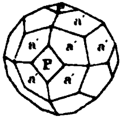

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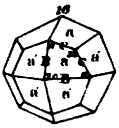

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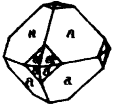

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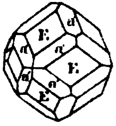

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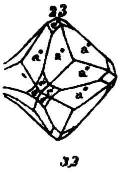

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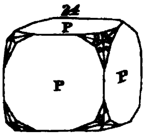

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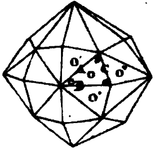

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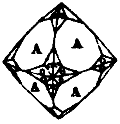

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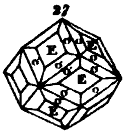

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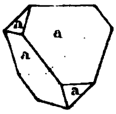

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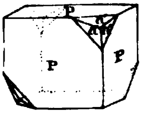

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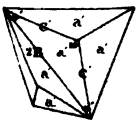

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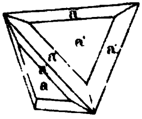

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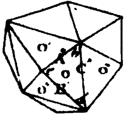

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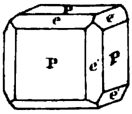

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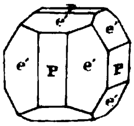

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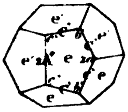

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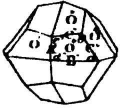

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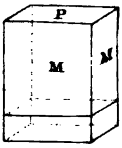

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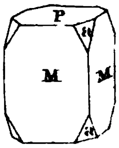

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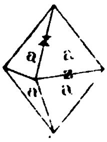

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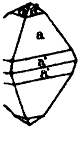

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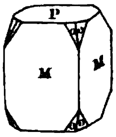

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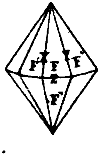

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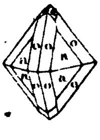

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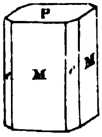

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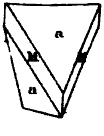

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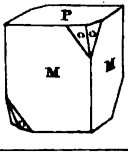

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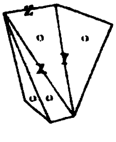

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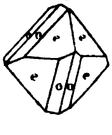
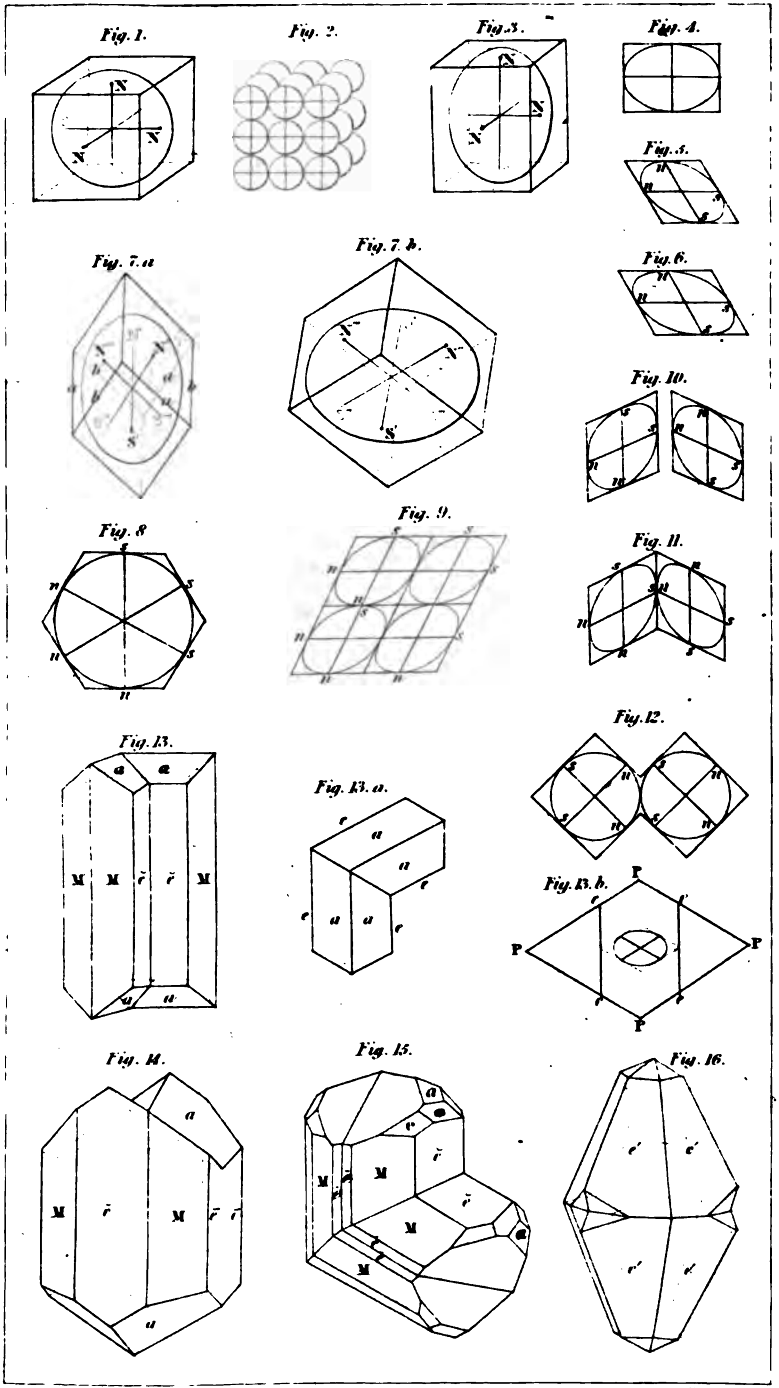


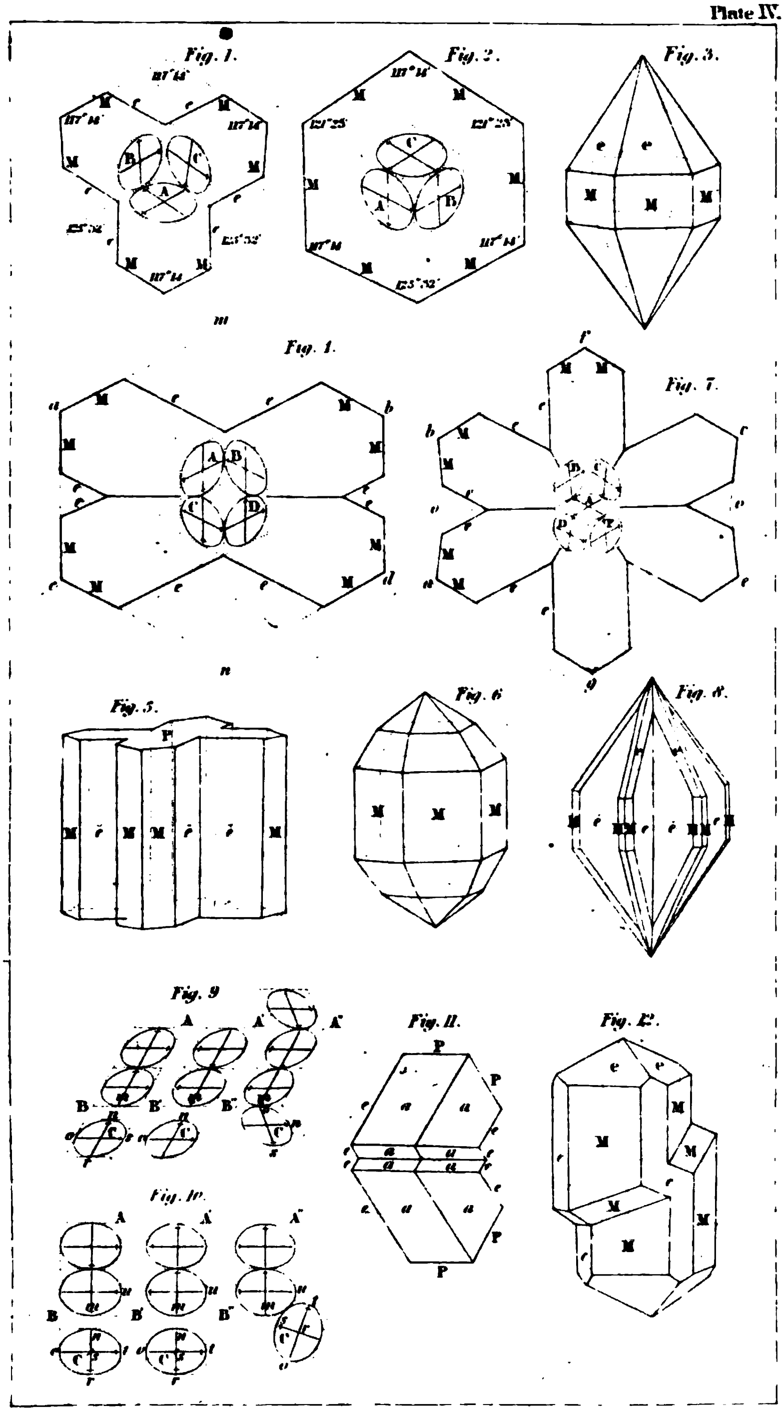
Plate III.



G. E. Sherman Sc.

FORMATION OF TWIN CRYSTALS.

Plate IV.



FORMATION OF TWIN CRYSTALS.

MINERALOGY.

PART I.

CRYSTALLOLOGY,

OR, THE SCIENCE OF THE STRUCTURE OF MINERALS.

SECTION I.

CRYSTALLOGRAPHY.

3. *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 microscopic point, to the diameter of a bushel measure. A

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[*] *Diodorus* II. 52, p. 163, Wess.—*τοὺς γαρ κρυστάλλους λίθους ἔχειν την σύστασιν ἐξ ὕδατος καθαροῦ παγέντος, οὐχ ὑπὸ ψυχους, ἀλλ' ὑπὸ θείου πυρος δυναμεως.*

Seneca, Quæst. 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.

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 870 pounds. One of the gigantic beryls from Acworth, New Hampshire, measures *four* feet in length, and two and a half in circumference. These large crystals never have the perfection and transparency of those of small size.

4. *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 the most important means of distinguishing minerals. This *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.

5. 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. The *fundamental forms*, as they are called, are modified by planes (termed *secondary planes*) on their edges or angles, which planes may be large or small, or may even obliterate the primary planes; and these 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 —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.

I. SYSTEMS OF CRYSTALLIZATION.

6. The more simple forms of Crystals are the following:—

1. *Prisms.* Prisms may have a 4-sided base, as in figures 1, 50, 69, 72, 87, and 92, on plates 1 and 2. When this base is square, and

the prism erect, as in figure 50, 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. If these lateral planes equal the basal, and like them are squares, the form is a *cube*, bounded by six equal squares. When the base is a rectangle instead of a square, the prism is a *right rectangular prism*, (figure 69, plate 2). 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.

Again, the base may be a *rhomb*, a form in which the sides are equal, (fig. 72, pl. 2); an erect prism with such a base is a *right rhombic prism*. 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 two oppposite 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*, (fig. 87, pl. 2).

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*, (fig. 91, pl. 2). 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, so that 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*, (fig. 103, pl. 2). 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

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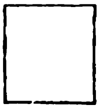
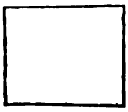
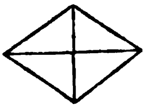
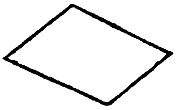
[*] The following figures represent the forms of bases alluded to:—


Square.


Rectangle.


Rhomb.


Rhomboid.

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

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.

Prisms also occur, having a six-sided base; and when the prism is a regular hexagon, and erect, it is called *the hexagonal prism.*

2. *Octahedrons.*—Octahedrons are 8-faced solids, as the term implies, derived from οκτακις, 8-*times*, and ἑδρα, *face*. These faces are triangles, as in figures 4 and 52, 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* (fig. 4, pl. 1) 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*, (fig. 52, pl. 1), 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.

The base in other octahedrons is *rhombic*, and in this case the form is called a *right rhombic octahedron*, (fig. 76, pl. 2). 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.

3. *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 figure 7, plate 1. 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.

7. The thirteen solids which have been thus far enumerated and described have been called *fundamental forms.* Among crystals there are many different prisms, octahedrons, and dodecahedrons, and forms of other kinds; but they have close relations to the preceding, and are viewed as only modifications of them. They may be described after considering the classification of these forms.

The terms *base, lateral planes, basal, lateral,* and *pyramidal edges, similar* edges and solid angles have been explained in the preceding remarks. The *axes* of crystals, as used in Crystallography, are imaginary lines connecting points diagonally opposite: either the centres of opposite faces, or of opposite edges, or the apices of opposite solid angles.

8. The *systems* of crystallization to which all the various forms are referable, are *six* in number.

I. *Monometric or Tesseral System.*—9. The cube, regular octahedron, and rhombic dodecahedron, as already remarked, are alike in their perfect symmetry: the height, length, and breadth are equal. The three axes are of equal length, and intersect at right angles. In the cube (figure 1) these axes connect the centres of opposite faces; in the octahedron, the apices of opposite solid angles; in the dodecahedron, 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 fig. 2, plate 1; then that in figure 3, and finally a *regular octahedron,* (fig. 4); 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.

By cutting off as evenly the *twelve edges* of another cube, the knife being equally inclined to the faces, we have the form in figure 5; then figure 6; and finally a *rhombic dodecahedron,* (figure 7), 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 figures 7, 6, 5, 1, and figures 4, 3, 2, 1.

The octahedron also is changed to a rhombic dodecahedron by removing its twelve edges, (figure 9), and continuing the removal (as in figure 8) till the original faces are obliterated, thus producing the dodecahedron, (figure 7).

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*.[*]

II. *Dimetric System.*—10. Includes the right square prism, (fig. 50), and square octahedron, (fig. 52). The axes of the prism connect the centres of opposite faces, and cross at right angles; one is the *vertical*, the other two the *lateral* axes. 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, (fig. 51), continued, leads to the octahedron. The vertical axis is a varying axis, and may be longer or shorter than the lateral; the lateral are equal. Hence the name of the system, alluding to the two kinds of axes, from δις, *two-fold*, and μετρον, *measure*.[†]

III. *Trimetric System.*—11. Includes the right rectangular prism, (fig. 69), the right rhombic, (fig. 72), and the rhombic octahedron, (fig. 76). 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 figs. 70, 71, 72; and so if the lateral edges of a rhombic prism are in like manner removed, (figs. 71, 70), the result is a rectangular prism, (fig. 69). This relation of these two forms is shown in figure 73, which represents a rhombic prism within a rectangular; 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, moreover, is derived from the rectangular prism, by removing the solid angles of the latter, a process begun in fig. 74; and it comes from a rhombic prism by removing the basal edges of the prism, as shown in figs. 72, 75, 76. 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,

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[*] This is the *Isometric* system of Hausmann; *Tessular* of Mohs and Haidinger; *Tesseral* of Naumann; the *Regular* of G. Rose; *Cubic* of Dufrenoy.

[†] This system is the *Pyramidal* of Mohs; *Tetragonal* of Naumann; *Monodimetric* of Hausmann; *Quadratic* of Kobell; *Bino-singulaxe* of Weiss.

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.*

IV. *Monoclinic System*.—12. Includes the right rhomboidal and oblique rhombic prisms. In the oblique rhombic prism, the vertical axis connects the centres of the bases, and the lateral the centres of opposite lateral edges. The three axes are unequal; the lateral, *bb*, *cc*, intersect one another at right angles; the vertical is at right angles with *cc*, but inclined to *bb*. Hence, among the three intersections, one is oblique. The axis *cc*, which is at right angles with the other two, is called the *orthodiagonal*, (from ορθος, *straight*); and the axis *bb*, which is inclined to the vertical, is the *clinodiagonal*, (from κλινω, *I 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 lateral plane for its base, as in fig. 88, and then the vertical axes in the forms correspond, as shown in fig. 92, in which both forms are combined. The removal of the edges *e* in 92, (as begun in fig. 90), produces finally the inner prism of 92, an oblique rhombic.

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

V. *Triclinic System*.‡—13. Includes the *oblique rhomboidal prism*. The three axes are unequal, and all intersect at oblique angles; and hence the name, from τρις, *three-times*, and κλινω.

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 oblique and one rectangular. The prismatic form corresponding would be an *oblique rectangular prism*.

VI. The *Hexagonal or Rhombohedral System*.§—14. Includes the hexagonal prism and rhombohedron. The hexagonal prism has a vertical axis connecting the centres of the bases, and three equal lateral axes. The lateral axes connect the centres of the opposite lateral faces or opposite lateral edges; and in each case (as is seen from the character of a regular hexagon), they intersect at angles of 60°

The rhombohedron has eight solid angles and twelve edges. Two of these angles, diagonally opposite, consist of three equal plane

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* This system is the *Prismatic* of Mohs; the *Rhombic* and *Anisometric* of Naumann; *Binary* of Weiss; the *Trimetric* of Hausmann.

† This system is the *Hemi-prismatic* of Mohs; the *Monoclinohedral* of Naumann; the *Clino-rhombic* of Kobell; the *Augitic* of Haidinger:—*Monoclinate* of former editions; the change in the termination is properly required by the Greek origin of the word.

‡ This system is the *Tetarto-prismatic* of Mohs; the *Triclinohedral* of Naumann; the *Clino-rhomboidal* of Kobell; the *Anorthic* of Haidinger.

§ The *Rhombohedral* of Mohs; *Hexagonal* of Naumann; *Monotrimetric* of Hausmann.

angles; the line connecting the apices of these two angles is the vertical axis of the rhombohedron, and the solid is said to be in position when this line is in a vertical position. The other six solid angles are similar. Placing the rhombohedron in position, (as in fig. 107), 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 apprehended 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 removed by planes parallel to the vertical axis, a regular hexagonal prism, terminated by a three-sided pyramid, is formed, as shown in figs. 109, 110; and if the lateral angles are removed in an analogous manner, another similar form is produced, as seen in figs. 111, 112. The two differ only in the form of the planes R, at their extremities. When at the same time the vertical solid angle is removed, as in fig. 113, the terminal plane of the hexagonal prism is formed, (fig. 114).

15. 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, (shown begun by the dotted lines in 114), and continuing the removal till the original form is obliterated; or again, by removing in a corresponding manner, the alternate solid angles. By the second method, fig. 114 would be reduced to 110, and finally to 107; by the first, 114 would be changed to 112, and then to 107.

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

16. Rhombohedrons are *obtuse* when the vertical axis is shorter than diagonals between the lateral solid angles; and *acute* when it is longer. In the former case, (fig. 107), the terminal edges are obtuse; the lateral acute; 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 (fig. 108) 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 may be viewed as the intermediate form, having angles of 90°.

17. Under these systems of crystallization, and the forms described, the variety of different 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 lateral and vertical axes.

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.*

II. MODIFICATIONS OF CRYSTALS.

I. LAWS GOVERNING THE MODIFICATIONS OF CRYSTALS.

18. The number of forms among the crystals of a single species is often quite large, and 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 in mind what is understood by *similar* edges and angles:—that with respect to edges, it signifies not merely alike in length, but also in the interfacial angle included at the edge; and for solid angles, it implies their being enclosed by the same plane angles equal each to each, and belonging to planes alike equal. Thus in the cube, the edges are all similar. In the right square prism, the edges are also rectangular, yet the lateral are not equal to the basal in length, and therefore they are dissimilar. In the right rhombic

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* The relations of the several forms of crystals are elegantly exhibited by means of glass models. 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 glue 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.

prism, the lateral edges have 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.[*]

1. *Laws of Symmetry.*

19. Secondary planes do not occur indiscriminately on a crystal, but are governed by the following simple laws:—

I. ***All the similar parts of a crystal may be simultaneously and similarly modified;*** or, by the subordinate law,

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

The operation of the second law produces ***hemihedral*** forms of crystals, or forms with half the usual number of secondary planes. The forms resulting from the first law, are termed ***holohedral*** forms, from ὅλος, *all*, and ἕδρα, *face.*

20. *Monometric System.*—According to the first law, if a single edge of a cube, octahedron, or dodecahedron, be truncated, all will be simultaneously truncated, (fig. 5, plate 1), for all are similar. If an edge of the same be replaced by a plane inclined unequally on two adjacent faces, in order to retain the symmetry a second plane must occur on this edge similar to the first, as is represented in fig. 10. This becomes evident, when we consider that these planes occupy similar parts of the crystal, and agreeably to the above law, all similar parts must be simultaneously modified. This is termed, as stated in the note below, a bevelment. It also follows, that all the edges of the solids will be similarly beveled.

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[*] In describing the modifications of form, which follow, a few technical terms are employed.

Replacement. An edge or angle is *replaced,* when cut off by one or more secondary planes.

Truncation. An edge or angle is *truncated,* when the replacing plane is equally inclined to the adjacent faces, (figs. 2, a, and 5, e).

Bevelment. An edge is *beveled,* when replaced by two planes, which are respectively inclined at equal angles to the adjacent faces, (fig. 10, e′). This term may be applied to an angle when replaced by three planes, each inclined at the same angle, to its adjacent face, (fig. 14). Truncation and bevelment can occur only on edges or angles formed by the meeting of equal planes.

Planes on an edge, have their intersections with the adjoining faces parallel to the edge. The intersections of e′ c′, fig. 10, are parallel to the original edge.

Planes on an angle intersect the basal face parallel to its diagonal. The intersection of a, with the basal P, (fig. 2 or 51), is parallel to the diagonal of P.

Intermediary planes intersect the basal faces parallel neither to the diagonal nor to an edge, but have an intermediary situation. Such are planes o, o, (figs. 24 and 58).

The facts stated above and in the following paragraphs, will be more thoroughly impressed on the mind of the student, if he should perform the dissections here described, with some convenient material, as chalk, raw potatoes, wax, or wood. By thus actually deriving one form from another, the mutual relations of the primary forms will be easily understood. Chalk is, for many reasons, preferable for this purpose. When the models are finished, their surfaces may be rendered quite hard, by covering them with a solution of gum or varnish.

Again, the truncation of *one* angle of a cube is necessarily accompanied by the truncation of *all*, (fig. 2). If a plane, situated as a′, in fig. 14, occur on an angle of this solid, three similar planes *may*, and therefore *must*, occur on the same angle, one inclining on each face. In addition, similar planes will occur on *all* the angles. So, in the octahedron, we find four planes a′, (fig 17), on each angle, one inclined on each face.

If an intermediary plane (o′, fig. 24) is situated on an angle of a cube, it will be accompanied by five others, or there will be six in all, and forty-eight in the whole solid, (fig. 24), since the number of similar parts about the angle is six. It should be observed, that two of these six planes may be said to belong to each edge. Thus, two to the edge P : P′, two to the edge P′ : P″, and that they correspond to bevelments of the same edges. This correspondence may be seen by comparing figs. 24 and 10.

For the same reason, there will be eight intermediary planes on each angle of the octahedron, two for each of the edges. It is manifest, that if one of these intermediary planes should be dropped, the symmetry of the crystal would be destroyed.

The obtuse and acute solid angles of the dodecahedron (§ 6, 3), will be independently modified. The modifications are the same as in the cube and octahedron, (plate 1, figs. 6, 8, 13, 18, 27).

21. The exemplifications of the second law, are of frequent occurrence. They are of two kinds: either,

1. *Half the similar angles, or edges, alternate in position, are modified independently of the other half;* or,

2. *All the similar angles, or edges, are modified, but by half the regular number of planes.*

Figs. 28 and 33 are examples of the first kind of ***hemihedrism***, in which half the angles of the cube are modified, while the remaining half are unmodified.

Fig. 42 is an instance of the second kind. All the edges are similarly replaced, but by one of the two beveling planes represented in fig. 10. The plane e′ is enlarged in fig. 43. From this last figure, it will be observed, that the suppressed planes are those which were alternate, and that two planes e′, incline on each face, P. The crystals have therefore a symmetrical character.

Another instance may be observed in fig. 48, in which each angle of the cube is replaced by three out of the six intermediaries in fig. 24; that is, by half the number of planes which the first law would require.

The *first* species of hemihedrism gives rise to solids, whose opposite planes are not parallel; a face of a tetrahedron, for example, has no opposite parallel face. The same is true of all solids resulting from this kind of replacement, and it arises from the fact, that opposite parts of the crystal, producing these forms, as, for instance, the diagonally opposite angles in figs. 28 and 33, are not similarly modified. Hemihedral crystals of this kind have, therefore, been called ***inclined hemihedrons.***

22. In hemihedrism of the *second* kind, the opposite parts of a crystal are similarly replaced, and, consequently, the hemihedrons proceeding from this kind of replacement have their opposite faces parallel. Such is the case in figs. 43 and 48. These solids have been termed *parallel hemihedrons*.

The same mineral never presents both of these species of hemihedrons. The former occurs in boracite, the latter in iron pyrites, and many other species. It is also important to observe, that minerals, whose crystals are hemihedrally modified, are invariably thus modified, if the secondary planes occur, in which the hemihedrism may take place. We may illustrate this statement by a reference, first, to the species iron pyrites, whose modifications follow the second of the above laws. The cubes of this species never occur with beveled or truncated edges, but (whenever the edges are modified) they are invariably replaced by planes *unequally* inclined to the adjacent faces. Again, the angles are never replaced by *six* intermediaries, but by *three alternate,* as in fig. 48. In *boracite,* we observe, that only one half of the angles are similarly replaced, and that the modified angles present all the planes required by the regular law for secondary planes; or if all the angles are similarly replaced, as may be true, especially if the replacing plane is only a truncation, then one half the replacements will be very much larger than the other half. The edges of the cube are not affected by this species of hemihedrism, as it influences only the replacements of the angles.

23. *Dimetric System.*—The modifications of the basal and lateral edges of a square prism, take place independently, owing to their dissimilarity, (§ 6). The lateral edges are included by equal planes, and, therefore, may be truncated or beveled, (figs. 61, 62). 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, (fig. 53).

The similar intermediary planes can be but two in number. The *two* which incline on the base, are unlike those inclining on the lateral planes, because the base and lateral planes are dissimilar. These intermediary planes are represented in fig. 58.

24. *Trimetric System.*—The edges of the right rectangular prism are of three kinds, and those of each kind are according to the above law, independently modified, (figs. 70, 77, 78, 79). 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, (fig. 74).

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, (fig. 84). The obtuse solid angles, and the acute, are also independent in their modifications. Each may have two like intermediary planes, (fig. 85). The replacements of the basal edges are similar and simultaneous, (fig. 75).

25. *Monoclinic and Triclinic Systems.*—In these systems, the obliquity of the crystal makes the upper and lower parts in front different, one obtuse and the other acute, which leads to independent modifications. For other points the preceding remarks suffice.

26. *Hexagonal System.*—The vertical solid angles of the rhombohedron are formed by the meeting of three equal planes, and equal plane angles. These angles may, therefore, be truncated, (fig. 113), 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, (figs. 109, 115, 117, 119).

The lateral angles, six in number, are replaced simultaneously, (figs. 111, 121). Two like intermediary planes may occur on each, (fig. 118).

The similar parts in the rhombohedron and hexagonal prism being three, or some multiple of three, (excepting the vertical solid angles), the similar secondary planes are also three, or some multiple of three.

II. FORMS RESULTING FROM THE MODIFICATIONS OF CRYSTALS.

27. On a former page, it is shown how the truncation of the angles of a cube, when continued to the obliteration of the original faces, produces an octahedron; the truncation of the edges of a cube or octahedron, a dodecahedron; and *conversely* the truncation of the angles of an octahedron or the acute solid angles of a dodecahedron, yields a cube; the truncation of the obtuse solid angles of a dodecahedron, an octahedron. The passage also of a square prism into a square octahedron was illustrated; that of a right rhombic prism into a rhombic octahedron; that of a right rhombic prism into a right rectangular prism; that of an oblique rhombic prism into a right rhomboidal prism; that of a rhombohedron into a hexagonal prism, and the converse.

There are many other resulting forms of a simple character which may be briefly reviewed.

1. *Monometric System.*

The *holohedral* and *hemihedral* forms may be separately considered.

28. *Holohedral Forms.*

*a. Tetrahexahedron.**—A bevelment of the edges of a cube is

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* Called *Fluoroid* by Haidinger, from its being a common form of fluor spar.

represented in fig. 10, and the result of a continuation of the process in fig. 11. This form is bounded by twenty-four triangular faces. The above name indicates its 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 e′ in fig. 12, which are observed to replace the solid angles of the octahedron inclining at the same time on its edges, if extended to the obliteration of the primary faces, produce the same form as above, (fig. 11). The replacement of the *six* acute solid angles of the dodecahedron by *four* planes resting on the primaries, (fig. 13), if continued, results in the same solid.

By varying the angle of the bevelment of the cube, tetrahexahedrons of different angles may be produced. Those of most common occurrence have the following angles:

Interfacial Angles.

	A	*C**	
1.=	133° 48′ 47″	157° 22′ 4″	
2.	143° 7′ 48″	143° 7′ 48″	occurs in garnet.
3.	154° 9′ 29″	126° 52′ 12″	" " fluor spar.

Plane Angles.

	a	*c*	
1.=	50° 14′ 16″	79° 31′ 28″	
2.	48° 11′ 23″	83° 37′ 14″	occurs in garnet.
3.	46° 30′ 30½″	86° 58′ 59″	" " fluor spar.

b. Trisoctahedron.—The angles of the cube are represented as replaced by three planes in figs. 14 and 19; 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 figs. 16 and 20. Fig. 15 is an intermediate form between 14 and 16. 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 ἑδρα, *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 more common name of the former is *trapezohedron*.

The *tetragonal trisoctahedron* or *trapezohedron*† (fig. 16) may

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* The letters designating the angles refer to the figure, plate 1. *C* is, however, substituted for 2*C*. The same is the case in the following forms. According to the system of crystallographic notation, these solids are designated, $\infty O\frac{3}{2}$; $\infty O2$; $\infty O3$.

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

be derived from the octahedron, by replacing its angles by four planes *inclining on its faces*, (fig. 17), and from the dodecahedron, by a truncation of its *twenty-four* edges, (fig. 18).

The *trigonal trisoctahedron*[*] proceeds from an octahedron, by beveling its *twelve* edges, (compare figs. 21 and 20); and from a dodecahedron, by a replacement of its six acute solid angles by four planes inclining on the edges.

Two trapezohedrons have the following angles; the first is of most common occurrence.

1. B=131° 48′ 37″, C=146° 26′ 34″. Fig. 16.
a=82° 15′ 3″, b=117° 2′ 8″, c=78° 27′ 46″. Ex. leucite and garnet.

2. B=144° 54′ 12″, C=129° 31′ 16″.
a=81° 25′ 37″, b=112° 53′ 7″, c=84° 15′ 39″. Ex. gold, silver, fluor.

A trigonal trisoctahedron, (fig. 20), occurring in fluor spar and galena, has the following angles:

A=152° 44′ 2″, B=141° 3′ 27″, b=118° 4′ 10″, c=30° 57′ 55″.[†]

c. Hexoctahedron.[‡]—Fig. 24 represents a cube, with six planes on each angle, and consequently forty-eight in all. The resulting solid is completed in fig. 25. Here, for each face of the octahedron is substituted a low six-sided pyramid. The name of this solid is derived from the Greek, ἑξάκις, *six-times*, ὀκτώ, *eight*, and ἕδρα, *face*, the 6×8-faced solid.

A replacement of the angles of the octahedron by eight planes, produces a similar solid, (fig. 26). A bevelment of the *twenty-four* edges of the dodecahedron (fig. 27) 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.

Two occurring varieties have the following interfacial and plane angles:

1. A=158° 12′ 48″, B=148° 59′ 50″, C=158° 12′ 48″, garnet.
2. 162° 14′ 50″, 154° 47′ 28″, 144° 2′ 58″, fluor spar.
1. a= 86° 56′ 25″, b= 56° 15′ 4″, c= 36° 48′ 31″.
2. 85° 50′ 23″, 54° 21′ 34″, 39° 48′ 3″.[§]

29. *Hemihedral Forms.*

a. Hemi-octahedron or *Tetrahedron.*—If half the angles of a cube are replaced by a single plane, as in fig. 28, the resulting form is a tetrahedron, or hemi-octahedron, (figs. 29, 30). The same may

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[*] The *Galenoid* of Haidinger, alluding to its occurrence as a form of galena.

[†] The crystallographic expressions for these trisoctahedrons are, for the tetragonal, $2O2$ and $3O3$; for the trigonal, $2O$.

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

[§] The crystallographic symbols are as follows: $3O\frac{3}{2}$, $4O2$.

arise from an octahedron, by an extension of one-half of its faces, to the obliteration of the other half. This process is represented partially completed in fig. 32.

Its plane angles are 60°, and its interfacial angles $70^\circ\ 31'\ 44''$.

b. Hemi-trisoctahedron.—Fig. 33 represents a cube with its alternate angles replaced by three planes. The planes in this figure, when occurring on all the angles, give rise to the tetragonal trisoctahedron, (fig. 16); occurring on but half, they produce the solid in fig. 34.

The secondary planes in fig. 19, occurring on but half of the angles and enlarged, form the solid in fig. 40, which is a hemihedral form of the trigonal trisoctahedron. Its faces are *tetragonal*, and it is, therefore, termed the ***tetragonal hemi-trisoctahedron***. It is the *deltohedron* of Haidinger.[*]

The former has *trigonal* faces, and is called the ***trigonal hemi-trisoctahedron***, or *cuproid*.[†]

A crystal of gray copper ore has the following angles:

$B = 109^\circ\ 28'\ 16''$, $C = 146^\circ\ 26'\ 33''$.
$a = 31^\circ\ 28'\ 56''$, $b = 117^\circ\ 2'\ 8''$.[‡]

c. Hemi-hexoctahedron.—A solid of this kind is represented in fig. 41. It is formed by a replacement of half the angles of the cube, by six planes, similar to those in fig. 24. As the opposite faces are not parallel, it is an *inclined hemi-hexoctahedron*.

If *all* the solid angles of the cube be replaced by *three* alternate planes, out of *six* intermediaries, (fig. 48), a hemihedral solid is formed, which is represented in fig. 49. It differs from the above in having parallel opposite faces, and is, therefore, a ***parallel hemi-hexoctahedron***, the *diploid* of Haidinger.

A variety of inclined hemi-hexoctahedron, (*boracitoid* of Haidinger), having the following angles, has been observed in boracite:

$A = 162^\circ\ 14'\ 50''$, $B = 124^\circ\ 51'$ $C = 144^\circ\ 2'\ 58''$.[§]
$a = 40^\circ\ 19'\ 7''$, $b = 54^\circ\ 21'\ 34''$, $c = 85^\circ\ 19'\ 19''$.

d. Hemi-tetrahexahedron, or ***Pentagonal Dodecahedron***.[‖]—A cube is represented in fig. 42, with but one of the two beveling planes on each edge, given in fig. 10. The same enlarged, is observed in fig. 43; fig. 44 represents the completed solid. The second of the above names is commonly applied to this solid.

Figs. 45, 46, exhibit the planes on the octahedron, which, extended, give rise to this solid, (figs. 47, 44).

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[*] *Deltoid dodecahedron* of Naumann.

[†] *Cyproid* or *Cuproid* of Haidinger, so named because it is similar to a form of gray copper ore.

[‡] Its crystallographic symbol is $\frac{2O2}{2}$.

[§] The crystallographic symbol is $\frac{4O2}{2}$.

[‖] *Pyritoid* of Haidinger.

Two forms of this kind have been observed in iron pyrites, and a third in cobaltine.

1. $A = 112^\circ\ 37'\ 12''$, $C = 117^\circ\ 29'\ 11''$.
$a = 102^\circ\ 35'\ 40''$, $b = 108^\circ\ 24'\ 30''$, $c = 110^\circ\ 17'\ 40''$.
2. $A = 126^\circ\ 52'\ 12''$, $C = 113^\circ\ 34'\ 41''$.
$a = 121^\circ\ 35'\ 18''$, $b = 106^\circ\ 36'\ 2''$, $c = 102^\circ\ 36'\ 19''$.
3. $A = 143^\circ\ 7'\ 48''$, $C = 107^\circ\ 27'\ 27''$.
$a = 141^\circ\ 16'\ 50''$, $b = 103^\circ\ 20'\ 33''$, $c = 96^\circ\ 1'\ 2''$.*

2. *Dimetric System.*

30. *Holohedral Forms.*

The replacement of the solid angles of a square prism by a single plane each may take place at different inclinations for each set of planes, so that the number of different octahedrons which may be thus obtained is indefinite: they will differ in the length of the vertical axis, as compared with the lateral.

Another series of octahedrons diagonal with these may be obtained by replacing the basal edges of the prism, (figs. 53, 54).

Two intermediate planes on each angle of the prism (fig. 58) produce, if extended, a double eight-sided pyramid, (fig. 59); and by varying the inclination of these planes, different double eight-sided pyramids are formed; the form is the *zirconoid* of Haidinger.

A square prism, diagonal with the primary, may be obtained by truncating its lateral edges, (fig. 61), and an eight-sided prism by beveling the same, (begun in fig. 62).

31. *Hemihedral Forms.*

A few hemihedral forms, appertaining to this class, are represented in figs. 63 to 67. The first is an irregular tetrahedron, called a *sphenoid;* it is formed in a similar manner with the monometric tetrahedron. The second is the commencement of the solid represented in fig. 67, the *disphene* of Haidinger. Fig. 68 is another example of this hemihedrism.

3. *Trimetric System.*

32. A replacement of the lateral edges of a right rectangular prism, has been stated to give rise to a rhombic prism; and different sets of planes will produce as many different rhombic prisms. If the edges ĕ (fig. 69) are replaced, as in fig. 78, or the edges é, as in fig. 77, prisms will also be formed, which, from their horizontal position, are called *horizontal prisms*, (fig. 79); one set pertaining to the *macrodiagonal* and the other to the *brachydiagonal.* By replacements of the solid angles different octahedrons may be formed. From the rhombic prism, we may have different vertical

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* The signs of these solids are, $\frac{[\infty O\frac{3}{2}]}{2}$, $\frac{[\infty O2]}{2}$, and $\frac{[\infty O3]}{2}$.

rhombic prisms by beveling the front or side lateral edges; and horizontal prisms by replacements of the obtuse or acute solid angles. Different octahedrons are formed by replacements of the basal edges; and also by replacing either the obtuse or acute solid angles by two planes each, (figs. 85, 86). An instance of hemihedrism in this system occurs in electric calamine, the extremities of whose prisms are modified unlike.

4. *Monoclinic System.*

33. The replacement of the four lateral angles of an oblique rhombic prism produces a horizontal *clinodiagonal prism*, or *clinodome*, (begun in *a*, fig. 98). The other four angles are not similar, two being obtuse and two acute, and hence they are not necessarily modified alike and together, (figs. 96, 97); but when replaced alike, they produce horizontal *orthodiagonal prisms*, and the two planes of each kind are called a *hemiprism*.

The bevelment of either the acute or obtuse lateral edges (begun in figure 100 with the front edge) produces, when extended, other oblique rhombic prisms of different angles.

As in the right rhombic prism, octahedrons may be formed by replacing the basal edges or solid angles, but the solid is oblique and the planes are of two kinds; each set is called a *hemipyramid*, one the positive, the other the negative.

The relation of the rhombic prism to the right rhomboidal, being already explained, further illustration is not necessary.

5. *Hexagonal System.*

34. The derivation of two six-sided prisms from a rhombohedron, has been fully explained in § 14; the one by a truncation of the six lateral edges, (figs. 109, 110); the other, by a replacement of the six lateral angles, (figs. 111, 112), by planes parallel to the vertical axis.

The remaining parts of the primary faces on the first of the above prisms, are rhombic, (fig. 110); those on the second are pentagonal, (fig. 112). This is an important distinction.

In fig. 115, the lateral edges of a rhombohedron are beveled; a greater extension of these secondary planes produces the solid represented in fig. 116, which is called a *scalene dodecahedron* or *scalenohedron*, since its faces are scalene triangles and twelve in number. By other sets of beveling planes other scalenohedrons are formed, many of which occur in the species calcite.

Bevelments of the terminal edges (fig. 117) continued, give rise to a similar solid. Replacements of the lateral angles, by two intermediary planes (fig. 118) produce other solids of the same kind.

35. A truncation of the terminal edges of the rhombohedron, is

observed in fig. 119. 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, (fig. 120; example, *lenticular calc spar*). It is much more obtuse than the primary. 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 (*a*, *a'*) on these angles, if not parallel to the vertical axis, incline alternately above and below, (fig. 121); and, therefore, by their extension, will give rise to rhombohedrons, (fig. 122, and fig. 2, under *calcite*). 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.

36. An isoceles dodecahedron, (fig. 124)—so called, because its faces are isoceles triangles,—may be obtained from a rhombohedron, by a replacement of the lateral angles, provided this replacement is carried so far that the remaining primary faces (fig. 124) just equal the secondaries produced by the replacement. In figure 124, the alternate faces, R, R, are primary, and the remainder secondary. Such is the origin of the pyramidal termination of crystals of quartz, and the form is called by Haidinger the *quartzoid*. A similar solid may also be formed by replacing the basal edges or angles of the hexahedral prism, (e, fig. 125).

Two intermediary planes on each angle of a hexagonal prism, produce, by their extension, a twenty-four-sided figure, formed of two twelve-sided pyramids placed base to base. This solid is represented in fig. 126. It is the *berylloid* of Haidinger.

37. Hemihedral forms often occur in the Hexagonal system, but usually in connection with holohedral. Under tourmaline, (fig. 3), is represented a six-sided prism of this mineral, differently terminated at its two extremities. The secondary faces *a'*, *a'*, at the upper extremity, replace the lateral angles; the secondary faces, e, e, e, at the lower, truncate the terminal edges; the three planes *a*, *a*, which truncate the alternate edges of the six-sided prism, replace alternate lateral angles of the primary. The six planes (*e*) which compose the hexagonal prism in this mineral, are formed on the six lateral *edges*, (not on the angles). We arrive at this conclusion, by observing, that the faces R, if the planes *a'* were removed, would be *rhombic* and *not pentagonal*. The hemihedral forms of tourmaline are *inclined* hemihedral, since the faces of one extremity are not parallel to those of the other. In apatite (see fig. 2) there is an example of hemihedrism of the parallel kind. The planes o o' are two out of *four* such planes on each angle which holohedrism would require. A similar kind of hemihedrism

is seen in figure 6 and 7, under quartz ; and as the planes are spiral in position, turning to the right or left, it is called *gyroidal hemihedrism* by Haidinger.

A triangular prism, a hemihedral form of the hexagonal prism, is of frequent occurrence in crystals of tourmaline.*

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* *On Lettering Figures of Crystals.*—Some difficulty is occasionally experienced by the young mineralogist in *reading* the figures of crystals, or, in other words, in determining the particular situation of each secondary plane. Much aid may be derived from a simple system of notation, in which letters on the planes shall designate the edge or angle on which these planes are situated. The following system is proposed for this purpose:

In applying the following principles, a few of the fundamental forms are supposed to have a certain position.

The right rhombic prism should be placed with an obtuse lateral edge towards the observer; the right rhomboidal, (except for the lettering of its primary planes,) on its rectangular base, as in fig. 88; the oblique rhombic and rhomboidal prisms, with the dominant solid angle in front; it is immaterial whether at the inferior or superior base. Farther than this, no attention need be paid to the situation of these solids.

The primary planes of prisms, when alike, as in the cube, are lettered P; if unlike, the letter P is retained for the basal, and M used for the lateral planes; and, finally, if the lateral are unlike, the larger lateral is lettered M, the smaller T, or the former M̄, and the latter M̆. (See figs. 69, 103).

The primary faces of the rhombohedron will be lettered R; those of the octahedron A; those of the rhombic dodecahedron, E. (See figs. 3, 4, 7, 107).

In general, the letter e may be applied to planes on the edges, a, to planes on the angles, and o, to intermediaries.

If the basal edges differ from the lateral, as in the prisms, the Roman e may be retained for the basal, and the italic *e* for the lateral.

If any of the edges are oblique, we may distinguish the *obtuse* by the mark —, the *acute* by the mark ⌣, and thus may have ē, ĕ, for planes on the obtuse and acute basal edges in the oblique prisms, (fig. 91), *ē*, *ĕ*, for planes on the obtuse and acute lateral edges. In the right rhomboidal prism the front superior basal edge is obtuse, ē, the inferior acute ĕ, while the lateral are rectangular, and are therefore lettered e, simply. (See fig. 88). In rectangular prisms, the longer basal edge may be marked ē and the shorter ĕ.

In the oblique rhomboidal prisms, there are two unlike obtuse basal edges, and two unlike acute. We may letter planes on the edge to the right hand ē′, or ĕ′, on that to the left, ′ē or ′ĕ.

If the front angles differ from the lateral, as in the rhombic and rhomboidal prisms, we may retain the Roman a for the front, and employ the italic *a* for the lateral, (fig. 72).

If the front angles at the two bases differ, as in the oblique prisms, the planes on the obtuse may be distinguished by ā, those on the acute by ă, (figs. 96, 97).

In the rhombohedron, the vertical solid angle may be lettered a, the lateral *a*; the terminal edges e, the lateral *e*.

All the monometric solids will be lettered, as if derived from the cube. In the other classes, the lettering will depend on the primary.

The changes of the letter o for intermediaries, and the use of the marks — and ⌣, will follow the same changes as the letter a: that is, intermediary planes about the angle ā, will be lettered ō, those about the angle *a*, *o*.

The main principles in this system of notation are:

1. Lettering planes on edges, e, on angles, a, and intermediaries, o.

2. Distinguishing planes on the basal edges from those on the lateral, when they are dissimilar, by lettering the former with a Roman e, and the latter with an italic *e*.

3. Distinguishing planes on *obtuse* edges from those on *acute*, or longer basal edges from the shorter, by placing the mark — over the letter for the former, and ⌣ for the latter, as ē, ĕ, *ē*, *ĕ*.

4. Distinguishing planes on the frontal angles from those on the lateral, by lettering the former with a Roman a, the latter with an italic *a*.

5. Distinguishing planes on obtuse frontal solid angles from those on acute, by the mark — over the letter for the former, and ⌣ for the latter.

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

38. This second 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 these axes at some distance from the centre of the crystal. Now this distance for these axes will either be as 1 : 1 (e, fig. 5), that is a ratio of equality—a truncating plane; or a ratio of 1 : 2 (like é, fig. 10 and fig. 42), 1 : 3, 2 : 3, or some other simple ratio. There is no haphazard scattering of facets, 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 $1a : 1b$ (ė, fig. 77, and a, fig. 82), or $1a : 2b$, $1a : 3b$, and so on.

39. Again, if there is a plane on an angle of a cube, it will meet, if extended, each of the three axes, and the ratio of the distances of the intersections from the centre will correspond to 1 : 1 : 1, (a, fig. 2, pl. 1), the distance being equal on each axis; also, 1 : 2 : 2, (a′, fig. 14), 1 : 3 : 3, 2 : 1 : 1, (a″ fig. 19), and so on; also, 1 : 4 : 2, (o, fig. 24, and o″, fig. 1, under pyrites), 2 : 3 : 6, (o′, fig. 1, under pyrites), and so on, for intermediary planes or such as are unequally inclined to the three axes. In a trimetric crystal, the ratios may be $1a : 1b : 1c$, (a, fig. 74, and e, fig. 75), $1a : 2b : 2c$, $2a : 3b : 6c$, and so on.

40. These numerical ratios are called the *parameters* of the planes. They afford an easy mode of designating the various planes of crystals. The planes, if extended, must meet one, two, or three axes: the faces of a cube intersect one axes and are parallel to the other two; planes on an edge intersect two axes and are parallel to the third; while planes on the angles, if extended, intersect all the axes. All planes of crystals necessarily fall into one of these three divisions.

When a plane is parallel to an axis it does not meet it short of an infinite distance, and hence the usual sign for infinity may represent this position. In this way, the plane P of a cube (fig. 1) may be distinguished by the significant symbol $1 : \infty : \infty$. The planes on an edge, by $1 : 1 : \infty$ (e, figs. 5, 6, 9), $1 : 2 : \infty$, (e′, figs. 10, 11, 12), $1 : 3 : \infty$, etc.; the planes on an angle as already explained.

More general expressions, including references to the lengths of the axes, are as follows: $1a : \infty b : \infty c$, (*M*, fig. 50, $\bar{M}$ or $\breve{M}$, fig. 69),

$1a : 1b : \infty c$, (e, fig. 53, and fig. 80), $\infty a : 1b : 1c$, (e, fig. 61, and figs. 70, 71), $1a : 2b : \infty c$, $1a : 4b : 2c$; or, using m and n for any occurring numbers, $1a : mb : nc$.

41. Since in all cases one of the terms in the ratio may be a unit, it is only necessary to express the other two. $2a : \infty c$ is as intelligible as $2a : 1b : \infty c$, and $4a : 2c$ as much so as $4a : 1b : 2c$; and $ma : nc$ as $ma : 1b : nc$.

42. A still more convenient form of expression is that introduced by Naumann;* it is a modification of the above, and has the advantage of brevity. The terms of the ratio, as 4 : 2 in one of those last quoted, are placed with a letter of the alphabet (P, O, or R) between; thus, $4P2$ signifies the same as $4a : 2c$, and mPn is a general expression for any plane, $ma : 1b : nc$. According to this system of notation, $\infty O \infty$ will be the symbol for a face of a cube, (P, fig. 1); ∞O the symbol for a plane truncating an edge of a cube, that is, for e, figs. 5, 6, and E, fig. 7, a rhombic dodecahedron; $\infty O2$, $\infty O3$, etc. for beveling planes of a cube, as e′, fig. 10, or the form in fig. 11; O, $2O$, $3O$, for planes on the angles of a cube, as a, fig. 2, and a″, fig. 19; $2O2$, $3O3$, equivalent to $\frac{1}{2}O$ and $\frac{1}{3}O$ for other planes on the angles, as a′, figs. 14, 15, 16; $4O2$, $6O3$ for other planes, like o′, fig. 24.

The letter O is used for the monometric system, of which the regular octahedron is the type, having the symbol O. For other systems P is used, excepting the rhombohedral, in which R is commonly employed.

The symbols stand not for single planes only, but for the solid which such planes bound. O is the symbol for the octahedron; ∞O for the dodecahedron; $2O2$ for the trapezohedron, fig. 16; $\infty O2$ for the form in fig. 11; $4O2$ for a form like fig. 25.

43. In trimetric forms the lateral axes are unequal. The positions of the planes with reference to the two are indicated by a long or short mark over the P. Thus, $\bar{P}\infty$ is the expression for a plane parallel to the longer axis, $\breve{P}\infty$ for one parallel to the shorter axis, and $m\bar{P}n$, $m\breve{P}n$, general terms for planes on the angles inclined towards one or the other of these axes, while mP is a general expression for planes having the ratios $1a : 1b : 1c$, $2a : 1b : 1c$, $3a : 1b : 1c$, and so on; that is, those which have a ratio of equality between the lateral axes, or which incline equally (considering the relative lengths of the axes) towards the longer and shorter axes. $\infty\bar{P}\infty$ and $\infty\breve{P}\infty$ represent the lateral faces of a rectangular prism, ∞P the face of the diagonal rhombic prism. For a basal plane, $0P$ is used.

44. For hemihedral forms, a denominator 2 is placed under the several expressions. Thus, for the tetrahedron, (fig. 30), which is hemihedral to the octahedron, the expression is $\frac{O}{2}$; and as there

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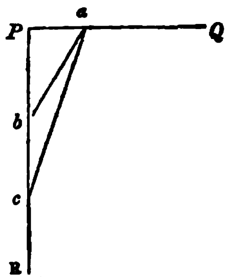
* Lehrbuch der reinen und angewandten Krystallographie, von Dr. Carl Friederich Naumann; in zwei Banden, 8°, mit 39 Kupfertafeln. Leipzig, 1830.

may be two such hemihedrons in reverse situations, as figs. 30, 31, (one corresponding to a, fig. 28, and the other to a replacement of the angles not replaced in fig. 28), the two are distinguished by adding the sign + or —; thus, $+\frac{O}{2}$ and $-\frac{O}{2}$. Figs. 33 and 34 have the same relation as 14, 16, figure 34 being hemihedral to figure 16; and as the symbol of fig. 16 is $2O2$, that of 34 is $\frac{2O2}{2}$. So, fig. 40 is $\frac{2O}{2}$; fig. 44, $\frac{[\infty O2]}{2}$, the bracket implying that the form is a parallel hemihedron.

45. The planes may be viewed in series, and a new interest perceived in the relations thus exhibited. $\infty\bar{P}\infty$ is the plane parallel to the macrodiagonal of a trimetric form. $m\bar{P}\infty$ represents other planes, (for example, $3\bar{P}\infty$, $2\bar{P}\infty$, $\bar{P}\infty$, $\frac{1}{2}\bar{P}\infty$, $\frac{1}{3}\bar{P}\infty$, &c.) parallel to the same diagonal or axis, which as m diminishes, more and more nearly approximate to the basal plane, and finally pass into it when $m=0$. Again, between $\infty\breve{P}\infty$ and $0P$, there is another similar series, all with parallel intersections, being parallel to the shorter axis. ∞P, mP, $0P$, represent another series diagonal to the two just alluded to; and ∞Pn, mPn, $0P$, other series. If $n=2$, we have a series $\infty P2$, $mP2$, $0P$, which, substituting possible numbers for m, may become $\infty P2 \ldots 4P2$, $P2$, $\frac{1}{2}P2$, $\frac{1}{3}P2$, $\frac{1}{4}P2 \ldots 0P$, other series may be $\infty P3 \ldots 6P3$, $3P3$, $P3$, $\frac{1}{2}P3$, $\frac{1}{3}P3 \ldots 0P$; in which again the mutual intersections of planes in the series will be parallel. From these explanations, this mode of viewing the planes in series is readily understood for other systems of crystallization.

46. In the *monoclinic* system, in which one of the axes is oblique, the upper angles and edges in front differ from the lower in front, and they are distinguished by the signs + and —; thus $+mP$ and $-mP$, $+mP\infty$ and $-mP\infty$, are corresponding planes above and below the lateral axes. Moreover, the front lateral edge of an oblique rhombic prism differs from the side-lateral, or in other words, the *clinodiagonal* differs from the *orthodiagonal;* planes parallel to the clinodiagonal are distinguished by placing an accent after the P, thus, $\infty P'\infty$, $mP'\infty$.



47. The relative dimensions of the axes of a crystal are readily obtained, in many cases, by a simple trigonometrical calculation. If in a right square prism there is a plane on a terminal edge, as *ab*, (the figure being a sectional [illegible]w), the angle *Qab* or *Rba* is ascertained by a goniometer. This gives, by subtraction from 180°, the angle *Pab* or *Pba*. Then the trigonometrical formula, *rad* : *Pa* (=1) : : tan *Pab* : *Pb*, affords the ratio of *Pa* to *Pb*, which is either the ratio of the height and breadth (1*a* : 1*b*) of the prism, or a related ratio, (1*a* : 2*b*, 1*a* : 3*b*, etc.) as above explained. The probability of its being the actual

ratio of $a : b$, may be inferred from the frequent occurrence of the plane, though there may still be some doubt; yet this is of little consequence, since in a single ratio thus obtained we have a key to all the others throughout the crystal.

48. Knowing the axes, we may reverse the process and ascertain the angles. If a plane, as *ac*, has the ratio $2a : 1b$, we have $Pa\ (=1 \text{ or } 1b) : rad :: Pc\ (=2a) : tan\ Pac$. Then subtracting *Pac* from 180°, gives *Qac*, the desired inclination. In the cube, where *a, b, c*, are all equal, the equation for a plane on an edge is simply, $1 : rad :: m : tan\ x$. By this means, and the use of spherical trigonometry for the oblique forms, the mathematical calculations with regard to crystals were first made by the Abbé Haüy.

49. The processes by analytical geometry have recently taken the place of the trigonometrical method, being recommended by their greater simplicity.

The explanations already made show how the positions of any plane may be expressed by reference to its intersections with the three axes, given in position; that is, the expression 1 : 2 : 2 for a plane on an angle of a cube, is an exact description of its position; and the expression 1 : 4 : 2 describes as exactly another plane. By the principles of analytical geometry a formula is deduced, by which, whatever the two planes, their mutual inclinations are calculated at once from this data; and conversely, the expression for the plane, the axes being known, is deduced from the angles.

50. In most crystals the edges of the planes will often be found to have several parallelisms in different directions. For example, the plane a, in a figure under Scapolite, makes parallel intersections between e and e; and again e makes parallel intersections with a, o, *e*. Now as there can be but one plane e that will make such parallel intersections, if the expressions for the adjoining planes are known, that of e is at once deduced by means of a simple formula. The expression, in this case, for a is P; for *e* is ∞P; and from this data we conclude, with certainty, that e is $2P\infty$. By such means, the eye of the experienced crystallographer reads off at a glance the exact character of a crystal.

We follow these general explanations by a brief review of the modes of determining the expressions for planes of crystals, and for calculating their axes and angles of inclination.

I. ORTHOMETRIC SYSTEMS.*

I. GENERAL FORMULAS.

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

51. Representing the parameters of any plane,—that is, the numerical ratio expressing its position with reference to the three axes—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 mPn, $m'Pn'$, 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'.

52. The three axes of a crystal may be considered as the intersections of three diametral planes, *one horizontal and two vertical.* Such planes divide the space about the centre into eight octants. In the above substitution the two planes are supposed to be in the same octant. If mPn is in an upper octant and $m'Pn'$ in the one directly below, then ma is a distance measured *above* the horizontal plane, and $m'a$ *below* it, and consequently one is +, the other —. So between other octants, it must be noted in employing the formula, that parameters on opposite sides of a diametral plane are respectively + and — in all instances: for the octants diagonally opposite, ma, b, nc, would be all + in one, and all — in the other.

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

53. When a plane $m''Pn''$ makes parallel intersections between two planes, $m'n'P$ and mPn, the relation of m and n is determined by the formula

$$m''n''(m'n-mn')rr'+r''m''(r'm-rm')nn'+n''r''(n'r-nr')mm'=0.$$

This formula 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.

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* The following pages are a condensed abstract from Naumann's very elaborate treatise, referred to in a note to page 42.

a. mPn.

$m'Pm'$, $(n'=m')$	1. $m''(m-m')n+n''(m'-n)m-m''n''(m-n)=0$.
$m'P2$, $(n'=2)$	2. $m''n''(m'n-2m)+2m''(m-m')n+n''(2-n)mm'=0$.
$m'P$, $(n'=1)$	3. $m''n''(m'n-m)+m''(m-m')n+n''(n-1)mm'=0$.
$m'P\infty$	4. $m''(m-m')n+n''(m'-m'')m=0$.
$\infty Pn'$, $(m'=\infty)$	5. $m''(n''-n')n+n''(n'-n)m=0$.
$\infty P2$	6. $m''(2-n'')n-n''(2-n)m=0$.
∞P	7. $m''(n''-1)n-n''(n-1)m=0$.
P	8. $m''(m-1)n-n''(n-1)m-m''n''(m-n)=0$.
$\infty P\infty$	9. $\frac{m''}{n''}=\frac{m}{n}$
$0P$	10. $n''=n$.

b. mPm, in which $n=m$.

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

c. $mP2$, in which $n=2$.

$m'P$	1. $m''n''(m-2m')+2m''(m'-m)+mm'n''=0$.
$m'P\infty$	2. $2m''(m-m')+n''(m'-m'')m=0$.
$\infty Pn'$	3. $2m''(n''-n')-n''(2-n')m=0$.
∞P	4. $n''(2m''-m)-2m''=0$.

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

$m'P\infty$	1. $m''(m-m')+n''(m'-m'')m=0$.
$\infty Pn'$	2. $m''(n''-n')+n''(n'-1)m=0$.
$\infty P2$	3. $2m''-n''(m''+m)=0$.
∞P	4. $n''=1$, $m''>m$.
P	5. $n''=1$, $m''<m$.
$\infty P\infty$	6. $\frac{m''}{n''}=m$.

e. $mP\infty$, in which $n=\infty$.

$\infty Pn'$	1. $n''(m''-m)-m''n'=0$.
∞P	2. $n''(m''-m)-m''=0$.

f. ∞Pn, in which $m=\infty$.

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

g. $\frac{mOn}{2}$ (in the Monometric System,)

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

$$h.\ \frac{mOm}{2}.$$

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

II. MONOMETRIC SYSTEM.

1. *Inclinations between planes of different forms.*

54. In the monometric system the axes are equal, $(a=b=c=1)$, and consequently in equations, the values of m, n, in each case stand for the axes. mOn is a general expression for holohedral planes or forms; $\frac{mOn}{2}$ for inclined hemihedrons, (as in figures 28 to 41, pl. 1, and page 43), $\frac{[mOn]}{2}$ for parallel hemihedrons, (as figures 44, 49, and the corresponding planes on figures 42 to 48).

55. The general equation for the inclination of two planes mPn, $m'Pn'$, is

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

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

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

	$\infty O\infty$	$\infty On'$	$m'Om'$
mOn	$\frac{mn}{M}$	$\frac{m(nn'+1)}{M\sqrt{n'^2+1}}$	$\frac{m(m'n+1)+n}{M\sqrt{(m'^2+2)}}.$
∞On	$\frac{n}{\sqrt{n^2+1}}$	$\frac{nn'+1}{\sqrt{(n^2+1)(n'^2+1)}}.$	

57. 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 $\frac{mOn}{2}$ on $-\frac{m'On'}{2}$,

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

and for $\frac{mO2}{2}$ on $-\frac{O}{2}$ or a tetrahedal face,

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

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

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

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

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

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

59. For mOn, using the letters A B C for the edges on which they are placed in figure 25,—

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

$$\text{Cos } C = -\frac{n(2m^2+n)}{m^2(n^2+1)+n^2}.$$

For ∞On, (fig. 11), $\quad \text{Cos } A = -\frac{n}{n^2+1}, \quad \text{Cos } C = -\frac{2n}{n^2+1}.$

For mOm, (fig. 16), $\quad \text{Cos } B = -\frac{m^2}{m^2+2}, \quad \text{Cos } C = -\frac{2m+1}{m^2+2}.$

For mO, (fig. 20), $\quad \text{Cos } A = -\frac{m^2+2m}{2m^2+1}, \quad \text{Cos } B = -\frac{2m^2-1}{2m^2+1}.$

60. In *inclined hemihedrons*, as $\frac{mOn}{2}$, figure 41, A' and C', are determined by the same formulas as above.

$$\text{Cos } B' = -\frac{mn(mn-2)}{m^2(n^2+1)+n^2}.$$

61. In *parallel hemihedrons*, as $\frac{[mOn]}{2}$, figure 49, (or planes o, fig. 48), B'' is determined by the same formula as above.

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

For ∞On, as in figure 44,

$$\text{Cos } A'' = -\frac{n^2-1}{n^2+1}, \quad \text{Cos } C'' = -\frac{n}{n^2+1}.$$

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

62. 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, mOn has edge A truncated by $m'Om'$ when $m' = \frac{2mn}{m+n}$; and if $mOn = 4O2$, then $m' = \frac{2\times4\times2}{4+2} = \frac{16}{6} = \frac{8}{3}$, and $m'Om'$, therefore, equals $\frac{8}{3}O\frac{8}{3}$. The same explanation answers for the rest of the table.*

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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; *Rhc.*, rhombic; *Term.*, terminal.

a. mOn, (fig. 25). 1. Edge A truncated by $m'Om'$, when $m'=\frac{2mn}{m+n}$
2. Edge C truncated by $m'O$, $m'=\frac{m(n+1)}{2n}$
3. Edge B truncated by $\infty On'$, $n'=n$
4. Solid angle a truncated by rhombic plane ∞O, $n=\frac{m}{m-1}$
5. Solid angle b truncated by O, $n=\frac{2m}{m+1}$

b. mOm, (fig. 16). 1. S-A. a repl. by 4 pl., I-E. with the same face of mOm parallel, $\frac{1}{2}m=\frac{m'n'}{m'+n'}$
2. Edge C truncated by $m'O$, $m'=\frac{m+1}{2}$
3. S-A. a repl. by 2 pl. $m'O$, incl. on edge C, I-E. par. to edge B of mOm, $m'=m$
4. Edge B truncated by $\infty On'$, $n'=m$
5. S-A. a repl. by 2 pl. $\infty On'$, incl. on B; I-E. of opposite pl. with the same face of mOm parallel, $n'=\frac{1}{2}m$
6. S-A. $2c$ repl. by 4 pl. $\infty On'$, incl. on B; I-E. par. to C, $n'=m+1$
7. S-A. a truncated by ∞O; I-E. of opposite pl. with same face of mOm parallel; fig. 18, planes E, $m=2$

c. mO. (fig. 20). 1. S-A. c repl. by 8 pl. $m'On'$; I-E. of 2 pl. incl. on same face of mO parallel, $2m=\frac{m'(n'+1)}{n'}$
2. S-A. c repl. by 4 pl $m'Om'$ incl. on A; I-E. of two pl. with same face of mO parallel, $m'=2m-1$
3. Edge A truncated by $m'Om'$, $m'=\frac{2m}{m+1}$
4. S-A. c repl. by 4 rbc. pl. $m'Om'$, incl. on A of mO, (fig. 22), $m'=m$
5. S-A. c repl. by 4 rbc. pl. $\infty On'$, incl. on B, $n'=\frac{m}{m-1}$
6. S-A. c repl. by 4 pl. $\infty On'$ incl. on B; I-E. with a face of mO par. to edge A, (fig. 23), $n=\frac{m'^2-1}{m'^2-m'}$,
7. Edge B truncated by ∞O.

d. ∞On. (fig. 11). 1. S-A. b repl. by 6 pl. $m'On'$; I-E. of pl. incl. on same face of ∞On parallel, $m'=n$
2. Edge A truncated by $m'Om'$, $m'=2n$
3. S-A. b repl. by 3 rbc. pl. $m'Om'$, incl. on edges A, $m'=n-1$

e. ∞O. (fig. 7). 1. Edges bevelled by $m'On'$, (fig. 27), $n'=\frac{m'}{m'-1}$
2. Edge truncated by $m'Om'$, (fig. 18), $m'=2$
3. Obtuse S-A. repl. by 3 pl. $m'O$, incl on faces of ∞O.

f. O. (fig. 4). 1. S-A. repl. by 8 planes $m'On'$, (fig. 26).
2. S-A. repl. by 4 pl. $m'Om'$ incl. on faces of O, (fig. 17).

g. $\infty O\infty$. (fig. 1). 1. S-A. repl. by 6 pl. $m'On'$, (fig 24).
2. S-A. repl. by 3 pl. $m'Om'$, incl. on P, (fig. 14).
3. S-A. repl. by 3 pl. $m'O$, incl. on edge, (fig 19).

h. $\frac{mOm}{2}$ (fig. 34). 1. Edge C′ trunc. by $+\frac{m'O}{2}$ (fig. 37), $m'=\frac{m+1}{2}$
2. Acute S-A. by 6 pl. $\infty On'$; I-E. par. to edge C′, (fig. 38), $n'=m+1$
3. Acute S-A. repl. by 3 rbc. pl. ∞O; I-E. of two planes on face of $\frac{mOm}{2}$ parallel, (fig. 36), $m=2$
4. Edge B′ trunc. by $\infty O\infty$.
5. Obtuse S-A. trunc, by $+\frac{O}{2}$ (fig. 35).
6. Acute S-A. trunc. by $-\frac{O}{2}$.

i. $\frac{[mOn]}{2}$ (fig. 49). 1. Edge B beveled by $\frac{[m'On']}{2}$ $n'=n,\ m'>m$

2. Edge A beveled by do. $m'=m,\ n'>n$

3. Edge C repl. by pl. $\frac{[m'On']}{2}$ incl. towards Edge B, $n'=\frac{m'(m^2-n)n}{(mn-1)mn+m'(m-n^2)m}$

4. Edge C repl. by pl. $\frac{[m'On']}{2}$, incl. towards Edge A, $n'=\frac{m'(mn-1)mn}{m'(m^2-n)n-m(m-n^2)}$

5. Edge B. trunc. by $\frac{[\infty On']}{2}$ $n'=n$

6. Edge A trunc. by $-\frac{[\infty On']}{2}$ $n'=m$

7. Edge A beveled by $m'Om'$, $m'=m$

8. Edge C repl. $m'Om'$, $m'=\frac{(mn-1)\,mn+(m-n^2)m}{(m^2-n)n}$

k. $\frac{[\infty On]}{2}$ (fig. 44). 1. Inequilateral S-A. c'' by pl. $-\frac{[\infty On']}{2}$, incl. on Edge A″; I-E. par. to transverse diag'l, $n'=n$

2. Equilat. S-A. trunc. by O, (figs. 45, 46, 47).

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

63. In the following formulas,

ν=half the inclination of *B* on *B* over angle *c*, (fig. 25).
δ=half the inclination of *B* on *B* over angle *a*.
δ'=the inclination of *C* on the horizontal 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 *mOn*,

a. $\mathrm{Cos}\ \nu=\frac{\cos\frac12 A\sqrt{2}+\cos\frac12 B}{\sin\frac12 B}$; $n=\tan\nu$; $m=\tan\frac12 B\sin\nu$.

b. $\mathrm{Cos}\ \varepsilon=\frac{2\cos\frac12 A+\cos\frac12 C}{\sin\frac12 C\sqrt{3}}$; $\delta'=144^\circ\,44'-\varepsilon$; $\tan\delta=\sin\delta'\tan\frac12 C$;

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

c. $\mathrm{Cos}\ \delta=\frac{\cos\frac12 C}{\cos\frac12 B}$; $\nu=135^\circ-\delta$; $n=\tan\nu$; $m=\tan\frac12 B\sin\nu$.

2. In *mOm*,

$\mathrm{Cos}\ \nu=\cot\frac12 B$; $m=\tan\nu$; $\frac12 A=90^\circ$.
$\mathrm{Cos}\ \varepsilon=\cos\frac12 C\sqrt{\frac13}$; $\delta'=144^\circ\,44'-\varepsilon$; $m+1=\tan\delta'\sqrt{2}$.

3. In *mO*,

$m=\tan\frac12 B\sqrt{\frac12}$. $\frac12 C=90^\circ$.
$\mathrm{Cos}\ \varepsilon=2\cos\frac12 A\sqrt{\frac13}$; $\delta'=144^\circ\,44'-\varepsilon$; $m=\tan\delta'\sqrt{\frac12}$.

4. In *∞On*,

$\mathrm{Cos}\ \nu=\cos\frac12 A\sqrt{2}$; $n=\tan\nu=\tan(135^\circ-\frac12 C)$.

III. DIMETRIC SYSTEM.

1. *Inclination between planes of different forms.*

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

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

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

65. 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 $M=\sqrt{[m^2a^2(n^2+1)+n^2]}$.

	$0P$	$\infty P\infty$	$\infty Pn'$	$m'P\infty$
mPn	$\frac{n}{M}$	$\frac{mna}{M}$	$\frac{ma(nn'+1)}{M\sqrt{[n'^2+1]}}$	$\frac{(mm'a^2+1)n}{M\sqrt{[m'^2a^2+1]}}$
mP	$\frac{1}{\sqrt{[2m^2a^2+1]}}$	$\frac{ma}{\sqrt{[2m^2a^2+1]}}$	$\frac{ma(n'+1)}{\sqrt{[2m^2a^2+1]}\sqrt{[n'^2+1]}}$	$\frac{mm'a^2+1}{\sqrt{[2m^2a^2+1]}\sqrt{[m'^2a^2+1]}}$
$mP\infty$	$\frac{1}{\sqrt{[m^2a^2+1]}}$	$\frac{ma}{\sqrt{[m^2a^2+1]}}$	$\frac{mn'a}{\sqrt{[m^2a^2+1]}\sqrt{[n'^2+1]}}$	$\frac{mm'a^2+1}{\sqrt{[m^2a^2+1]}\sqrt{[m'^2a^2+1]}}$
∞Pn		$\frac{n}{\sqrt{[n^2+1]}}$	$\frac{nn'+1}{\sqrt{[n^2+1]}\sqrt{[n'^2+1]}}$	

66. The inclination of mPn on $0P$ will be obtained by making $\cos Q = -\frac{n}{M}$: so in other cases.

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

67. In the dimetric system, the forms mPn are double 8-sided pyramids, (fig. 59, pl. 1); mP and $mP\infty$ are octahedrons, like figure 52, one intermediate to the other; ∞Pn are 8-sided prisms; ∞P and $\infty P\infty$ are 4-sided prisms.

For X, Y, Z, in mPn, (see figure 59, in which the edge X is that connecting the vertical and a lateral axis),

$$\text{Cos } \tfrac{1}{2}X=\frac{ma}{M}. \qquad \text{Tan } \tfrac{1}{2}X=\frac{n\sqrt{(m^2a^2+1)}}{ma}.$$

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

$$\text{Cos } \tfrac{1}{2}Z=\frac{n}{M}. \qquad \text{Tan } \tfrac{1}{2}Z=\frac{ma\sqrt{(n^2+1)}}{n}.$$

68. The formulas become for

mPm; $\text{Tan } \tfrac{1}{2}X=\frac{\sqrt{(m^2a^2+1)}}{a}$. $\text{Tan } \tfrac{1}{2}Y=\frac{\sqrt{(a^2(m+1)^2+2}}{a(m-1)}$. $\text{Tan } \tfrac{1}{2}Z=a\sqrt{(m^2+1)}$.

mP; $\text{Tan } \tfrac{1}{2}X=\frac{\sqrt{(m^2a^2+1)}}{ma}$. $\tfrac{1}{2}Y=90°$. $\text{Tan } \tfrac{1}{2}Z=ma\sqrt{2}$.

$mP\infty$; $\frac{1}{2}X=90°$. $\text{Tan}\,\frac{1}{2}Y=\frac{\sqrt{(m^2a^2+2)}}{ma}$. $\text{Tan}\,\frac{1}{2}Z=ma$.

∞Pn; $\text{Tan}\,\frac{1}{2}X=n$. $\text{Tan}\,\frac{1}{2}Y=\frac{n+1}{n-1}$. $\frac{1}{2}Z=90°$.

69. Putting T for the angle of inclination of two planes over the axial angle of the base, (F on F''', fig. 59), and U for the inclination of two planes over the adjacent basal angle, (F' on F'''),

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

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

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

a. mPn	(fig. 59). 1. Edge Y truncated by $m'P$, when	$m'=\frac{m\,(n+1)}{2n}$
	2. Term. A. repl. by 4 rbc. pl. $m'P$, incl. on edge Y,	$m'=\frac{m}{n}$
	3. Basal A. at Y repl. by 2 pl., $m'P$, incl. on Y; I-E. par. to X, (fig. 60),	$m'=m$
	4. Edge X trunc. by $m'P\infty$,	$m'=m$
	5. Term-A. repl. by 4 rbc. pl. $m'P\infty$, incl. on X,	$m'=\frac{m\,(n-1)}{n}$
	6. Basal A. at X repl. 2 pl. $m'P\infty$, incl. on X, I-E. par. to Y,	$m'=\frac{m\,(n+1)}{n}$
	7. Basal edge trunc. by $\infty Pn'$,	$n'=n$
b. mP	(fig. 52). 1. Term. edge bev. by $m'Pn'$, (fig. 60),	$m'=m$
	2. Basal A. repl. by 4 pl. $m'Pn'$, I-E. par. to term. edges,	$\frac{m'}{n'}=m$
	3. Term. edge trunc. by $m'P\infty$, (fig. 55),	$m'=m$
	4. Basal A. repl. by 2 pl. $m'P\infty$, incl. on Term. E, I-E of two pl. with same face of mP parallel, (fig. 56),	$m'=2m$
c. $mP\infty$	1. Term. E. bev. by $m'P'n$, (sim. to fig. 60),	$m=\frac{m'\,(n'+1)}{n'}$
	2. Basal A. rep. by 2 pl. $m'P$ incl. on Term-E; I-E. of 2 pl. with same face of $mP\infty$ par. (sim. to fig. 56),	$m'=m$
	3. Term-E. trunc. by $m'P$, (fig 55),	$m'=\frac{1}{2}m$
	4. Basal E. bev., or Term-A. repl. by 4 pl. $m'P\infty$ with horizontal intersections, (sim. to fig. 57),	
d. $\frac{mP}{2}$	(fig. 63). 1. Middle edges bev. by $\pm\frac{m'Pn'}{2}$, (fig. 64),	$\frac{m'}{n'}=m$
	2. Angles rep. by a pl. $-\frac{m'P}{2}$; I-E. par. to middle edges,	$m'=m$
	3. Ang. repl. by 2 pl. $m'P\infty$; I-E. of 2 pl. with same face of $\frac{mP}{2}$ parallel,	$m'=2m$
	4. Angles repl. by ∞P,	
	5. Middle edges repl. by $\infty P\infty$, (fig. 65).	

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

71. Let $\nu' =$ the inclination of X on base of pyramid mPn.
$\delta' =$ " Y " "
$\nu =$ half the angle of the base which edge X meets.
$\delta =$ " " " " " Y "

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

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

a. In mPn,

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

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

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

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

b. In mPm,

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

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

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

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

$\text{Cos}\ \delta' = \frac{1}{a} \cot \frac{1}{2}Y\sqrt{2}. \qquad 2\,m - 1 = \frac{1}{a} \tan \delta'\sqrt{2}.$

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

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

d. In mP,

$ma = \cot \epsilon. \qquad \cos \epsilon = \cot \frac{1}{2}X.$

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

e. In $mP\infty$,

$ma = \cot \epsilon. \qquad \cos \epsilon = \cos \frac{1}{2}Y\sqrt{2}.$

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

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

IV. TRIMETRIC SYSTEM.

1. *Inclinations between planes of different forms.*

72. 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 fig. 76.

The inclination of a plane mPn, on another $m'Pn'$, may be ascertained by means of the general formula, p. 45, by substituting, when the forms are

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

73. *a.* For $m\bar{P}n$ on $m'\bar{P}\infty$, 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 $m\bar{P}n$ on $\infty\bar{P}\infty$, the formula becomes

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

c. For $m\bar{P}n$ on $\infty\bar{P}n'$,

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

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

74. The form mPn in the trimetric system, is represented in the octahedron, figure 76, plate 2. Placing X, Y, Z for the interfacial angles at the edges so marked, and writing, as above,

$$M \text{ for } \sqrt{(a^2\,b^2+c^2a^2+b^2c^2)}$$

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

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

75. Simplifying for the particular cases following:

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

f. $m\bar{P}\infty$ Tan $\tfrac{1}{2}X=\frac{c}{ma}$ Tan $\tfrac{1}{2}Z=\frac{ma}{c}$

g. $\bar{P}\infty$ Tan $\tfrac{1}{2}X'=\frac{c}{a}$ Tan $\tfrac{1}{2}Z'=\frac{a}{c}$

It will be observed that in ∞P, (which is a vertical prism,) the angle Z (see figure 76) becomes 180^{c}; Y is the front angle of the prism and X the side angle. So with the rest.

3. *Dimensions of forms.*

76. 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;

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

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

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

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

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

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

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

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

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

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

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.

78. For determining m and n, we deduce from the equations for

a. ∞P and $\infty\breve{P}n$ (§ 74 *a*, *b*), $n=\tan\frac{1}{2}X+\tan\frac{1}{2}X'$; $n=\tan\frac{1}{2}Y'+\tan\frac{1}{2}Y$.

b. ∞P and $\infty\bar{P}n$, $n=\tan\frac{1}{2}X'+\tan\frac{1}{2}X$, $n=\tan\frac{1}{2}Y+\tan\frac{1}{2}Y'$, in which the accented letters pertain to the form ∞P.—Also,

c. From the equations for $m\breve{P}\infty$ and $\breve{P}\infty$,

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

d. From the equations for $m\bar{P}\infty$ and $\bar{P}\infty$,

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

4. *Combinations in the Trimetric System.*

79. 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.

$$\left.\begin{array}{l}\text{1. } m'\bar{P}n'\text{, bev. macrod. terminal edge of } m\bar{P}n\text{, when}\\ \text{2. } m'\breve{P}n'\text{, bev. brachyd. terminal edge of } m\breve{P}n\text{, when}\end{array}\right\}\frac{m'}{n'}=\frac{m}{n}.$$

$$\left.\begin{array}{l}\text{3. } m'\bar{P}n'\text{, bev. brachyd. terminal edge of } m\bar{P}n\text{, when}\\ \text{4. } m'\breve{P}n'\text{, bev. macrod. terminal edge of } m\breve{P}n\text{, when}\end{array}\right\}m'=m.$$

5. $m'\breve{\bar{\bar{P}}}n'$, bev. basal edges of $m\breve{\bar{\bar{P}}}'n$, when $n'=m$.
6. $m\bar{P}n$ repl. macrod. A. of $m'\bar{P}n'$ by 4 pl.; I-E. par. to brachyd. E., when $m'=m$.
7. $m\breve{P}n$ repl. macrod. A. of $m'\breve{P}n'$ by 4 pl.; I-E. par. to brachyd. E. when $\frac{m'}{n'}=\frac{m}{n}$.
6. $m\breve{P}n$ repl. brachyd. A. of $m'\breve{P}n'$ by 4 pl.; I-E. par. to macrod. E., when $m'=m$.
9. $m\bar{P}n$ repl. brachyd. A. of $m'\bar{P}'n$ by 4 pl.; I-E. par. to macrod. edge, when $\frac{m'}{n'}=\frac{m}{n}$.

10. $m\breve{\bar{\bar{P}}}n$ bevels terminal edge of $m'\breve{\bar{\bar{P}}}$, when $m'=\frac{m}{n}$.

11. $m'\breve{\bar{P}}n'$ repl. by 4 pl., lat. A. of $m\bar{\breve{\bar{P}}}n$; I-E. par. to term. E., when $\frac{m'}{n'}=m$.
12. $m'\breve{P}n'$ bev. macrod. E.; $m'\bar{P}n'$, bev. brachyd. E.; when $m'=m$.
13. $m'Pn'$ repl. lat. angle; I-E. par. to term-edge of mP, when $\frac{m'}{n'}=m$.
14. $m'\bar{P}\infty$ trunc. brachyd.; $m'\breve{P}\infty$ trunc. macrod. term. E.; when $m'=m$.

When a form $m''Pn''$ forms parallel intersections with

$m\breve{\bar{\bar{P}}}n$ and $m'\breve{\bar{\bar{P}}}n'$; $m''n''(m'n-mn')+m''(m-m')nn'+n''(n'-n)mm'=0$.

$m\breve{\bar{\bar{P}}}n$ and $m'\bar{\bar{\bar{P}}}n'$; $m''n''(m'-mn')n+r''m''(m-m'n)n'+n''r''(n'n-1)m'm=0$.

mP and $m'\breve{\bar{\bar{P}}}n'$; $m''n''(m'-mn')+m''(m-m')n'+n''(n'-1)mm'=0$.
mP and $\infty Pn'$; $m''(n''-n')+n''(n'-1)m=0$.

mP and $m'\breve{\bar{\bar{P}}}\infty$; $m''(m-m')+n''(m'-m'')m=0$.
mP and $\infty P\infty$; $mn''-m''=0$.

∞P and $m'\breve{\bar{\bar{P}}}n'$; $m''(n''-1)n'-n''(n'-1)m'=0$.

∞P and $m'\breve{\bar{\bar{P}}}\infty$; $m''(n''-1)-m'n''=0$.

80. The following are other general laws for the combination of forms:

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

b. 1. $m'\breve{\bar{P}}n'$ repl. I-E of ∞P and $m\breve{\bar{P}}\infty$, when $n'=\frac{m'}{m'-m}$

2. " trunc. I-E. of mP and $\infty\breve{\bar{P}}\infty$, $m'=mn'$

3. " bev. longer or shorter term. E. of mP, $m'=m$

4. " repl. I-E. of $m\breve{\bar{P}}n$ and $\infty\breve{\bar{P}}\infty$, $\frac{m'}{n'}=\frac{m}{n}$

c. Forms having horizontal intersections have $n'=n$

V. HEXAGONAL SYSTEM.

81. In the hexagonal system there are three lateral axes intersecting at 60°. The form mPn completed is a double twelve-sided pyramid or berylloid, (fig. 126); mP and $mP2$ are double six-sided pyramids or quartzoids, (like fig 124 in form), the series $mP2$ intermediate to the series mP: ∞P and $\infty P2$ are hexagonal prisms, respectively corresponding to the pyramids. ∞Pn, except when $n=2$, represents twelve-sided prisms. mR $(=\frac{mP}{2})$ stands for rhombohedrons, (R, fig. 107, and other rhombohedrons of the same series); and $-mR$ for an intermediate series, (e, figs. 119, 120, and a′, figs. 121, 122). The form in figure 116 (a scalenohedron) is a hemihedral form in the hexagonal system, with the general sign $\pm\frac{mPn}{2}$, and the planes e′, fig. 117, and o, figure 118, if extended to the completion of a form, would produce other similar solids. Designated with reference to the axes 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 $\frac{mPn}{2}$ 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

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

mR^{∞} is the corresponding expression for the hexagonal prism (otherwise $\infty P2$) in the series mR^n, or it is a scalenohedron with an infinite axis. Planes like o, figure 7, under Quartz, have the symbol $\frac{l}{r}\frac{mPn}{4}$ or $\frac{r}{l}\frac{mPn}{4}$ $(\text{or}\frac{m'R^{n'}}{2})$, $\frac{l}{r}$ or $\frac{r}{l}$ being used according as the planes are to the left or right above.

1. *Inclinations between planes of different forms.*

82. The formula for mPn on $m'Pn'$, is as follows—making

$$M=\sqrt{(4m^2a^2(n^2-n+1)+3n^2)} \text{ and } M'=\sqrt{(4m'^2a^2(n'^2-n'+1)+3n'^2)}.$$

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

83. The table below contains the same for more simple cases:—

	$0P$	∞Pn	$mP2$
$m'Pn'$	$\frac{n'\sqrt{3}}{M'}$	$\frac{m'a(2nn'-n-n'+2)}{M'\sqrt{(n^2-n+1)}}$	$\frac{n'(mm'a^2+1)\sqrt{3}}{M'\sqrt{(m^2a^2+1)}}$
$m'P2$	$\frac{1}{\sqrt{(m'^2a^2+1)}}$	$\frac{m'an\sqrt{3}}{\sqrt{(m'^2a^2+1)}\sqrt{(n^2-n+1)}}$	$\frac{mm'a^2+1}{\sqrt{(m'^2a^2+1)}\sqrt{(m^2a^2+1)}}$
$\infty Pn'$	0	$\frac{2nn'-n-n'+2}{2\sqrt{(n'^2-n'+1)}\sqrt{(n^2-n+1)}}$	

84. The formulas for the rhombohedral forms vary, as the forms are of like or unlike signs. In the following, we make

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

85. The cosine of the inclination of

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

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

86. These simplified, become for

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

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

$$mR^n \text{ on } m'P2=-\frac{(mnm'a^2\pm1)\sqrt{3}}{N\sqrt{(m'^2a^2+1)}}.$$

87. Also when the forms are both above or both below the horizontal axes,

$$\text{Cos of } \frac{mPn}{2} \text{ on } \frac{m'Pn'}{2}=-\frac{2mm'a^2(2nn'-n-n'+2)+3nn'}{M\,M'}.$$

$$\frac{mPn}{2} \text{ on } -\frac{m'Pn'}{2}=-\frac{2mm'a^2(nn'+n+n'-2)-3nn'}{M\,M'}.$$

88. When one is above and the other below,

$$\text{Cos of } \frac{mPn}{2} \text{ on } \frac{m'Pn'}{2}=-\frac{2mm'a^2(nn'+n+n'-2)-3nn'}{M\,M'}.$$

$$\frac{mPn}{2} \text{ on } -\frac{m'Pn'}{2}=-\frac{2mm'a^2(nn'-n-n'+2)-3nn'}{M\,M'}.$$

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

89. For the form mPn (fig. 126) we have, for the inclinations between the planes,

$$\operatorname{Cos} \tfrac{1}{2}X=\frac{ma\,(2-n)}{M}. \qquad \operatorname{Cos} \tfrac{1}{2}Y=\frac{ma\,(n-1)\,\surd 3}{M}. \qquad \operatorname{Cos} \tfrac{1}{2}Z=\frac{n\surd 3}{M}.$$

90. *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,

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

b. For mP,

$$\operatorname{Tan} \tfrac{1}{2}X=\frac{\surd(m^2a^2+1)\,\surd 3}{ma}. \qquad \operatorname{Tan} \tfrac{1}{2}Z=2ma\surd\tfrac{1}{3}=\tan \tfrac{1}{2}U.$$

$$\operatorname{Tan} \tfrac{1}{2}T=\frac{ma\surd 3}{\surd(m^2a^2+3)}.$$

c. For $mP2$,

$$\operatorname{Tan} \tfrac{1}{2}Y=\frac{\surd(3m^2a^2+4)}{ma}. \qquad \operatorname{Tan} \tfrac{1}{2}Z=ma=\tan \tfrac{1}{2}T.$$

$$\operatorname{Tan} \tfrac{1}{2}U=\frac{ma\surd 3}{\surd(m^2a^2+4)}.$$

d. For ∞Pn,

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

e. For $\frac{mPn}{2}$, (fig. 116),

$$\operatorname{Cos} \tfrac{1}{2}X=\frac{ma\surd 3}{M}. \qquad \operatorname{Cos} \tfrac{1}{2}Z=\frac{\surd(m^2a^2\,(2-n)^2)+3n^2}{M}.$$

For cos ½Y, the same formula as in mPn.

f. For $\pm\frac{mP}{2}$ or $\pm\, mR$,

$$\operatorname{Cos} X=\frac{2m^2a^2-3}{4m^2a^2+3}=-\cos Z. \qquad Y=180^\circ.$$

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

$$\operatorname{Cot} \alpha=2ma\surd\tfrac{1}{3}. \qquad \operatorname{Cot} \beta=ma\surd\tfrac{1}{3}.$$

g. For mR^n,

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

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

h. For ∞R^n,

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

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

91. *a*. mP (fig. 124). Term. edge trunc. by $m'P2$, when $m'=m$
2. Lat. A. repl. by $m'P2$; I-E. par. to term. E. (fig. 127), $m'=2m$
3. Basal A. trunc. by $\infty P2$; Basal E. by ∞P.

b. $mP2$ 1. Term. E. trunc. by $m'P$, $m'=\frac{3}{4}m$
2. Basal E. trunc. by $\infty P2$; Basal A. by ∞P.

c. ∞Pn	1. Edge Y trunc by ∞P: Edge X trunc. by $\infty P2$.	
d. mR^n (fig. 116).	1. Obtuse term. E. bev. by $m'R^{n'}$,	$m'(3n'+1)=m(3n+1)$
	2. Acute term. E. bev. by $mR^{n'}$,	$m'(3n'-1)=m(3n-1)$
	3. Basal edge bev. by $m'R^{n'}$,	$m'=m$
	4. Term. A. repl. by 6 pl. $m'R^{n'}$; I-E. horizontal,	$n'=n$
	5. Term. A. repl. by 6 pl. $m'R^{n'}$; I-E. par. to basal edges of mR^n,	$m'=m$
	6. Basal A. repl. by 2 pl. $m'R^{n'}$; I-E. horizontal,	$n'=n$
	7. Obtuse term. E. truc. by $m'R$,	$m'=\frac{1}{2}m(3n+1)$
	8. Term. A. repl. by 3 rbc. pl. $m'R$,	$m'=m$
	9. Acute Term. E. trunc. by $-m'R$,	$m'=\frac{1}{2}m(3n-1)$
	10. Lat. A. repl. by $-m'R$; I-E. par. to obtuse Term. R,	$m'=\frac{1}{2}m(3n+1)$
	11. Basal A. repl. by $\infty R^{n'}$; I-E. horizontal,	$n'=n$
	12. Basal A. trunc. by ∞R: Basal E. trunc. by $\infty P2$.	
e. mR (fig. 107).	1. Lat. E. bev. by $m'R^{n'}$, (fig. 115),	$m'=m$
	2. Term. E. bev. by $m'R^{n'}$, (fig. 117),	$\frac{1}{2}m'(3n'-1)=m$
	3. Term. E. trunc. by $-m'R$, (fig. 119),	$m'=\frac{1}{2}m$
	4. Lat. A. repl. by $-m'R$; I-E. par. to incl. diagonal,	$m'=2m$
	5. Lat. A. repl. by 2 pl. $\infty R^{n'}$, (fig. 118).	
	6. Lat. A. trunc. by ∞R, (fig. 111).	
	7. Lat. E. trunc. by $\infty P2$, (fig. 109).	
	8. Lat. A. repl. by 2 pl. $m'R2$; I-E. par. to incl. diag.	$m'=\frac{4}{3}m$
f. $mP2$	1. Altern. term. E. bev. by $m'R^{n'}$,	$\frac{1}{2}m'(3n'+1)=m$
	2. Altern. term. E. trunc. by $m'R$,	$m'=\frac{1}{2}m$
	3. Lat. A. repl. by $m'R$; I-E. par. to Term. E,	$m'=\frac{3}{2}m$

92. *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 $m''P2$, 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 $m''P2$, $-m'R^{n'}$, mR^n,

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

e. If the planes are $m''R^{n''}$, $m'P2$, mR^n,

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

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

93. *a.* From the angles X, Y, Z of mPn,

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

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

b. From a prism ∞Pn,

$$\frac{n}{2-n}=\sqrt{\tfrac{1}{3}}\times\tan\tfrac{1}{2}X. \qquad \frac{n+1}{n-1}=\sqrt{3}\times\tan\tfrac{1}{2}Y.$$

c. From a pyramid *mP*,

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

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

d. From a pyramid *mP*2,

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

Z'' is the corresponding angle in the form *P*2.

e. From a scalenohedron $\frac{mPn}{2}$,

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

f. From a rhombohedron *mR*,

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

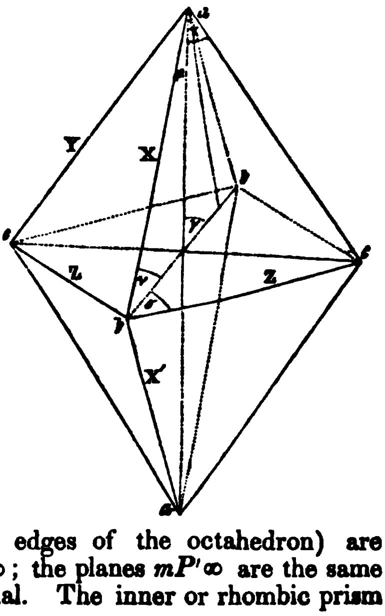
α and β are used as in page 59; and α' and β' are corresponding angles in *R*.

g. From a scalenohedron mR^n,

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

II. CLINOMETRIC SYSTEMS.

I. MONOCLINIC SYSTEM.



94. The annexed figure represents the form ±*P*, in the monoclinic system; *a*, *b*, *c*, are the axes. The inclination of *a* on *b* is oblique, and the angle is marked γ; *b* is the clinodiagonal, *c* the orthodiagonal. The upper faces in front are +*P*, the lower −*P*; and so with any forms *mP*, and also *mPn* and *mP*∞, they are relatively + and −, above and below the clinodiagonal. ±*mP*∞ is a form truncating the edge X above or *X'* below, and ∞*P*∞ 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 *mP'n*, *mP'*∞, ∞*P'*∞; the planes *mP'*∞ are the same above and below the orthodiagonal. The inner or rhombic prism

in fig. 92 is described by the expression $0P$, ∞P; and the outer prism by $0P$, $\infty P\infty$, $\infty P'\infty$; figure 96, by $0P$, ∞P, $+mP\infty$; figure 97 by $0P$, ∞P, $-mP\infty$; figure 98 by $0P$, ∞P, $mP'\infty$; figure 100 by $0P$, ∞P, $\infty P'\infty$, ∞Pn; figure 101 by $0P$, ∞P, $+mP$; figure 95 by $0P$, $\infty P\infty$, $\infty P'\infty, mP'\infty$.

95. The plane P of the preceding figure is inclined to each of the three axial planes or sections. Let the inclination 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 $-P$ 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, Edge X' on a by μ',
X on b ν, X' on b ν',
Y on a π, Z on b σ.

96. Then,

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

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

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

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

$$\text{Tan}\,X=\frac{\tan\sigma}{\sin(\gamma+\mu)}=\frac{\tan\pi}{\sin\mu}. \qquad \text{Tan}\,X'=\frac{\tan\sigma}{(\sin\gamma-\mu')}=\frac{\tan\pi}{\sin\mu'}.$$

$$\text{Tan}\,Y=\frac{\tan\mu}{\sin\pi}. \qquad \text{Tan}\,Y'=\frac{\tan\mu'}{\sin\pi}.$$

$$\text{Tan}\,Z=\frac{\tan(\gamma+\mu)}{\sin\sigma}. \qquad \text{Tan}\,Z'=\frac{\tan(\gamma-\mu')}{\sin\sigma}.$$

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

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

$$\text{Tan}\left\{\begin{matrix}\mu\\\mu'\end{matrix}\right.=\frac{b\sin\gamma}{a\mp b\cos\gamma}. \qquad \text{Tan}\left\{\begin{matrix}\nu\\\nu'\end{matrix}\right.=\frac{a\sin\gamma}{b\mp a\cos\gamma}.$$

$$\text{Tan}\,\pi=\frac{c}{a}. \qquad \text{Tan}\,\sigma=\frac{c}{b}.$$

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

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

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

99. *a.* In ∞P,

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

b. In $\pm P\infty$,

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

c. In $P'\infty$,

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

$$\text{Tan } \begin{matrix}Y\\ Y'\end{matrix}=\mp\frac{\tan\gamma\sqrt{(a^2+c^2)}}{c}.$$

By writing *ma* for *a* these formulas apply to $\pm mP\infty$ and $mP'\infty$.

d. The equation for Z in the prism ∞P gives the inclination of the face of an oblique rhombic prism on its lateral faces, that is of $0P$ on ∞P, or any ∞Pn. The same angle may be obtained by the equations—putting Π for the angle,

$$\text{Cos } \Pi=\cos\gamma \sin X. \quad \text{Sin } \Pi=\frac{\cos\sigma}{\cos X}.$$

The angle X here is the angle of that name in the prism ∞Pn, whose inclination on $0P$ is desired.

Determination of the lengths of the axes.

100. Besides the formulas already given, the following relations of the axes are convenient:—$a : b : c=$

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

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

Also for determining the angle γ,

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

Rules for determining the signs of planes.

101. The following are the more important rules for determining by inspection the signs of planes:

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 clinodiagonal, 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 pertaining 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 $\pm mP'n$ belong to $\pm\frac{m}{n}P\infty$, or $\pm\frac{m}{n}Pn'$.

3. Rbc. pl. repl. clinod. A. of intersection of $\pm mP$ and ∞P, is $\pm 2mP\infty$.

4. Plane trunc. E. between $+mP$ or $-mP$ and ∞P inclined to different poles, is $2mP'\infty$.

5. Plane trunc. E. between $+mP$ or $-mP$ and the pairs of faces $\infty P\infty$ or $\infty P'\infty$, is $\pm mnPn$ or $\pm mnP'n$. Hence, planes whose I-E. with P are par. to clinod. or orthod. E. have the sign $m'P'm'$ or $m'Pm'$.

6. Plane repl. E. between $\pm mP\infty$ or $mP'\infty$ and ∞P, is $\pm m'P\frac{m'}{m'-m}$ or $m'P'\frac{m'}{m'-m}$.

7. Plane $m''P$, truncating I-E. of $\pm mP\infty$ and $m'P'\infty$ is $\frac{mm'}{m+m'}P$. When $m''=1$, $m'=\frac{m}{m-1}$; when $m'=1$, $m''=\frac{m}{m+1}$; when $m=1$, $m''=\frac{m'}{m'+1}$; when $m'=m$, $m''=\frac{m}{2}$. Each form $m''Pn''$ replacing same E. has $m''=\frac{n''m'm}{m+n''m'}$.

8. If a plane $m'Pn'$ forms with $m''P\infty$ an I-E. par. to the I-E. of $m''P\infty$ with the opposite $mP'\infty$; or if $m'P'n'$ forms with $m''P'\infty$ an I-E. par. to the I-E. of $m''P'\infty$ with the opposite $mP\infty$; then $m'=\frac{m''mn'}{mn'-m''}$; $m''=\frac{mm'n'}{mn'+m'}$; $m=\frac{m''m'}{m'n'-m''n'}$.

If $n'=1$, as in $m'P$, $m'=\frac{m''m}{m-m''}$; $m''=\frac{mm'}{m+m'}$; $m=\frac{m''m'}{m'-m''}$.

If $n'=m'$, as in $m'Pm'$, or $m'P'm'$, $m'=\frac{m''(m+1)}{n}$; $m''=\frac{mm'}{m+1}$; $m=\frac{m}{m'-m''}$.

If $m''=m$ in $m''P\infty$ and $mP\infty$, or in $m''P'\infty$ and $mP\infty$, $m'=\frac{m''n'}{n'-1}$, $m''=m=\frac{m'n'-m'}{n'}$.

II. TRICLINIC SYSTEM.

102. All the axial intersections in this system are oblique. As in the trimetric system, the larger lateral axis and the axial section corresponding is called the *macrodiagonal*, the shorter the *brachydiagonal*. The fundamental octahedron has only opposite faces similar, and is designated by the expression $\pm{}_{,}P_{,,}$ and its front planes severally $+P_{,,}$ $+{}_{,}P$, $-P_{,,}$ $-{}_{,}P$, the position of the accent marking the situation of the face P to the right or left. The planes mP and mPn are expressed by using with P the accent of the face towards which the plane inclines; and their parallelism or inclination to the macrodiagonal or brachydiagonal is distinguished by the marks — or ‿ over the P; as $m_{,}\bar{P}n$, $m\breve{P}_{,}n$. The replacement of the vertical angles by a plane parallel with the horizontal axial section, has the sign $0P$, as in other systems; and the corresponding replacements of the basal angles, are $\infty\bar{P}\infty$ and $\infty\breve{P}\infty$.

Determination of the interfacial angles of triclinic forms.

103. *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, X on b by ν,
Y on a by π, Y on c by ρ,
Z on b by σ, Z on c by 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:

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

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

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

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

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

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

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

104. The three sections, the macrodiagonal, brachydiagonal, and basal, divide the fundamental octahedrons 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. $\text{Tan } \tfrac{1}{2}(X+Y) = \cot \tfrac{1}{2}A \, \dfrac{\cos \frac{1}{2}(\pi-\mu)}{\cos \frac{1}{2}(\pi+\mu)}.$

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

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:

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

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

3. For Y and Z, from C, ϱ and τ,

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

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

105. 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,

$$\cos Z=\frac{\cos B}{\sin\psi}\sin(X-\psi),$$

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

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

$$\cot\psi=\cos\nu\tan\beta,$$

$$\text{or}\ \cot\psi=\cos\varrho\tan C.$$

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

106. 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, are obtuse, the cosine becomes minus:

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

$$\text{Tan}\ \varpi=\frac{c\sin\beta}{a-c\cos\beta},\quad \tan\varrho=\frac{a\sin\beta}{c-a\cos\beta},$$

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

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

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

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

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

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.

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

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

and consequently,

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

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

$$\text{Sin } \varpi = \frac{\sin \mu \sin X}{\sin Y}.$$

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

109. *a. Interfacial angles of the vertical hemiprism.* The angles σ and τ are first to be found from the values of b, c, and a, 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;
$C+Y+Z=180°$.

Determination of the dimensions of forms.

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

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

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

$$b : c :: \sin Y \sin \beta : \sin X \sin \gamma.$$

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

$$a : c :: \sin Z \sin \alpha : \sin X \sin \gamma.$$

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

$$a : b :: \sin Z \sin \alpha : \sin Y \sin \beta.$$

111. 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,

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

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

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

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

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

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

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

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

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

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

Determination of the dimensions of forms.

112. The following general rules are obvious deductions from the principles heretofore explained:

If two planes form, by their intersection, an edge parallel to the

1. basal section, $b : c :: b' : c'$,
2. macrodiagonal section, $a : b :: a' : b'$,
3. brachydiagonal section, $a : c :: a' : c'$.

The formulas and rules deduced for the trimetric and monoclinic forms, will be found of essential importance, also, in this system of crystallization. From § 101, 3, it results, that when a face replacing the angle between $mP_{,,}$, $m_{,}P$, $\infty P_{,,}$ and $\infty_{,}$P, has a rhomboidal form, its sign is of the form $2mP_{,}\infty$. Other laws are derived with equal facility from the remaining paragraphs in the same section.[*]

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[*] This subject ma y be closed by three examples of the mode of calculation.

Example 1. *Iron Pyrites.* (See figure 1 under Pyrites).—The several forms contained in this crystal are the following:

P$=\infty O\infty$, fig. 1, plate 1. a$=O$, fig. 2. a$'=m''Om''$, fig. 14.

o$''=\frac{[mOn]}{2}$. o$'=\frac{[m'On']}{2}$. e$'=\frac{[\infty On']}{2}$. e$''=\frac{[\infty On'']}{2}$.

By measuring e′ on P and substracting 90° from the angle, we obtain the angle e′ on e′ over P, which equals ν; and hence from § 63, 4, since $n=\tan\nu$, we find e$'=\infty O2$. e′ ($\infty O2$) truncates the edge o″ : o″, that is, the longest edge of the parallel hemi-hexoctahedron o″; therefore, (§ 62, *i*, 5,) $n'=n=2$ and $\frac{[mOn]}{2}=\frac{[mO2]}{2}$. But o″ makes parallel intersections with e′ and a′ and consequently by means of the general equation, § 58, for the parameter of a plane forming parallel intersections with two others, we find o$''=\frac{[4O2]}{2}$.

In the same manner also, it is found that a$'=2O2$, (§ 62, *i*, 8).

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*, (fig. 49); and therefore (§ 62, *i*, 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$=O$, e$'=\infty O2$, 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 $\frac{[3O\frac{3}{2}]}{2}$. Also from § 62, *i*, 5, e$''=\frac{[\infty O\frac{3}{2}]}{2}$.

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$''=\frac{[\infty O\frac{3}{2}]}{2}$. Consequently, (§ 62, *i*, 5), o$''=\frac{[3O\frac{3}{2}]}{2}$.

The expression for the crystal is, therefore,

$$\infty O\infty.\ \ \frac{[3O\frac{3}{2}]}{2}\ \ \frac{[4O2]}{2}\ \ \frac{[\infty O2]}{2}\ \ \frac{[\infty O\frac{3}{2}]}{2}.\ \ O.\ \ 2O2.$$

Example 2. *Columbite.* (See fig. 2, under Columbite).—In this figure we may select 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 $P=0P$; $\bar{M}=\infty\bar{P}\infty$; $\breve{M}=\infty\breve{P}\infty$; and since the edge a : e is horizontal, as seen in the crystal, $e=\infty P$.

The angle $\breve{M}$: $\breve{e}=156°\ 6'$, and therefore $\frac{1}{2}X$ in the prism $\breve{e}$ ($\infty\breve{P}n$)$=68°\ 6'$. Half the same angle in the prism e (∞P)$=39°\ 40'$: hence (§ 78, *a*) $n=3$ and $\breve{e}=\infty\breve{P}3$.

Since ŏ′, ŏ′, bevel the longer terminal edge of a (P), they have the general sign $\breve{P}n$, (§ 80, *b*, 3), and because also ŏ′ forms parallel intersections with $\breve{e}$ ($\infty\breve{P}3$) and $P(0P)$, ŏ$'=\breve{P}3$, (§ 80, *c*).

ē truncates the brachyd. terminal edge of the pyramid ŏ′ ($\breve{P}3$), and consequently ē$=\frac{1}{3}\bar{P}\infty$, (§ 80, *a*, 2).

The planes ŏ″ ($m\breve{P}n$) replace the edge ŏ′ : $\breve{M}$, and therefore, (§ 80, *b*, 4), since ŏ$'=\breve{P}3$, $\frac{m}{n}=\frac{1}{3}$. But by measurement of the interfacial angle $\breve{M}$: ĕ we find it to equal 150° 20′; and hence since (§ 75, *d*), $\tan\frac{1}{2}Z$ in the prism ĕ ($m\breve{P}\infty$)$=m\frac{a}{b}$, we deduce, that ĕ$=$

III. CLEAVAGE.

113. It is a fact of common observation, that the mineral called mica, (sometimes, improperly, insinglass), is easily split into thin transparent plates or laminæ. This is often effected with but little

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$2\breve{P}\infty$. Now $\breve{o}$ truncates the macrod. terminal edge of the pyramid $\breve{o}'$, and consequently, $\breve{o}''=2\breve{P}n$; and since $\frac{m}{n}=\frac{1}{3}$, $n=6$ and $\breve{o}''=2\breve{P}6$.

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, (§ 78, *a*) $\bar{e}=\infty\bar{P}2$.

The expression thus deduced for the crystal is as follows:

$$0P.\ \tfrac{1}{2}\bar{P}\infty.\ P.\ \breve{P}3.\ 2\breve{P}6.\ 2\breve{P}\infty.\ \infty\bar{P}\infty.\ \infty\bar{P}2.\ \infty P.\ \infty\breve{P}3.\ \infty\breve{P}\infty.$$

By substituting the values of the axes in the different forms for *a*, *b*, *c*, in the equations § 74, 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 $\breve{P}3$ ($\breve{o}'$) 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 $2\breve{P}6$ ($\breve{o}''$) may be obtained.

Example 8. *Monazite.* (See fig. 8, under Monazite).—Assuming ė as a face of the fundamental form, $\bar{e}=\infty P\infty$, $\breve{e}=\infty P'\infty$. The general descriptive expressions for the remaining planes are as follow:

$\bar{a}=mP\infty$ $\quad a=mP'\infty$ $\quad a'=m'P'\infty$ $\quad \breve{e}'=\infty P'n$

$\breve{a}=-mP\infty$ $\quad \check{e}=-mP$ $\quad o'=m'P'n$ $\quad M=\infty Pn$

The plane *a* ($mP'\infty$) forms parallel intersections with ė and ě, which intersections, since they are parallel with the edge ė : $\bar{e}$ ($\infty P\infty$) are also parallel with the orthodiagonal edge of ė (*P*). Hence,

$$\check{e}=-P\ (\S\ 101,\ 1,\ b),\text{ and } a=P'\infty\ \ (\S\ 101,\ 1,\ b);$$

and also since *M* forms parallel intersections with ė and ě,

$$M=\infty P\ (\S\ 101,\ 1,\ a).$$

$\bar{a}$ truncates the edge between ė and ě, which is the clinodiagonal edge of *P*, and therefore,

$$\bar{a}=P\infty\ (\S\ 101,\ 2).$$

$\breve{a}$ in the same manner truncates the clinodiagonal edge of —*P*. Consequently,

$$\breve{a}=-P\infty.\ \ (\S\ 101,\ 2).$$

The intersection of *o′* ($mP'n$) with ė (*P*) is parallel to the clinodiagonal edge of *P*, consequently $n=m$ (§ 101, 5), and $o'=mP'm$. Again *o′* forms parallel intersections with *a* ($P'\infty$) and *M* (∞P), and therefore its sign is of the general form $mP'\frac{m}{m-1}$, (§ 101, 6). But from the above, $n=m$, and consequently $n=\frac{m}{m-1}$; from which we find $m=2$, and,

$$o'=2P'2.$$

The edge $o' : a'$ ($m'P'\infty$) is parallel to the orthodiagonal edge of *o′* ($2P'2$,) consequently $m=2$ (§ 101, 1, *b*), and

$$a'=2P'\infty.$$

The intersection of *o′* ($2P'2$) with $\breve{e}'$ ($\infty P'n'$) is parallel to the basal section of $2P'2$, (apparent in the crystal, though not in the figure, a perspective representation of it); hence $n'=2$ (§ 101, 1, *a*), and

$$\breve{e}'=\infty P'2.$$

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 more difficulty than separating the leaves of a book, and at once suggests the idea, that, like a book, this mineral may be composed

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be necessary first to determine ĕ' by measuring the interfacial angles M : ĕ and ĕ' : ĕ; these angles 136° 35' and 117° 51' diminished by 90° give the angles X in the two forms M (∞P) and ĕ' ($\infty P'n'$); and then, since tan 46° 35' = 2 tan 27° 51', it follows that $n'=2$ and ĕ' = $\infty P'2$. Thence since the intersection of o' with ĕ' is parallel to the basal section of o', ($mP'm$), $o'=2P'2$ (§ 101, 1, *a*) as before found. The same might have been similarly determined by measuring the inclination of P on a and a'.

For the calculation of the dimensions and angles of the crystal we have as data, $\infty P\infty : P\infty = 140° 40'$, $\infty P\infty : -P\infty = 126° 8'$, $\infty P\infty : \infty P = 136° 35'$.

$$180°-140° 40' = 39° 20' = \mu',$$
$$180°-126° 8' = 53° 52' = \mu,$$
$$136° 35'-90° = 46° 35' = X \text{ in } \infty P.$$

Since $P\infty$ and $-P\infty$ are coördinate forms, we may determine γ by the equation, $\tan\gamma = \frac{2\sin\mu\sin\mu'}{\sin(\mu-\mu')}$, whence we obtain

$$\gamma = 76° 14' = C.$$

To determine the axes there are given the angles γ, μ, and X in the form ∞P. If $b=1$, $\tan X \sin\gamma = c$ (§ 99, *a*); consequently,

$$c = 1{\cdot}0265.$$

$$\text{Again } a = \frac{\sin(\gamma+\mu)}{\sin\mu} = \frac{\sin 49° 54'}{\sin 53° 52''};$$

therefore,

$$a = {\cdot}9471.$$

Hence,

$$a : b : c = {\cdot}9471 : 1 : 1{\cdot}0265.$$

After thus determining the axes, the angles X, Y, Z, in the various forms, are readily obtained by the equations, p. 62. For example, with regard to the form $\pm P$, 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 ō : ŏ. 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 ĕ on ō and ĕ on ŏ. Again, by the equations, $\tan Z = \frac{\tan(\gamma-\mu')}{\sin\sigma}$, $\tan Z' = \frac{\tan(\gamma-\mu)}{\sin\sigma}$, ($\sigma$ being found by the equation $\sin\sigma = \frac{c}{b}$), we find the angles Z, Z', which are the supplements of ĕ on ō and ĕ on ŏ. $Y+Y'$ = the inclination of ō on ŏ over an orthodiagonal terminal edge, and $Z+Z'$ = the inclination of ō on ŏ over a basal edge of the form $\pm P$.

In the form $2P'2$, whose axes have the ratio $2a$, $2b$, c, the angle μ is identical with the corresponding angle in P. 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 ∞P, $\tan \left\{ \begin{matrix} Z \\ Z' \end{matrix} \right. = \mp \frac{\tan\gamma\sqrt{(b^2+c^2)}}{c}$, (§99, *a*) which affords the supplement of the desired inclination; or by the equation, (§ 99, *d*), $\sin\Pi$ (the sought angle) $= \frac{\cos X}{\cos\sigma}$, or $\cos\Pi = \sin X \cos\gamma$, in which X is the angle X in the form M (∞P). The interfacial angle a : ĕ is determined by the equation for $\tan Y$ in $P'\infty$.

In a similar manner the angles of the other forms may be obtained.

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*. Calcareous 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 sometimes effectual with quartz. In many instances, cleavage cannot be effected 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.*

114. 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.*

Cleavage may take place as follows:—

a. Parallel to all the faces of a fundamental form, and alike in each direction.

b. Parallel to but two faces of a fundamental form, and alike in each direction.

c. Parallel to but one face of a fundamental form.

d. Parallel to two or three faces, and unlike in the three directions.

e. Parallel to vertical diagonal planes; and if these planes are unequal, parallel either to the longer or shorter diagonal, (*macrodiagonal* or *brachydiagonal*).

f. Parallel to a diagonal plane oblique between opposite solid angles, in one or more directions.

g. Parallel to other secondary planes.

115. According to the law 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 diagonal 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 are at right angles with the third.

116. Cleavage is said to be *basal* when in a form it is parallel to the base, $(0P)$; and *lateral*, when parallel to the lateral planes. ***Prismatic***, when parallel to the lateral planes ∞P, (M of a rhombic prism). ***Diagonal***, in a rhombic prism, when vertical and parallel to the planes $\infty P\infty$. 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.

In some cases, rhombohedrons have a cleavage parallel to a plane truncating the vertical angle; cleavage is then 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.

117. 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.

118. The varieties of cleavage in connection with the actual forms of crystallization lead to the conclusion that there are at least *thirteen fundamental forms* among crystals, as stated on page 25. The three forms, the cube, the regular octahedron, and the dodecahedron, belong to one system, the monometric. But in some cases the cleavage is *cubic*, in others *octahedral*, and in others *dodecahedral*. Hence it is naturally inferred that each may properly be considered a fundamental form. So there are dimetric crystals with cleavage that affords a square prism, and others with cleavage that yields a square octahedron. The same reasoning applies to all the forms mentioned on pages 23, 24. These, therefore are justly styled the *fundamental forms* in crystallography; for cleavage is the proper basis of evidence on this point.

In most cases, the mineralogist needs seek to ascertain only the system of crystallization, which is of more certain knowledge.

IV. IRREGULARITIES OF CRYSTALS.

119. The laws of crystallization, when unmodified by external causes, produce forms of exact symmetry; the angles are not only equal, but also the polygonal faces of crystals and their 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.

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.*

120. 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. 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, (fig. 25, p. 80), 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, (fig. 43 and 44, pl. 1), the most common secondary of pyrites; and they have evidently resulted from an oscillation between the primary and this secondary.

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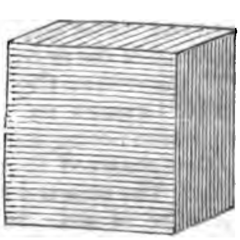

Iron Pyrites.

Diagonal striæ sometimes occur on the faces of a cube showing an oscillatory combination between the

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[*] Many of the following facts, with the general arrangement of them, are extracted from Naumann's work on Crystallography.

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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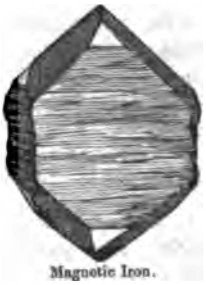

Magnetic Iron.

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 *a* and *e*, (figures 2 and 3 under *Tourmaline*).

121. It is obvious that the irregularities described must sometimes 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.

122. 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. Angular markings are also often observed, as on quartz crystals, beryls, &c., indicating the internal structure of the crystal.

2. *Cavernous Crystals.*

123. 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 enlonged cube with its upper edges replaced by faces of the

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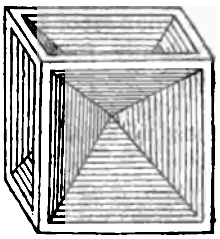

Common Salt.

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.

3. *Curved Surfaces.*

124. 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. (See fig. 20, page 79, and fig. 1, 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 in figure 2 of *spathic iron*. The saddle shaped crystals of the same mineral (fig. 1) 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.*

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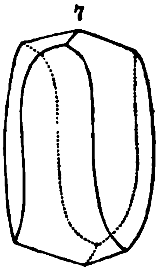

The surfaces of crystals are sometimes rounded, in consequence of having been partially fused, or dissolved. The globular quartz of St. Lawrence Co., N. Y., is supposed by Prof. Emmons to have been thus rounded.

II. VARIATIONS IN THE FORMS AND DIMENSIONS OF CRYSTALS.

125. 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.

126. *Monometric System.*—A *cube* (figure 1, plate 1) lengthened or shortened along one axis, becomes a right square prism, (figure

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* Figure 6, under quartz, is a *left-handed* crystal, as is apparent from the relative situation of the planes *o* and *a*.

50, plate 1); and if varied in the direction of two axes is changed to a rectangular prism, (figure 69, plate 2). 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.

An octahedron *flattened* parallel to a face is reduced to a tabular crystal, (fig. 8). If *lengthened* in the same direction, it takes the form in figure 9; or if still further lengthened to the obliteration of A′, it becomes an acute rhombohedron, (same figure).

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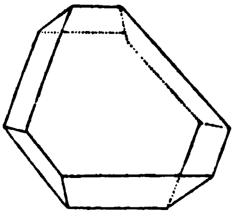

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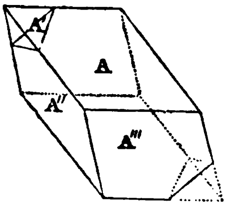

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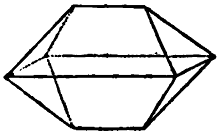
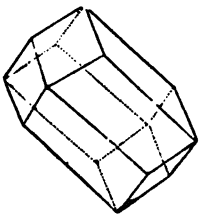


When an octahedron is extended in the direction of a line between two opposite edges, it has the general form of a rectangular octahedron; and still further extended, as in figure 10, it is changed to a rhombic prism with dihedral summits. The figure represents this prism lying on its acute edge, (spinel, fluor, magnetic iron).

11



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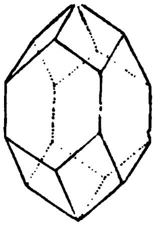

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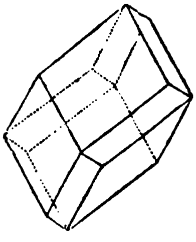

The ***dodecahedron*** lengthened along a diagonal between the obtuse solid angles, becomes a six-sided prism with three-sided summits, as in figure 11; and shortened in the same direction, is a ***short*** prism of the same kind, (fig. 13). Both resemble secondaries to a rhombohedron, and are common in garnet and zinc blende. When lengthened in the direction of one of the crystallographic axes, it becomes a square prism with pyramidal summits, (fig. 12), and shortened along the same axis it is reduced to a square octahedron with truncated basal angles, (figure 14).

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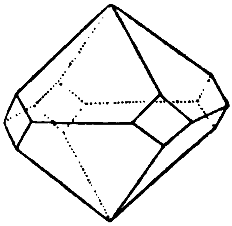

The trapezohedron is still more disguised by its distortions. When elongated in the line of an octahedral axis it assumes the orm in figure 15, and still farther lengthened, to the obliteration of ome of the planes, becomes a scalene dodecahedron, (fig. 16). This has been observed in fluor spar. If the elongation takes place along a crystallographic axis, it changes to a double eight-sided pyramid with four-sided summits, (fig. 17); or if these summit planes are obliterated by a farther extension, it becomes a complete eight-sided double pyramid, (figure 18).

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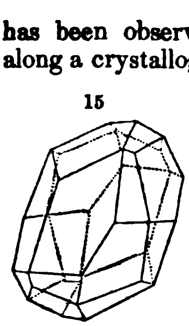

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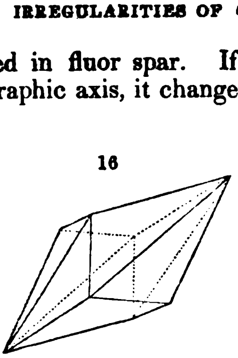

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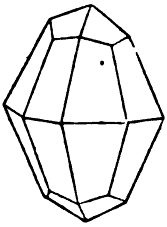

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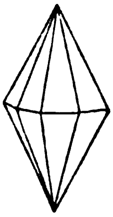
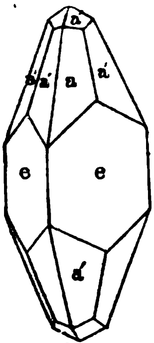


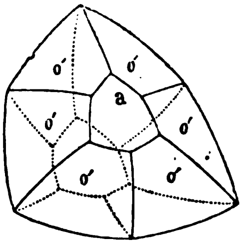
Still more complex forms are of occasional occurrence among monometric crystals, especially when modified by secondary planes. Figure 19 represents a garnet from Monzoniberg; it is a combination of the dodecahedron and trapezohedron; but the crystal is so altered by distortion, that only *four* dodecahedral faces (e) remain and *sixteen* of the trapezohedral, (a′); and the latter are of very unequal size. Figure 20 is a distorted form 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, (see fig. 25, plate 1). Figure 21 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.

19



Garnet.

20



Diamond.

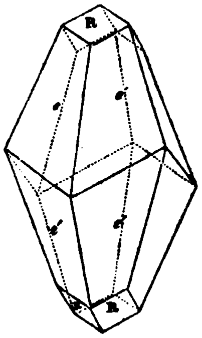
21

Galena.

127. The annexed figure of calcite (fig. 22) represents a scalene

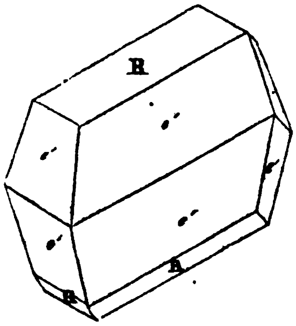
dodecahedron, with its apices replaced by planes of the primary rhombohedron.

22



Calcite.

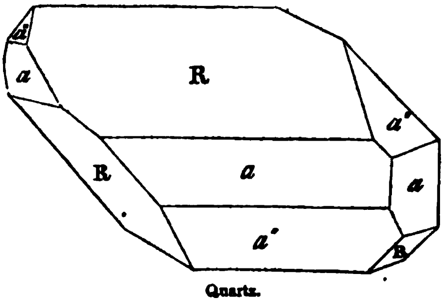
23



Calcite.

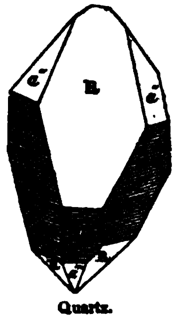
A distorted form of the same from Rossie is shown in figure 23, which appears, however, to be an eight-sided prism, bounded laterally by the planes R, e', e', and R, and their opposites, and terminated by the remaining planes of figure 22. The annexed figures of quartz, (fig. 24 and 25,) represent distorted 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.

24



Quartz.

25

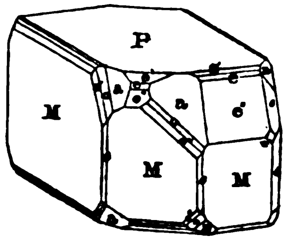


Quartz.

Figure 4 and 5 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 if an angle of this size is made out, the edge corresponding may be set down as one of the lateral edges of the prism. Thus with the goniometer, and the principle that like planes are like in surface, and noting also the cleavage, if any exists, we may develop the whole character of a crystal, however much disguised.

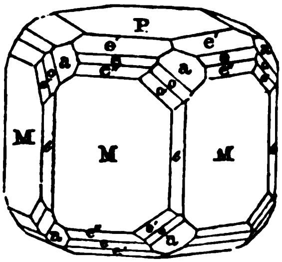
Figure 26 of apatite is the same form that is represented in figure 27, but greatly distorted. The planes e′ e, e″, between P and the right M, are enlarged, while the corresponding planes below are in part obliterated. By observing that similar planes are lettered alike, the two figures may be compared throughout. Figure 28 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.

26



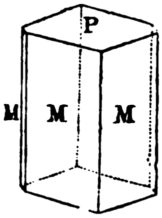
Apatite.

27



Apatite.

28

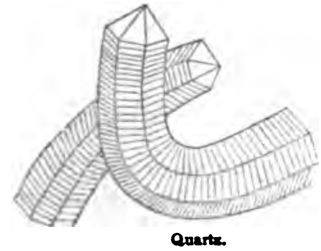


Beryl.

Curved Crystals.

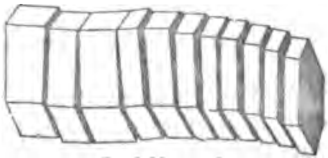
128. Curves in imbedded crystals are of frequent occurrence; and in implanted crystals they are not very uncommon. The annexed figure of quartz (fig. 29) illustrates this kind of distortion: the same is described by Beck as occurring in the apatite of St. Lawrence Co., N. Y. Six-sided prisms of calcite are occasionally curved in the same manner.

29



Quartz.

30

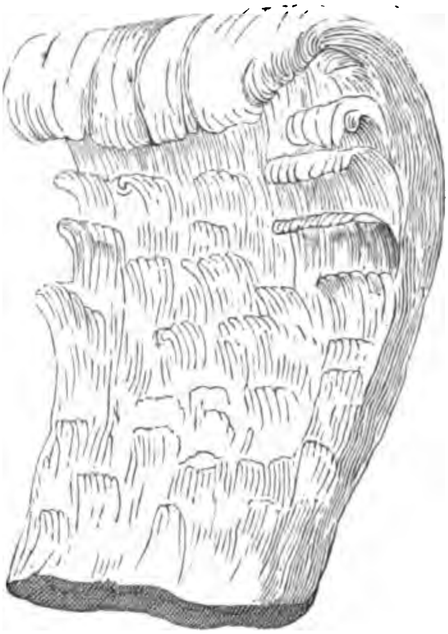


Beryl, Monroe, Ct.

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 figure 30.

129. Very singular curvatures are described by Herschel, (Phil. Mag. 1833, ii, 110), as occurring in crystalline plates of ice adhering to stems of plants. These plates were implanted longi-

81



Gypsum, Mammoth Cave.

tudinally on opposite sides of the stem, and curved so far around as nearly to encircle it. They had a fibrous look, like some varieties of gypsum. The author has observed similar crystallizations in the vicinity of New Haven. The plates were attached to a single side of the stem, and curving around, almost enclosed it like a cylinder. An instance of the same on a stone wall has been observed by Prof. Rigaud. The plates of ice were attached to the edges of the stones and curved away from the mortar. They were found only on a part of the wall recently built. Prof. Locke of Cincinnati, has described (American Jour. of Science, xlii, 206) similar crystallizations of alabaster (gypsum) from the mammoth cave of Kentucky. "Alabaster rosettes" occur 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.

III. INTERNAL IMPERFECTIONS AND IMPURITIES.

130. 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 matter collects 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 o′, (see fig. under Zircon). 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.

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. In this way transparent crystals sometimes have an exterior coating of an opaque white color. 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.

131. 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, prism 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 of the rest, some are of easy fusibility, others of difficult, and others infusible: so that at least five different substances were indicated.* 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.

IV. VARIATIONS IN THE ANGLES OF CRYSTALS.

132. The greater part of the distortions described, leave unaltered the interfacial angles of crystals. But those imperfections that produce convex, curving or striated faces, necessarily cause variations, as explained on pp. 76, 77. 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 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.

133. 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.

According to the measurements of calc spar by A. Baudrimont, the rhombs of this mineral seldom have the three angles at summit perfectly identical.

134. The variations of angle just alluded to, are of no constant character, and are therefore imperfections. A cube under some circumstances may have the angle 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

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* See further on this subject, Trans. Roy. Soc. of Edinburg, for 1823 and 1826; and Trans. Roy. Soc. London, 1847, xvi, 11; also Amer. Jour. Science, xii, 214, 1827, and [2] v, 420, 1848.

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.

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 MEASUREMENTS OF CRYSTALS.

135. Owing to the irregular variations of form in crystals, it is evident that the shape alone will seldom be sufficient to determine the system of crystallization. The indications giving important aid, may be briefly reviewed.

136. *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 farther evidence as to the system, as the principles already explained sufficiently elucidate.

137. *b. Lustre, Hardness, Color, Character of Surfaces.*—Like planes are like 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).

138. *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; and it is especially useful for the species of mica, whose external form is seldom well developed. Micas of the same form—a hexagonal prism—have thus been shown to belong to distinct systems, the hexagonal and trimetric.

139. *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.

140. *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 prisms 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.

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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.

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.

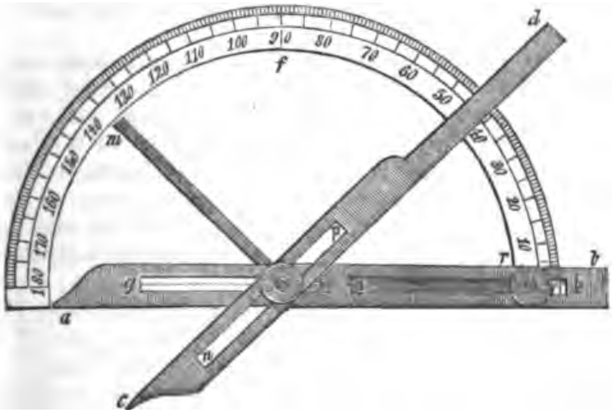
141. *f. Measurements of angles.*—The importance of this means of ascertaining the system of crystallization is obvious. As has been implied, (see pp. 76, 84), it may lead to erroneous deductions; but in most cases it enables us to correct conclusions drawn from other sources. It generally gives essential aid in carrying out the mode of discrimination last laid down.

USE OF GONIOMETERS.

142. The angles of crystals are measured by means of instruments called *Goniometers.*

143. *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 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 the 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 surfaces of the same. This should be determined by close examination, holding it at the same time up to the light and observ-

32



ing 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.

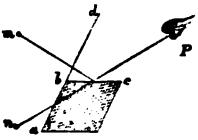
For measuring crystals partially imbedded, the arc is usually jointed at *f*, so that the part, *af*, may be folded back on the other quadrant. When the angle has been measured, the arms are secured in their place by the screw at *o*, and the arc restored to its former position, and there fastened by 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 chords or tangents, either of which is usually to be found in a box of mathematical instruments, or may be obtained separately at the shops: or it may be measured by applying the arms directly to the graduated arc.

The results obtained with a common goniometer are seldom within a quarter of a degree of truth. It is, however, sufficiently accurate for common use. For polished crystals, we have a much superior instrument in the *Reflective Goniometer* of Wollaston.

144. *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.

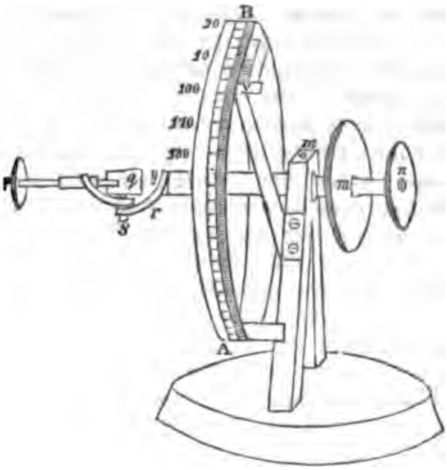
38



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^{c}, 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.

This object is conveniently accomplished by the ingenious and simple contrivance of Wollaston.

34



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 moveable 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 for the experiment. If the crystal is correctly adjusted, the selected bar 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 same bar is seen by reflection in the next face, and if here there is also a coincidence of the reflected bar 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.

145. *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 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.

146. *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 moveable glass reflects the sight-threads of the other glass: it is then turned around till the other face gives the same reflection. The arc through which the crystal is revolved, is then read off on the graduated circle.

147. *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.

148. In goniometrical measurements, a knowledge of the following simple principle in mathematics is of great importance. "*The sum of the three angles of a triangle equals* 180°," or, in more general terms, "*The sum of the angles of a polygon equals twice as*

many right angles as there are sides less two." If there are five sides, the figure contains 2×(5—2)=6 right angles, or 540°.

Having measured *Qab*, (see fig., p. 43), when practicable, the angle *Rba* should also be measured. If the sum of the two angles thus obtained, equals 270°, we may be quite confident of the correctness of the measurement; but if not, the measurement should be repeated.

If the angle *QPR* is oblique, the sum of the two angles, *Qab* and *Rba*, may be obtained by adding to 180° the angle *QPR*; that is, if *QPR*=110°, 110°+180°=290°. If, then, we find by the goniometer that the sum of the two angles equals 290°, the coincidence between observation and calculation is proof of accuracy. If there is not this coincidence, the measurements should be repeated. Errors may thus be corrected in the examination of crystals.

VI. COMPOUND CRYSTALLINE STRUCTURE.

149. 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. The latter are aggregations of numerous imperfect crystals, either laterally apposed, as in the fibrous structure, or confusedly mingled and compacted together, as in minerals of a granular structure.

I. COMPOUND CRYSTALS.

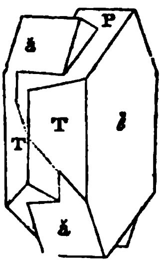
150. Compound crystals are analogues of monsters in the animal kingdom. They may be composed of two united crystals, or of several.

151. *Compound Crystals, composed of two individuals, or Twin Crystals.*—Representations of some of these compound forms are given in the following figures, and in figs. 13, 14, 15, 16, pl. 3. 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, bringing the same surfaces in contact that were separated. Fig. 128, pl. 2, 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 fig. 129.

If a right rhombic prism be divided in a vertical plane, parallel to a lateral face, (fig. 130), and one of the parts be revolved half around, as it were on an axis passing from M to the opposite face, the form in fig. 131 is obtained. This is easily verified by actual trial.

If the same rhombic prism were divided along a vertical diagonal section, and a similar revolution of one half were made, no twin crystal would result that could be distinguished as such, except by refraction. But with an *oblique* rhombic, in which the base is inclined to the lateral planes, a solid similar to that in fig. 14, pl. 3, is obtained; or similar to figs. 35 and 36 following, representing crystals of feldspar, one a right-handed twin and the other left-handed; the simple form is seen in fig. 1 under feldspar. Fig. 37 represents a twin of hornblende, in which composition has taken

35



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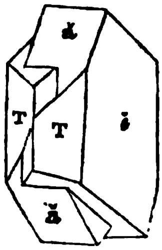
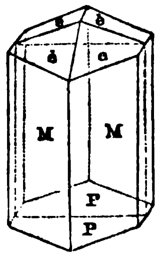


Feldspar.

37

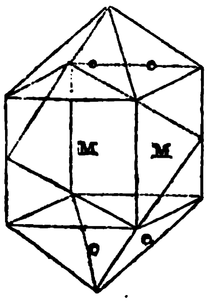


Hornblende.

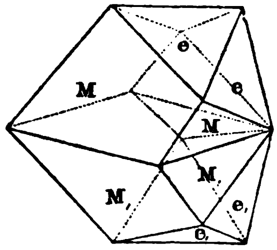
place parallel to a section indicated by the dotted lines; the simple form is shown in fig. 3 under Hornblende.

The following figures illustrate a twin of Tin Ore. If the square

38



39



prism with pyramidal terminations, fig. 38, be cut diagonally from one solid angle to the opposite, and one part revolved upon the other 180°, it produces the form in fig. 39.

Viewing the above examples with reference to the *fundamental* form in each case, we observe that in the first, composition has taken place parallel to a primary face; in the second, parallel to a plane on an edge; and in the last, parallel to a plane on an angle. Composition is thus in all cases parallel to some plane of simple sign and common occurrence.

Fig. 3 under gypsum; 10, 11, 12, 13, under calcite; 2 under arragonite; 4 under feldspar; 4 under copper pyrites—are other examples of these modes of composition.

152. Fig. 16, plate 3, represents a scalene dodecahedron of calcite, in which composition has apparently taken place, parallel to a horizontal section through its centre. By considering the situation of the primary rhombohedron in this solid, it is perceived that the composition is parallel to a plane truncating the terminal solid angle. This figure presents none of the faces of the rhombohedron, a fact which indicates the perfect union that exists between the two individuals,—or rather, that their union was cotemporaneous with the commencement of their formation, and proceeds from the double nature of the nucleal molecule of the crystal. The same complete union, begun evidently with the first molecule of the crystal, is indicated by each of the figures above referred to. The secondary planes have all the perfection and regularity of position characterizing the simple crystal; and the only irregularity is the complete inversion of one half of the form.

These twins are distinct from a kind of compound crystal, arising from the union of two crystals some time subsequent to the commencement of their formation. The above are designated *connatal* compound crystals, the later *postnatal;* the commencement in the former being cotemporaneous with that of the crystals composing them, while in the latter, it is subsequent to the same.

153. Composition parallel to some plane on an edge or angle different from truncating planes, occasionally takes place in crystals that are hemihedrally modified. In the species iron pyrites, twins are of frequent occurrence compounded parallel to a face of a pentagonal dodecahedron. Observing that the edges of the cubes of this mineral are rarely *truncated,* but when modified, are usually replaced by the planes of this hemihedral solid, it is obvious that this peculiarity is owing to the same modification of the molecule that causes its hemihedral crystallizations.

154. A geniculated crystal of quartz has been described by Brooke, (Phil. Mag. May, 1837), in which composition had taken place parallel to a plane truncating a pyramidal edge. This plane referred to a rhombohedral primary, is an intermediary. But crystals of quartz are so uniformly modified hexagonal prisms, that we infer with reason that the hexagonal prism has the relations of a primary; and referring the plane to this form the composition is parallel to a plane on an angle.

155. *Compound Crystals, composed of more than two individuals.*—The same kind of composition often takes place parallel to more than one primary face, edge, or angle, producing compound crystals composed of several individuals. Fig. 3, pl. 4, is a hexagonally prismatic crystal of White Lead Ore, in which composition has taken place parallel to two primary faces. This crystal resembles a secondary to a rhombohedron or hexagonal prism, but is distinguished by the inequality of its lateral angles. Fig. 5, plate 4, is a stellated form of carbonate of lead, in which the composition is parallel to all the lateral faces.

The following are other forms. Fig. 40 is a stellated crystal of snow, consisting of six crystals diverging very regularly at angles

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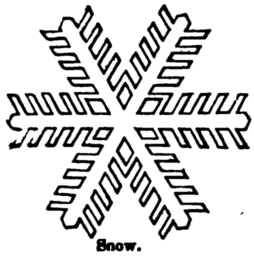
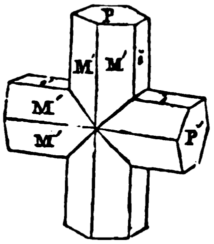


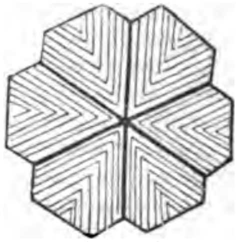
Snow.

41



Stauroтide.

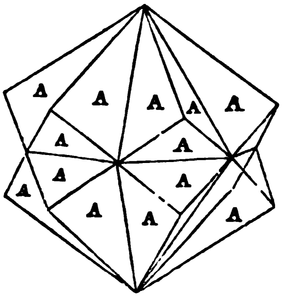
42



Chrysoberyl.

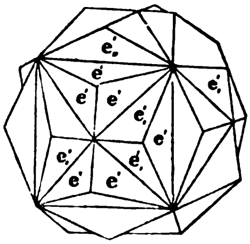
of 60°. Fig. 41 is another of Staurotide, and fig. 42 one of Chrysoberyl. Fig. 43 is a compound form of fluor spar, in which composition similar to that in fig. 128, plate 2, has taken place parallel to each of the octahedral faces. Fig. 44 is another of iron pyrites, compounded parallel to each face e′ in the pentagonal dodecahedron, the simple form of which is shown in fig. 44, plate 1. Very complex forms are often produced by this mode of composition.

43



Fluor Spar.

44



Pyrites.

Occasionally the same compound crystal exhibits *two* modes of composition at the same time. Forms of this kind have been observed in sphene and calc spar.

156. Crystals are often grouped in linear series, and thus constitute long threads or reticulations. Native copper and silver frequently occur in strings of crystals, exemplifying this kind of combination.

In clustered crystals, it is very generally a fact that adjoining crystals are united by a plane parallel to one of the principal sections or more common secondary planes, as parallel to the truncating plane of an edge or angle; and sometimes parallel to other secondary planes, when they are of common occurrence in the species. Senarmont mentions the union in galena paralel to the octahedral faces as common, and also describes an instance where the union was parallel to the plane 3O$\frac{3}{2}$.

157. 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 three 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 each of the 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.

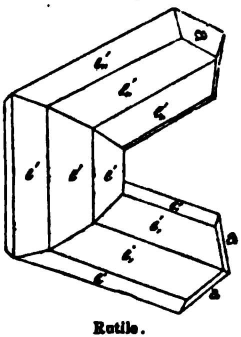
This tendency to parallelism in the positions of associated crystals is even apparent in crystalline aggregates. In granite, for example, which is composed of feldspar, quartz, and mica, the feldspar crystallizations have usually a common position; that is, the corresponding extremities lie in the same 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 pefect cleavage plane of the feldspar. The parallel positions of the mica in gneiss causes the fissile character of that rock.

158. *Postnatal Compound Crystals.*—We have already defined postnatal twins to be those in which composition has taken place after each crystal had attained some considerable size. Fig. 11, under Quartz, represents one of these double crystals. The simple crystals in these instances are uniformly united by similar parts, and, consequently, have their similar faces parallel.

Groups or aggregations of crystals of various sizes, are frequently instances of postnatal composition. Often, however, the aggregation is very irregular.

Another mode of postnatal composition is observed in doubly geniculated crystals, as those of rutile, annexed figure, and figure 12, plate 4. 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.

45



Rutile.

Characteristics of Compound Crystals.—Compound crystals may usually be distinguished by their reëntering angles, or by the striæ on their surfaces. These striæ meet at an angle in the line where composition has taken place.

II. AGGREGATIONS OF IMPERFECT CRYSTALS.

159. 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 any thing 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.*

160. 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.*

161. 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.*

162. 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. Granular minerals, when easily crumbled in the fingers, are said to be *friable.*

4. *Imitative Shapes.*

163. *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.*

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 the Greek α and μορφη, *shape.*

VII. PSEUDOMORPHOUS CRYSTALS.[*]

164. *A pseudomorphous crystal possesses a form that is foreign to the species to which the substance belongs.*

a. 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.

b. Again: crystals are sometimes removed entirely, and at the same time, and with equal progress, another mineral is substituted: for example, cubes of fluor spar may be transformed to quartz, without a change of form. The petrifaction of wood is of the same kind. This process may extend only to the surface of a crystal; and if its interior is subsequently dissolved out, a hollow pseudomorph results.

c. Again: cavities left empty by a decomposed crystal are refilled by another species, by *infiltration*, and the new mineral takes on the external form of the original mineral, as a fused metal copies the form of the mould into which it is cast. A cubic crystal of salt in clay, for example, is removed by percolating water, and the cubical cavity is afterwards filled by gypsum.

d. Again: crystals are sometimes *incrusted* over by other minerals, as cubes of fluor by quartz; and when the fluor is afterwards dissolved away, as sometimes happens, hollow cubes of quartz are left.

165. The pseudomorphs of the first kind here mentioned are *pseudomorphs by alteration;* those of the second, *pseudomorphs by replacement;* those of the third, *pseudomorphs by infiltration;* those of the fourth, *pseudomorphs by incrustation.*

166. These several processes are not always wholly distinct, or distinguishable in the result. It may be difficult to determine, in the case of many silicified crystals, whether there has been a gradual *replacement* of the mineral by the new material, while removal was in equal progress, as is true of petrified wood, or whether the cavity was first formed and then the silica was *infiltrated.* It may be doubtful, also, in many cases, whether the change by *incrustation* was not actually a change by *replacement* for the exterior of the original crystal, and then this process ceasing after a thin layer of new material was formed, the remaining part of the old crystal within was subsequently removed by solution. Much investiga-

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[*] For much information on this subject, Science is indebted to W. Haidinger, whose early views are published in Brewster's Edinb. Jour., vols. ix and x, and more recently in his Handb. der bestimmenden Mineralogie, Vienna, 1845, where his views on pseudomorphism are fully detailed. Extensive and important investigations have also been made by Dr. J. Reinhard Blum, who published an 8vo. volume of 378 pp., entitled Die Pseudomorphosen des Mineralreichs, at Stuttgart, in 1843, and a Supplement of 218 pp., in 1847.—See a review of this work, in Am. Jour. Sci. xlviii, p. 66, and remarks by the author, p. 81.

tion of the subject, and as far as possible, a study of actual cases in progress, may be required, before each instance of pseudomorphism shall be referable to its place in one of the four divisions here laid down. The petrifaction of wood is a plain instance of replacement; for here every fibre of the original wood is usually copied with the utmost perfection.

167. The process by which pseudomorphs of the first two kinds (by *alteration* and *replacement*) are produced is chemical in its nature. In the first, it depends on chemical affinities and attendant causes alone, acting either with or without water, and the water, when present, either cold or heated. In the second, the process of solution and substitution is not less chemical. When a substance is undergoing the change of state called solution, the molecular forces are in excited action, and if any other substance is present just then passing from the liquid to a solid state, the passage of the former to the liquid state appears to aid by a transfer of force or by induction, in causing the change to a solid state in the latter, molecule for molecule, and thus the replacement is gradual and successive, and every minutest stria is copied.

With regard to pseudomorphs of the last two kinds, the process is altogether mechanical. It is simply the filling of a ready-made mould, or the incrusting of a model

168. The following is a list of the pseudomorphs that have thus far been described, taken from the valuable work by Dr. Blum. For the convenience of reference we distribute them under the heads,

I. Pseudomorphs having one or more elements of the original mineral: and,

II. Pseudomorphs without any element of the original mineral.

It should, however, be remembered, that when a pseudomorph contains an element identical with one in the original mineral, it is still possible in some cases, that in the process of change, the whole of the original species was removed, and the substitute introduced as a whole.

I. PSEUDOMORPHS RETAINING PART OF THE ORIGINAL MINERAL.

1. *Earthy Carbonates, Sulphates, Fluorids.*

Pseudomorph.	*Form imitated.*
Calc Spar,	Gay-Lussite, Gypsum.
Dolomite,	Calc Spar.
Gypsum,	Anhydrite, Calc Spar.
Heavy Spar,	Witherite, Baryto-calcite, Calc Spar.
Fluor Spar,	Calc Spar.

2. *Siliceous, or Silicates of the earths.*

a. *Magnesian.*

Talc,	Kyanite, Feldspar, Pyrope, Chiastolite, Couseranite.

Pseudomorph.	*Form imitated.*
Steatite,	Hornblende, Dolomite, Spinel, Quartz, Andalusite, Chiastolite, Topaz, Feldspar, Mica, Wernerite, Tourmaline, Staurotide, Garnet, Idocrase, Augite.
Serpentine,	Augite, Hornblende, Chrysolite, Spinel, Mica, Garnet, Chondrodite.
Chlorite,	Garnet, Hornblende, Feldspar.
Hornblende,	Augite.
Green Earth,	Augite.
Rensselaerite,	Augite.

b. *Aluminous.*

Cimolite,	Augite.
Lithomarge,	Topaz, Feldspar.
Kaolin,	Feldspar, Porcelain Spar, Leucite.
Mica,	Pinite, Iolite, Feldspar, Andalusite, Wernerite, Tourmaline.
Aspasiolite, Fahlunite, Esmarkite, Bonsdorffite, Chlorophyllite, Weissite, Praseolite, Pyrargillite, Gigantolite, Pinite,	Iolite.
Prehnite,	Analcime, Leonhardite, Natrolite.
Wernerite,	Epidote.
Kyanite,	Andalusite.

c. *Silica.*

Quartz,	Garnet.
Opal,	Augite.
Jasper,	Hornblende.
Chalcedony,	Datholite.

3. *Metals and Metallic Ores.*

Specular Iron,	Magnetic Iron.
Red Iron Ore,	Pyrites, Cube Ore, Brown Iron Ore, Spathic Iron.
Magnetic Iron Ore,	Spathic Iron.
Brown Iron Ore,	Specular Iron, Ankerite, Pyrites, White Iron Pyrites, Scorodite, Cube Ore, Spathic Iron.
Göthite,	Pyrites.
White Iron Pyrites,	Brittle Silver Ore.
Pyrites,	Mispickel, Brittle Silver Ore, Red Silver Ore.
Green Vitriol,	Pyrites.
Stilpnosiderite,	Vivianite.
Spathic Iron,	Calc Spar, Dolomite.
Pyrolusite,	Manganite.
Hausmannite,	Manganite.
Pseudotriplite,	Triphyline.
Calamine,	Calc Spar.
Cobalt Bloom,	Smaltine.
Bismuth Ochre,	Needle Ore.
Minium,	White Lead Ore, Galena.
Anglesite,	Galena.
White Lead Ore,	Galena, Anglesite, Leadhillite.
Pyromorphite,	Galena, White Lead Ore.
Molybdate of Lead,	Galena.
Native Copper,	Red Copper Ore.
Copper Pyrites,	Vitreous Copper.
Variegated Copper Ore,	Vitreous Copper.
Black Copper,	Vitreous Copper.

Pseudomorph.	*Form imitated.*
Malachite,	Red Copper Ore, Copper Pyrites, Gray Copper Ore, Azurite, Calc Spar, White Lead Ore.
Azurite,	Gray Copper Ore.
Chrysocolla,	Copper Mica, and Red Copper Ore.
Kupferindig,	Copper Pyrites.
Kupferpecherz,	Copper Pyrites.
Wolfram,	Scheelite.
Antimony Bloom,	Gray Antimony.
Antimony Ochre,	Gray Antimony.
Antimony Blende,	Gray Antimony.
Stiblite,	Gray Antimony.

II. PSEUDOMORPHS HAVING NO ELEMENT OF THE ORIGINAL MINERAL.

a. Saline or Earthy.

Common Salt,	Dolomite.
Anhydrite,	Common Salt.
Gypsum,	Common Salt.
Polyhalite,	Common Salt.
Strontianite,	Gypsum.

b. Magnesian or Aluminous.

Meerschaum,	Calc Spar.
Lithomarge,	Fluor Spar.
Feldspar,	Calc Spar.

c. Silica.

Quartz,	Heavy Spar, Fluor Spar, Gypsum, Calc Spar, Baryto-calcite, Dolomite, Scheelite, Galena, White Lead Ore, Specular Iron, Pyrites, Spathic Iron:—as *Prase*, Calc Spar:—as *Chalcedony*, Heavy Spar, Fluor Spar, Calc Spar, Dolomite, Pyromorphite: — as *Carnelian*, Calc Spar:—as *Hornstone*, Fluor Spar, Calc Spar, Mica, Spathic Iron: as *Semiopal*, Calc Spar.

d. Carbon.

Graphite,	Pyrites.

e. Metallic Ores.

Peroxyd of Iron,	Fluor Spar, Calc Spar.
Brown Iron Ore,	Heavy Spar, Fluor Spar, Calc Spar, Dolomite, Quartz, Comptonite, Blende, Galena, Pyromorphite, White Lead Ore, Red Copper Ore.
Pyrites,	Heavy Spar, Calc Spar, Quartz.
Stilpnosiderite,	Dolomite, Calamine.
Pyrolusite,	Calc Spar, Dolomite.
Hausmannite,	Calc Spar.
Manganite,	Calc Spar.
Psilomelane,	Heavy Spar, Fluor Spar, Cube Ore.
Calamine,	Fluor Spar.
Electric Calamine,	Fluor Spar, Calc Spar, Dolomite, Galena, Pyromorphite.
White Lead Ore,	Heavy Spar, Fluor Spar.
Chrysocolla,	White Lead Ore.
Tin Ore,	Feldspar.

Many species become gradually hydrated as alteration or decomposition commences. Iolite is an example of this, and orthite, some micas, and probably feldspar and other species. The mineral has still the original form, and not unfrequently this form has been considered, quite erroneously, the crystalline form of the hydrous mineral. Such hydrous species are pseudomorphs, and should not be confounded with those hydrous minerals whose water was an essential ingredient at their crystallization, and upon which, in part, the form depends.

169. The discussion of the origin of these various pseudomorphs belongs rather to Chemistry or Chemical Geology, than to the Science of Mineralogy. But few remarks, therefore, are added in this place.

a. The change of *carbonate of lime* to *sulphate of lime* or *gypsum*, is an example of the simple expulsion of carbonic acid by sulphuric acid, the latter resulting either from the aqueous decomposition of a sulphuret, as iron pyrites, or from the evolution of sulphur gases by heat or volcanic action. Alterations of this kind have taken place on a large scale in nature.

b. Large deposits of *anhydrite* have been changed to *gypsum* by the absorption of water at the common temperature. At Bex, in Switzerland, is a fine example. On digging down sixty or one hundred feet, the unaltered anhydrite is reached.

c. The change of *feldspar* to *kaolin* is of common occurrence, and takes place from the simple decomposition of the feldspar under the action of water, either pure or carbonated. 3 atoms of feldspar together, consist of 3 parts of alumina, 3 of potash, and 12 of silica. If 3 parts of potash and 8 of silica be removed, it leaves 3 of alumina and 4 of silica, which is the composition of kaolin, except that 6 of water are added.

d. Steatite constitutes many different pseudomorphs. In the change to *hornblende*, a removal only of lime is required. $\dot{C}a\,\ddot{S}i+\dot{M}g^3\,\ddot{S}i^2$, dropping $\dot{C}a$, becomes $3(\dot{M}g\,\dddot{S}i)$. Usually in this and other cases, some water is added, the steatite being commonly hydrated. Steatitic *spinels* occur in the granular limestone of Sussex Co., N. J., and of Orange Co., N. Y., and are common elsewhere. The change is a simple substitution of silica for alumina; thus $\dot{M}g\,\ddot{\mathbf{Al}}$ becomes $\dot{M}g\,\ddot{S}i$. The Rensselaerite of Northern New York is an interesting example of the change of augite to steatite, on a large scale.

e. The crystals of *serpentine* described, have the form of those of *chrysolite*, and have been supposed to be altered chrysolite, though of this there is much doubt. Quenstedt, who first suggested this view, (Poggend. Ann., 1835), remarked that 4 of chrysolite, $(\dot{M}g^{12}\,\ddot{S}i^4)$ giving up $3\dot{M}g$ and taking $6\dot{\mathbf{H}}$, become $2\dot{M}g^3\,\dddot{S}i^2+3\dot{M}g\,\dot{\mathbf{H}}^2$, or serpentine.

170. The dissolving powers of heated waters, especially those of the ocean, from submarine volcanic action, must have been active in many pseudomorphic changes, particularly those requiring something more than atmospheric causes at the ordinary temperature. Silica is readily taken up under these circumstances, as shown about the geysers of volcanic regions, and on cooling, it is again deposited. This fact, in connection with its common occurrence in small quantities in all waters, accounts for the frequency of siliceous pseudomorphs. Marine waters also contain magnesian salts, and therefore, when heated, are fitted for those changes in which magnesia is concerned; and the cases of this kind are of very wide extent, and great geological influence.

171. 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.

172. Crystallogeny, or the formation of Crystals, may be treated of either in a practical point of view, by a review 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.

I. PRACTICAL CRYSTALLOGENY.

173. Crystallization may take place either 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 or changing its temper, (since it depends on varying the size of the crystalline grains), is an example of the *fourth.* All solidification of inorganic matter is crystallization, and the solid condition is arrived at in one or the other of these methods. Fre-

quently, 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.

174. 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.

Crystals frequently contain parallel layers of other substances, as of pyrites, which have been formed during intermissions in the crystallizing process. In a large rhombohedron of calcite from Rossie, the plane a, could be distinguished by a layer of pyrites, although there was no such plane externally. The crystal once had such a plane, and the pyrites was then deposited; but subsequently the rhombohedron was finished out, and without any lateral enlargement. The annexed figure represents another crystal from Rossie, in which the sides were enlarged after an intermission, without additions to a, and consequently there is a raised ridge around this plane. The cap quartz is another example of intermitted crystallization.

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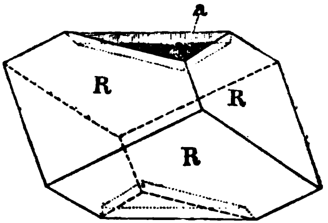

175. Crystallization without a change from the solid state, is well illustrated by facts mentioned to the author by Mr. N. P. Ames. If a bar of tempered steel, bent in the form of a semicircle, be heated on the inner side, when the heat has reached a certain point, the bar may easily be bent around and 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. The accident which took place in 1842, on the Versailles railroad, was owing to the breaking of an axle, which was rendered brittle by the same cause.

176. The same process—long continued heat without fusion—has acted widely in nature, producing probably the crystalline structure of granular limestone, and many other crystalline rocks, and originating, in certain cases, the groups of crystals in these rocks. Matter of like kinds tends strongly to segregate together; and when a material is distributed as an impurity through a rock, as phosphate or fluorid of lime through limestone, it may slowly collect in cavities, and leave the limestone nearly or quite pure of them. Thus it is, we may believe, that crystallizations of fluor spar and apatite originate in limestone. The limestone being formed of animal remains, the material of these minerals is necessarily present.*

177. *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

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* The author omits much that is introduced in previous editions, on the formation of crystals, and would refer to them for the facts there stated: also to his Memoirs in the American Journal of Science, *on the formation of fluor spar, apatite, and chondrodite, in limestone*, second series, vol. ii, p. 88; and *on the minerals of trap and the allied rocks*, vol. xlix, 49. Also for facts and observations on the crystallizations in furnace scoriæ and the formation of minerals, see MITSCHERLICH, Ann. de Chim., xxiv, 355, and Pogg. Ann. 1826, 630; BERTHIER, Ann. de Ch. xxiv, 376; ROSE, Pogg. Ann. xxxiii and Ann. de Ch. lvii, 219; BECQUEREL, Ann. de Ch., vols. xli, xlii, lx; BIRD, Phil. Mag. x, 376; EBELMEN, Comptes Rendus, xxv, 279, 661; SENARMONT, Comptes Rend., June, 1849; PERCY and MILLER, Rep. Brit. Assoc. for 1846.

Ebelmen has succeeded in making Chrysoberyls, Emeralds, Chrysolite, red Sapphire, and Chromic Iron, by combining the bases with a volatile ingredient, as boracic acid, phosphoric acid, and some other substances, and subsequently subjecting to a high heat.

† Traité élémentaire de Minéralogie, par F. S. Beudant, 2 vols. 8vo. 1830, 2d ed. T. I, p. 189.

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," (fig. 2, pl. 1). 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. Arragonite, 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.

178. 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.*

179. 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.

180. *The influence of magnetism or electricity on crystallization*, has received some attention of late, 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.†

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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.

II. THEORETICAL CRYSTALLOGENY.

THEORIES OF VARIOUS AUTHORS.

181. 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. 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.

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[*] Epicurus.

[†] 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. Carlsruhe 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."

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 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

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[*] *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).

[†] 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 esse 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, sunt 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.

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 primary forms of crystals, and Romé de Lisle that of first measuring their angles, and thus rendering crystallography subservient to the purposes of the mineralogist.

182. 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, (fig. 132, pl. 2), or, two rows in one direction, and one in the other, (fig. 133), 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.

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.

183. 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, (fig. 134). If, to the octahedron, two three-sided pyramids are added, (tetrahedrons, fig. 136), one to each of two opposite faces, a rhombohedron is formed, (fig. 135). A rhombohedron of this kind is easily obtained in the cleaving of fluor spar; it is reduced to the octahedron by separating two tetrahedrons.

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.

184. Other theories have been proposed, but only one seems to require 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 primary 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 occurrence 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 farther 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.*

185. 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.

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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.

186. *Forms of Molecules.*—Adopting the idea of spherical and spheroidal molecules, we suppose the molecule of each primary to 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 primary of the same dimensions.[†]

187. *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 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,

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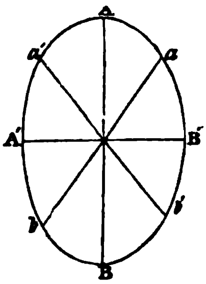
[*] The following remarks are made in explanation of the solids, termed ellipsoids, or solid ellipses, and their conjugate axes and diameters.

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, (figs. 1, 3, 7, plate 3). 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, 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. He also speaks of the axes being always at right angles with one another, which is not always true of the optical axes, and cannot be of the crystallogenic. 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.

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 fixed directions in each molecule.

These fixed 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 of the prism; for action in these directions only can 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, (fig. 1, plate 3). Influenced by these axes, the spheres will combine, as in fig. 2, 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*, (fig. 3), with rectangular axes. The *rectangular prism* has three unequal dimensions, and therefore the ellipsoidal molecule is *not* an ellipsoid of revolution. Fig. 4 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 *conjugate axes*. 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*, (fig. 6), and may be any unequal conjugate diameters of the ellipsoid, at right angles with the vertical axis.

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*, figures 7*a*, and 7*b*. The dotted letters in the above figures are supposed to be situated on the back faces.*

188. 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. Rhombdl. Prism.*
Prisms, all of whose axes intersect at *oblique* angles, and are therefore conj. diam. (not axes) of the molec.	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 proceed 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.

189. 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.

190. *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.

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* The rhombohedron thus formed differs materially from that proposed by Wollaston, (fig. 185. pl. 2). The molecules influenced by these axes will take an arrangement similar to that in the cube and other prisms.

This is a natural inference from the general nature of attraction. It also proceeds from the nature of axial attraction, that similar axes will by their union form a straight line; that is, will unite as in fig. 9, plate 3, and not as in fig. 11.

191. *Connatal Compound Crystals.*—The mutual influence of the molecules causes them to assume the parallel position of figure 9, plate 3, 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 fig. 10, plate 3. A north and south pole are here adjacent, as in figure 9; 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 figure 11, 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 primary face. Figure 13, plate 3, represent a crystal of arragonite thus formed, and figure 13*a*, a horizontal section of the same. The planes *ĕ, ĕ*, truncate the acute lateral edges, as may be observed in figure 13*b*.

It is obvious that the axes of the molecules, which are at right angles with those represented in figure 11, (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.

192. 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 fig. 12, plate 3, 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. 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 fig. 14, pl. 3, which represents a crystal of pyroxene compounded parallel to the edge ĕ. The figures of the crystals of feldspar, given on page 92, 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 figs. 15 and 16, plate 3, the former a crystal of manganite, the latter a scalene dodecahedron of calcite.

193. 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. Several of these forms are represented in figs. 3, 5, 6, 8, plate 4.

Fig. 1 represents a horizontal section of a crystal of white lead ore, 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.

Fig. 2 is a horizontal section of fig. 3, (another crystal of the same mineral), whose lateral angles are given in fig. 2. Composition of the first kind 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, (fig. 1), 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 prisms A and B have one of their acute lateral edges—the distant ones—truncated; for the two upper edges in fig. 2 are parallel to the shorter diagonals of A and B, and therefore are also parallel to the truncating plane just referred to. Fig. 2 under the species *arragonite* is an instance of this mode of formation; two of the lateral planes of the prism are the planes ĕ, and four are primary planes, M, 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 fig. 6, a crystal of Witherite, is exhibited in the outer lines of fig. 4. 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. 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.

In fig. 7, a compound nucleus is represented, in which composition of the first kind has been effected parallel 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 fig. 8, a crystal of white lead ore. This arrangement is probably the origin of the stellate crystallizations of snow.

194. Compound crystals of *the first kind* are most common in rhombic prisms, and especially when the lateral angle is nearly 120°; and if exactly 120°, as is the fact with snow, *simple* crystals are seldom observed. Three molecules, whose lateral axes are inclined at an angle of 120°, form by their union a perfectly compact group, similar to fig. 1, pl. 4,—except that all their axes are united in close contact; and consequently their mutual action produces almost necessarily this compound structure. The union of six molecules by their acute angles, may also take place in the same manner, for 6×60° equals 360°.

Rhombic prisms, whose angles vary much from 120°, do not present this kind of compound crystal. The following are the species in which it is of frequent occurrence: Arragonite, (116° 10′), Strontianite, (117° 32′), Witherite, (118° 30′), White lead ore, (117° 14′), Vitreous Copper, (119° 35′), and Brittle Silver Ore, (115° 39′); and in all other species in which this mode of composition is not observed, the angle differs more from 120° than in those enumerated. There is an exception to this remark in the case of *white iron pyrites*, the lateral angles of whose rhombic prisms equal 106° 2′. But this exception illustrates well the general principle. These crystals are composed of *five* simple crystals, and the angle 73° 58′, (the acute angle of the prism), varies but little from 72°, or *one fifth* of 360°. The occurrence of these forms, therefore corroborates the views I have attempted to explain.

195. *Postnatal Compound Crystals.*—Postnatal crystals are described in § 158 to be of two kinds.

1. Doubly geniculated crystals, or those which have been apparently *bent* subsequent to their formation.

2. Those which are composed of two distinct crystals, united by their similar parts.

196. 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, (fig. 9, plate 4), 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. 11, pl. 4, is a section of a crystal, (a little resembling fig. 13, pl. 3), in which there is seen both a connatal and postnatal composition. The latter was effected as above described. Geniculation, according to the second kind of composition, may be illustrated by means of fig. 10; 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 assume the intermediate position seen in A″B″C, in which, contact has taken place at the point of equilibrium between two poles. Fig. 1, under *rutile*, represents a crystal thus geniculated.

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 postnatal geniculation, according to the third kind of composition, flows readily from the above. An example is given in fig. 12, pl. 4.

The remaining kind of compound crystal is represented in fig. 11, 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.*

197. It has been abundantly explained that the same substance may crystallize under a variety of forms, all being modifications of

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* See for fuller details on this subject, an article by the author in the American Journal of Science, [2], iv, 364.

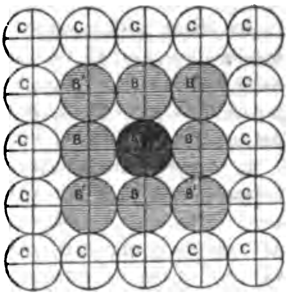
one type. A species may occur under the form of a cube, or a cube with truncated edges, or with bevelled edges, or with variously modified angles. *If, then, a certain state of the attraction in a molecule will produce the primary cube, some variation from this state is necessary to produce another form, and a different variation for every different secondary form.*

198. 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.*

199. 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.

200. 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 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.*

47

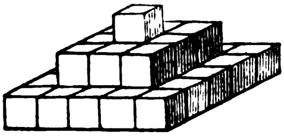


201. In an enlarging cube, the molecules are added in planes of increasing breadth, as in this way only would the form continue to be a cube. If we consider the case, we find that the central molecule attracts a molecule by each of its poles, and also simultaneously the added molecules act by their lateral axes to complete the plane. We observe in the sectional view (through the centre) in figure 47, 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.

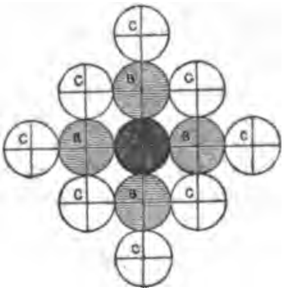
If now when the B's are uniting, their lateral axes do not act at the same time, then the forming cube will have the edges truncated as in fig. 5, pl. 1. To understand this we must study the steps in the process. Fig. 48 presents the same secondary planes as in fig. 5, without the primary faces. It is 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 a 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 fig. 49. When

A attracts B, B does not act laterally as in fig. 47; 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.

48



49



202. Again in fig. 50, we have a section of another figure, (the same secondary as in fig. 10, pl. 1), 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 fig. 48 or 49, another with the ratio 1 : 1.

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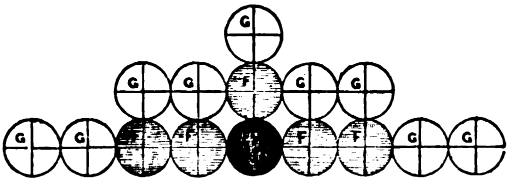

If the period of time occupied by the union of a molecule be represented by *p*, then when the lateral axes act only after the period of time *p*, and then add a single row of molecules, the secondary plane is the truncating plane 1 : 1. For the plane having the ratio 1 : 2, in which two are added laterally 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 $\frac{1}{3}p$.

203. To understand the origin of planes on an angle, we must again consider the actual circumstances. Fig. 51 (the same secondary as in fig. 2, pl. 1) 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 fig. 49; 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 ter-

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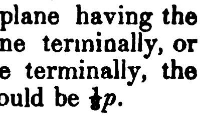

minal and lateral axes, and another interval p, between the adding of the four molecules and the action by *their* lateral axes. And this is the difference between the plane truncating an angle, (fig. 2, plate 1), and another truncating an edge of a cube, (fig. 5, plate 1). This plane truncating an angle 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 a face of the cube, and the centre of the latter from the same is 45°.

204. 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.*[*]

205. 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 cleavage 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.

206. 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.

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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 theory above offered with regard to the origin of secondary planes, is near that presented in 1839 to the Royal Society, by Prof. Necker. How far they are identical, I cannot decide with certainty from the brief notice of his paper which I have seen in the

The constancy of certain forms in some species is evidence of the peculiar susceptibilities of the molecules of those 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.*

207. *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.*

Philosophical Magazine, vol. xiv, p. 216. M. Necker supposes that there is a tendency in crystals to take the spheroidal forms of their molecules; that when the secondary axes are destroyed by different causes, simple crystals are produced. According to the view here presented, there is no tendency of this kind recognized; the concentration of the primary axes producing simple forms is the ordinary condition of the molecules of some substances in solidification; and by this concentration, however produced, the secondary axes lose their force.

* 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, as I have elsewhere observed, (Zooph., p. 89), is another illustration of intermittent growth; for here the different sides of the growing plant (*five*, in many plants, and *six* in many others) 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.

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.**

208. 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 of fibres, producing a *fibrous structure.* Such a structure is common in narrow seams in rocks, and the fibres are usually elongated across the seam.

209. 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

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* Many crystals, as remarked on page 75, 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 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.

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.*

210. 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 so 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 forgotten, had a clearer insight into the nature of crystallization, than any of his cotemporaries, and many of his successors—p. 144: "Crystallisatio 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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* 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.

PART II.

PHYSICAL PROPERTIES OF MINERALS.

I. CHARACTERS DEPENDING ON LIGHT.

211. 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.

212. 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 zinc blende.

4. *Pearly:* like pearl. Ex. talc, native magnesia, stilbite, &c. When united with sub-metallic, the term *metallic-pearly* is used.

5. *Silky:* like silk; it is the result of a fibrous structure. Ex. fibrous carbonate of lime, fibrous gypsum.

6. *Adamantine:* the lustre of the diamond. When also submetallic, it is termed *metallic-adamantine.* Ex. carbonate of lead, dark red silver ore.

b. The *degrees of intensity* are denominated as follows:—

1. *Splendent:* reflecting with brilliancy, and giving well defined images. Ex. Elba iron ore, tin ore.

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 plate in foliated minerals, very commonly differs in lustre from the sides, and in some cases the latter are vitreous, while the former is pearly.

II. COLOR.

213. 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 the 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, molybdena.—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 the 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:* native sulphur.—2. *Straw-yellow:* pale yellow; topaz.—3. *Wax-yellow:* grayish yellow with some brown; zinc blende, opal.—4. *Honey-yellow:* yellow with some red and brown; calc spar.—5. *Lemon-yellow:* native 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 varieties of realgar.—2. *Hyacinth-red:* red with yellow and some brown; hyacinth, garnet.—3. *Brick-red:* polyhalite, some varieties of 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 varieties of jasper.—13. *Brownish-red:* jasper, brown iron ore.

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:* common 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. Labrador feldspar.

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. variegated copper ore. 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; fahlerz 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 carbonate of manganese. 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 only by crystals which have at least two kinds of axes; the colors are the same in the direction of like axes, and often different in the direction of unlike axes. It exists in tourmaline, iolite, mica, chrysoberyl, &c. Iolite owes its name (*dichroite*) to this property. Mica is nearly opaque in one direction, while it is transparent in another; it also presents different colors in these directions.

III. DIAPHANEITY.

214. 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 every degree in the mineral kingdom, 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.

215. 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 obliquely, 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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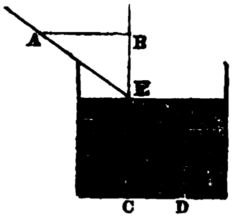

The part of the ray AED, within the water, is nearer the perpendicular BC, than if it had proceeded in its original direction AE; or, if we consider the ray as passing from the water into the air, the part AE, is farther from the same perpendicular than if it had proceeded in the original direction DE. 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.

216. The following are the indices of refraction for the substances enumerated:

Tabasheer,	1·211	Carbonate of Strontian,	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	Carbonate of Lead,	2·084
Quartz,	1·548	Native Sulphur,	2·115
Euclase,	1·642	Blende,	2·260
Calc Spar,	1·654	Diamond,	2·439—2·755
Arragonite,	1·693	Chromate of Lead,	2·500—2·974

There is some variation at times in the same species, and it often corresponds to a change of color.

217. *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. Calc spar has a negative axis, quartz, a positive. The following are the indices for a few substances:

	Ordinary ray.	Extraordinary ray.
Calc spar (neg.)	1·654	1·483
Arragonite (neg.)	1·693	1·535
Quartz (pos.)	1·548	1·558
Euclase (pos.)	1·642	1·663

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, phosphate of lead, arsenate and molybdate of lead, cinnabar, anatase, of a *negative* axis.

218. 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 so in oblique prisms. The angle between these axes has been determined for many minerals, and has served to distinguish species. The following are some examples:

Carbonate of Strontian,	6° 56′	Topaz (Brazilian),	49—50°
Mica—different kinds	6°, 14°, 25°, 30°, 31°, 32°, 34°, 37°, 45°	Strontianite,	50°
		Comptonite,	56° 6′
Talc,	7° 24′	Gypsum,	60°
Carbonate of Lead,	17° 30′	Iolite,	62° 16′
Arragonite,	18° 18′	Topaz (Aberdeenshire),	65°
Chrysoberyl,	27° 51′	Kyanite,	81° 48′
Heavy Spar,	37° 42′	Epidote,	84° 19′
Stilbite,	41° 42′	Chrysolite,	87° 56′
Anhydrite,	44° 41′	Copperas,	90°

The relation of double refraction to crystalline form was first pointed out by Brewster. He showed that 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.

219. *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 successively 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. Figure 53 shows the position of the colored rings and cross in calc spar, and figure 54 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 figures 55 and 56, the latter alternating with the former in the revolution of the plate.

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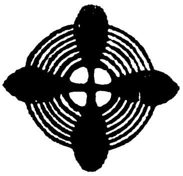

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56

Calcite. Nitre.

220. 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, 33° 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 is 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.

221. 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.

V. PHOSPHORESCENCE.

222. 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 following table contains some of the results of T. J. Pearsall's* investigations: the second column gives the color of the natural phosphorescence; the third, the color induced by electric discharges.

Green fluor from Cornwall.	Rose, ending with orange.	6—12 discharges; bright green ending with purple, 36 discharges; green, almost as intense as natural.
Green cubes from Wear Dale, Cumberland.	Deep blue and purple.	20—40; greenish, then violet, and finally fine purple.
Pale yellow cubes from Gersdorff.	Green and violet.	12, 24, 36 discharges; yellowish and finally purple.
Massive fluor from Derbyshire.	Dull green and pink, of short duration.	24 discharges; yellowish.

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

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* Jour. of Royal Institution, i, 77, 287.

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 equally permanent, however, 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 also 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.

II. ELECTRICITY—MAGNETISM.

223. The electric and magnetic characters of crystals bear but slightly upon the Science of Mineralogy, although of high interest to the student of physics. Our observations are therefore brief, notwithstanding the wide extent and importance of the subject.

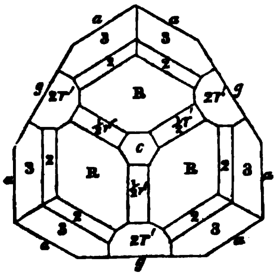
224. *Frictional Electricity.*—The development of electricity *by friction*, is a familiar fact. There is no line of distinction among minerals, dividing them into *positively* electric and *negatively* electric; for both kinds of electricity may be presented by different varieties of the same species, 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.

225. *Pyro-electricity.*—On heating crystals of some minerals, they become electric with opposite polarity in opposite parts. This property is called *pyro-electricity*. Tourmaline is one of the species thus affected: boracite is another. 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, 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 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 figure 3, 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.

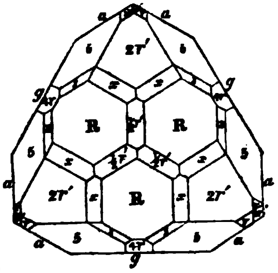
57

Analogue Pole.



58

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, 4*r*, 5*r'*, while on the other the longest rhombohedron is 2*r'*, 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.*	

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* Ueber die Pyro-electricität der Mineralien, von P. Riess und G. Rose, Akad. Wissensch. 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.

Riess and Rose have confirmed the observations with regard to the above mineral species. Brewster has added *calc spar*, *yellow beryl*, *celestine*, *white lead ore*, *red and blue fluor spar*, *diamond*, *orpiment*, *analcime*, *amethyst*, *idocrase*, *mellite ?*, *native 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.

226. 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.

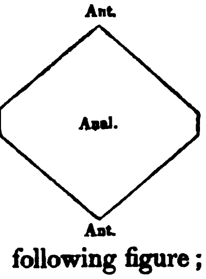
The examples of the first kind, are tourmaline, electric calamine and scolecite, *uniaxial;* axinite, *biaxial;* boracite and rhodizite *with four axes*.

Electric 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 fig. 1 of this species, the plane a 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.

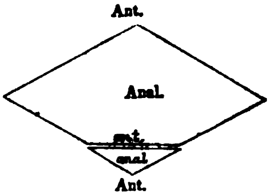
The species in which pyro-electricity of the second kind has been observed, are prehnite and topaz. If figure 59 represent a tabular crystal of prehnite, the poles will be situated as marked, the analogue being central and the antilogue at either extremity of the shorter diagonal of the rhombic prism. 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.

59



The particular character of the axes in sphene, heavy spar, and rock crystal has not been made out. Two specimens of heavy spar 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

60



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* Riess and Rose.

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.

227. *Magnetism*—.All substances are either *magnetic* or *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, palladium, platinum, osmium ;* and 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. Titanic iron 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. Delesse 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 platina,	2·173—3·047
Magnetic iron ore,	15·00—65·00
Franklinite from the United States,	1·038
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
Trachyte,	1·312—0·350
Obsidian,	0·050—0·019
Basalt,	2·574—0·178
Dolerite,	3·377—0·478
Serpentine,	2·249—0·585
Diorite,	0·735—0·022
Porphyry, (from Chagey),	0·478

228. *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 kya-

nite, 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. A bare allusion to the subject is all that is proper in this place.*

III. HEAT.

229. 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, diminished 4′ 46″; and in arragonite, between 63° and 212° F., the angle of the prism increased 2′ 46″. 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.

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.

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* See farther, Faraday on Bismuth, Phil. Mag. [3], xxxiv, 75 and Am. J. Sci. [2], vii, 425; and Plücker's recent results, Phil. Mag. [3], xxxiv, 460, and Am. J. Sci. [2], viii, 480.

(*b*.) 230. 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 arragonite, 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	1·28	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.

231. Savart has obtained a correspondence to the phenomena of light and heat in the unequal elasticity of crystals along unequal axes.[*]

232. M. Wiedemann,[†] moreover, has recently 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.

[†] Poggendorf's Annalen, lxxvi, 1849.

IV. SPECIFIC GRAVITY.

233. 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 when the substance is a gas, 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.

234. 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 weigh 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.

235. These characters are of three kinds:—1. Hardness; 2. State of Aggregation; 3. Fracture.

I. HARDNESS.

236. 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.* In older works on the science, the very indefinite terms *hard, soft, tender,* &c., were employed to express the degrees of hardness. Afterwards, minerals were described as harder or softer than glass, or than one another. Consequently, the standards were almost as numerous as the mineral species, and no information was conveyed to the person unacquainted with the species with which comparison was made: or if acquainted with the species, since many minerals vary somewhat in their hardness, the statement was still indefinite, unless the particular variety was noted. The confusion and incorrectness thus introduced into the science, have been removed by the selection of a few minerals of common occurrence as standards of comparison. 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. *Calcareous Spar;* transparent variety.
4. *Fluor Spar;* crystalline variety.
5. *Apatite;* transparent variety.

5·5. *Scapolite;* crystalline variety.

6. *Feldspar;* 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 species 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.***

II. STATE OF AGGREGATION.

237. 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.

III. FRACTURE.

238. 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 nearly or quite flat.
3. *Uneven;* 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.

239. 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.

240. 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. *Horseradish 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.
4. *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 CHARACTERS OF MINERALS.

I. COMPOSITION OF MINERALS.

1. *General Remarks on the Constitution of Minerals.*

241. 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-two, forty-nine of which are metals.

242. The following table contains their names, with the abbreviations by which they are represented, and their atomic weights. In the catalogue here given, we have included also the more common compounds of the elements with oxygen and sulphur, 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 F̶e means 2 of Iron to 3 of Oxygen. This table contains the most recent results of chemists, and is much altered from that by Berzelius.

ALUMINIUM, Al,	170·9	
Alumina, $\overset{\dots}{\overline{\mathrm{Al}}}$,	641·8	(O, 46·74)
2 $\overset{\dots}{\overline{\mathrm{Al}}}$	1283·6	
3 $\overset{\dots}{\overline{\mathrm{Al}}}$	1925·4	
4 $\overset{\dots}{\overline{\mathrm{Al}}}$	2567·2	
5 $\overset{\dots}{\overline{\mathrm{Al}}}$	3209·0	
6 $\overset{\dots}{\overline{\mathrm{Al}}}$	3850·8	
ANTIMONY (Stibium), Sb,	1612·9	
Sul. Antim., $\mathrm{Sb\,S^3}$,	2212·9	(S, 27·12)
ARGENTUM (Ag) see *Silver.*		
ARSENIC, As,	937·50	*Pelouze.*
Arsenic Acid, $\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}$,	1437·5	(O, 34·78)
Sulphuret of A., $\mathrm{As\,S^3}$,	1537·5	(S, 39·0)
AURUM (Au) see *Gold.*		
BARYUM, Ba,	856·8	
Baryta, $\dot{\mathrm{Ba}}$,	956·8	(O, 10·45)
2 $\dot{\mathrm{Ba}}$	1913·6	
3 $\dot{\mathrm{Ba}}$	2870·4	
4 $\dot{\mathrm{Ba}}$	3827·2	
BERYLLIUM (Be) see *Glucinum.*		
BISMUTH, Bi,	2660·8	
Oxyd of Bismuth, $\overset{\dots}{\overline{\mathrm{Bi}}}$,	2960·8	(O, 10·13)
BORON, B,	136·2	
Boracic Acid, $\dddot{\mathrm{B}}$,	436·2	(O, 68·78)
BROMINE, Br,	1000	
CADMIUM, Cd,	696·8	
CALCIUM, Ca,	251·5	*Berz.*
Lime, $\dot{\mathrm{Ca}}$,	351·5	(O, 28·45)
2 $\dot{\mathrm{Ca}}$	703·0	
3 $\dot{\mathrm{Ca}}$	1054·5	
4 $\dot{\mathrm{Ca}}$	1406·0	
5 $\dot{\mathrm{Ca}}$	1757·5	
6 $\dot{\mathrm{Ca}}$	2109·0	
CARBON, C.	75	*Dumas.*
Carbonic Acid, $\ddot{\mathrm{C}}$,	275	(O, 72·73)
2 $\ddot{\mathrm{C}}$	550	
3 $\ddot{\mathrm{C}}$	825	
4 $\ddot{\mathrm{C}}$	1100	
5 $\ddot{\mathrm{C}}$	1375	
6 $\ddot{\mathrm{C}}$	1650	
CERIUM, Ce,	575	*Hermann.*
Protoxyd of C., $\dot{\mathrm{Ce}}$,	675	(O, 14·82)
Peroxyd of Cerium, $\overset{\dots}{\overline{\mathrm{Ce}}}$,	1450	(O, 20·69)
CHLORINE, Cl.	443·3	
Hydrochlor. Acid, HCl,	455·8	

CHROMIUM, Cr,	328·4	*Berlin.*
Oxyd of Chrome, $\overset{\dots}{\overline{\mathrm{Cr}}}$,	956·8	(O, 31·35)
Chromic Acid, $\dddot{\mathrm{Cr}}$,	628·4	(O, 47·74)
COBALT, Co,	368·65	
Oxyd of Cobalt, $\dot{\mathrm{Co}}$,	468·65	(O, 21·34)
COLUMBIUM (Tantalum) Ta,	2296·7	
Columbic Acid, $\dddot{\mathrm{Ta}}$,	2596·7	(O, 11·55)
COPPER (Cuprum), Cu,	395·6	
Oxyd of Copper, $\dot{\overline{\mathrm{Cu}}}$,	891·2	(O, 11·22)
Oxyd of Copper, $\dot{\mathrm{Cu}}$,	495·6	(O, 20·17)
DIDYMIUM, D,	620 ?	*Marignac.*
ERBIUM, Eb,		
FERRUM (Fe) see *Iron.*		
FLUORINE, F,	237·5	*Louyet.*
Hydrofluoric Acid, HF,	250·0	(F, 95)
GLUCINUM (Beryllium), Be,	58·084	*Awd.*
Glucina, $\dot{\mathrm{Be}}$,	158·084	(O, 63·26)
or Glucinum, Be,	87·12	*Berz.*
Glucina, $\overset{\dots}{\overline{\mathrm{Be}}}$,	474·24	(O, 63·26)
GOLD (Aurum), Au,	2455	
HYDRARGYRUM (Hg) see *Quicksilver.*		
HYDROGEN, H,	12·5	
Water, $\dot{\overline{\mathrm{H}}}$,	112·5	(O, 88·89)
2 $\dot{\overline{\mathrm{H}}}$	225·0	
3 $\dot{\overline{\mathrm{H}}}$	337·5	
4 $\dot{\overline{\mathrm{H}}}$	450·0	
5 $\dot{\overline{\mathrm{H}}}$	562·5	
6 $\dot{\overline{\mathrm{H}}}$	675·0	
7 $\dot{\overline{\mathrm{H}}}$	787·5	
8 $\dot{\overline{\mathrm{H}}}$	900·0	
9 $\dot{\overline{\mathrm{H}}}$	1012·5	
IODINE, I,	1586	
IRIDIUM, Ir.	1232	
IRON (Ferrum), Fe,	350	
Protoxyd of Iron, $\dot{\mathrm{Fe}}$,	450	(O, 22·22)
2 $\dot{\mathrm{Fe}}$	900	
3 $\dot{\mathrm{Fe}}$	1350	
4 $\dot{\mathrm{Fe}}$	1800	
Peroxyd of Iron, $\overset{\dots}{\overline{\mathrm{Fe}}}$,	1000	(O, 30)
KALIUM (K) see *Potassium.*		
LANTHANUM, La,	588	*Marignac.*
Protoxyd of L., $\dot{\mathrm{La}}$,	688	(O, 14·55)
Peroxyd of L., $\overset{\dots}{\overline{\mathrm{La}}}$.	1476	(O, 20·33)
LEAD (Plumbum), Pb,	1294·6	
Oxyd of Lead, $\dot{\mathrm{Pb}}$.	1394·6	(O, 7·17)

	1	2	3	4	5	6	7	8	9
$\overset{\dots}{\overline{\mathrm{Al}}}$	46·74	93·48	140·22	186·96	233·70	280·44	327·18	373·92	420·66
$\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}$	34·78	69·56	104·34	139·12	173·90	208·68	243·46	278·24	313·02
$\dot{\mathrm{Ba}}$	10·45	20·90	31·35	41·80	52·25	62·70	73·15	83·60	94·05
$\overset{\dots}{\overline{\mathrm{Be}}}$	63·26	126·52	189·78	253·04	316·30	379·56	442·82	506·08	569·34
$\dot{\mathrm{Ca}}$	28·45	56·90	85·35	113·80	142·25	170·70	199·15	227·60	256·05
$\ddot{\mathrm{C}}$	72·73	145·46	218·19	290·92	363·65	436·38	509·11	581·84	654·57
$\overset{\dots}{\overline{\mathrm{Cr}}}$	31·35	62·70	94·05	125·40	156·75	188·10	219·45	250·80	282·15
$\dddot{\mathrm{Cr}}$	47·74	95·48	143·22	190·96	238·70	286·44	334·18	381·92	429·66
$\dot{\mathrm{Co}}$	21·34	42·68	64·02	85·36	106·70	128·04	149·38	170·72	192·06
$\dot{\overline{\mathrm{Cu}}}$	11·22	22·44	33·66	44·88	56·10	67·32	78·54	89·76	100·98
$\dot{\mathrm{Cu}}$	20·17	40·34	60·51	80·68	100·85	121·02	141·19	161·36	181·53
$\dot{\mathrm{Fe}}$	22·22	44·44	66·66	88·88	111·10	133·32	155·54	177·76	199·98

LIME, see *Calcium.*		
LITHIUM, Li,	81·66	
Lithia, $\dot{\mathrm{Li}}$,	181·66	(O, 55·05)
MAGNESIUM, Mg,	154·5	*Svanb.*
Magnesia, $\dot{\mathrm{Mg}}$,	254·5	(O, 39·3)
2 $\dot{\mathrm{Mg}}$	509·0	
3 $\dot{\mathrm{Mg}}$	763·5	
4 $\dot{\mathrm{Mg}}$	1018·0	
5 $\dot{\mathrm{Mg}}$	1272·5	
6 $\dot{\mathrm{Mg}}$	1527·0	
MANGANESE, Mn,	344·7	
Protoxyd of M., $\dot{\mathrm{Mn}}$,	444·7	(O, 22·47)
2 $\dot{\mathrm{Mn}}$	889·4	
3 $\dot{\mathrm{Mn}}$	1334·1	
4 $\dot{\mathrm{Mn}}$	1778·8	
Peroxyd of M., $\dddot{\bar{\mathrm{Mn}}}$,	989·4	(O, 30·32)
2 $\dddot{\bar{\mathrm{Mn}}}$	1978·8	
3 $\dddot{\bar{\mathrm{Mn}}}$	2968·2	
4 $\dddot{\bar{\mathrm{Mn}}}$	3957·6	
MERCURY (Hg) see *Quicksilver.*		
MOLYBDENUM, Mo,	575·83	*Svanb.*
Molybdic Acid, $\dddot{\mathrm{Mo}}$.	875·83	(O, 34·3)
NATRIUM (Na) see *Sodium.*		
NICKEL, Ni,	369·33	
Protoxyd of Nickel, $\dot{\mathrm{Ni}}$,	469·33	(O, 21·3)
NIOBIUM, Nb,		
NITROGEN, N,	175	
2 N	350	
3 N	525	
Nitric Acid, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$,	675	(O, 74)
2 $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$	1350	
3 $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$	2025	
4 $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$	2700	
NORIUM,		
OSMIUM, Os,	1243·6	
OXYGEN, O,	100	
PALLADIUM, Pd,	665·48	
PELOPIUM,		
PHOSPHORUS, P,	392	*Berz.*
Phosphoric Acid, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$,	892	(O, 56·05)
2 $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	1784	
3 $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	2676	
4 $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	3568	
PLATINUM, Pt,	1232·08	
PLUMBUM (Pb) see *Lead.*		
POTASSIUM (Kalium), K,	488·86	
Potassa, $\dot{\mathrm{K}}$,	588·86	(O, 16·98)
2 $\dot{\mathrm{K}}$	1177·72	
3 $\dot{\mathrm{K}}$	1766·58	
4 $\dot{\mathrm{K}}$	2355·44	
QUICKSILVER (Hydrargyrum), Hg,	1250	
RHODIUM,	651·96	
RUTHENIUM, Ru,	652	
SELENIUM, Se,	495·3	
SILICIUM, Si,	277·31	*Berz.*
Silica, $\dddot{\mathrm{Si}}$,	577·31	(O, 51·96)
2 $\dddot{\mathrm{Si}}$	1154·62	
3 $\dddot{\mathrm{Si}}$	1731·93	
4 $\dddot{\mathrm{Si}}$	2309·24	
5 $\dddot{\mathrm{Si}}$	2886·55	
6 $\dddot{\mathrm{Si}}$	3463·86	
7 $\dddot{\mathrm{Si}}$	4041·17	
8 $\dddot{\mathrm{Si}}$	4618·48	
9 $\dddot{\mathrm{Si}}$	5195·79	
SILVER (Argentum), Ag,	1350	
Sulphuret of S., AgS,	1550	(S, 12·9)
SODIUM (Natrium), Na,	287·2	
Soda, $\dot{\mathrm{Na}}$,	387·2	(O, 25·83)
2 $\dot{\mathrm{Na}}$	774·4	
3 $\dot{\mathrm{Na}}$	1161·6	
4 $\dot{\mathrm{Na}}$	1548·8	
STANNUM (Sn) see *Tin,*		
STIBIUM, (Sb) see *Antimony.*		
STRONTIUM, Sr,	548	*Pelouse.*
Strontia, $\dot{\mathrm{Sr}}$,	648	(O, 15·43)
SULPHUR, S,	200	
Sulphuric acid, $\dddot{\mathrm{S}}$,	500	(O, 60)
TANTALUM (Ta) see *Columbium.*		
TELLURIUM, Te,	801·8	
TERBIUM, Tb,		
THORIUM, Th,	743·86	
Thoria, $\dot{\mathrm{Th}}$,	843·9	(O, 11·84)
TIN, (Stannum), Sn,	735·3	
Oxyd of Tin, $\ddot{\mathrm{Sn}}$,	935·3	(O, 21·38)
TITANIUM, Ti,	301·6	
Oxyd of Titanium, $\dddot{\bar{\mathrm{Ti}}}$,	903·2	(O, 33·22)
Titanic Acid, $\ddot{\mathrm{Ti}}$,	501·6	(O, 39·87)
TUNGSTEN (Wolfr'um), W,	1183·4	
Tungstic Acid, $\dddot{\mathrm{W}}$,	1483·4	(O, 20·16)

	1	2	3	4	5	6	7	8	9
$\dot{\bar{\mathrm{H}}}$	88·89	177·78	266·67	355·56	444·45	533·34	622·23	711·12	800·01
$\dot{\mathrm{K}}$	16·98	33·96	50·94	67·92	84·90	101·88	118·86	135·84	152·82
$\dot{\mathrm{Li}}$	55·05	110·10	165·15	220·20	275·25	330·30	385·35	440·40	495·45
$\dot{\mathrm{Mg}}$	39·30	78·60	117·90	157·20	196·50	235·80	275 10	314·40	353·70
$\dot{\mathrm{Mn}}$	22·47	44·94	67·41	89·88	112·35	134·82	157·29	179·76	202·23
$\dddot{\bar{\mathrm{Mn}}}$	30·32	60·64	90·96	121·28	151·60	181·92	212·24	242·56	272·88
$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$	74·00	148	222	296	370	444	518	592	666
$\dot{\mathrm{Na}}$	25·83	51·66	77·49	103·32	129·15	154·98	180·81	206·64	232·47
$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	56·05	112·10	168·15	224·20	280·25	336·30	392·35	448·40	504·45
$\dot{\mathrm{Pb}}$	7·17	14·34	21·51	28·68	35·85	43·02	50·19	57·36	64·53
$\dddot{\mathrm{Si}}$	51·96	103·92	155·88	207·84	259·80	311·76	363·72	415·68	467·64
$\dot{\mathrm{Sr}}$	15·43	30·86	46·29	61·72	77·15	92·58	108·01	123·44	138·87

URANIUM, U,	750	*Peligot.*	YTTRIUM, Y,	402·5	
Protoxyd of U., $\dot{\mathrm{U}}$,	850	(O, 11·76)	Yttria, $\dot{\mathrm{Y}}$,	502·5	(O, 19·90)
Peroxyd of U., $\dddot{\bar{\mathrm{U}}}$,	1800	(O, 16·66)	ZINC, Zn,	406·6	*Erdmann.*
Protoperox. of U., $\dot{\mathrm{U}}\dddot{\bar{\mathrm{U}}}$,	2650	(O, 15·10)	Oxyd of Zinc, $\dot{\mathrm{Zn}}$,	506·6	(O, 19·74)
VANADIUM, V,	856·9		2 $\dot{\mathrm{Zn}}$	1013·2	
WATER, see *Hydrogen.*			ZIRCONIUM. Zr,	419·73	
WOLFRAMIUM (W) see *Tungsten.*			Zirconia, $\dddot{\bar{\mathrm{Zr}}}$,	1139·5	(O,26·3)

As the use of the table in deducing formulas involves the frequent multiplication of the oxygen percentage, their multiples by the digits 1 to 9 are given, for the compounds of most common occurrence, at the foot of the two preceding pages.*

243. 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 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 contains 2 of iron to 3 of oxygen, and therefore has the atomic weight 1000, ($2\times350=700$, and $700+300=1000$). To ascertain the percentage of oxygen in this oxyd, we have 300 of oxygen in 1000 parts; hence if 1000 parts contain 300, what will 100 parts contain: therefore dividing 300×100 by 1000 gives the oxygen percentage. Hence too if we multiply the percentage 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, $46{\cdot}74\times641{\cdot}8 \div 100=300$, the amount of oxygen; and in this way the correctness of the oxygen percentage may be verified.

244. 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 58·949, antimony 22·846, and sulphur 16·609 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 percentage of each element by the atomic weight of the same;* as, 58·949 by 1350, the atomic weight of silver. (See preceding table). This process gives the relation,

$$0{\cdot}043 : 0{\cdot}014 : 0{\cdot}083;$$

and *dividing each by the smallest,* to simplify it, it becomes

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* The student may find some aid in reading German labels, or consulting analyses, from the following list of significations of a few German words:—

Blei, Lead.
Eisen, Iron.
Kali, Potash.
Kalkerde, Lime.
Kieselerde, } Silica.
Kieselsäure, }
Kobalt, Cobalt.
Kohlensäure, Carbonic Acid.
Kupfer, Copper.
Natron, Soda.
Salpetersäure, Nitric Acid.
Schwefel, Sulphur.
Salzsäure, Muriatic Acid.
Stickstoff, Nitrogen.
Talkerde, Magnesia.
Thonerde, Alumina.
Wasserstoff, Hydrogen.
Wismuth, Bismuth.

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.

2. An analysis of Feldspar gives in 100 parts,

Silica 64·20, Alumina 18·40, Potash 16·95.

From the above table we find that 100 of silica contain 51·96 of oxygen; consequently if 100 give 51·96, the amount in 64·20 parts will be found by multiplying 51·96 by 64·20, and dividing by 100. So in 100 parts of alumina the oxygen is 46·74; hence the oxygen in 18·40 parts of alumina will equal, $\frac{18{\cdot}40\times46{\cdot}74}{100}$. In this way we ascertain that

64·20 of silica contain	33·35 of oxygen,		or dividing each by the smallest,	12
18·40 of alumina "	8·60	"		3
16·95 of potash "	2·87	"		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:

$$\dot{K}\,\dddot{Si}+\dddot{\overline{Al}}\,\dddot{Si}^3.$$

The index ^{3} expresses the number of atoms of silica: had the 3 been written as a prefix, thus—

$$3\dddot{\overline{Al}}\,\dddot{Si},$$

it would have meant 3 atoms of a compound of silica and alumina.

3. In the same manner we find that Yenite contains

3 of lime,	6 of protoxyd of iron,	2 of peroxyd of iron,	4 of silica.
$3\dot{Ca}$	$6\dot{Fe}$	$2\dddot{\overline{Fe}}$	$4\dddot{Si}$

Apportioning the silica to the several bases, 1 atom to the lime, 2 to the protoxyd of iron, and 1 to the peroxyd, it gives the formula

$$\dot{Ca}^3\dddot{Si}+2\dot{Fe}^3\dddot{Si}+\dddot{\overline{Fe}}^2\dddot{Si},$$

in which the simple ratio between the oxygen of the bases and the oxygen of the silica is well illustrated. But lime and protoxyd of iron are isomorphous, and are therefore often linked together in the formula, as one may replace the other. Adding these terms gives 3 atoms of the two, to 3 of silica; the formula then becomes

$$3(\dot{Ca},\dot{Fe})^3\dddot{Si}+\overline{F}e^2\dddot{Si}\text{—or }3\dot{R}^3\dddot{Si}+\overline{F}e^2\dddot{Si},$$

$\dot{R}$ being used as a general expression for the different isomorphous bases included within the brackets. This mode of stating a formula in general terms by the use of R is often employed. In linking together isomorphous constituents as above, the sum of like constituents is first obtained; next, if there is a common divisor, the results are to be divided by this divisor; and then the formula written out. Thus, $\overline{C}u$ and Pb being isomorphous—

$$(3\,\overline{C}u\,S+Sb\,S^3)+2(3\,Pb\,S+Sb\,S^3)=3(\overline{C}u,Pb)\,S+Sb\,S^3.$$

4. In the *first* example above, the sulphur is usually supposed to be combined both with the silver and the antimony, making the mineral a compound of sulphuret of antimony and sulphuret of silver. The sulphuret of antimony in such compounds contains 3 atoms of sulphur; this leaves 3 atoms of sulphur for the 3 atoms of silver. The formula is therefore (using the mark (ı) for an atom of sulphur),

$$3\,\overset{\prime}{Ag}+\overset{\prime\prime\prime}{Sb}\text{, or, under another form, }\overset{\prime}{Ag}{}^3\,\overset{\prime\prime\prime}{Sb}.$$

245. To deduce the percentage 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 577·31, and 4 times this, is 2309·24. Setting this down and the atomic weight of alumina and potash below it, and adding, we have,

4 of Silica,	2309·24
1 of Alumina,	641·80
1 of Potash,	588·86
Total,	3539·90

or the atomic weight of the compound. Now if this amount (3539·9) of feldspar contains 2309·24 of silica, what will 100 parts contain? Hence we divide the atomic weight of each constituent in succession by the sum of the whole, and this gives the percentage relation for each.

246. *Isomorphism—Dimorphism and Trimorphism.*—In the early stages of mineralogical and chemical science, identity of crystalline form was supposed to indicate an identity of chemical composition. As facts multiplied, the truth of this law was doubted, and in 1817, its uncertainty was well illustrated by Beudant in an article tending to prove the superiority of crystallographic characters for the distinction of mineral species. The law, however, by which the variations in the composition of the same species were governed, was not fully understood till 1819, when Mitscherlich brought out the fact that certain substances may replace one another in the composition of compounds, without varying the crystalline form. This property he called *Isomorphism*, from ἴσος, *equal*, and μορφη, *form* ; and those bases that admitted of mutual substitution, were termed *isomorphous*. By referring to the analyses of pyroxene or garnet, a remarkable disagreement will be observed between the several varieties of each, arising from the isomorphous nature of magnesia, lime, and protoxyd of iron. In some specimens one of these bases is replaced wholly by both or one of the others ; and often all three are found combined, and sometimes protoxyd of manganese is also added.

The carbonates of lime, magnesia, iron, manganese, and zinc have a common rhombohedral form, the angle R : R of which varies from 105° in carbonate of lime to 107° 40′ in carbonate of zinc. Again the sulphate of lime, (anhydrous), of baryta, strontia, lead, are isomorphous, the form being trimetric, and M : M=respectively 100° 8′, 101° 40′, 104°, 103° 43′. The angles, as observed, are only approximately identical, and the term *plesiomorphism* has therefore been proposed, yet it is hardly a necessary substitute, and has not been adopted.

247. Again, according to another principle, the same chemical compound may present two distinct unrelated forms. Thus carbonate of lime crystallizes in rhombohedrons, (p. 205); and also in trimetric forms, and when the latter, it is called *arragonite*, (p. 208). The principle here involved is termed *dimorphism*, from δις, *twice*, and μορφη, *form*. In titanic acid we have an example of *three* distinct forms for one chemical compound, one called *rutile*, another *brookite*, another *anatase*, (pp. 387–389), a case of what has been named *trimorphism*. *Bromlite* and *barytocalcite* (p. 198) are chemically identical, yet the former is *trimetric* and the latter *monoclinic*. Moreover, *bromlite* ($\dot{C}a$, $\dot{B}a$) $\ddot{C}$ is isomorphous with *arragonite*, $\dot{C}a\ddot{C}$, and as the latter is the same compound with calcite, this kind of compound, $\dot{R}\ddot{C}$, is trimorphous, (R standing for Ca, Ba, and the allied substances).

The following examples illustrate the variety of forms that may belong to different compounds.

$\dot{R}\ddot{C}$—1, rhombohedral, (calcite); 2, trimetric, (arragonite); 3, monoclinic, (bromlite).
FeS^2—1, monometric, (common pyrites); 2, trimetric, (white iron pyrites).
$\ddot{T}i$—1 and 2, dimetric, (rutile and anatase); 3, trimetric, (brookite).
Feldspar—1, monoclinic, (feldspar); 2, triclinic, (albite); and 3, (since leucite is the same compound with andesine), monometric.
Garnet—1, monometric, (garnet); 2, monoclinic, (allanite, in part); 3, hexagonal, (hexagonal mica).

An exhibition of the various cases of isomorphism and dimorphism or trimorphism will be found in the chemical classification at the close of this volume.

248. The physical characters vary with the form. In arragonite H=3·5—4, G=2·92—2·94. In calcite, H=3, G=2·52—2·7. Again in rutile G=4·18—4·29; in anatase G=3·85—3·93; in brookite G=4·15. In the feldspars the monometric form has the lowest specific gravity, the monoclinic the next lowest, and the triclinic the highest, and the reverse is true of their atomic volumes.

249. Two substances may be both isomorphous and correspondingly dimorphous, and they are then said to be *isodimorphous.* Thus, titanic acid takes on dimetric and trimetric forms; and its isomorph, oxyd of tin, has corresponding forms.

250. Isomorphism in compounds always follows isomorphism in the elements of which they consist; and these isomorphous compounds consist usually of the isomorphous elements *in the same proportions,*—that is, they are *homologous* compounds. Thus in one group, they are *peroxyds;* in a second, *protoxyds;* and so with other cases.

251. A proper classification of the elements exhibits their isomorphous relations and that of their homologous compounds, and it also classes together, on the ground just stated, those elements that are alike in their modes of combination. The following is such a classification, as nearly as we can now ascertain:

1. Oxygen, sulphur, selenium;—fluorine, chlorine, bromine, iodine.
2. Carbon, boron, silicon.
3. Nitrogen; phosphorus, arsenic, antimony, bismuth; tellurium, vanadium; osmium, iridium.
4. Titanium, tin;—columbium, niobium, pelopium;—tungsten, molybdenum;—uranium.
5. *a.* Cerium, lanthanum, didymium, yttrium; glucinum; zirconium, norium; aluminium, chromium, iron, manganese, cobalt, nickel;—zinc, magnesium, calcium, strontium, baryum, lead.
   b. Copper, mercury, silver, sodium, potassium, lithium.
   c. Gold, platinum, palladium, rhodium, ruthenium.
   d. Hydrogen.

The peroxyds of cerium, lanthanum, zirconium, aluminium, chromium, iron, and manganese, mutually replace one another; and so the protoxyds;—in other words, like compounds of each group are isomorphous.

252. Prof. G. Rose has shown that iridium and osmium, and probably also palladium, are isomorphous with antimony, arsenic and tellurium. They all assume rhombohedral forms; in

Osmium,	R : R=84° 52′.	Tellurium,	R : R=86° 57′.
Iridium,	" 84° 52′.	Antimony,	" 87° 35′.
Arsenic,	" 85° 04′.	Bismuth,	" 87° 40′.

Palladium, *undetermined.*

253. The isomorphism of Ȼu (or Cu^2) with Pb has been recently admitted, and evidence of its correctness has been brought forward by the distinguished chemist just mentioned. So also Ȼu and Ag, are isomorphous. Hence cuproplumbite, whose formula

$$\text{Ȼu}\,S+2\,Pb\,S=(\text{Ȼu}, Pb)^3\,S^3=(\text{Ȼu}, Pb)\,S,$$

is analogous to galena (Pb S) in composition as well as crystallization. Copper glance, ȻuS, and stromeyerite, (Ȼu, Ag) S, are isomorphous. By doubling the atomic weight of copper, Ȼu then becomes Cu, and the seeming anomaly is removed.

254. It has been assumed that sulphur and arsenic are isomorphous. But as Rose observes, the view is not supported by a similarity of crystallization in the elements, nor by an analogy in their compounds. There are wide discrepancies in the angles, when the forms are of the same system. For example, in the rhombic prism of marcasite, ($\mathrm{Fe\,S^2}$), the angle $M : M = 106^\circ\ 36'$; in that of leucopyrite, ($\mathrm{Fe\,As^2}$), the same angle is 122° 26′; and in mispickel, ($\mathrm{Fe\,As^2 + Fe\,S^2}$, which Frankenheim has written $\mathrm{Fe\,(As,\,S)^2}$), this angle is 111° 53′. These three compounds are probably therefore distinct types.

255. The isomorphism of substances, according to Dr. H. Kopp, is connected with an equality of atomic volume. He ascertained the atomic volumes of many acknowledged isomorphous or rather plesiomorphous compounds, (by dividing the atomic weight by the specific gravity,) and found a conformity among substances so related. For example, for the carbonates of zinc and magnesia, mesitine, carbonates of iron and manganese, dolomite, and calc spar, the atomic volumes are as in the following table:

	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′
Calc spar,	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.[*]

256. Isomorphism has been supposed to be confined to like or homologous compounds. Yet the discrepancies in composition among the varieties of epidote, scapolite, and some other species, have shown that there are exceptions not harmonizing with the received law. Hermann has recognized these cases of isomorphism under the new term *heteromerism*—which term, as all *unlike* compounds are heteromerous, is of unmeaning application here, and should be written out in full, *heteromerous isomorphism*.

G. Rose has pointed out a few more striking cases of isomorphism among unlike compounds. After showing that *bournonite* and *dark red silver ore* have analogous chemical formulas, (see beyond), he remarks that the first occurs in rhombic prisms, the other in rhombohedral forms. He then points out the close approximation in form between bournonite, arragonite, and nitrate of potash,

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[*] Dr. Kopp also deduces a formula for calculating the volume from the length of the axis, and finds it to give results agreeing very nearly with the above. These principles are illustrated by numerous examples, in an article in the L. E. and D., Phil. Mag. for April, 1841, p. 255.

each crystallizing in right rhombic prisms, and next the relation in form between calc spar, (a dimorph with arragonite); nitrate of soda, (a homologue of nitrate of potash), and red silver ore, (a homologue of bournonite). This is seen in the following table:—

1. *Form that of Calc Spar.*

	Formula.	R : R.
a. Calc spar and isomorphs,	$\dot{\mathrm{R}}\,\ddot{\mathrm{C}}$	105°—107° 40′
b. Nitrate of Soda,	$\dot{\mathrm{Na}}\,\overset{.....}{\mathrm{N}}$	106° 33′
c. Dark red silver ore,	$(\mathrm{Ag\,S})^3+\mathrm{SbS}^3$	108° 18′
Light red silver ore,	$(\mathrm{Ag\,S})^3+\mathrm{AsS}^3$	107° 36′

2. *Form that of Arragonite.*

	Formula.	M : M.
a. Arragonite, Cerusite, &c.,	$\dot{\mathrm{R}}\,\ddot{\mathrm{C}}$	116°—118° 30′
b. Nitrate of potash,	$\dot{\mathrm{K}}\,\overset{.....}{\mathrm{N}}$	119°
c. Bournonite,	$(\frac{1}{3}\overline{\mathrm{Cu}}\mathrm{S}+\frac{2}{3}\mathrm{PbS})^3+\mathrm{SbS}^3$	115° 16

There is hence an obvious isomorphism between these compounds.

257. Another example is in the case of the rhombohedral metals, whose angles are given on page 152, and the rhombohedral peroxyds, *specular iron*, *titanic iron*, *corundum*, (pure alumina), in which the angle R : R is between 85° 55′ and 86° 6′, the last being the angle of corundum, and 86° that of specular iron.

258. But these, as the author finds, are but a few among the many groups. It appears, in fact, that isomorphism may be independent of any relation in composition. The following are some of the groups distinguished:—

1. Chrysoberyl ($\dot{\mathrm{Be}}\,\dddot{\overline{\mathrm{Al}}}$, or, with the old atomic weight, $\dddot{\overline{\mathrm{Be}}}\,\dddot{\overline{\mathrm{Al}}}^6$),—Chrysolite ($(\dot{\mathrm{Mg}},\dot{\mathrm{Fe}})^3\dddot{\mathrm{Si}}$),—Serpentine ($2\dot{\mathrm{Mg}}^3\dddot{\mathrm{Si}}^2+3\dot{\mathrm{Mg}}\dot{\mathrm{H}}^2$),—Villarsite ($4(\dot{\mathrm{Fe}},\dot{\mathrm{Mg}})^3\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$),—Picrosmine ($2\dot{\mathrm{Mg}}^3\dddot{\mathrm{Si}}^2+3\dot{\mathrm{H}}$),—Epsom Salt ($\dot{\mathrm{Mg}}\dddot{\mathrm{S}}+7\dot{\mathrm{H}}$).
2. Quartz ($\dddot{\mathrm{Si}}$),—Chabazite ($(\dot{\mathrm{Ca}},\dot{\mathrm{Na}},\dot{\mathrm{K}})^3\dddot{\mathrm{Si}}^2+3\dddot{\overline{\mathrm{Al}}}\dddot{\mathrm{Si}}^2+18\dot{\mathrm{H}}$).
3. Corundum ($\dddot{\overline{\mathrm{Al}}}$),—Phenacite ($\dot{\mathrm{Be}}^3\dddot{\mathrm{Si}}$).
4. Tungsten ($\dot{\mathrm{Ca}}\dddot{\mathrm{W}}$),—Fergusonite ($\dot{\mathrm{Y}}^6\overset{.....}{\overline{\mathrm{Ta}}}$).
5. Zircon ($\dddot{\overline{\mathrm{Zr}}}\,\dddot{\mathrm{Si}}$),—Rutile ($\ddot{\mathrm{Ti}}$), with which tin ore ($\ddot{\mathrm{Sn}}$) is a known isomorph.
6. Cinnabar (HgS),—Eudialyte ($2\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+\dddot{\overline{\mathrm{Zr}}}\dddot{\mathrm{Si}}^2$).
7. Borax ($\dot{\mathrm{Na}}\dddot{\mathrm{B}}^2+10\dot{\mathrm{H}}$),—Pyroxene ($\dot{\mathrm{Mg}},\dot{\mathrm{Ca}},\dot{\mathrm{Fe}})^3\dddot{\mathrm{Si}}^2$.
8. Anatase ($\ddot{\mathrm{Ti}}$),—Horn Quicksilver (HgCl).
9. Sulphur (S),—Scorodite ($\dddot{\overline{\mathrm{Fe}}}\overset{.....}{\mathrm{As}}+4\dot{\mathrm{H}}$).
10. Celestine ($\dot{\mathrm{Sr}}\dddot{\mathrm{S}}$),—White Iron Pyrites ($\mathrm{FeS}^2$),—Graphic Tellurium ($\mathrm{AgTe}+2\mathrm{AuTe}^3$).
11. Chromate of Lead ($\dot{\mathrm{Pb}}\dddot{\mathrm{Cr}}$),—Monazite ($(\dot{\mathrm{Ce}},\mathrm{Th},\dot{\mathrm{La}})^3\overset{.....}{\mathrm{P}}$).
12. Beryl ($\dot{\mathrm{Be}}^3\dddot{\mathrm{Si}}^2+\dddot{\overline{\mathrm{Al}}}\dddot{\mathrm{Si}}^2$),—Nepheline ($\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+2\dddot{\overline{\mathrm{Al}}}\dddot{\mathrm{Si}}$).

The isomorphism of chrysolite and serpentine with other related magnesian species is now well known. We observe also that a brachydiagonal prism in chrysolite has the angle 80° 53′, and a corresponding one in chrysoberyl 119° 46′. The tangents of half of these angles are nearly as 1 : 2; and a vertical prism of the former has the angle 49° 50′, and one of chrysoberyl 70° 40′, giving the relation of 1 to 1½. The crystallographic axes of these species, as they have been given, are as follows:—

	a		b		c
Chrysoberyl,	0·58	:	1	:	0·465
Chrysolite,	1·1733	:	1	:	0·93

in which, the 1st and 3d terms of chrysolite are double the same in chrysoberyl. The relation is farther seen in the following angles of a rhombic octahedron in the above mentioned species :—

Chrysolite,	139° 55′	85° 15′	108° 31′
Serpentine,	139° 34′	88° 26′	105° 26′
Villarsite,	139° 45′	86° 56′	106° 52′
Chrysoberyl,	139° 53′	86° 16′	

In picrosmine a brachydiagonal prism has the angle 117° 49′, near 119° 46′ of chrysoberyl, and a vertical prism the angle 53° 08′, near 49° 50′ of chrysolite. Epsom salt has the same axes as chrysolite, except that for the assumed fundamental form the vertical axis is approximately one half less. The numbers given are, 0·5703 : 1 : 0·9089.

For the other groups we pass on without remark in this place.

259. The author also finds that the law of equality of volume, or of a simple ratio, holds for these anomalous cases, as well as for those to which it was applied by Kopp. We do not obtain a simple ratio, in most instances, if we compare the *aggregate* atomic volume of the mineral, as has sometimes been done ; but if this sum is divided by the number of atoms of elements, the relations are at once apparent. We thus obtain—

1. Chrysoberyl 37·15, serpentine 44·9, chrysolite 41·6, villarsite 41·65, epsom salt 44, picrosmine (which is less closely related in angle) 46·68.
2. Quartz 54, chabazite 51·5.
3. Corundum 32·3, phenacite 35·74, arsenic 163 (=5×32·6).
4. Scheelite 50·3, tungstate of lead (an acknowledged isomorph of scheelite) 59·5, fergusonite 57·0.
5. Zircon 41·05, rutile 40·7.
6. Cinnabar 90, eudialyte 58, (58 : 90 nearly as 2 : 3).
7. Borax 46·38, pyroxene 46·1—48·8, glauber salt 49·6.
8. Anatase 44·66, horn quicksilver 130·62 (44·62 : 130·62 : : 1 : 3).
9. Sulphur 98, scorodite 47·1 (98 : 47·1 : : 2 (nearly) : 1).
10. Celestine 49, white iron pyrites 52·5, graphic tellurium 113·75.
11. Monazite 51·44, chromate of lead 55·6, (probably dimorphous with tungstate of lead, &c.)
12. Beryl 53·46, and nepheline 56·66.
13. Hornblende $\dot{R}^4\dddot{Si}^3$, and including aluminous varieties, 48·2—48·6,—acmite $\dot{N}a\dddot{Si}+\overline{Fe}\dddot{Si}^2$ 48·33,—pyroxene $\dot{R}^3\dddot{Si}^2$ 46·1—48·8.
14. Scapolite $(\dot{C}a,\dot{N}a)^3\dddot{Si}^2+2\overline{Al}\dddot{Si}$54,—meionite $\dot{C}a^3\dddot{Si}+2\overline{Al}\dddot{Si}$ 55·65,—wernerite $\dot{C}a^3\dddot{Si}+3\overline{Al}\dddot{Si}$ 51·6,—dipyre $4(\dot{C}a, \dot{N}a)\dddot{Si}+8\overline{Al}\dddot{Si}$ 55·21.
15. Talc $\dot{M}g^6\dddot{Si}^4$ 51·65, $\dot{M}g^4\dddot{Si}^3$ 51 73, $\dot{M}g\dddot{Si}$ 51·35.
16. Epidote $\dot{R}^3\dddot{Si}+2\overline{R}\dddot{Si}$ 45·285,—orthite of the Ural $2(\dot{R}^3\dddot{Si}+\overline{R}\dddot{Si})+\dot{H}$ 48·025,—orthite of Hitteroe $(R^3\dddot{Si}+\overline{R}\dddot{Si})+\dot{H}$, 48·43.
17. The Feldspar family :—1. *Monoclinic.* Orthoclase 60·4, ryacolite 57·8, loxoclase 56·0, baulite 55·85 ; 2. *Triclinic.* Albite 55·67, andesine 55, labradorite 53·0, oligoclase 54·64, anorthite 52·85, vosgite 52·84 ; 3. *Monometric.* Leucite 63·08.—Petalite 57·3 falls with the feldspars, both in atomic volume and crystallization, while spodumene falls near andalusite.
18. Andalusite 41·94, spodumene 43·44.
19. Kyanite $\overline{Al}^3\dddot{Si}^2$, 37·10, bucholzite $\overline{Al}\dddot{Si}$ 39·84.

This subject will be found discussed with full details and more examples in the American Journal of Science, [2], vol. ix, 1850.

We add for comparison and farther illustration a series of isomorphous substances and the related dimorphous. The compounds are homologous carbonates. 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.

$\dot{Zn}\ddot{C}$	$\dot{Mg}\ddot{C}$	$\dot{Fe}\ddot{C}$	$\dot{Mn}\ddot{C}$	$\dot{Ca}\ddot{C}$	$\dot{Pb}\ddot{C}$	$\dot{Sr}\ddot{C}$	$\dot{Ba}\ddot{C}$
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 are all acknowledged isomorphs, according to the old principle. Yet the range of numbers is wide. The rhombohedral species increase in atomic volume about 0·075 for a *diminution* of 1′ of angle; and the trimetric 0·1 for an *increase* of 1′ of angle. This subject has various applications, which cannot be properly included in this place.

260. *Cause of Dimorphism.*—Dimorphism 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. These 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 arragonite 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 arragonite were minute six-sided prisms and double six-sided pyramids, (fig. 124, plate 2). They change to rhombohedrons of calc spar if left moist; but if washed and dried at once, they remain permanent. By exposing arragonite 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 arragonite 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 attached 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 arragonite and calc spar; and he suggests that one may be a winter, the other a summer deposit.‡

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* Rose, Lond. and Ed. Phil. Mag. [3], xii, 465.

† Lond. and Ed. Phil. Mag. [3], xii, 330—1841.

‡ Pogg. li, 506—1840.

261. Dimorphism depends therefore on the circumstances attending crystallization. Temperature appears to be the main cause: yet it is possible that the nature of the solvent, or the presence of some accidental ingredient in the solution, or the electrical state of the support, 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 arragonite crystals by mixing a strontian salt with the solution of lime, and shows that the strontia in arragonite has nothing to do with producing the rhombic form.

II. CHEMICAL EXAMINATION OF MINERALS.

262. 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. We here mention only the more ordinary chemical and blowpipe tests.

I. CHEMICAL TESTS.

263. 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. Other carbonates require an 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 certain ores of copper are acted on by nitric acid.

264. In such examinations with acids it is important to observe the odor of the escaping gas; also, whether very suffocating and disagreeable, 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. Another kind of vapor expelled by strong sulphuric acid will corrode glass placed over it, an effect due to the presence of fluorine.

265. 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. 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. These facts will often assist in distinguishing minerals. The minerals that gelatinize in this manner are silicates, mostly those of the zeolite family; it arises from the separation of the silica in a gelatinous state.

266. The following are some of the more common chemical reactions:

a. Carbonates.—Effervesce with dilute muriatic acid, yielding a colorless inodorous gas, which gives a white precipitate when passed into lime water. The fumes 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, and on heating, reddish vapors of nitrous acid. With heated muriatic acid yield an acid that dissolves gold, becoming at the same time yellow.

d. Phosphates.—Dissolve in muriatic, nitric, or sulphuric acid. 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.

e. Chlorids.—In solution afford with nitrate of 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 with sulphuric acid yields muriatic acid, which acts as just stated with nitrate of silver; or heated with oxyd of manganese, affords chlorine.

f. 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.

g. 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 acids.

h. 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.

i. 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.

k. 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.

l. 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.

m. 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.

n. 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.

o. 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.

p. 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.

q. 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 sulphate of iron, metallic gold.

r. 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.

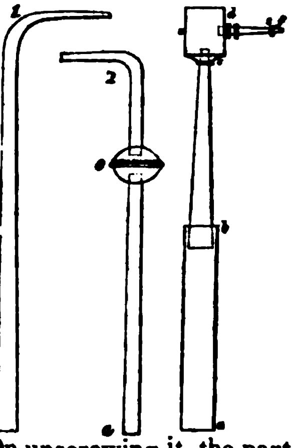
II. ACTION WITH THE BLOWPIPE.

267. 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 figs. 62, 63) is usually added. The air-chamber in fig. 63 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 fig. 63, has a screw 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.

61 62 63



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 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 usually requisite is 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.

268. 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 3 or 4 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.

269. 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 or 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. The 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.

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[*] This salt, a phosphate of soda and ammonia, may be made by dissolving 16 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.

b. ***Boracic acid*** and ***iron wire,*** used in testing for phosphoric acid.

c. Tin-foil, for fusing 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 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.

e. 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.

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.

270. 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 vitiates the test

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* On this subject consult Berzelius on the blowpipe, of which an excellent translation has been published at Boston, by Mr. J. D. Whitney, pp. 237, 8vo. 1845. This work has been consulted in preparing the table here given.

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 platina 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 1 part of fluor finely pulverized, and 1½ 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 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; 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.

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 platina 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 platina 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.

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 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.

24. *Silver.*—The ores on charcoal, with or 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.

26. *Fluorids.*—When fluorids are heated with salt of phosphorus previously melted in an open glass tube, the glass is corroded, and Brazil paper, if placed within the tube, is turned yellow. The salt of phosphorus for this experiment should be free from all chlorids.

27. *Sulphates.*—Like the sulphurets, in their reaction with a glass of borax and silica.

28. *Nitrates.*—They detonate 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 Turner's reagent, (a mixture of two parts of fluor spar and one of bisulphate of potash), the flame is brightly tinged with green.

For a more complete account of the blowpipe and of its use in chemical analysis, I would refer to the Treatises by Berzelius and Plattner.

271. 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. *Platina 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.

272. *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 $\frac{1}{4}$ 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.*

When cupellation is performed in the larger way, small cups (cupels) of bone ashes are used, and these are placed in a muffle, made of stone ware, fitted for the circulation of air through it while it is inserted into the side of the furnace. The air and heat oxydize the lead with the same result as described.

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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, and it is very convenient when they are so small as to be weighed with great difficulty or doubtful accuracy.

PART IV.

TAXONOMY.

I. MINERALOGICAL SPECIES.

273. 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 inorganic 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 Botanical and Zoological sciences, 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.

274. 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 and gases 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.

275. 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 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 possible 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, this principle has seemed inadequate to meet all cases,—as with epidote; 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. But keeping crystallization in view—a quality of the most fundamental character in molecules—research will yet discover a principle (if not already accomplished) which will give wider limits to isomorphism and include these seemingly anomalous cases. Individuals of analogous constitution that are one in crystallization, are 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.

276. 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, if both are not 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 may be presented by the same species.

2. *Streak.*—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 great 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. Brewster, by these means, has distinguished species 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 establishment 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 a thorough chemical analysis, 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.

II. CLASSIFICATION OF MINERALS.

277. 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, (§ 1). 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. A thorough knowledge of chemistry is required to appreciate such an arrangement, and the fullest development of the science to give it perfection.

This view lowers mineralogy from its usual rank along side of botany and zoology, as observed in the introductory remarks to this volume. It exhibits, however, the true character and standing of the science, and enables us to appreciate its real objects and scope, and the basis upon which a classification should rest. Since minerals are treated of apart from other inorganic compounds only for practical purposes, it is not important that the arrangement should depend on the strictest scientific grounds. The special ends of the study may naturally be regarded, and such a classification adopted as shall best promote their accomplishment. These ends are: 1, teaching the distinguishing characteristics of minerals; 2, giving useful information about species. The union of these two objects, although distinct, is to some extent expected and sought for by the student. Such has been the aim in making out the arrangement which is here adopted. It is a mixed system, formed with a reference to the natural relations of the species, and at the same time involving a consideration of their chemical composition, the whole combined in the way deemed best for the advancement of the mineralogical student.

We have in fact returned to the old-fashioned style of arranging the ores of the metals under the head of each metal, and the alkaline and earthy minerals under their bases. Yet we have studied to bring out natural affinities, and when the arrangement failed of exhibiting them, they have been inculcated by full explanations. The silicates in such a practical arrangement, are in general best kept together in associated groups, and the greater part of this portion of the arrangement is based on true chemical principles.

278. Chemistry is slowly preparing the way for a perfect classification of inorganic substances, yet it is at present far from this result. Never perhaps in the history of the science have opinions been more widely different than now among the leaders in this department. Still, as it is of interest to the student to view minerals in what may be considered their truest scientific relations, a classification according in the view of the author with the present condition of chemical science has been attempted, and is given near the close of the volume. Chemical composition is the source of

physical characters, and physical characters are a guide in properly appreciating the nature of chemical composition. In the arrangement, we have eschewed all servility to assumed distinctions, and looked for natural groupings in something more than mere external appearance, or mere identity of elements in composition. The isomorphous relations of the species, as far as possible have been considered, and whatever would exhibit true fundamental affinities.

III. NOMENCLATURE.

279. A systematic nomenclature like that for botany and zoology, is out of place in this science, for reasons already stated, 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 far less than a thousand, and the double names of Natural History, therefore, can well be dispensed with. The addition of the termination *ite* or *lite*, (originally from λίθος, *stone*), or of any other concise affix, 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. As a name is a name after it is once adopted, the origin of the word is not of much importance. Yet it should be remembered that the use of names of persons eminent in other sciences 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.

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[*] The author has here departed widely from principles deemed important in former editions of this treatise. The arrangement of Mohs, followed in the main heretofore, has not for some time been esteemed by him satisfactory, and it has been more and more obvious, with every passing year, that it could not 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; and now that prejudices of early instruction have lessened, it seems 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 cronstedtite, spodumene with prehnite; iolite with quartz and chrysolite: and so on. Some of these, the author in adopting the arrangement, had thrown out; but others remained, and were inseparable from the system. 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 recent *chemical* systems, 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.

The author in this edition has therefore been constrained to adopt an arrangement less presumptuous in its claims. He has had in view the objects of the student, and the practical aim of the science, (or rather *semi-science*, for mineralogy is not more than this), and it is believed that with the aid of the tables for determining species, the system will be no less convenient than the former for communicating a knowledge of minerals.

General View of the Classification adopted.

I. NITROGEN, HYDROGEN.

II. CARBON, BORON.

III. SULPHUR, SELENIUM.

IV. HALOID MINERALS; or the Alkalies and Earths, and their compounds with Water or the Soluble Acids, (Carbonic, Sulphuric, Phosphoric, Arsenic, Boracic), or of their metallic bases with Chlorine or Fluorine.

1. Salts of Ammonia.
2. Salts of Potassa and Soda.
3. Salts of Baryta and Strontia.
4. Salts of Calcia (Lime) and Magnesia.
5. Salts of Alumina.
6. Salts of Yttria, Ceria, &c.

V. EARTHY MINERALS; or Silica and Siliceous or Aluminous compounds of the Alkalies and Earths, and substances Isomorphous.

1. Silica.
2. Silicates of Lime and Magnesia.
    - *a.* Hydrous Silicates or Borosilicates of Lime.
    - *b.* Hydrous Silicates of Magnesia.
    - *c.* Anhydrous Silicates of Lime and Magnesia.
3. Silicates of Alumina.
    - *a.* Hydrous Silicates.
    - *b.* Anhydrous Silicates.
4. Aluminates of Magnesia.
5. Silicates and Aluminates of Glucina.
6. Silicates of Zirconia, Thoria, Yttria, Ceria, &c.

VI. METALS AND METALLIC ORES, (exclusive of the Alkalies and Earths).

1. Tin, Titanium, Molybdenum.
2. Titanates, Columbates, Niobates, Tungstates, Molybdates.
3. Uranium.
4. Bismuth, Tellurium, Antimony, Arsenic.
5. Chromium.
6. Iron.
7. Manganese.
8. Cobalt, Nickel.
9. Zinc, Cadmium.
10. Lead.
11. Copper.
12. Quicksilver.
13. Silver.
14. Platinum, Iridium, Osmium, Palladium, Ruthenium.
15. Gold.

VII. RESINS.

PART V.

DESCRIPTIVE MINERALOGY.

I. NITROGEN–HYDROGEN.

NITROGEN.

Gaseous. G.=·9757. Colorless. Inodorous. Tasteless.

Composition.—Pure nitrogen, but often mixed with oxygen. Nitrogen extinguishes a lighted candle introduced into it, and is destructive to life.

This gas is given out in great abundance over an extent of four or five acres, near the town of Hoosic, N. Y., and also issues through the waters of the Lebanon Springs, which are not far distant. The Lebanon waters are tasteless, and have a temperature of 73° F., while other springs in the vicinity stand at 52°. The gas, according to Daubeny, consists of nitrogen 89·4, and oxygen 10·6, or atmospheric air 50, and pure nitrogen 50. At Canoga, Seneca Co., N. Y., there is another nitrogen spring. There are other springs in Virginia, west of the Blue Ridge at Warm and Hot Springs; in Buncombe Co., N. C.; and on the Washita in Arkansas.

There are many foreign localities. Among them may be instanced the mineral springs of Cheltenham and Harrowgate. At Bath the gas escapes at the rate of 267 cubic inches a minute, or 222 cubic feet a day; it contains 2 or 3 per cent. of oxygen, and often a little carbonic acid.

This gas is supposed to proceed from a decomposition of the atmosphere, and the formation of nitric acid from its oxygen and a small portion of the nitrogen.

The *atmosphere* consists of 79 parts of nitrogen and 21 of oxygen, besides a small proportion of carbonic acid. It is about 815 times lighter than water, and 11,605 times lighter than mercury.

HYDROGEN.

Gaseous. G.=0·0694. Colorless and inodorous when pure. Index of refraction, 0·470.

Composition.—Hydrogen gas, but usually impure. It burns with a pale blue flame and little light.

Hydrogen is evolved from beds of coal and stagnant pools. But it is usually met with in combination with carbon.

The following are some of the gaseous hydrogen compounds:—

Carburetted Hydrogen.—A gas with an empyreumatic odor, and burning with a bright yellow light. There are two compounds, one CH^2=carbon 75, hydrogen 25; and the other C^2H^2=carbon 85·7, hydrogen 14·3. The latter is the more common in nature, but they are often mixed.

Carburetted hydrogen is most abundant about beds of coal and beds of bituminous shale. It often issues with much force from small cavities in the interior of coal mines, forming what is termed a *blower*. At Fredonia, Chatauque Co., N. Y., there is a copious discharge of gas from a shaft sunk into the slate rock, and it is used for lighting the village. A gasometer of 220 cubic feet is filled in about fifteen hours. The slate contains considerable bituminous matter and some thin coaly seams. This gas is evolved at several other places in the same county, and in other parts of the State. On the Kenawha river, Va., large quantities of gas escape from the "gas wells," and it is used for evaporating the brine. At one of the works of this kind, 450 bushels of salt are made daily.

Phosphuretted Hydrogen takes fire on coming into the atmosphere. It has an alliaceous odor and bitter taste. G.=1·761. *Composition*, hydrogen 8·71, phosphorus 91·29. It is one of the products of vegetable decomposition, and occurs about marshy places. It is supposed to constitute the phosphoric matter called *jack o'lantern*.

Sulphuretted Hydrogen has a putrid odor. *Composition*, hydrogen 5·824, sulphur 94·176. G.=1·1912. It occurs about sulphur mineral springs issuing through the waters, and is sometimes formed in the vicinity of volcanoes. The various sulphur waters of the middle and western portions of the United States, abound in sulphuretted hydrogen. Sulphur springs occur also near Tampa Bay, Florida.

MURIATIC ACID.*—Hydrochloric Acid.

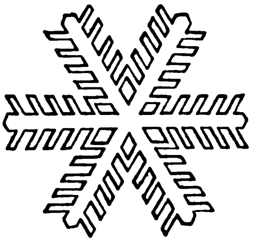
Gaseous. G.=1·2847. Colorless. Odor pungent. Taste acid.

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.

WATER.

Liquid. G.=1. Colorless. Inodorous. Tasteless.



Water becomes solid at 32° F., forming ice or snow, and boils at 212° F. In the solid state, it has a crystalline structure, and in the condition of snow, often presents compound crystals, having a stellated form. The angles of the prisms composing them, are 120° and 60°. A cubic inch of pure water at 60° F., and 30 inches of the barometer, weighs 252·458 grains.

Composition.—HO=Oxygen 88·94, hydrogen 11·06.

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. 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.

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[*] The acid gases, *carbonic acid* and *sulphurous acid*, are described, one under Carbon, and the other under Sulphur.

II. CARBON–BORON.

Carbon occurs crystallized in diamond and graphite, and amorphous in mineral coal. The crystalline forms of diamond and graphite are different, and carbon must therefore be dimorphous. Mineral coal has been considered a third condition of carbon. The three, as observed by Berzelius, differ in specific gravity, specific heat, conducting power for heat and electricity, and chemical relations ; and besides, while coal is combustible, graphite is so incombustible as to be used for crucibles and furnaces.

Carbon combined with oxygen, forming carbonic acid, ($\ddot{C}$a,) is of frequent occurrence in nature. And this acid, united to bases, constitutes the various carbonates, as calc spar, dolomite, magnesite, spathic iron. With hydrogen, carbon forms carburetted hydrogen, (p. 173).

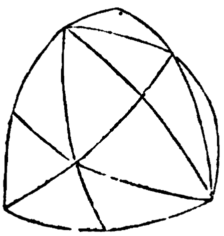
Boron occurs in nature only in the condition of boracic acid, ($\dddot{B}$o) ; and this acid either exists native, (then called *sassolin*) ; or in combination alone with bases, as in *borax*, (hydrous borate of soda), *hayesine*. (hydrous borate of lime), *hydroboracite*, (hydrous borate of lime and magnesia), *boracite* (borate of magnesia) and *rhodizite*—allied to boracite ; or in connection with silica, as in *datholite*, (a hydrous borosilicate of lime), and in *tourmaline* and *axinite*, both anhydrous aluminous silicates.

In the pure state, boron is a pulverulent solid, of a greenish brown color, without taste or odor, and infusible. It is most closely related to silicon and carbon.

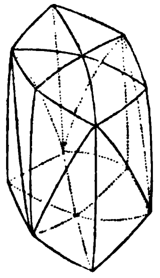
DIAMOND. Adamant. Demant, *W.* Diamant, *L.* and *H.* 'Αδάμας.

Monometric. The following forms, and also figs. 3, 5, 6, 7, 8, 9, 20, 41, pl. 1 ; the faces are often curved. Cleavage octahedral,

1

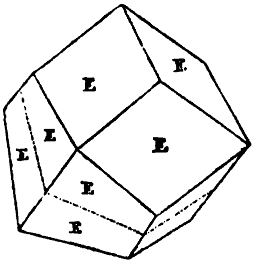


2



North Carolina.

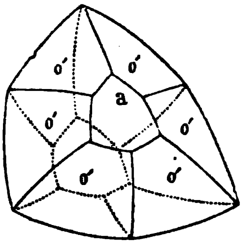
3



highly perfect. Compound crystals: fig. 129, pl. 2 and figure 3; composition parallel to the face of the octahedron. Also figure 4; composition of the same kind, but the crystal shortened in the direction of an octahedral axis. Rarely massive.

H.=10. G.=3·5295, Thomson; 3·55, Pelouze. Lustre brilliant adamantine. Streak uncolored. Color white or colorless; occasionally tinged yellow, red, orange, green, brown, or black. Transparent; translucent when dark colored. Fracture conchoidal.

4



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. Some specimens, exposed to the sun for a short time, give out light when carried into a dark place.

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 placed symmetrically 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.

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 in the district between Golconda and Masulipatam; near Parma in Bundelcund, where some of the most magnificent specimens have been found; also on the Mahanuddy near Ellore. The locality on the island of 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., (A. J. S. [2], ii, 253).

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 diamond which formed the eye of a Brahminical idol and was purchased by the Empress Catharine II. of Russia, from a French grenadier, who had stolen it, weighs 194¼ carats, and is as large as a pigeon's egg. The Pitt or regent diamond is of less size, it weighing but 136·25 carats or 419¼ grains; but on account of its unblemished transparency and color, it is considered the most splendid of Indian diamonds. It was sold to the duke of Orleans, by Mr. Pitt, an English gentleman, who was governor of Bencoolen in Sumatra, for £130,000. It is cut in the form of a brilliant, and is estimated at £125,000. Napoleon placed it in the hilt of his sword of state. 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. The crystals they yield are seldom large. Maure mentions one of 120 carats, but they rarely exceed 18 or 20. The famous diamond, weighing 1680 carats, belonging to the Emperor of Brazil, is supposed to be a topaz.

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 first discovered in 1456, by Louis Berquen, a citizen of Bruges, previous to which time, the diamond was known only in its native uncut state.

The diamond, besides its use as an ornament, is exceedingly 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 term *Adamant*, Gr. ἀδαμας, (of which the word *diamond* is probably a corruption), is supposed to be derived from Greek ἀ, privative, and δαμάω, *to subdue*, as if invincible by fire. This name was applied by the ancients to several minerals differing much in their physical qualities. A few of these are quartz, specular iron ore, emery, and other substances of rather high degrees of hardness, which cannot now be identified. It is doubtful whether Pliny had any acquaintance with the real diamond.

The diamond is supposed to have been of vegetable origin. It has probably proceeded from the slow decomposition of some vegetable resin 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, *H.*—*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 has been detected by Professor Rogers,* and soda by Professor Horsford.

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. I. *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 irides-

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* Am. Jour. Sci., [2], v, 404.

cent. Opaque. Fractue 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.

II. *Bituminous Coal.*—The proportion of bitumen is indefinite, varying from 10 to 40 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 1·2 and 1·5 : 1·26—1·37, Pennsylvania; 1·27, Newcastle, England; 1·199, Lancashire cannel; 1·27—1·32, Scotland; 1·31—1·33, France; 1·27—1·3, Belgium.

Professor W. R. Johnson obtained the following results in his analyses:—

	Moisture.	Vol. combustible matter.	Ashes and clinkers.	Fixed carbon.
Pennsylvania anthracites,	1·34	3·84	7·37	87·45
Maryland free-burning bituminous coal,	1·25	15·80	9·94	73·01
Pennsylvania free-burning bituminous coal,	0·82	17·01	13·35	68·82
Virginia bituminous,	1·64	36·63	10·74	50·99
Cannelton, Indiana, bituminous,	2·20	33·99	4·97	58·44

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. G.=1·265. 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 contains about 11 per cent. of earthy matter. The combustible part, according to Kirwan, consists of carbon 75·2, volatile matter 21·7, cinders 3·1. 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.

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.

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 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 Khorassan or Northern Persia, in Hindostan, north of the gulf of Cutch, in the province of Bengal (the Burdwan coalfield) 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 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 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 63,000 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 west of the Mississippi. 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 1–4½ 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*. Mines of Cannel coal are found near Greensburg, Beaver Co., Pa., 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 extend across from the Firth of Forth to the Firth of Clyde, whole area 1650 square miles. In Ireland, the three are the Limerick 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, $\frac{1}{17}$ 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 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. Bituminous coal, either cretaceous or oolitic in age, (probably the former), occurs on the Rocky Mountains, according to Lieut. Abert, near the Raton Pass—lat. 37° 15′, long. 104° 35′—also, according to Fremont, near lat. 41½°, long. 111°, on Muddy river.

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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.

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.	Area of coal land.	Proporti'ns of coal to their whole areas.	Proporti'ns relative parts of 1000 of coal areas.
	Sq. miles. English.	Square miles.		
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,	203,786	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

" Hence, as regards European countries, Great Britain takes the first rank: Belgium, as regards territorial proportion, occupies the second rank, although in relative coal area she is the least of the four. Pennsylvania, in respect of territorial proportion, is higher than any of these, being relatively one-third: but in absolute area of coal formation, the four eastern colonies of British America united exceeds them all, being larger than that of Great Britain, France, Belgium and Spain conjoined. This table is not strictly perfect; since we possess the areas of the concessions only in France; and, in Spain, only the single coal region of Asturias. We add the areas of Prussia and Austria, but cannot state the proportions of coal formations therein. The American area of coal is nearly three-fourths of the whole amount in our table."

The vegetable origin of coal is generally admitted. It is proved not only by the presence of distinct leaves and fragments of plants along with the coal, and the transitions between them, but also by the detection of the structure of vegetable tissue even in the hardest anthracite.* Fluor spar has been detected associated with cannel coal, by Prof. Rogers.

GRAPHITE. Black Lead. Plumbago. Carburet of iron.

Hexagonal. In flat six-sided tables, having the basal planes 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 supposed to be 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	9·1	8	4	oxyd, 1·4	—
Oxygen,	9	—	—	—	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).

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* Prof. Bailey, Amer. Jour. Sci, [2], i, 407.

At a high temperature it burns without flame or smoke, and leaves usually a portion of red oxyd of iron. Infusible before the blowpipe both alone and with reagents. Unaltered by acids.

Graphite occurs in beds and imbedded masses, laminæ, or scales, in granite, gneiss, mica slate, primitive limestone, and gray-wacke, and is sometimes connected with deposits of coal. It is also met with in greenstone.

A remarkable fine variety of graphite occurs at Borrowdale in Cumberland, in nests in a greenstone rock which constitutes a bed in a clay slate. In Glenstrathfarrar in Inverneshire, 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.

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 Greenville, L. C., associated with sphene and tabular spar in primitive limestone; in Wake, N. C.; on Tyger river, and at Spartenburg 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.

Graphite is extensively employed in the manufacture of pencils. It is also a good material for crucibles, on account of its extreme infusibility; and is used for diminishing friction in heavy machinery, and for giving a gloss to iron stoves, grates, &c.

In the United States, the mines of Stockbridge, 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*, often applied to this species, is entirely inappropriate, as it does not contain a trace of lead.

The name graphite is derived from γραφω, *I write*, in allusion to its extensive use as a material for writing, arising from its property of leaving a trace on paper. Graphite has probably the same vegetable origin as mineral coal.

CARBONIC ACID.

Gaseous. G.=1·5245. Colorless. Taste, slightly acid. Excites a pungent sensation in the nostrils, and destroys life.

Composition.—$\ddot{C}$=Carbon 27·65, oxygen 72·35. 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. Acide boracique, *H.*

Triclinic, *Miller*, with an angle between the base and one of the sides, 75° 30′. 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.—$\overline{B}+3\dot{H}$=boracic acid 56·38, water 33·62. 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.

It fuses in a candle, and at first tinges the flame green; but this color disappears when the water of crystallization has evaporated. When cooled, the globule has a glassy appearance, and is opaque, if any gypsum is present.

This species has been found abundantly in the crater of Vulcano, one of the Lipari isles, where it forms a thin 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, from which place it derived its 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. These lagoons yield from seven to eight thousand pounds troy per day. The boracic acid thus obtained is in large crystalline flakes.

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 place, 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.

III. SULPHUR–SELENIUM.

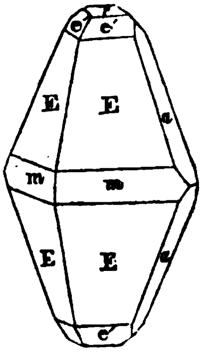
Sulphur is abundant native. It is also a common ingredient in metallic ores, forming native sulphurets with the various metals, excepting gold, platinum, and the associate metals, and also the metals of the alkalies and earths. With oxygen it forms sulphurous and sulphuric acids, ($\ddot{S}$ and $\dddot{S}$), and with hydrogen, sulphuretted hydrogen.

Sulphuric acid occurs in nature combined with various bases, forming sulphates—as gypsum, heavy spar, the alums, vitriols, etc. It is rarely a constituent in a silicate, as in the Haüyne family.

Selenium rarely occurs native. It is usually combined with the metals, forming seleniurets, and is thus united with silver, mercury, copper, lead, zinc, and bismuth, as well as sulphur. It is isomorphous with sulphur, and forms analogous compounds with oxygen, ($\ddot{S}e$, $\dddot{S}e$), but neither selenous nor selenic acid has yet been found native, and the latter is rarely met with combined with oxyd of lead.

Sulphur and selenium are both vaporizable at a low temperature without residue. Selenium before the blowpipe gives an odor like decaying orse-radish.

NATIVE SULPHUR. Naturlicher Schwefel. Soufre, *H.*



Trimetric. E : E (adjacent in the same pyramid)=106° 38′, and 84° 58′, E : E (adjacent but in different pyramids)=143° 17′. *m* : *m*=101° 59′, *m* : E=161° 39′, E : *a*=132° 29′, e′ : e′ (adjacent)=127° 1′, p : e′=134° 53′, p : *a*=117° 48′. Cleavage parallel with E and *m* imperfect. Compound crystals: composition parallel with p. Imperfect crystallizations: imitative shapes and amorphous; composed of concentric coats; also fine granular, or impalpable.

H.=1·5—2·5 G.=2·072, crystals from Spain. Lustre resinous. Streak sulphur-yellow—yellowish-white. Color sulphur-yellow, sometimes reddish or greenish. Transparent—subtranslucent. Fracture conchoidal, more or less perfect. Sectile.

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, with M : M=90° 32′, and P : *ē* (plane truncating the obtuse or front lateral edge)=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. At Radoboy, near Crapina in Croatia, it occurs in imbedded spheroidal masses, which have a brownish tinge, owing to the presence of bitumen.

Sulphur is found as a deposit about the sulphur springs of New York, Virginia, &c., and occurs 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. It occurs in masses in limestone on the Potomac, 25 miles above Washington.

The sulphur mines of Sicily, the crater of Vulcano, and the Solfatara near Naples, afford immense quantities of sulphur for commerce. Previous to becoming an article of commerce, it is purified by fusion or sublimation. It is also largely obtained in roasting the sulphurets of iron and copper. The manufacture of gunpowder, of sulphuric acid, casts, cements, and various pharmaceutical preparations, are among the important processes in which sulphur is required.

SULPHURIC ACID.

Liquid. G.=1·85. Colorless. Odor pungent. Taste intensely acid.

Composition.—$\dddot{S}\dot{H}$=Oxygen 48·89, sulphur 32·78, and water 18·33=100.

This acid, in a dilute state, has been found in the neighborhood of several volcanoes. According to Professor Baldassari, it occurs near Sienna, in the cavities of the small volcanic mountain named Zocolino. Pictet asserts, also, that he has distilled it from a cavern near Aix, in Savoy. Water strong with sulphuric acid occurs at Alabama, Genesee Co. N. Y.; also in Tuscarora, 20 miles north of Port Dover, Lake Erie, Canada. The former was found by B. Silliman, Jr., to contain 40 grains in a gallon; the latter 4 parts of free sulphuric acid in 1000, besides sulphates of the alkalies, lime, magnesia, alum and oxyd of iron. Paramo de Ruiz in New Grenada, and Rio Vinagre, are volcanic localities.

SULPHUROUS ACID.

Gaseous. G.=2·234, Thenard. Colorless. Taste acid. Odor pungent.

Composition.—$\ddot{S}$=Sulphur 50·14, oxygen 49·86; 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.

Sulphurous acid is often used for bleaching.

NATIVE SELENIUM.

In incrustations of a submetallic lustre; and grayish or brownish black color; translucent and red in thin splinters. Powder deep red. 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.

* * *

IV. HALOID MINERALS.

I. AMMONIA.

Ammonia, a gaseous alkali in the pure state, is contained to some extent in the atmosphere, and in the soils where animal decomposition is in progress. Many mineral decompositions taking place in contact with water and the atmosphere and absorbing oxygen, also produce ammonia. It is also found as a muriate, sulphate, carbonate, and phosphate; and also as a magnesian phosphate, (struvite), and soda phosphate, (stercorite).

Owing to its volatility it is easily driven off from its combinations, when assay is heated with soda, and a pungent odor (often called harts-n) is perceived. The salts are for the most part soluble, and have an rid taste.

SAL-AMMONIAC. Muriate of Ammonia. Chlorid of Ammonium. Salmiak, *L.* Naturlicher Salmiac, *W.* Ammoniaque muriatée, *H.*

Monometric: figures 1 and 16, plate 1. Cleavage octahedral. Also stalactitic and in globular masses; in crusts, or as an efflorescence.

H.=1·5—2. G.=1·528. Lustre vitreous. Streak white. Color white; often yellowish or grayish. Translucent—opaque. Fracture conchoidal. Taste saline and pungent.

Composition.—NH^4Cl=Ammonium 33·89, chlorine 66·11. 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 volcanoes, as at Etna, the island of Vulcano, Vesuvius, and the Sandwich Islands. 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. It occurs also in Bucharia; at Kilauea in Hawaii, a variety which contains largely of iron, and becomes rusty yellow on exposure.

Sal ammoniac has not been found in nature in sufficient quantities for commerce. It is manufactured from refuse animal matter, coal, soot, and the waters of gas works. It is a valuable article in medicine and dyeing, and is employed by tinmen to prevent the oxydation of metallic surfaces that are to be tinned or soldered; also mixed with iron filings to pack the joints in steam apparatus.

The ἅλς ἀμμωνιακὸς, sal-ammoniac of Dioscorides, Celsus, and Pliny, is fully proved by Beckmann (Hist. of Inventions, iv, 360) to be common rock salt. It is described by Pliny as a native salt, dug in Egypt, near the oracle of Ammon, whence its name; this name was afterwards transferred to the muriate of ammonia, when, subsequently, it was manufactured in Egypt. Sal-ammoniac is not supposed to have been entirely unknown to the ancients, but to be described, in connection with one or two other species, under the name of *nitrum*, which, according to Pliny, gave the test of ammonia when mingled with quicklime. (Moore's Ancient Mineralogy, p. 96).

MASCAGNINE. Maskagnin, *Karsten, Reuss.* Sulphate of Ammonia.

Trimetric. M : M=107° 40′. Cleavage parallel with the longer diagonal of a rhombic prism. Usually in mealy crusts and stalactitic forms.

Lustre when crystallized, vitreous. Color yellowish-gray, lemon-yellow. Translucent. Taste pungent and bitter.

Composition.—$NH^4\dddot{S}+2\dot{H}$=Sulphuric acid 53·28, ammonia 22·81, water 23·91. 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 Sinese e del Valterrano in Siena, 1779).

BICARBONATE OF AMMONIA.

In crystals, having two brilliant cleavages inclined to one another, at an angle of 112°. G.=1·45. H.=1·5. Yellowish to white, *Composition.*—$NH^3\ddot{C}^2+2\dot{H}$.—Ammonia 21, carbonic acid 55·50, water 23·50=100, E. F. Teschemacher, (Phil. Mag. 1846, xxviii, 548).

From guano deposits on the coast of Africa and Patagonia.

PHOSPHATE OF AMMONIA.

Crystalline and transparent, with a single brilliant cleavage.

Found in small quantities with the preceding.

STRUVITE, *Ulex*, Afv. K. V. Ac. Förh. iii, 32, and Phil. Mag. [3], xxix, 124. Guanite, *E. F. Teschemacher*, Chem. Gaz. Dec. 1845, and Phil. Mag. [3], xxviii, 546.

Trimetric; sometimes hemihedral like electric calamine. Considering the dissimilar parts the extremities, M : M=96° 50′; a macrodiagonal prism, (ē)=63° 30′, a brachydiagonal (ĕ)=95° 10′, ē : ĕ=112°; another macrodiagonal prism (ē′)=57°—57° 30′ : ē′ on the adjoining face of a rhombic pyramid 142° 10′—143°. Cleavage brachydiagonal, perfect.

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.—$NH^4\dot{M}g\overset{\cdot\cdot\cdot\cdot\cdot}{P}+5\dot{H}$, Teschemacher, who obtained for the guanite:

Am. 14·30, $\dot{M}g$ 17·00, $\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 30·40, $\dot{H}$ 38·10=99·80.

Ulex, whose analysis does not appear to be satisfactory, obtained $NH^4\dot{M}g^2\overset{\cdot\cdot\cdot\cdot\cdot}{P}+13\dot{H}$. 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.

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 or cold water.

Composition.—$(\dot{N}a+NH^3)\overset{\cdot\cdot\cdot\cdot\cdot}{P}+10\dot{H}$. Analysis by T. J. Herapath, (Quart. J. Chem. Soc. April, 1849):

$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 34·325, Am. 7·680, $\dot{N}a$ 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 from 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.

II. POTASSA—SODA.

Potassa and soda occur in nature, combined with sulphuric, carbonic, nitric, and boracic acids; also with phosphoric acid in an ammoniacal compound described on the preceding page. Chlorid of potassium is of occasional occurrence, and chlorid of sodium (common salt) is an abundant species. These bases are also found in many siliceous minerals; in acmite of the hornblende family; in the zeolites, apophyllite, thomsonite, soda-mesotype, analcime, chabazite, and more sparingly in others; in some micas; in many of the feldspar family, as leucite, nepheline, feldspar, albite, ryacolite, loxoclase, oligoclase; also in some tourmalines, and in sodalite, haüyne and the allied species; also in some sulphates of iron.

Lithia is another alkali of the same group. It occurs in the siliceous minerals, lepidolite, spodumene, petalite, and castor.

The following salts are more or less soluble. For blowpipe tests distinguishing soda and potash compounds, see page 162.

APHTHITALITE. Sulphate of Potash. Arcanite, *Haidinger*. Aphthalose, *Beudant*. Vesuvian Salt, *Lond. Phil. Trans.*, 1813.

Trimetric. M : M=120° 24′. Occurs massive, or imperfectly mammillary, and in crusts.

H.=2—3. G.=1·731. Lustre vitreous. Color white, sometimes tinged with blue or green. Translucent. Taste saline and bitter, disagreeable.

Composition.—$\dot{K}\overline{S}$=Potash 54·08, sulphuric acid 45·92. A specimen from Vesuvius contained sulphate of potash 71·4, sulphate of soda 18·6, muriate of soda 4·6, muriate of ammonia, copper, and iron 5·4=100, (Phil. Trans. 1813). Fuses before the blowpipe, without intumescence.

Found at Vesuvius, upon the lava, in masses often an inch or more in thickness. Aphthitalite was so named from ἄφθιτος, *indestructible*.

POLYHALITE. Bloedite, *John*.

Trimetric. M : M=115°. 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.—$\dot{K}\overline{S}+\dot{M}g\overline{S}+2\dot{C}a\overline{S}+2\dot{H}$. Analyses: 1, Stromeyer; 2, Rammelsberg, (Pogg. Ann. lxviii, 512).

	$\dot{K}\overline{S}$	$\dot{M}g\overline{S}$	$\dot{C}a\overline{S}$	NaCl	F^2O^3	$\dot{H}$
1. Ischl,	27·70	20·08	44·47	0·19	0·34	5·95=98·94
2. Aussee,	28·10	20·59	45·34	0·11	0·33	5·24, $\overline{Si}$ 0·2=100

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 and Aussee, in Austria, with common salt, gypsum, and anhydrite; at Berchtesgaden in Bavaria.

The name Polyhalite is derived from πολύς, *many*, and ἅλς, *salt*, in allusion to the number of salts in the constitution of the mineral.

The *Bloedite* of John from Ischl, afforded him

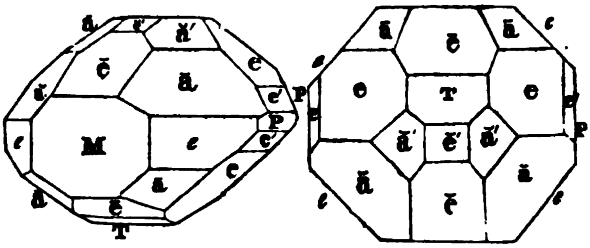
$\dot{\rm Mg}\dddot{\rm S}$ 36·66, $\dot{\rm Na}\dddot{\rm S}$ 33·34, $\dot{\rm Mn}\dddot{\rm S}$ 0·33, NaCl 0·33, $\dot{\rm H}$ 22·00=92·76,

with 0·24 sulphate of peroxyd of iron.

The specimens from Vic in Lorraine, analyzed by Berthier, are supposed to be glauberite mixed with rock-salt.

GLAUBER SALT. Sulphate of Soda. Mirabilite, *Haid.* Exanthalose, *Beudant.* Soude Sulfatée, *H.* Glaubersalz.

Monoclinic. M : *e*=133° 15½′, *e* : *e*=86° 31′, M : ĕ=104° 41′, M : ė=132° 4′, ă : ă=93° 12′, M : T=72° 15′. Cleavage parallel with P. 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.—$\dot{\rm Na}\dddot{\rm S}+10\dot{\rm H}$=Soda 19·38, sulphuric acid 24·85, water 55·77. Beudant's *Exanthalose* from Vesuvius contains but two of water, ($2\dot{\rm H}$).

Occurs at Ischl and Hallstadt in Austria, also in Hungary, Switzerland, Italy, Spain, &c. It is 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.

The artificial salt was first discovered by a German chemist by the name of Glauber, and hence its name.

ASTRAKANITE, *Rose.*

In imperfect prismatic crystals, whitish and translucent.

Composition.—$\dot{\rm Mg}\dddot{\rm S}+\dot{\rm Na}\dddot{\rm S}+4\dot{\rm H}$. Analysis by G. Rose:

$\dot{\rm Na}\dddot{\rm S}$ 41·00, $\dot{\rm Mg}\dddot{\rm S}$ 35·18, $\dot{\rm H}$ 21·56, MgCl 0·33, Gypsum and sand 1·75.

From the salt lakes east of the mouth of the Volga.

REUSSIN, *Karsten.*

In white, flat, six-sided crystals, and also acicular, in radiating groups. Also as a mealy efflorescence. Color white. Taste saline and bitter.

Composition.—Analysis by Reuss, (Crell's Annal. 1791, ii, 18):

$\dot{\rm Na}\dddot{\rm S}$ 66·04, $\dot{\rm Mg}\dddot{\rm S}$ 31·35, CaCl 2·19, Gypsum 0·42.

From the neighborhood of Seidlitz in Bohemia.

THENARDITE, *J. L. Casaseca*, Ann. Ch. Phys. xxxii, 311. Anhydrous Sulphate of Soda.

Trimetric. Right rhombic prism, fig. 72, pl. 2, M : M=125°; also, figs. 75, 76, pl. 2. Cleavage perfect parallel with P and M; most so parallel with P.

H.=2—2·5. G.=2·73. Lustre vitreous. Color white. Translucent. Becomes covered with a white powder on exposure to the air.

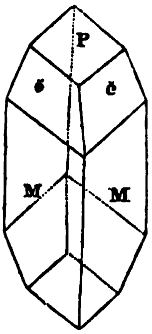
Composition.—$\dot{N}a\dddot{S}$=Soda 56·12, sulphuric acid 43·38; analysis by Casaseca (loc. cit.) Anhydrous sulphate of soda 99·78, carbonate of soda 0·22. Wholly soluble in water. Colors the blowpipe flame deep yellow.

The only known locality is Espartinas in Spain, 5 leagues from Madrid, and 2¼ from Aranjuez. The water exudes during winter from the bottom of a basin, and becoming concentrated in the summer season, deposits crystals of thenardite. This species was named in honor of the celebrated French chemist, Thenard.

GLAUBERITE, *Brongniart*, J. des Mines, xxiii, 5. Brongniartin, *v. Leonh.*

Monoclinic. M : M of an oblique rhombic prism =83° 20′, P : M=104° 15′; 104° 11′, (crystal from Vic), Dufrénoy. Secondary forms, similar to fig. 101, pl. 2; another variety has the front lateral edge ē truncated; P : ē=137° 9′, ē : ē=116° 20′, M : ē=131° 40′. Cleavage perfect parallel to P.

H.=2·5—3. G.=2·75—2·85. Lustre vitreous. Streak white. Color pale-yellow or gray. Fracture conchoidal; brittle. Taste slightly saline.



Composition.—$\dot{N}a\dddot{S}+\dot{C}a\dddot{S}$=Sulphate of soda 51·13, and sulphate of lime 48·87.

Kobell obtained from a specimen from Berchtesgaden, sulphate of soda 48·6, sulphate of lime 51·0. Crystals from Atacama gave Hayes (Jour. Bost. Nat. Hist. Soc. iv, 498) sulphuric acid 57·22, soda 21·32, lime 20·68, iron 0·14=99·66. 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, which becomes opaque on cooling.

In crystals in rock salt at Villa Rubia, near Ocana in New Castile; also at Aussee, in Upper Austria, and at the salt mines of Vic, in France; and in the Province of Tarapaca, Peru, the crystals as above according to Teschemacher.

NITRE. Nitrate of Potash. Saltpetre. Kalisalpeter.

Trimetric. In rhombic prisms; M : M about 120°; often having the acute lateral edges truncated, and the acute solid angles deeply replaced. 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.—$\dot{K}\overset{\cdot\cdot\cdot\cdot\cdot}{N}$=Potash 46·56, nitric acid 53·44. Klaproth obtained for an African specimen, (Beit. i, 317), Nitrate of potash 42·55, sulphate of lime 25·45, 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. It is also manufactured from soils where other nitrates (nitrate of lime or magnesia) 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. Other similar caverns in the western part of the United States also contain it.

SODA NITRE. Nitrate of Soda. Nitratine, *Haid.* Soude Nitratée, *H.* Natron Salpeter, *Leonh.*

Rhombohedral; R : R=106° 33′. Cleavage rhombohedral, perfect. In efflorescences; also massive, granular.

H.=1·5—2. G.=2·0964; 2·290, (Tarapaca), Hayes. Lustre vitreous. Color white; also, reddish-brown, gray, and lemon-yellow. Transparent. Rather sectile. Fracture indistinctly conchoidal. Taste cooling.

Composition.—$\dot{Na}\overset{\cdot\cdot\cdot\cdot\cdot}{N}$=Nitric acid 63·40, and soda 36·60. Deflagrates on charcoal with less violence than nitre, and also deliquesces, causing a yellow light. Dissolves in three parts of water at 60° F.

In the district of Tarapaca, near the northern frontier of 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. (Vid. 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. On account of deliquescing, it is unfit for making gunpowder.

A. A. Hayes obtained for masses collected by Mr. Blake, Nitrate of soda 64·98, sulphate of soda 3·00, common salt 28·69, iodic salts 0·63, shells and marl 2·60=99·90.

NATRON. Carbonate of Soda. Soude Carbonatée. Naturliches Mineral Alkali, *W.*

Monoclinic. M : M=76° 28′, P : M=71° 17′. H.=1—1·5. G.=1·423. Vitreous to earthy. White, sometimes gray or yellow, owing to impurities. Taste alkaline.

Composition.—$\dot{Na}\ddot{C}+10\dot{H}$. Effervesces strongly with nitric acid.

Occurs at the soda lakes of Egypt, at Debreczin in Hungary, and in various parts of Africa, Asia, and America. This is the *nitre* of the Bible.

THERMONATRITE, *Haid.*

Trimetric. In rectangular tables with beveled sides. Two prisms have the angles 83° 50′ and 107° 50′. Usual as an efflorescence.

H.=1—1·5. G.=1·5—1·6. Lustre vitreous. Colorless.

Composition.—$\dot{Na}\ddot{C}+\dot{H}$=Soda 50·1, carbonic acid 35·4, water 14·5. Beudant obtained in two analyses:

	$\dot{Na}\ddot{C}$	$\dot{H}$	$\dot{Na}\dddot{S}$	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 1·4=100

This is the more common salt in nature, natron changing to it, on efflorescing. It occurs at the various localities of natron.

TRONA. Sesquicarbonate of Soda. Prismatic Natron, *J.* Urao.

Monoclinic. M : T of a right rhomboidal prism=103° 15′. Cleavage orthodiagonal, 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.—$\dot{N}a^2\ddot{C}^3+4\dot{H}$. Analysis by Klaproth, (Beit. iii, 83), Carbonic acid 38, soda 37, water 22·5, 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.

GAY-LUSSITE. Natrocalcite.

Monoclinic. M : M of oblique rhombic prism=68° 50′, P : M=83° 30′. Cleavage parallel with M perfect; parallel with P less so. The crystals have usually the edge *ē* truncated.

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.—$\dot{N}a\ddot{C}+\dot{C}a\ddot{C}+5\dot{H}$=Carbonate of soda 35·89, carbonate of lime 33·79, water 30·32=100. Analysis by J. B. Boussingault, (Ann. Ch. Phys., vii, [3], 488, 1843),

$\dot{N}a\ddot{C}$ 34·5, $\dot{C}a\ddot{C}$ 33·6, $\dot{H}$ 30·4, Clay 1·8=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.

SYLVINE. Chlorid of Potassium. Muriate of Potash. Kali schwefelsäures.

Monometric. In cubes. Cleavage cubic. Also compact.

H=2. G.=1·9—2. Color white, or colorless. Vitreous. Soluble, taste like common salt.

Composition.—KCl=Potassium 52·54, chlorine 47·46.

Occurs with rock salt at Hallein and Berchtesgaden, and also at Vesuvius about the fumaroles of the volcano.

COMMON SALT. Rock Salt. Muriate of Soda. Chlorid of Sodium. Naturlich Kochsalz, *W.* Steinsalz, *L.* Soude muriatée, *H.* Sal gemme.

Tesseral. Figures 1, 2, 3, 4, 5, 7, 10, plate 1; cleavage cubic, perfect. Massive and either columnar or granular.

H.=2·5. G.=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 60·34, sodium 39·66. Commonly mixed with some sulphate of lime, chlorid 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	$\dot{\mathrm{Ca}}\dddot{\mathrm{S}}$	$\dot{\mathrm{Na}}\dddot{\mathrm{S}}$	$\dot{\mathrm{Mg}}\dddot{\mathrm{S}}$.	
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 $\dot{\mathrm{H}}$ 0·7=100, B.
4 " *red*,	99·8	—	—	—	—	— $\dot{\mathrm{H}}$ 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	—	1·80	1·57=100, B.
9 Algiers,	97·8	1·1	—	Silica	1·5	$\dot{\mathrm{H}}$ 0·6=100, F.

A purplish blue variety owes its color to a trace of iodine, a red variety to oxyd of iron, and another to infusoria. 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.

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 the sandstones below the coal. It 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 a 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 ten days or a fortnight, the water fully saturated with the salt, is conveyed by aqueducts to evaporating houses, and the chambers, after being cleared out, are again filled.

It also occurs forming hills and extended plains near Lake Oroomiah; about Algeria, abundantly; in India in the province of Lahore, and in the valley of Cashmere; in China and Asiatic Russia; in South America, in Peru, and the Cordilleras of Grenada.

In the United States, salt has been found forming large 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

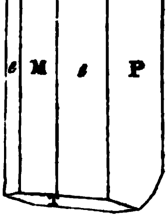
Sea water at Nantucket gives a bushel of salt for every 350 gallons.

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,	0·088	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. 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 altered by Marchand, to correspond to recent atomic weights.

BORAX. Tincal. Pounxa. Swaga. Zala. Borate of Soda.



Monoclinic. T : M=106° 35′, M : P=90° : M : *e* =133° 30′, *e* : *e*=87° 0′. ă : ă=122° 23′. Cleavage parallel with M perfect; less so parallel with *e*. Compound crystals; composition parallel with M; P : P′=146° 50°.

H.=2—2·5 G.=1·716. Lustre vitreous—resinous; sometimes earthy. Streak white. Color white; sometimes grayish, bluish or greenish. Translucent—opaque. Fracture conchoidal. Rather brittle. Taste, sweetish-alkaline, feeble.

Composition.—$\dot{N}a\dddot{B}^2+10\dot{H}$=Soda 16·37, boracic acid 36·53, water 47·10. 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 green. With fluor spar and bisulphate of potash, it colors the flame around the powder a clear green.

Borax was originally brought from a lake in Thibet, containing both borax and common salt, which, from its elevated situation, is frozen the greater part of the year. 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 Tuscany lagoons, by the reaction of this acid on carbonate of soda. It has also been found at the mines of Potosi in Peru, and also in Ceylon.

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.

III. BARYTA—STRONTIA.

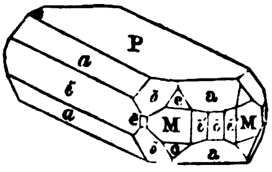
Baryta and Strontia are found combined with sulphuric and carbonic acids; also in some silicates, as the zeolites, brewsterite, and harmotome, and in certain ores of manganese, especially psilomelane and braunite. The earths have high specific gravities, and give the same peculiarity to their salts. They are isomorphous, and may also replace different oxyds of the magnesian series. The carbonates of baryta and strontia are isomorphous with arragonite, one of the forms of carbonate of lime, and also with carbonate of lead, while the sulphates of baryta and strontia are in like manner isomorphous with the sulphate of lead. Bromlite, a carbonate of baryta and lime, belongs to the arragonite series. Moreover it is the same compound with *baryto-calcite*, which is monoclinic.

The species here included range in specific gravity between 3·5 and 4·8. None of them are soluble. None form a jelly with acids or give the reaction of the silicates. The *sulphates* fuse with more or less difficulty or not at all, and are insoluble in the acids. The *carbonates* effervesce with acids, and fuse easily or not at all.

HEAVY SPAR. Sulphate of Barytes. Hepatite, *Haus.* Barytine, *B.* Barosselenite. Aerhenstein. Bolognian Spar. Cawk. Litheospore. Allomorphite, *Breit.* Schwerspath. Stangenspath, *W.*

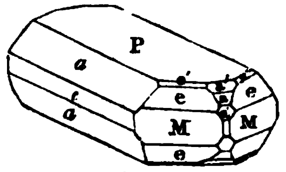
Trimetric. M : M=101° 42′, M : ē=140° 51′, M : ĕ=129° 9′,

1



Cheshire, Conn.

2



Cheshire, Conn.

P : a=141° 4′, P : a′=158° 1′, P : a″=121° 46′, P : e′=165° 26′, P : e =115° 39′, P : *a*=127° 15′, *a* : ĕ=142° 45′. Cleavage basal, rather perfect, lateral less so. Imperfect crystallizations, in globular forms, fibrous or lamellar; coarsely laminated, laminæ convergent and often curved; granular; colors sometimes banded like stalagmite. Crystals usually tabular.

H.=2·5—3·5. G.=4·3—4·72, 4·4864, 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.—$\dot{Ba}\bar{S}$=Sulphuric acid 34·37, and baryta 65·63. Oxyd of iron, silica, carbonate of lime, and alumina, occur sometimes as impurities, and sulphate of strontian is a common ingredient. 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* of Breithaupt contains 1·90 per cent. of sulphate of lime. *Hepatite* is an impure spar affording a fetid odor on friction. Decrepitates before the blowpipe, and 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 crystallizations of lime and strontian.

At Dufton, England, large transparent crystals occur; one of them of a tabular form, in Mr. Allan's cabinet, weighs forty-two pounds, and measures ten inches across its basal plane. Some of the most important European localities are at Felsobanya and Kremnitz in Hungary, and 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, and 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, 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. A massive variety, indistinctly and very delicately fibrous, and with banded shades of reddish, grayish, and yellowish shades occurs in large masses, 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 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 with calc spar and specular iron, and on the banks of Laidlaw lake in Rossie: and 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. H.; Brown's creek and Haysboro', near Nashville, Tennessee, and the lead mines of the west; at Perkiomen, Pa., in delicate crystals: also at Eldridge's gold mine, in Buckingham Co., Virginia, and 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.

The white varieties of heavy spar are ground up and employed as a white paint, either alone or mixed with white lead.

DREELITE, *Dufrénoy,* Ann. de Ch. et de Ph. lx, 102.

Rhombohedral. R : R=93° or 94°. Cleavage rhombohedral, in traces only.

H.=3·5. G.=3·2—3·4. Lustre pearly; splendent on a surface of fracture. Streak and color white.

Composition.—$\dot{Ca}\bar{S}+3\dot{Ba}\bar{S}$. Analysis by Dufrénoy, (loc. cit.):

$\dot{Ba}\bar{S}$ 61·73, $\dot{Ca}\bar{S}$ 14·27, $\dot{Ca}\bar{C}$ 8·05, $\bar{Si}$ 9·71, $\bar{Al}$ 2·40, $\dot{Ca}$ 1·52, $\dot{H}$ 2·31=100.

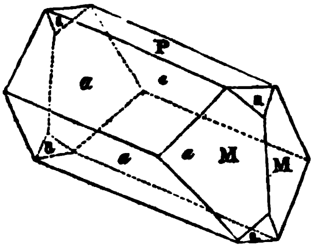
In small unmodified crystals, disseminated on the surface, and in the cavities of a quartzose rock, at Beaujeu, France, Dep. of the Rhone.

It was named by Dufrénoy in honor of M. de Drée, a liberal patron of science.

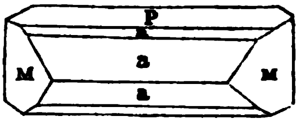
Thomson has analyzed another compound of the sulphates of baryta and lime, (Min. i, 106), consisting of 71·9 of the former to 28·1 of the latter; it was from Harrowgate in Yorkshire.

CELESTINE. Sulphate of Strontian. Zölestine, *Wern.* Cölestin.

1. Etna.



2. Lake Erie.



Trimetric. M : M of rhombic prism=104°—104° 30′; P : *a*=128° 1′, *a* : *a*=103° 58′, P : a=140° 42′, a : a=78° 35′, P : a′=157° 45′, a : a′=162° 57′. Cleavage distinct parallel with M, less so parallel with P. Also, fibrous and radiated; sometimes globular; occasionally granular.

H.=3—3·5. G.=3·92—3·963. 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.—$\dot{S}r\dddot{S}$=Sulphuric acid 43·64, and strontia 56·36. 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.

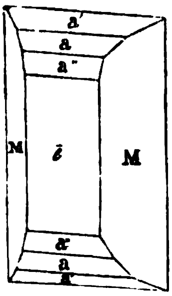
Celestine is usually associated with secondary or transition limestone, or secondary sandstone. It also occurs in trap rocks and in beds of gypsum, in which it is often associated with sulphur.

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; in Sernaja Gora, Russia. 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 Tamtallan in East Lothian; near Knaresborough in Yorkshire, and at Nörten in Hanover.

Beautiful specimens, finely crystallized, of a bluish tint, are found in compact limestone about Lake Erie, particularly on Strontian island, where the rock abounds in splendid crystallizations. Scoharie and Lockport, N. Y., have also 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. At the latter place it is associated with pearl spar and anhydrite.

Baryto-celestine.—Dr. Thomson separates from the above species the radiated celestine, from Drummond's Island, Lake Erie, and Kingston, U. C. An analysis made in his laboratory gave sulphate of barytes 35·195, and sulphate of strontian 63·204, with a little iron and water. H.=2·75. G.=3·921. Color white, with a bluish tint; structure laminated, laminæ divergent. A similar variety from Nörten, Hanover, contains, according to Gruner, 26 per cent. of sulphate of baryta.

WITHERITE, *Werner.* *Withering*, Phil. Trans. 1784, p. 298. Carbonate of Barytes. Barolite.



Trimetric. M : M=118° 30′, M : ē=149° 15′, ē : a″=145° 30′, ē : a=126° 16′, ē : a′=110° 30. Cleavage lateral, imperfect. Compound crystals, composition producing hexagonal prisms similar to those of arragonite. Imperfect crystallizations, in globular, tuberose, and botryoidal forms; structure either columnar or granular: also amorphous.

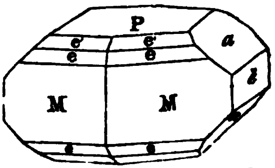
H.=3—3·75. G.=4·29—4·30. Lustre vitreous, inclining to resinous. Streak white. Color white, often yellowish, or grayish. Subtransparent—translucent. Fracture uneven. Brittle.

Composition.—$\dot{Ba}\ddot{C}$=Carbonic acid 22·41, baryta 77·59. 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 Brownley Hill, Cumberland, contains 34·30 of sulphate of baryta; formula=$2\dot{Ba}\ddot{C}+\dot{Ba}\dddot{S}$. G.=4·141. The specimen consisted of a congeries of large six-sided prisms terminated by low six-sided pyramids.

Witherite was first observed at Alston Moor in Cumberland, associated with galena, in veins traversing the coal formation. The fibrous translucent variety occurs at Anglezark in Lancashire. Tarnowitz in Silesia; Szlana, Hungary; Saltzburg, and Neuberg, Austria; Peggau in Styria; Barnaul, Russia, in the Altai; some places in Sicily; and the mine of Arqueros, near Coquimbo, Chili, are other localities.

This mineral is poisonous, and is used in the north of England for killing rats.

STRONTIANITE. Carbonate of Strontian. Strontites. Strontiane Carbonatée, *H.* Emmonite, *Thomson.*



Trimetric; M : M=117° 19′; M : ĕ =121° 20′, e′ : e′=108° 12′ e : e′=144° 20′. Crystals often compound, like those of arragonite. Surface P usually striated parallel to the shorter diagonal. Cleavage lateral, nearly perfect; in traces parallel to ĕ. Imperfect crystallizations, in columnar globular forms; also fibrous and granular.

H.=3·5—4. G.=3·605—3·713. Lustre vitreous; inclining to resinous on uneven faces of fracture. Streak white. Color asparagus green, apple-green; also white, gray, yellow, and yellowish-brown. Transparent—translucent. Fracture uneven. Brittle.

Composition.—$\dot{Sr}\ddot{C}$=Carbonic acid 29·93, and strontia 70·07.

Thomson found the two varieties from Strontian to contain 6 to 8·64 p. c. of $\dot{Ca}\ddot{C}$; and another from the United States, named by him *Emmonite*, in honor of Prof. Emmons, affords 12·5 per cent. of $\dot{Ca}\ddot{C}$; also specimens from Clausthal contain 6¼ per cent.

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 was first observed at Strontian in Argyleshire, in veins traversing gneiss, along with galena and heavy spar; it occurs there 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.

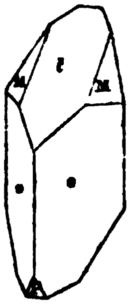
In the United States it occurs at Scoharie in granular and columnar masses, and also in crystals, forming nests or geodes often large in the hydraulic limestone, associated with heavy spar, iron pyrites, and calc spar. At Muscalonge Lake a massive and fibrous variety of a white or greenish white color, 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

$\dot{Sr}\ddot{C}$ 62·6, $\dot{Ba}\dddot{S}$ 27·5, $\dot{Ca}\ddot{C}$ 2·6, and oxyd of iron 0·1.

It is supposed to be a mechanical mixture.

BARYTO-CALCITE, *Brooke*, Ann. Phil. viii, 114, 1824. Bicalcareo-carbonate of Barytes of *Thomson*.



Monoclinic; M : M=106° 55′, P : M=102° 50′, o : o=95° 7½′, M : ĕ=143° 27′. Cleavage perfect parallel with M; less easily effected parallel with P; only the lateral observed by Levy; also massive.

H.=4. G.=3·6363—3·66. Lustre vitreous, inclining to resinous. Streak white. Color white, grayish, greenish, or yellowish. Transparent—translucent. Fracture uneven.

Composition.—$\dot{Ba}\ddot{C}+\dot{Ca}\ddot{C}$=Carbonate of baryta 66·2, carbonate of lime 33·8=100. Analyses: 1, Children, (Ann. Phil. viii, 115); 2, Delesse, (Ann. Ch. Ph. [3], xiii, 425).

	$\dot{Ba}\ddot{C}$	$\dot{Ca}\ddot{C}$	$\dddot{Si}$
1.	65·9	33·6	—=99·5
2.	66·20	31·89	0·27=98·36

B.B. alone, infusible. 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, both massive and crystallized.

BROMLITE, *Johnston*, Phil. Mag. vi, 1, and xi, 45. *Thomson*, ibid. x, 373, and Rec. of Gen. Sci. i, 373. *Delesse* and *Descloiseaux*, Ann. Ch. Ph. [3], xiii, 425. Alstonite, *Breithaupt*.

Trimetric; M : M=118° 50′, Descloiseaux. In compound crystals; form, double six-sided pyramids, with angles 122° 30′, and 143°; reëntering angle of macles 178° 51′. Cleavage indistinct.

H.=2·5. G.=3·718, Thomson; 3·706, Johnston. Lustre vitreous. Color snow-white. Translucent. Fracture granular and uneven.

Composition.—$\dot{Ba}\ddot{C}+\dot{Ca}\ddot{C}$, like Barytocalcite.

	$\dot{Ba}\ddot{C}$	$\dot{Ca}\ddot{C}$	$\dot{Sr}\ddot{C}$	$\dot{Mn}\ddot{C}$	$\dddot{Si}$	$\ddot{Mn}$
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. The form is like a secondary of Arragonite or Witherite, and the angle M : M differs but 20′ from that of Witherite. (See figure 3, plate 4).

IV. LIME—MAGNESIA.

Lime does not occur native. It is found abundantly as a carbonate, constituting thus the ordinary limestone and marbles. As a sulphate, it forms gypsum and anhydrite. It also exists in combination with phosphoric, arsenic, antimonic, tungstic, titanic, and columbic acids. Also with silica as a silicate of lime in tabular spar, dysclasite, apophyllite, datholite, and some allied species; in the *zeolites*, heulandite, laumonite, stilbite, epistilbite, thomsonite, edingtonite, phillipsite, lime-mesotype, prehnite, chabazite; in anorthite, and labradorite, scapolite, latrobite, gehlenite; in epidote, idocrase, and garnet; and in augite, hornblende, and many other silicates, it replaces magnesia. Besides, there are fluorids and chlorids of calcium.

Magnesia exists pure in the mineral *periclase*. It is also abundant as a carbonate, but occurs more commonly along with lime, constituting dolomite; it is also met with combined with phosphoric, sulphuric, and nitric acids; it characterizes a large number of hydrous silicates, allied to talc and serpentine; and exists also in the anhydrous silicates, augite, hornblende, chrysolite, boltonite, chondrodite; and in combination with alumina it forms spinel.

Lime and magnesia are isomorphous, as already explained. Yet there are large classes of compounds, as the zeolites and feldspars, in which magnesia seldom takes the place of lime. Carbonate of magnesia and lime mingle in various proportions under a common crystalline form; and these pass so gradually into carbonates of iron and manganese, that the varieties are separated with difficulty; carbonate of zinc belongs to the same group.

In the species here concluded, G.=2—3·75. H. usually not exceeding 5; rarely, for compounds of magnesia, 6 or 8. For the blowpipe reactions of magnesian compounds, see page 163.

The *carbonates* are insoluble and infusible, and effervesce with acids, (when pulverized and heated, if not otherwise). H. not above 4. The sulphate of lime is insoluble* and fusible; the sulphate of magnesia is soluble with a bitter taste. The phosphates are insoluble and fuse with difficulty. The fluorids phosphoresce, and fuse with difficulty, and with acids give the reaction of fluorine; H.=4—5·5. The borates give the reaction for boracic acid. H.=1 to 2 and G.=2 when hydrous; H.=7—8, and G.=2·9—3·4, when anhydrous and magnesian alone.

The *arsenates* are fusible or infusible, and on charcoal give off alliaceous fumes; soluble in acids; H.=1·5—3. G.=2·6—3.

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* The sulphate, phosphate and fluorid of lime are soluble in minute quantities.

PERICLASE. Periclasia, *Scacchi*, Mem. Min. Naples. Periklase, *Damour.*

Monometric. In cubes and octahedrons, and also in disseminated grains. Cleavage cubic, perfect.

H.=nearly 6. G.=3·674, Damour. Color grayish to dark-green Transparent to translucent.

Composition.—$\dot{M}g$, or magnesia, with 1 part in 25 of protoxyd of iron. Analyses: 1 Scacchi, (loc. cit.); 2, 3, 4, 5, Damour, (Ann. d. M. [4], iii, 360, and Bull. Soc. Geol. de France, 1849, p. 313).

1.	$\dot{M}g$ 89·04	$\dot{F}e$	8·56=97·60, Scacchi.
2.	92·57		6·94, insol. 0·86=100·37, Damour.
3.	91·18		6·30, " 2·10= 99·58, Damour.
4.	93·86		5·97=99·83, Damour.
5.	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 a white lamellar carbonate of lime, and also in spots of clustered crystals, on Mt. Somma.

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.

Hexagonal. In six-sided tables with the edges replaced; and also foliated massive. Cleavage eminent, basal, folia easily separable. Also fibrous, fibres separable and elastic.

H.=1·5. G.=2·35, Haidinger. Lustre pearly. Streak white. Color white, inclining to gray, blue, or green. Translucent—subtranslucent. Sectile. Thin laminæ flexible.

Composition.—$\dot{M}g\dot{H}$=Magnesia 69·67, water 30·33. Analyses by Bruce, (Min. Journ. i, 26), Fyfe, (Ed. Phil. J. N. S., viii, 352), Vauquelin, (Ann. du Mus. d'Hist. Nat. xx, 167), Stromeyer, (Untersuch. p. 467), Thomson, (Min. i, 157), J. D. Whitney, (Jour. Bost. Soc. Nat. Hist. 1849, p. 36).

	Hoboken.	Hoboken.	Hoboken.	Swinaness.	Hoboken.	Swinaness.	*Nemalite.*
$\dot{M}g$	70	69·75	64·0	66·67	68·345	67·98	62·89
$\dot{H}$	30	30·25	29·0	30·39	30·902	30·96	28·36
$\dot{M}n$	—	——	——	1·57	0·637	1·57	——
$\dot{F}e$	—	——	2·5	1·18	0·116		4·65
$\dot{C}a$	—	——	——	0·19	——	——	$\ddot{C}$ 4·10
$\dddot{S}i$	—	——	2·0	——	——	——	——
	100, B.	100·00, F.	97·5, V.	100·00, S.	100·000, S.	100·51, T.	100·00, W.

Nemalite of Hoboken is shown by Whitney to be fibrous brucite. Connell (Proc. Brit. Assoc. for 1847) obtained, Magnesia 57·86, water 27·96, carbonic acid 10·0, silica 0·80, protoxyd of iron 2·84; but his specimen, according to Whitney, contained carbonate of magnesia as impurity. Thomson found 12⅓ per cent. of silica, which also must have been due to impurities.

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 (p. 163).

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. 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; also in Richmond Co., N. Y., and on the peninsula east of New Rochelle, Westchester Co.

This mineral was discovered and described by the late Dr. Bruce of New York.

VÖLKNERITE, *Hermann*, J. f. pr. Chem. xl, 11.

Hexagonal. Cleavage basal, eminent, lateral distinct. Also lamellar massive.

G.=2·04. Color white. Lustre pearly, and feel greasy.

Composition.—$\dot{\text{Mg}}^6\dddot{\text{Al}}+15\dot{\text{H}}$=Magnesia 39·59, alumina 16·65, water 43·76. Analysis by Hermann, $\dot{\text{Mg}}$ 38·59, $\dddot{\text{Al}}$ 17·65, $\dot{\text{H}}$ 43·76=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. It is named in honor of Captain Völkner.

This species, if a true *aluminate*, might be arranged on a following page with the aluminates of magnesia. The resemblance in characters to brucite is so great, that we leave it for the present in this place.

Hydrotalcite of Hochstetter (J. f. pr. Ch. xxvii, 376), is referred to Völknerite by Hermann, (ib. xlvi, 237). It is a foliated pearly mineral, translucent, or in thin folia transparent, with a greasy feel, and hardness=2·0. Hochstetter obtained

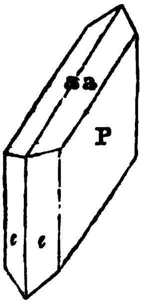
$\dddot{\text{Al}}$ 12·00, $\dddot{\text{Fe}}$ 6·90, $\dot{\text{Mg}}$ 36·30, $\dot{\text{H}}$ 32·06, $\ddot{\text{C}}$ 10·54, insoluble 1·20=99·60.

It occurs at Snarum in Norway.

GYPSUM. Sulphate of Lime. Alabaster. Selenite. Satin Spar. Gyps. Plaster of Paris. Schaumkalk. Γύψος.

Monoclinic. M : T (right rhomboidal prism)=113° 18′; P : a=108° 16′, a : a=143° 28′, *e* : *e*=111° 14′, P : *e*=124° 23′, P : *e′*=144° 9′. Cleavage eminent, parallel to P; parallel to M much less perfect; parallel to T difficult, on account of the flexibility of the mineral in this direction. Compound crystals: composition parallel to each of the three primary faces; parallel with a plane truncating edge a : a; parallel with a. The arrow-shaped crystals result from composition parallel to T. Lamellar-stellate, lamellar and granular; often massive, and sometimes nearly impalpable.

1 Poland, Ohio.



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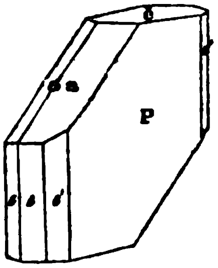

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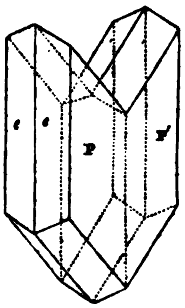

H.=1·5—2. G.=2·26—2·35; 2·33, selenite. Lustre of P pearly and shining, of M and T vitreous. Massive varieties often glistening, sometimes dull earthy. Streak white. Color usually white; sometimes gray, flesh-red, honey-yellow, ochre-yellow, blue: impure varieties often black, brown, red, or reddish-brown. Transparent —opaque. Brittle parallel to M.

Composition.—$\dot{\mathrm{C}}\mathrm{a}\dddot{\mathrm{S}}+2\dot{\mathrm{H}}$=Sulphuric acid 46·49, lime 32·64, water 20·87. 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 have been distinguished by the name *Selenite;* the fine massive varieties are called *Alabaster;* the fibrous, *Satin Spar*. *Schaumkalk* is a variety in small scales of a pearly lustre. Gypsum often forms very 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 Ocana, 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, in limestone along with pearl spar and anhydrite; also near Camillus, Onondaga County, and occasional crystals are met with in the vicinity of Manlius. In Ohio, large transparent crystals (fig. 1) 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, (see § 129).

Plaster of Paris is gypsum which has been heated and ground up. It 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. Gypsum is also employed for improving lands. The uses of alabaster are well known.

The fibrous variety when cut *en cabochon*, and polished, reflects light similarly to cat's eye.

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. Jour. 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. Jour. Sci. xlviii, 69), and the compound here described may have been formed in the course of the transition.

ANHYDRITE. Cube Spar, Muriacite, *W.* Karstenite, *Haus.* Vulpinite. Anhydrous Sulphate of Lime.

Trimetric; forms rectangular; common form similar to fig. 70, plate 2. $\bar{\mathrm{M}} : e$=140° 4′; also with planes on the angles, inclined towards $\bar{\mathrm{M}}$; $\bar{\mathrm{M}}$ on each, 153° 50′, 143° 37′, 124° 10′. Cleavage perfect parallel to the sides of a rectangular prism, less so parallel to the base. Also fibrous, lamellar, granular, and sometimes impalpable. The lamellar and columnar varieties often curved or contorted.

H.=3—3·5. G.=2·899—2·957. Lustre somewhat pearly, parallel to $\bar{M}$ and $\breve{M}$: vitreous parallel to P, and in the imperfectly crystallized varieties, vitreous inclining to pearly. Streak grayish-white. Color white, sometimes with a grayish, bluish or reddish tinge; also brick-red. Fracture uneven; of finely lamellar and fibrous varieties, splintery.

Composition.—$\dot{C}a\dddot{S}$=Lime 41·25, sulphuric acid 58·75. 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 often attracts moisture, and assumes an appearance somewhat resembling gypsum. It is readily distinguished by its cleavage.

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 particles. *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 Saltzburg 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 Luneberg, 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 it has been found at Lockport, N. Y., of a fine blue color, in geodes of black limestone, accompanied with crystals of calcareous spar and gypsum. The decomposed variety has also been observed at the same place, forming a thin incrustation on the foliated variety, and also between the folia. In Nova Scotia it forms extensive beds at the estuary of the Avon and the St. Croix river, and is common elsewhere, associated with gypsum, in the carboniferous formation.

EPSOMITE, *Beud.* Epsom salt. Bittersalz, *Wern.* Sulphate of Magnesia.

Trimetric; M : M=90° 38′, figure 72, pl. 2, also figure 75, pl. 2, the planes e being enlarged, and the acute lateral edges also replaced. Other crystals have, in addition, the obtuse lateral edges truncated. 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.—$\dot{M}g\,\dddot{S}+7\dot{H}$=when pure, Magnesia 16·32, sulphuric acid 32·53, water 51·15. 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.

This salt is a frequent ingredient in mineral waters, and often occurs also as an efflorescence on rocks. In the former state it exists at Epsom, whose springs have long been famous. At Idria, in Carniola, it occurs in silky fibres, and is hence called *hairsalt* by the workmen. It is also obtained at the gypsum quarries of Montmartre, near Paris; in Fitou, Dep. of the Aude, France; in Arragon 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 Epsom salt, 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).

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.

NITROCALCITE, *Shep.* Nitrate of Lime. Kalksalpeter, *Haus.*

In efflorescent silken tufts and masses. Color white or gray. Taste sharp and bitter.

Composition.—$\dot{C}a\ddot{\ddot{N}}+\dot{H}$=Lime 30·86, nitric acid 59·26, water 9·88. 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.

NITROMAGNESITE, *Shep.* Nitrate of Magnesia. Magnesia Saltpeter.

In deliquescent efflorescences. Color white.

Composition.—$\dot{M}g\ddot{\ddot{N}}+\dot{H}$=Nitric acid 64·8, magnesia 24·4, water 10·8. Very deliquescent.

Occurs in limestone caverns with nitrate of lime.

CALC FAMILY.

The Calc Family includes the carbonate of lime, of magnesia, of protoxyd of iron, zinc, manganese, with the combinations of these isomorphous carbonates with one another, which are in various proportions, having the general formula, $(\dot{C}a, \dot{M}g, \dot{F}e, \dot{M}n, \dot{Z}n)\ddot{C}$. They crystallize in rhombohedrons, varying in angle from 105° to 107° 40′. Cleavage rhombohedral, perfect. G. 2·6—3·99. Soluble in acids with effervescence, though in some cases with difficulty, unless pulverized and heated. The carbonate of lime is dimorphous, and this will probably prove true also of the other carbonates.

Breithaupt distinguishes among these carbonates 24 species,[*] while others reduce them to 5 or 6. The gradations are such, both in composition and crystalline form, that the nice distinctions introduced by this mineralogist cannot be sustained, and they are the more objectionable since it has been found that the same rhombohedron may have its three

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[*] The following are Breithaupt's subdivisions:—

1. Archigonal; 150°; G=2·74—2·75.
2. Kouphone; 105° 2½′; G=2·678.
3. Eugnostic; 105° 5′; G=2·717—2·72.
4. Polymorphic; 105° 8′; G=2·708—2·712.
5. Meroxenic; 105° 11′; G=2·69.
6. Haplotypic; 105° 14′; G=2·728—2·729.
7. Melinic; 105° 17′; G=2·695—2·697.
8. Diastatic; 105° 23′; G=2·775.
9. Eumetric; 106° 11′; G=2·917.
10. Tautoclinic; 106° 11′; G=2·963—2·964.
11. Paratomic; 106° 12′; G=3·045—3·6.
12. Dimeric; 106° 15′; G=2·889—2·898.
13. Cryptic; 106° 19′; G=2·809—2·810.
14. Isometric; 106° 19′; G=2·849—2·859.
15. Sideric; 106° 45′; G=3·849.
16. Rosic; 106° 51′; G=3·588.
17. Caminoxenic; 107°; G=3·765.
18. Olezonic; 107° 8′; G=3·744.
19. Allotropic; 107° 11′; G=3·992.
20. Mesilinic; 107° 14′; G=3·350.
21. Brachytipic; 107° 25½′; G=3·125.
22. Hystatic; 107° 28½′; G=3·089.
23. Manganic; 107° 30′; G=3·592.
24. Zincic; 107° 40′; G=3·177—3·144.

angles unequal, (see page 84). We retain here the subdivisions that seem to be most convenient, remarking at the same time that the lines of demarcation are not in all instances strongly drawn. The carbonates of iron, manganese, and zinc properly pertain to the group.

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.

Rhombohedral; R : R=105° 5′; varying from 105° to 105° 25′. Figures from 109 to 122, plate 2; also the annexed figures.

R : *e′*=150° 58′ 16″, *e′* : *e′* (over a basal edge)=132° 58′, R : *a* =134° 36′, R : e=142° 32′, e : e=134° 57′, e : *a*=116° 15′.

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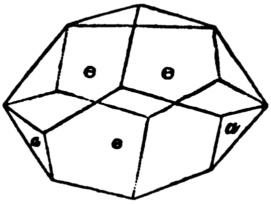

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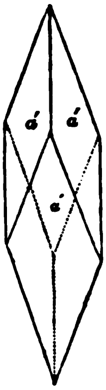

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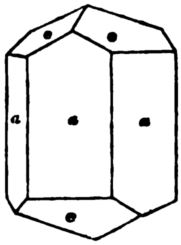

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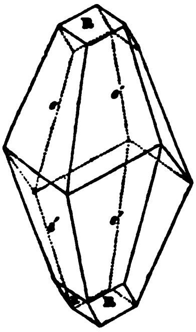

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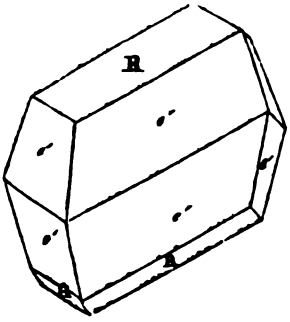

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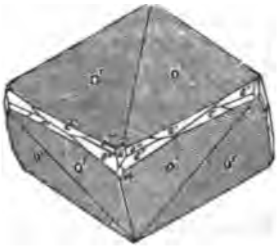

St. Lawrence Co., N. Y.

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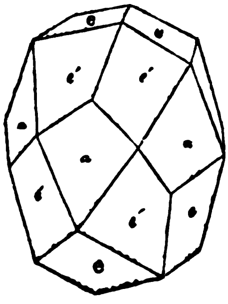

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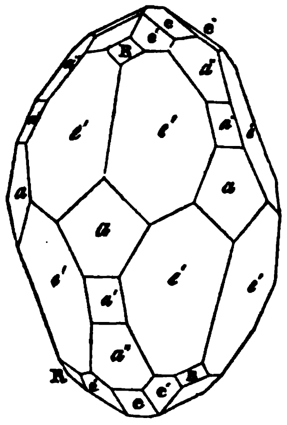
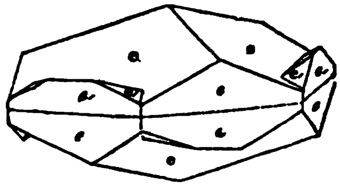


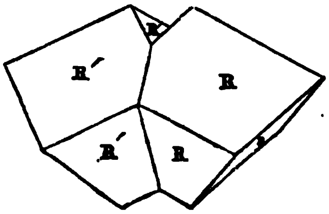
Derbyshire.

9

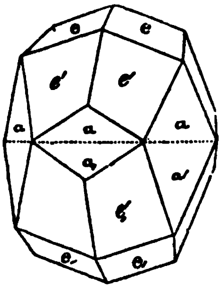


Alstonmoor.

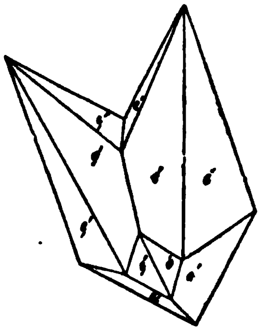
11



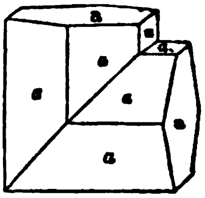
10



12



13



Rhombohedrons of different angles occur in nature. In that resembling figure 122, the angle is 78° 51′. In another (fig. 2) 65° 50′; in others more acute, 63° 51′, 61° 33′, 60° 36′; and more obtuse, 88° 18′, 95° 28′, 151° 21′, &c. Figure 5 is a distorted form of figure 4 from Rossie, St. Lawrence Co., N. Y. Cleavage rhombohedral, highly perfect. Compound crystals, figure 16, plate 3. Figure 9 is an instance of similar composition. Figure 10 the same kind of composition in the form represented in figure 7. In figure 11 the composition is of the same kind, but has taken place parallel to a plane on a *lateral angle;* and figure 12 is another example in a scalene dodecahedron, (figure 116, plate 2). 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. The purest kinds vary, according to Beudant, from 2·5239—2·7234, (Ann. des Mines, [2], v, 275). Lustre vitreous—subvitreous—earthy. Streak white, or grayish-white. Color usually white; also various pale shades of gray, red, green, and yellow; also brown and black, when impure. Transparent—opaque. The transparent varieties exhibit strong double refraction. Fracture usually conchoidal, but obtained with difficulty, when the specimen is crystallized.

Composition.—$\dot{C}a\ddot{C}$; Lime 56·13, and carbonic acid 43·07; 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, 97·91 carbonate of lime, and 2·34 carbonate of lead. Johnston found in the same from Wanlockhead, Scotland, 7·8 per cent. of carbonate of lead.

B.B. infusible; loses, however, carbonic acid, gives out 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 gray-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.

The term *Iceland spar* is applied to transparent calc spar; the best specimens come from Iceland. *Satin spar* is a fibrous carbonate of lime, having a delicate satin lustre. *Oolite* is a compact limestone consisting of minute spherical grains or particles 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 variety, usually white and possessing a purely earthy aspect, and absence of lustre. It is usually much softer than the other varieties of this species. *Agaric Mineral*, or *Rock Milk*, is 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. The material 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*. *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, large portions of sand.

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 2 or 3 per cent. of magnesia, and 10 to 20 of silica and alumina, (or clay). The varieties in the United States contain 20 to 40 per cent. of magnesia, and 12 to 30 per cent. of silica and alumina. A variety worked extensively at Rondout, N. Y., afforded Prof. 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 brownish 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 *luma-*

chelle is a dark brown shell marble, having brilliant fire or chatoyant reflection 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.

Marl contains often 40 to 50 per cent. of carbonate 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.

The most interesting localities of calc spar in the United States, both as regards size of crystals and crystalline form, exist in St. Lawrence and Jefferson Counties, New York. The finest specimens have been obtained at the Rossie lead mine. The crystals are highly modified and often transparent even when large. One gigantic crystal, nearly transparent, in the cabinet of Yale College, weighs 165 pounds. 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 gigantic 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 crystallizations are also procured here. In Essex County, N. Y., town of Moriah, on Mill brook, near Port Henry, crystals of calc spar occur in white limestone. Dog tooth spar (fig. 4, and fig. 116, plate 2) occurs of great beauty 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. In *Maine*, at Thomaston, lenticular and prismatic crystals are common. In *New Jersey*, at Bergen, fine crystallizations of yellow calc spar occur with datholite, &c., in trap; 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. *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 Schoharie, 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 Schoharie, (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—$\overline{\text{Si}}$ 12·5, $\dot{\text{C}}\text{a}$ 7·5, $\dot{\text{M}}\text{g}$ 4·2, MgF 26·62, CaF 26·34, $\text{Mg}\ddot{\overline{\text{P}}}$ 8·00, $\bar{\bar{\text{A}}}\text{l}$ and $\bar{\bar{\text{F}}}\text{e}$ 14·84. Other analyses gave similar results.

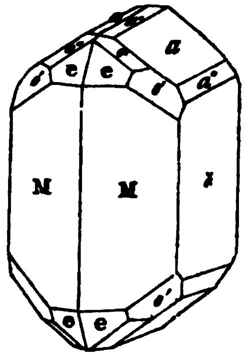
The material of our common marbles is either granular or compact limestone. These rocks when burnt form quicklime. A fine compact limestone is employed in lithography, and that from Solenhofen near Munich, is most noted. Calc spar is also used as a flux for smelting ores.

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.

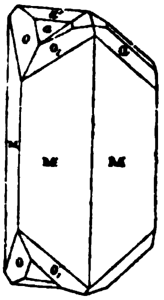
ARRAGONITE. Eisenbluth, *W.* Igloite. Flos ferri. Needle Spar. Tarnowitzit. Aragonspath.

Trimetric; M : M=116° 16′. M : $\breve{e}$=121° 52′, $\breve{e}$: *a*=125° 46′, $\breve{e}$: *a*′=109° 49′, $\breve{e}$: *a*″=155° 10′. Cleavage parallel with M. Compound crystals, similar to figures 13, plate 3, and 3, 5, 6, and 11, plate 4; also figure 2. Also globular, reniform, and coralloidal shapes; sometimes columnar, composed of straight or divergent fibres.

1



2



H.=3·5—4. G.=2·931, Haidinger; 2·927, Biot. 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.—$\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$, like calcite. Analyses: 1—4, Stromeyer; 5, 6, Nentwich, (Versamml. ung. Naturf., Neusohl, 1846); 7, Böttger, (Pogg. Ann. xlvii, 497).

	$\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Sr}}\ddot{\mathrm{C}}$	$\dot{\mathrm{Pb}}\ddot{\mathrm{C}}$	$\dot{\mathrm{H}}$	$\bar{\mathrm{F}}\mathrm{e}\dot{\mathrm{H}}$	
1. Brisgau,	97·0963	2·4609	——	0·4102	———	=99·9674, St
2. Nertschinsk,	97·9884	1·0933	——	0·2578	———	=99·3345, St.
3. Eschwege,	96·1841	2·2390	——	0·3077	0·2207	=98·9515, St.
4. Aussig,	98·0000	1·0145	——	0·2139	0·1449	=99·3733, St.
5. Herrengrund, G=2·93	98·62	0·99	——	0·17	$\bar{\mathrm{F}}\mathrm{e}$ 0·11	=99·89, N.
6. Retzbanya, G=2·66	99·31	0·06	——	0·33	$\dot{\mathrm{Cu}}\ddot{\mathrm{C}}$ 0·19	=99·89, N.
7. *Tarnowitzite*,	95·940	——	3·859	0·157	——	=99·966, B.

Delesse finds in the arragonite of Herrengrund, near Neusohl, Hungary, no strontia, and 0·13 per cent. of water.

When arragonite is heated, it falls to powder. It is phosphorescent on red hot iron, and soluble with effervescence in nitric and muriatic acids.

The most common repositories of arragonite 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.

This mineral was first discovered in Arragon, 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 Brisgau 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. Arragonite and carbonate of lead are isomorphous.

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 arragonite occurs at New Garden, in Chester Co., Pennsylvania.

MAGNESITE. Carbonate of Magnesia. Baudisserite. Breunnerite. Rhomb Spar. Giobertite, *Beudant.*

Rhombohedral; R : R=107° 22′. Cleavage rhombohedral, perfect. Also massive; granular, or fibrous, and sometimes in radiating groups.

H.=3—4. G.=2·8—3. Lustre vitreous; fibrous varieties sometimes silky. Color white, yellowish or grayish-white, brown. Transparent—opaque. Fracture flat conchoidal.

Composition.—$\dot{\mathrm{M}}\mathrm{g}\ddot{\mathrm{C}}$=Magnesia 48·07, carbonic acid 51·93. Analyses: 1, Klaproth, (Beit. v, 100); 2, Lampadius, (Dess. Samml. pr. ch. Abhandl. iii, 241); 3, 4, Stromeyer, (Untersuch. 133); 5, Rammelsberg, (Pogg. Ann.); 6, Scheerer, (Nyt. Mag. f. Nat. iv, 342).

	$\dot{\mathrm{M}}\mathrm{g}$	$\ddot{\mathrm{C}}$	$\dot{\mathrm{H}}$	$\dot{\mathrm{C}}\mathrm{a}$
1. Kraubat,	48·0	49·0	3·0	——=100·0, Klap.
2. Hrubschitz,	47·0	51·0	1·6	——=99·6, Lamp.
3. Salem,	47·89	51·83	——	0·28=100·0, Str.
4. Baumgarten, *Giobertite,*	48·36	50·22	1·39	$\dot{\mathrm{M}}\mathrm{n}$ 0·21=99·18, Str.
5. Frankenstein,	48·004	51·996	——	——=100·00, Ramm.
6 Arendal, G.=3·068,	46·93	52·57	——	$\dot{\mathrm{F}}\mathrm{e}$ 0·87=100·37, Scheer.

Guyton Morveau found 14 per cent. of silica in the magnesite of Castellamonte.

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.

At Hoboken, N. J., it occupies seams and cavities in dolomite and serpentine, having a closely aggregated fibrous structure; also at Bolton, Mass., where it appears in delicate, indistinctly fibrous masses, traversing white limestone; at Lynnfield, Mass., coating serpentine; at Barehills, near Baltimore, Md.; in Pennsylvania, cryst. at W. Goshen, Chester Co., and near Texas, Lancaster Co.

Carbonate of magnesia combines in various proportions with the carbonates of lime, of iron, of manganese; with carbonate of lime it forms dolomite, with carbonate of iron mesitine spar, with carbonate of manganese oligon spar; and there are many intermediate compounds.

DOLOMITE. Bitter Spar. Pearl Spar. Magnesian Limestone. Gurhofite. Brown Spar. Bitterkalk. Bitterspath. Miemite. Conite. Tharandite. Ankerite.

Rhombohedral; R : R=106° 10′—106° 20′. Two secondary rhombohedrons resembling fig. 118, pl. 2, have the angles (*a′* : *a′*) 79° 36′, and 66° 7′. Cleavage rhombohedral, perfect. Faces *a′* usually with horizontal striæ. Compound crystals, similar to fig. 11, page 206, presented by a greenish-white cleavable variety from Mexico. Imperfect crystallizations, 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.—($\dot{Ca}$, $\dot{Mg}$) $\ddot{C}$. Analyses: 1, Klaproth, (Beit.); 2, Pelletier, (Ann. Ch. Phys. xiv, 194); 3, Kühn, (Ann. d. Ch. u. Pharm. lix., 363); 4, Göbel, (Pogg. xx, 536); 5, Suckow, (J. f. pr. Chem. viii, 408); 6, Laugier, (Mem. du M. d'hist. Nat. xix, 142); 7, R. E. Rogers and M. H. Boye, (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, Kühn, (loc. cit.); 15, 16, 17, Klaproth; 18, 19, Kühn, (loc. cit.); 20, John, (Schw. J. v. 13); 21, Schrötter, (Baumg. Zeits. viii, 1); 22—24, Berthier, (T. d. Ess. i, 494).

	$\dot{Ca}\ddot{C}$	$\ddot{C}\dot{Mg}$	$\dot{Fe}\ddot{C}$	
1. Zillerthal, *cryst.*	52·	45·	—— $\bar{Fe}$ 3·00=100, Klap.	
2. Traversella, G.=2·629.	51·00	44·32	4·68=100, Pell.	
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, Suck.	
6. La Spezzia, *Dol.*	55·36	41·30	—— $\bar{Fe}$ 2·0, $\dddot{Si}$ 0·5=99·16, Laug.	
7. N. Jersey, *Dol.*	56·11	42·54	—— $\bar{Al}$, $\bar{Fe}$, $\bar{Mn}$ 0·15, insol. 0·04, $\dot{H}$. 0·48=99·32, R. and B.	
8. Thuringia, *Rauhkalk,*	55·62	42·40	0·56=98·58, Ramm.	
9. Gulbrandsdal, Norway,	55·88	40·47	2·81=99·16, Scheer.	
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, Ramm.	
12. Glücksbrunn, *fib.*	60·00	36·50	4·00=100·50, Klap.	
13. Liebenstein,	63·88	33·24	0·91, $\dot{Mn}\ddot{C}$ 0·07=98·10, Wack.	
14. Bohemia,	61·30	32·20	6·27=99·77, Kühn.	
15. Hall, *cryst.*	68·0	25·5	1·0, $\dot{H}$ 2·0, $\bar{Al}$ 2·0=98·50, Klap.	
16. Taberg, *cryst.*	73·	25·	2·25=100·25, Klap.	
17. *Gurhofian,*	70·50	29·50	—— =100, Klap.	
18. Bohemia,	77·63	18·77	3·67=100·07, Kühn.	
19. Kolosoruk, *cryst.*	85·84	10·39	5·53=101·76, Kühn.	
20. Meissner, *Conite,*	28·0	67·4	3·5 =99·0, John.	
21. Styria, *Ankerite,*	50·11	11·85	35·31	$\dot{Mn}\ddot{C}$ 3·08=100·35, Schrötter.
22. “ “	51·1	25·7	20·7	“ 3·0 =99·8, Berthier.
23. Corniglion, *Ankerite,*	50·9	29·0	18·7	“ 0·5 =99·1, Berthier.
24. Villefranche, “	60·9	30·3	6·0	“ 3·0 =100·2, Berthier.

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, equivalent to $\dot{Ca}\ddot{C}$ 54·2, $\dot{Mg}\ddot{C}$ 45·8. In analyses 10 to 13 a ratio of 3 : 2.—In 14 to 16, 2 : 1.—In 17, 3 : 1.—In 18, 5 : 1.—In 19, 1 : 3.—In 20, 3 : 1.

No. 21, (Ankerite), gives the formula $\dot{Ca}\ddot{C}+(\frac{2}{5}[\dot{Fe}, \dot{Mn}]+\frac{3}{5}\dot{Mg})\ddot{C}$.
No. 22, “ “ “ “ $\dot{Ca}\ddot{C}+(\frac{1}{2}\dot{Fe}+\frac{1}{2}\dot{Mg})\ddot{C}$.
No. 23, “ “ “ “ $\dot{Ca}\ddot{C}+(\dot{Mg}, \dot{Fe})\ddot{C}$.

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	$\dot{Mg}$ 16·68	$\dot{Co}$ 5·17	$\dot{Fe}$ 1·36=100
2.	45·37	31·86	17·37	4·24	1·16=100,

affording the formula $\dot{Ca}\ddot{C}+(\dot{Mg}, \dot{Fe}, \dot{Co})\ddot{C}$.

Soluble in the acids, but more slowly than calcite. B.B. acts like calcite; some varieties darken and increase in hardness. 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.

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. *Gurhofite* is a compact snow-white subtranslucent variety, so named from a locality of it at Gurhof, in Lower Austria.

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 Freiburg in Saxony, in the lead mines of 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. 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.

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.

BREUNNERITE, *Haid.* Bitter Spar and Brown Spar *in part.* Mesitine Spar. Talkspath. Magnesitspath. Mesitinspath. Pistomesite.

Rhombohedral. R : R=107° 10′—107° 30′. 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.—$(\dot{M}g, \dot{F}e, \dot{M}n)\ddot{C}$. 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).

		$\dot{M}g\ddot{C}$	$\dot{F}e\ddot{C}$	$\dot{M}n\ddot{C}$	
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 $\dot{M}n\ddot{C}$, Strom.
8. "	2 : 1	58·68	39·38	——	$\dot{C}a\ddot{C}$ 2·30=100·36, Fritzsche.
9. " Piedmont,	2 : 1	56·14	43·36	——	$\dot{C}a\ddot{C}$ 0·39= 99·89, Gibbs.

In the above, the proportion of the magnesian carbonate to the rest, is given in the first column. The mesitine spar occurs in lenticular forms, and the first five in the primary rhombohedrons, 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.

NOTE.—The carbonate of iron (spathic iron) and of manganese, (diallogite), with oligon spar, are described severally under the divisions Iron and Manganese.

HYDROCALCITE. Hydrous Carbonate of Lime. *Scheerer*, Ann. der Ph. u. Ch. lxviii, 381.

In small rhombohedral crystals, and forming an incrustation on wood under water.

Composition.—$\dot{Ca}\ddot{C}+5\dot{H}$=Carbonate of lime 52·7, and water 47·3. Exposed to the air, the water passes off and it becomes anhydrous. The crystals contain 1 per cent. of organic matter. By the action of absolute alcohol, it loses 2 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.

HYDRODOLOMITE. Dolomite Sinter, *Kobell*, J. f. pr. Ch. xxxvi, 304. Hydromagnocalcit, *Ramm.*

In sinter-like globular masses, of a yellowish-white color and earthy texture.

Composition.—$(\dot{Ca}, \dot{Mg},)^4\ddot{C}^3+4\dot{H}$, or $3\,[(\dot{Mg}, \dot{Ca},)\,\ddot{C}+\dot{H}]+\dot{Mg}\dot{H}$, Ramm.

Kobell obtained Lime 25·22, magnesia 24·28, carbonic acid 33·10, water 17·40=100. Affords water in a tube; otherwise like ordinary calc sinter. It has the composition of the *magnesia alba* of the shops, except that part of the magnesia is replaced by lime.

From Vesuvius, where it has a stalactitic form.

HYDROMAGNESITE, *Kobell.* Hydro-carbonate of Magnesia, *Thomson.*

In crusts: also as a white powder. H.=2. Lustre earthy. Streak and color white.

Composition.—$\dot{Mg}^4\ddot{C}^3+4\dot{H}$, or $3\,(\dot{Mg}\ddot{C}+\dot{H})+\dot{Mg}\,\dot{H}$=Magnesia 44·68, carbonic acid 35·86, water 19·46=100·00. According to Wachtmeister, (K. V. Ac. H. 1827, p. 17), and Kobell, (J. f. pr. Ch. iv, 80),

	$\dot{Mg}$	$\ddot{C}$	$\dot{H}$	$\dddot{Si}$	$\ddot{\overline{Fe}}$
1. Hoboken,	42·41	36·82	18·53	0·27	1·66, with earthy matter 1·39=99·99, W.
2. Negroponte,	43·96	36·00	19·68	0·36	——=100, K.

B.B. infusible; affords moisture in a tube, and finally becomes pure magnesia. Effervesces and dissolves in acids.

Occurs at Hrubschitz in Moravia in serpentine; on Negroponte near Kumi; with brucite in serpentine at Hoboken in New Jersey; and in serpentine also in Richmond and Westchester Cos., N. Y. This is identical with the *magnesia alba* of the shops.

Predazzite, (Petzholdt). Predazzite is a bitter spar allied to Gurhofian, from Predazzo in the southern Tyrol, containing in addition to 6·98 per cent. of water,

$\dot{Ca}\ddot{C}$ 68·7, $\dot{Mg}\ddot{C}$ 30·3, $\dddot{Si}$, $\dddot{\overline{Al}}$, $\ddot{\overline{Fe}}$ 1·0=100.

If the water is in chemical combination, it affords the formula $2\dot{Ca}\ddot{C}+\dot{Mg}\ddot{C}+\dot{H}$=Carbonate of lime 65·95, carbonate of magnesia 28·13, water 5·92.

LANCASTERITE, *Silliman, Jr.*

Monoclinic? Usually foliated like Brucite, but sometimes in small crystals resembling somewhat those of stilbite or gypsum, with diagonal cleavage eminent.

H.=2·5. G.=2·33—2·35. Color white. Lustre strongly pearly. Translucent. Thin folia inelastic, somewhat flexible.

Composition.—$\dot{Mg}\ddot{C}+\dot{Mg}\dot{H}^2$—Carbonic acid 27·11, magnesia 50·78, water 22·11—100. Analyses by H. Erni, (communicated to the Author),

	$\ddot{C}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{H}$
1.	27·07	50·01	1·01	21·60— 99·69
2.	26·85	50·72	0·96	21·47—100·00

In two other trials the $\dot{H}$ and $\ddot{C}$ together equaled 49·83 and 49·86, after 1½ days drying in the water-bath. In a matrass yields much water. B.B. exfoliates and becomes a little yellowish or brownish. Gives the reaction of magnesia. Dissolves with effervescence in acids.

From Lancaster Co., Pennsylvania, near Texas, on sepentine.

PENNITE, *Hermann*. J. f. pr. Chem. xlvii, 13.

Incrusting, with the surface often consisting of minute globules.

H.=3·5. G.=2·86. Color whitish, or greenish, to pale green. Lustre weak.

Composition.—3 $(\dot{Mg}, \dot{Ca}, \dot{Ni})\ddot{C}+\dot{H}$. Analysis by Hermann, (loc. cit.)

$\ddot{C}$ 44·54, $\dot{Ca}$ 20·10, $\dot{Mg}$ 27·02, $\dot{Ni}$ 1·25, $\dot{Fe}$ 0·70, $\dot{Mn}$ 0·40, $\dddot{Al}$ 0·15, $\dot{H}$ 5·84=100.

B.B. infusible; with borax intumesces and forms a glass which is brownish red in the outer flame.

With emerald nickel and graduating into it, in Texas, Lancaster Co., Pennsylvania.

APATITE, *Werner*. Phosphate of Lime. Spargelstein, Phosphorit, *W.* Asparagus stone. Moroxite. Chrysolite. Eupyrchroite, *Emmons*. Augustite. Pseudo-apatite, *Breit.*

Hexagonal; hemihedral. Fig. 114 and fig. 125, pl. 2; also the annexed figures: fig. 3 is a distorted form of fig. 2. P : e=139° 45′, P : e′=157°, P : e″=120° 20′, M : e=130° 15′, P : a=143° 39′, P : a′=124° 30′, Descloiseaux. Cleavage basal and lateral, both imperfect. Also globular and reniform, with a fibrous or imperfectly columnar structure; also massive, structure granular.

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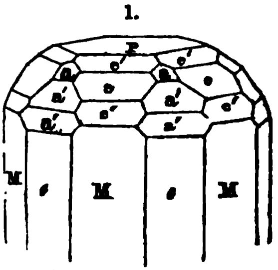

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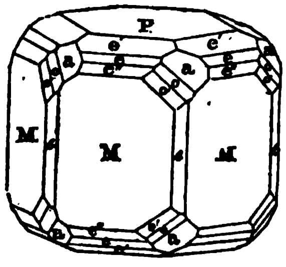
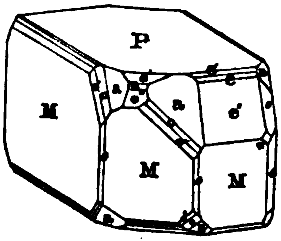


St. Gothard.

3



St. Gothard.

H.=5, sometimes 4·5. G.=3—3·285. Lustre vitreous, inclining to subresinous. Streak white. Color usually sea-green, bluish-green, or violet blue; sometimes white; also 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.—3 $\dot{Ca}^3 \overset{\cdot\cdot\cdot\cdot\cdot}{P}+Ca\,(Cl, F)$=Phosphate of lime 92·3, and fluorid of calcium 7·7. According to G. Rose, (Pogg. ix),

	Snorum, 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	a 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

Rammelsberg makes the composition of an apatite from Schwarzenstein in Zillerthal, Lime 49·66, phosphoric acid 42·58, with calcium 4·06, chlorine 0·07, fluorine 3·63. In a phosphorite from Estremadura, Daubeny found 14 per cent. of fluorid of calcium, (Ca F), leading to the formula, according to Rammelsberg, $4\,\dot{C}a^{3}\,\dddot{P}+3\,Ca\,(F, Cl)$.

B.B. infusible alone except on the edges; gives the test of phosphoric acid, (p. 165). 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 foreign localities are Ehrenfriedersdorf in Saxony; 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. *Eupyrchroite* of Emmons is similar.

Magnificent crystals of apatite are found in St. Lawrence Co., N. Y., in white limestone, along with scapolite, sphene, &c. One crystal from Robinson's farm, in Hammond, was nearly a foot in length, and weighed 18 pounds. Smaller crystals are abundant, and the prisms are frequently well terminated. Besides the locality in Hammond, fine crystals are obtained about a mile southeast of Gouverneur, in a similar gangue, 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 12 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. In *New Hampshire*, crystals, often large, are abundant in the south part of Westmoreland, four miles south of the north village meeting-house, occupying 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, (northwest 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 Suckasung, N. J., of a brown color, in massive magnetic pyrites; also at Perth, Canada.

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* of Breithaupt is considered by Rammelsberg an earthy variety of apatite.

TALC-APATITE, *Hermann*, J. f. pr. Ch. xxxi, 101.

This variety of apatite, from chlorite slate in the Schischimskian mountains near Slatoust, contains Lime 37·50, magnesia 7·74, phosphoric acid 39·02, sulphuric acid 2·10, chlorine 0·91, fluorine and loss 2·28, oxyd of iron 1·00, insoluble 9·50=100, whence the formula $3\,\dot{\mathrm{C}}\mathrm{a}^3\,\dddot{\overline{\mathrm{P}}}+\dot{\mathrm{M}}\mathrm{g}^3\,\dddot{\overline{\mathrm{P}}}$. 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 simple.

WAGNERITE, *Fuchs*. Pleuroclase. Talc Phosphorsäurer. Fluophosphate of Magnesia, *Thom.* Magnésie Phosphatée.

Monoclinic; M : M=95° 25′, P : M=109° 26′. Most of the prismatic planes deeply striated. Cleavage parallel to M, and the orthodiagonal; to P imperfect.

H.=5—5·5. G.=3·068 transparent crystal, and 2·985 untransparent, Rammelsberg. Lustre vitreous. Streak white. Color yellow, of different shades; often grayish. Translucent. Fracture uneven and splintery across the prism.

Composition.—$\dot{\mathrm{M}}\mathrm{g}^3\dddot{\overline{\mathrm{P}}}+\mathrm{MgF}$=Phosphoric acid 43·32, magnesia 50·38, fluorine 11·35. Analysis by Fuchs, (Schweig. J. xxxiii, 269), and more recently by Rammelsberg, (Ann. der Ph. u. Ch. lxiv, 251 and 405, and 2d Suppl. p. 168).

	$\dddot{\overline{\mathrm{P}}}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{n}$	HF
1.	41·73	46·66	5·00	0·5	6·50=100·39, Fuchs.
2.	40·61	46·27	4·59	$\dot{\mathrm{C}}\mathrm{a}$ 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 hydro-fluoric acid.

This rare species occurs in the valley of Höllengraben, near Werfen, in Saltzburg, Austria, in irregular veins of quartz, traversing clay slate.

FLUOR SPAR. Fluate of Lime. Fluorid of Calcium. Ratofkit, *John.* Chlorophane. Blue John. Chaux Fluatée, *H.* Flusspath. Muria Phosphorans, *Linn.*

Monometric; octahedral; the most common form is the cube, fig. 1, pl. 2; also figs. 2, 3, 5, 6, 7, 9, 10, 11, 14, 16, 24, and 25, and the same in combination. Cleavage octahedral, perfect. Compound crystals, fig. 129, pl. 2; also the annexed fig. 2, which is an instance of the same kind of composition; but the individuals continued beyond the face of composition, and one partially enveloped by the other. Rarely columnar; often granular, coarse or fine.

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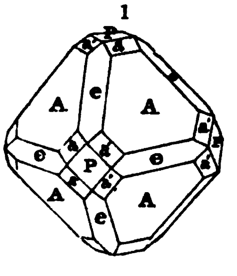

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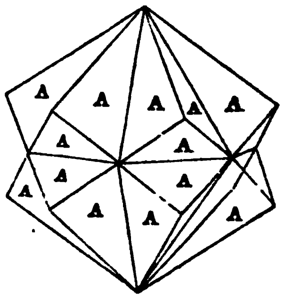

H.=4. G.=3·14—3·178. Lustre vitreous; sometimes splendent; usually glimmering in the massive varieties. Streak white. Color white, yellow, green, rose and crimson-red, violet-blue, sky-blue, and brown: wine-yellow, greenish and violet-blue, are the most common; the red varieties are the rarest. Transparent—subtranslucent. Brittle. Fracture of fine massive varieties flat conchoidal and splintery.

Composition.—CaF=Fluorine 48·6, and calcium 51·4.

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 Welserdorf contained 0·02078 nitrogen, 0·00584 hydrogen, 0·0365 carbon, and 0·08692 chloric acid.

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, (§ 222.) 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, (p. 165).

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. In Derbyshire, it is abundant; and also in Cornwall, where the veins intersect much older rocks. It is a common mineral in the mining districts of Saxony. In the dolomites of St. Gothard it occurs in pink octahedrons; and at Munsterthal in Baden in flesh-red hexakisoctahedrons. It has been detected in cannel coal by Prof. Rogers.

The most remarkable locality of fluor spar in the United States, 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, occur in granular limestone. Rossie and Johnsburgh, St. Lawrence county, 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, at Shawneetown, and other places, a dark purple fluor, often in large crystals, occurs through the soil, or in limestone. At the north village of Westmoreland, N. H., two miles south of the meeting house, 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 mine in Massachusetts; 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.

HAYESINE. Borate of lime, *A. A. Hayes*. Borocalcite. Borsaurerkalk.

In masses having a globular form, consisting of interwoven fibres. Opaque, snow-white, silky, and having a peculiar odor.

Composition.—$\dot{\mathrm{Ca}}\dddot{\mathrm{B}}^2+6\dot{\mathrm{H}}$=Lime 18·51, boracic acid 45·95, water 35·54. Hayes obtained Lime 18·89, boracic acid 46·11, water 35·00. In warm water the fibrous masses expand and form a consistent paste with more than eight times their volume.

This salt occurs quite abundantly on the dry plains near Iquique, S. A., associated with magnesian alum, (Pickeringite of Hayes), where it was obtained by Mr. J. H. Blake.

A similar compound (probably the same mineral) has been analyzed by Ulex (Ann. Ch. u. Pharm. lxx, 49) with the following result:

Lime 15·7,	Soda 8·8,	Boracic acid 49.5,	Water 26·0,
15·9,	" 8·8,	" 49·5,	" 25·8,

giving the formula $\dot{N}a\,\overline{B}^2+\dot{C}a^2\overline{B}^3+10\dot{H}$. It occurs in Southern Peru, in white reniform masses, from the size of a hazlenut to that of a potato, and is there called teza. On fracturing them, they are found to consist of white silky interwoven fibres, which rapidly absorb water, and have a slight saline taste.

HYDROBORACITE. Hydrous Borate of Lime and Magnesia. Hydrous Calcareo-biborate of Magnesia, *Thomson*.

Resembles fibrous and foliated gypsum.

H.=2. G.=1·9. Color white, with spots of red from iron. Thin plates translucent.

Composition.—$\dot{C}a^3\overline{B}^4+\dot{M}g^3\overline{B}^4+18\dot{H}$=Boracic acid 47·43, lime 14·52, magnesia 10·53, water 27·52. Analyses by M. Hess, (Pogg. xxxi, 49):

	$\overline{B}$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$
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.

BORACITE, *Werner*. Borate of Magnesia, *P*. Borazit. Magnésie-boratée, *H*.

Monometric; hemihedral. In cubes, dodecahedrons, and other forms, with tetrahedral replacements, figs. 28, 33, pl. 1, and the following:

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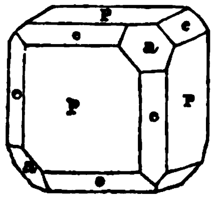

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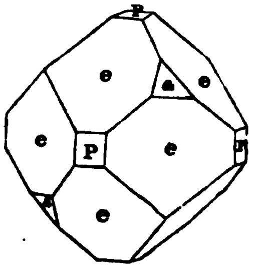


Cleavage octahedral, in traces. Also amorphous.

H.=7. G.=2·974, Haidinger; 2·9134, massive, Karsten. Lustre vitreous, inclining to adamantine. Streak white. Color white, inclining to gray, yellow, and green. Subtransparent—translucent. Fracture conchoidal, uneven. Pyro-electric.

Composition.—$\dot{M}g^3\overline{B}^4$=Magnesia 30·45, boracic acid 69·55. Stromeyer, (Gilbert's Annalen, xlviii, 215), Arfvedson, (K. V. Ac. H., 1822, p. 92), and Rammelsberg, (Pogg. xlix, 445), obtained

Boracic acid,	67	69·7	69·252
Magnesia,	33=100, St.	30·3=100, Arf.	30·748=100, Ram.

A compact boracite from Strassfurth 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.

B.B. intumesces, and forms a glassy globule, which becomes crystalline, opaque, and white, on cooling. Heat excites four sets of electrical poles, (see page 187).

Boracite has been observed only in beds of gypsum, or salt, and associated with anhydrite. It occurs in crystals at Kalkberg and Schildstein in Lüneberg, Hanover, at Segeberg, near Kiel in Holstein, at Luneville, La Meurthe, France. Also massive, or forming part of the rock at a mine of rock salt, at Strassfurth, near Minden, Prussia.

RHODIZITE, *G. Rose*, Poggendorf's Annalen, xxxiii, 253.

Monometric and hemihedral like boracite; planes a smooth and shining; e with less lustre and often uneven.

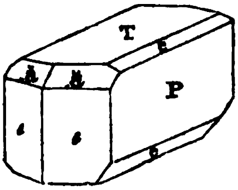
H.=8. G.=3·3—3·42. Lustre vitreous, passing into adamantine, splendent. Color grayish or yellowish white. Translucent. Pyro-electric.

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, and appears to contain no silica. Dissolves with great difficulty in muriatic acid. Resembles boracite in its pyro-electric qualities.

This species is supposed to be closely allied to the preceding, and is considered a lime-boracite.

Rhodizite was discovered by G. Rose, in very minute crystals on some of the red tourmalines from near Mursinsk, Siberia, and named from 'ροδιζειν, *to make of the color of the rose*, in allusion to its tinging flame red. The largest crystals seen were two lines in diameter.

PHARMACOLITE, Brewster's Edinb. J., 1822, iii, 302. Arsenate of Lime. Chaux. Arseniatée, *H.* Arsenikblüthe, in part, *Werner*. Picro-pharmacolite.



Monoclinic; right rhomboidal; M : T =96° 46′, P : T=90′, *e* : *e*=117° 24′, P : *e*=121° 18′. Cleavage parallel to T, eminent. Crystals usually lengthened in the direction of P, and one face *e* often obliterated by the extension of the other. Surfaces T and e usually striated parallel to their mutual intersection. Rarely in distinct 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 P, inclining to pearly. Streak white. Color white or grayish; frequently tinged red by arsenate of cobalt. Translucent—opaque. Fracture uneven. Thin lamina flexible.

Composition.—$\dot{\text{C}}\text{a}^2\ddot{\ddot{\text{A}}}\text{s}+6\dot{\text{H}}$=Arsenic acid 50·94, lime 25·19, water 23·87. Analysis by Klaproth, (Beit. iii, 277), John, (Chem. Untera. ii, 221), and Rammelsberg, (Pogg. Ann. lxii, 150):

	$\dot{\text{C}}\text{a}$	$\ddot{\ddot{\text{A}}}\text{s}$	$\dot{\text{H}}$
1. Wittichen,	25·00	50·54	24·46=100, K.
2. Andreasberg,	27·28	45·68	23·86=96·82, John.
3. Glücksbrunn,	23·59	51·58	23·40, $\dot{\text{C}}\text{o}$, $\overline{\text{F}}\text{e}$, 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.

The *Picropharmacolite* of Stromeyer, from Riechelsdorf, (Gilb. Ann. lxi, 185), contains Lime 24·646, arsenic acid 46·971, magnesia 3·228, oxyd of cobalt 0·998, water 23·977=

99·815, affording the formula $(\dot{C}a, \dot{M}g)^5 \,\ddot{\bar{A}}s^2+12\dot{H}$, Ramm.; but it is probably impure pharmacolite.

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*.

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.

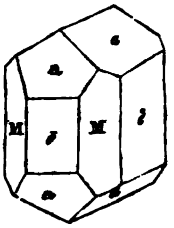
Composition.—$(\dot{C}a, \dot{M}g, \dot{M}n)^3 \,\ddot{\bar{A}}s$. Analyses by Kühn:

	$\dot{C}a$	$\dot{M}g$	$\ddot{\bar{A}}s$	$\dot{M}n$	
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 Längbanshytta in Wermland, with an ore of iron and granular bitter spar. This mineral was called Berzeliite by Kühn, in honor of Berzelius; but this name is already appropriated to another mineral.

HAIDINGERITE, *Turner*. Brewster's Journal, iii, 303.



Trimetric; M : M=100°. M : ē=140, M : ĕ =130, *a* : *a* (adjacent planes)=126° 58′, ĕ : *a*= 116° 31′. Cleavage highly perfect and easily obtained parallel to ĕ. 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.

Composition.—$\dot{C}a^2\ddot{\bar{A}}s+4\dot{H}$=Arsenic acid 55·344, lime 27·365, water 17·291. 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.

First distinguished as a species by Haidinger. A single specimen only has been observed, and that was associated with pharmacolite. It is supposed to have come from Joachimstahl.

V. ALUMINA.

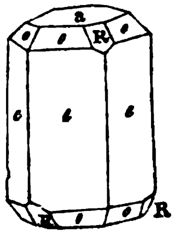
Pure alumina ($\bar{A}l$) is the mineral or gem sapphire, corundum, or emery. Combined with water it forms the hydrates, diaspore and gibbsite; with sulphuric acid it gives rise to several sulphates; and combinations of a sulphate ($\bar{A}l\dddot{S}^3$) with a sulphate of potash, soda, magnesia, or some other allied base ($\dot{R}\dddot{S}$) and 24 parts of water ($24\dot{H}$) produce a series of alums, crystallizing alike in octahedral forms. It also unites with phosphoric acid; and its metallic base combined with fluorine, forms, along with sodium, the minerals cryolite and chiolite. Its most common mode of occurrence is in combination with silica, it entering into the composition of much the larger part of the silicates. The zeolites, feldspars, micas, garnet, tourmaline, kyanite, andalusite, beryl, euclase, topaz, and numerous other species contain it as an essential ingredient; and it occurs occasionally in hornblende and in some other magnesian species. Combined with magnesia, protoxyd of zinc, iron, or manganese, it produces a series of spinels having in common an octahedral form; with glucina it forms chrysoberyl. It is the characterizing ingredient of clay, and of many hydrous species like halloysite.

Being isomorphous with peroxyd of iron, ($\bar{F}e$), it is often replaced by this base; consequently there is a phosphate of iron resembling phosphate of alumina; and many of the aluminous silicates vary widely in character from a more or less general substitution of one base for the other. Peroxyd of manganese ($\bar{M}n$) also performs to some extent the same part in replacement; and so also zirconia ($\bar{Z}r$) and peroxyd of cerium, ($\bar{C}e$). Alumina also has been supposed to replace silica, as in some varieties of hornblende, where the presence of alumina is attended with a diminution of the proportion of silica.

Owing to the relation of $\bar{A}l$ and $\bar{F}e$ there are spinels in which the alumina is replaced partly by peroxyd of iron. And magnetic iron, franklinite as well as chromic iron, belong to the same series.

Pure alumina is insoluble and infusible; H.=9. The *hydrates* are insoluble and infusible, and yield water; H.=3—6·5. None of the salts in this chapter gelatinize with acids. The *sulphates* are mostly soluble, and have an alum taste; the insoluble sulphates dissolve in acids without effervescence; H.=1—5: G=1·5—2·8. The *phosphates* fuse with difficulty or not at all, and give the blowpipe reaction for phosphoric acid, and usually that of alumina; H.=3—6. G.=2·3—3·2. The *fluorids* are very easily fusible, but insoluble; H.=2—4. G.=2·7—3.

SAPPHIRE. Corundum. Emery. Oriental Amethyst. Oriental Topaz, Ruby, Emerald, Amethyst. Adamantine Spar. Salamstein. Smirgel. Korund. Demanthspath. Telésie. Corindon. Asteria *of Pliny*.



Rhombohedral; R : R=86° 6′. R : *e*=136° 57′, R : *o*=154° 1½′, a : *o*=118° 51′, *o* : *e*=151° 9′. Cleavage basal, in some varieties perfect, but interrupted by conchoidal fracture; imperfect commonly in the blue variety. Large crystals usually rough. Also massive granular or impalpable; often in layers from composition parallel to R.

H.=9. G.=3·909—4·16. Lustre vitreous; in some specimens inclining to pearly on a, and at times 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. When compact, exceedingly tough.

Sapphire is pure alumina crystallized. The silica that different analyses have appeared to detect in it, has probably been derived from the mortar in which the mineral was abraded. B.B. unaltered, both alone and with soda; fuses entirely with borax, though with great difficulty; and also, if pulverized, with salt of phosphorus. It is not attacked by acids. Friction excites electricity, and in polished specimens the electrical attraction continues for a considerable length of time.

The species sapphire includes corundum and emery, in addition to the finely colored varieties that have always borne this name. Corundum includes the gray and darker colored opaque crystallized specimens, or cleavably massive; emery, massive varieties of dingy color. The *red* sapphire is sometimes called the *Oriental ruby*; the yellow, *topaz*; the green, *emerald*; violet, *amethyst*; and hair-brown, *adamantine spar*. The asteriated crystals are often called *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 found in 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 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 Expaillie 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, and in Gellivara, Sweden. Emery is found in large boulders at Naxos, and several of the Grecian islands. Also in Asia Minor, 12 miles east of Ephesus, near Gummuchkeny, where it was discovered in situ by Dr. J. Lawrence Smith, associated with emerylite and other micas, oxyds of iron, chloritoid, pyrites, and calc spar, between Eskihissar and Melas, as seen by Tchihatcheff, and also to the north of Smyrna. Other localities are in Bohemia, near Petschau, in the Ural, near Katherinenburg, and in the Ilmen mountains, not far from Miask.

A fine blue variety of sapphire occurs at Newton, N. J., with hornblende, mica, feldspar, and tourmaline, connected with an extensive bed of granular limestone. The crystals are often several inches long, and when regular are rhombohedrons or six-sided prisms. Well-defined crystals of bluish and pink colors are found in a similar situation at Warwick, N. Y., where they occasionally occupy the cavities of large crystals of spinel. At Amity, N. Y., white, blue and reddish crystals occur with 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 emerylite, and in albite some masses weighing 4000 pounds, and crystals being occasionally 4 inches long. Pale blue crystals are met with at West Farms, Conn., near Litchfield, associated with kyanite. A blue massive corundum, affording broad cleavage surfaces, is abundant in large masses in Rutherford Co., North Carolina; and a fine red sapphire has been obtained in Chester Co., Georgia. Perth, Canada, also affords this species.

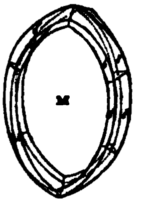
The red sapphire is more highly esteemed than other varieties of this species. A crystal weighing four carats, perfect in transparency and color, has been valued at half the price of a diamond of the same size. They seldom exceed half an inch in length. Two splendid red crystals, however, having the form of the scalene 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.

Blue sapphires occur of larger size. According to Allan, Sir Abram Hume possesses a distinct crystal, which is three inches in length; and in Mr. Hope's collection of precious stones there is one crystal, formerly the property of the Jardin des Plantes, for which he gave £3000 sterling.

The sapphire admits of the highest degree of polish. It is cut by means of diamond dust, and polished on copper or lead wheels with the powder of emery. It is used for jewelling watches, and has been cut into lenses. The applications of emery are well known.

The word *sapphire* is from the Greek *σαπφειρος*, the name of a blue stone, highly valued by the ancients. This does not however appear to have been the sapphire of the present day, but the lapis lazuli, which more nearly 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 very frequently disseminated through lapis lazuli, looking like gold. (Moore's An. Min.) Corundum is a word of Asiatic origin.

DIASPORE, *Haüy*. Dihydrate of Alumina, *Thom.* Stephanite.



Trimetric? according to Haidinger. M : M=129° 54′. Cleavage brachydiagonal, eminent; also lateral and basal, less perfect. Occurs in irregular lamellar prisms, and foliated massive.

H.=6—6·5. G.=3·4324, Haüy; 3·452, Duf. Lustre brilliant and pearly on cleavage faces; elsewhere vitreous. Color greenish-gray or hair-brown; crystals sometimes violet-blue in one direction, reddish plum-blue in another, and pale asparagus-green in a third. When thin, translucent—subtranslucent. Very brittle.

Composition.—$\dddot{\text{Al}}\dot{\text{H}}$=85·10 alumina, 14·90 water. Analyses: 1, Vauquelin, (Ann. de Ch. xlii, 113); 2, Children, (Ann. Phil. [2], iv, 146); 3, 4, Dufrénoy, (Ann. des Mines, 1837); 5, 6, Hess, (Pogg. xviii, 255); 7, Damour, (Comptes Rend. xxi, 322); 8, Löwe, (Pogg. lxi, 307):

	$\dddot{\text{Al}}$	$\dot{\text{H}}$	$\dot{\text{Fe}}$	$\dddot{\text{Si}}$
1.	80·0	17·3	3·0	——=100·3, Vauq.
2. Sweden, (?)	76·06	14·70	7·78	——=98·54, Children.
3. Siberia,	74·66	14·58	$\dddot{\text{Fe}}$ 4·51	2·90, $\dot{\text{Ca}}$ and $\dot{\text{Mg}}$ 1·64=98·29, Duf.
4.	78·93	15·13	" 0·52	1·39, $\dot{\text{Ca}}$ 1·98=97·95, Duf.
5. Miask,	85·44	14·56	—	——=100, Hess.
6. "	85·61	14·39	—	——=100, "
7. Siberia,	79·91	14·90	—	——unattacked 5·80=100·61, Dam.
8. Schemnitz,	85·131	15·00	—	——=100·131, Löwe.

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; and with corundum at St. Gothard. The angles and figure above, by Haidinger, are from Schemnitz crystals; and Dufrénoy suggests that the mineral may be a distinct species. The specific gravity is but 3·303. The Siberian diaspore afforded Lelievre, however, the angle M; M=128° to 129°, but has been supposed to be clinometric. The dichroism above described characterises the Schemnitz crystals.

GIBBSITE, *Torrey*, N. Y. Med. and Phys. Jour. 1, 68. Hydrargillite, *G. Rose*, Pogg. xlviii, 564.

Hexagonal, in small crystals with replaced lateral edges and eminent basal cleavage. Planes M vertically striate. 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, 2·387, Hermann. Color grayish, greenish, or reddish-white. Lustre of P pearly; of stalactites faint. Translucent. A strong argillaceous odor when breathed on. Tough.

Composition.—$\bar{\text{A}}\text{l}\dot{\text{H}}^3$=Alumina 65·56, water 34·44. Analyses; 1, Torrey, (loc. cit.); 2, Thomson; 3, Hermann, (J. f. pr. Chem, xl, 32, and xlvii, 1); 4, 5, 6, B. Silliman, Jr., (Am. Jour. Sci. [2], vii, 411); 7, Hermann, (as above); 8, Kobell, (J. f. pr. Chem. xli):

		$\bar{\text{A}}\text{l}$	$\dot{\text{H}}$	$\bar{\text{F}}\text{e}$	$\ddot{\text{S}}\text{i}$	$\dddot{\text{P}}$	
1.	Richmond, Mass.	64·8	34·7	—	—	—	=99·5, Tor.
2.	"	54·91	33·60	3·93	8·73	—	=101·16, Thom.
3.	"	26·66	35·72	—	—	37·62	=100, Herm.
4.	"	63·446	34·477	—	—	—	$\dot{\text{M}}\text{g}$ 0·3, insol. 1·777=100, B. S.
5.	"	64·955	34·078	—	—	0·590	$\dot{\text{M}}\text{g}$ 0·3. insol. ·082=100, B. S.
6.	"	64·160	34·151	—	—	*trace*	$\dot{\text{M}}\text{g}$ 0·3, insol. 0·127=100·238, B. S.
7.	*Hydrarg.*, Ural,	64·03	34·54	—	—	1·43	=100, Herm.
8,	" Villa Rica,	65·6	34·4	—	—	—	=100, Kob.

Silliman, Jr., did not find the phosphoric acid attributed to the Gibbsite by Hermann, and ascertained that the silica of Thomson's analysis was due to a mixture with allophane, with which mineral it is often associated. The species hydrargillite therefore falls into Gibbsite. The absence of phosphoric acid has also been still more recently proved by Mr. Crossley in the laboratory of Dr. C. T. Jackson.

In a matrass, yields water. B.B. infusible; on charcoal decrepitates, becomes opaque, and crystals exfoliate; phosphoresces. A fine blue with cobalt solution.

The crystallized gibbsite was discovered by Lissenko in the Schischimskian mountains near Slatoust in the Ural. The larger crystals were 1 to 2 lines long. The stalactitic occurs at Richmond, Mass., in a bed of brown iron ore; also at Lenox, Mass.; at the Clove mine, Union Vale, Duchess Co., N. Y., on hematite; in Orange Co., N. Y.

This species was named in honor of Col. George Gibbs, the original owner (after extensive foreign travel) of the large Gibbs' cabinet of Yale College.

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.=2—3. Lustre vitreous—silky. Color white, or tinged with yellow or red. Subtranslucent—subtransparent. Taste like that of common alum.

Composition.—$\bar{\text{A}}\text{l}\dddot{\text{S}}^3+18\dot{\text{H}}$=Alumina 15·40, sulphuric acid 36·05, water 48·55. 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):

	$\bar{A}l$	$\dddot{S}$	$\dot{H}$	$\bar{F}e$	$\dot{M}g$	$\dot{C}a$	$\dddot{S}i$	
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. Bogota, *Davyte*,	15·00	29·00	51·80	1·20	——	——	——	Earthy 3·0=100·00, M.
4. Milo,	14·98	40·31	40·94	——	0·85	——	1·18,	$\dot{N}a$ 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	37·88	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 =98·43, R.
9. Freienwalde,	11·28	35·64	48·85	——	1·91	0·45		$\dddot{S}i$ 0·43, $\dot{F}e$ 0·72, $\dot{K}$ 0·47, $\dot{M}n$ 0·31, $\dddot{S}i$ 0·43=100, Ramm.
10. Adelaide, N. S. W.	17·09	35·63	46·70	——				$\dot{C}u$ 0·04 and earthy substance 0·50=99·96, Herap.

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 Göbel, (Schw. J. lx, 401), afforded alumina 38·75, sulphuric acid 58·58, sulphate of protoxyd of iron 2·78=100·11=$\bar{A}l\,\dddot{S}^2$; the water was not determined.

The *Keramohalite* of J. Juraśky, (Ost. Blat. f. Lit. 1847), from near Königsberg in Hungary, has the same composition as alunogen. It is described as occurring in crystalline crusts and also as presenting six-sided tables of 92° and 134°, with the crystallization monoclinic. Juraśky obtained for its composition—

$\bar{A}l$ 14·30, $\dot{F}e$ 2·15, $\dddot{S}$ 36·75, $\dot{H}$ 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 having the general formula $\dot{R}\,\dddot{S}+\bar{A}l\dddot{S}^3+24\dot{H}$, $\dot{R}$ standing for different bases, as potash, soda, magnesia, protoxyd of manganese, &c. Crystals octahedral. 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.—$\dot{K}\dddot{S}+\bar{A}l\dddot{S}^3+24\dot{H}$=Sulphate of potash 18·3, tersulphate of alumina 36·2, and water 45·5. 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. In the brown coal, at Tschermig, in Bohemia, it occurs in layers having a fibrous structure. It has also been obtained at the volcanoes of the Lipari isles and Sicily. Cape Sable, Maryland, affords large quantities of alum annually.

Alum is an important material in the arts. It is used in the manufacture of leather, in dyeing, also as a preventive of putrefaction. Large artificial crystals of an octahedral form are obtained without difficulty from a saturated solution.

2. **SODA ALUM.** Solfatarite, *Shep.* Alun Sodifère, *Duf.* Natronalaun, *Ramm.*

In fibrous crusts or masses. H.=2—3. G.=1·88. Resembles the preceding, but more soluble.

Composition.—$\dot{N}a\dddot{S}+\bar{\ddot{A}}l\dddot{S}^3+24\dot{H}$=Sulphate of soda 15·54, tersulphate of alumina 37·37, water 47·02. Analysis by Thomson, (Ann. Lyc. N. Y., 1828).

From St. Juan near Mendoza.—$\bar{\ddot{A}}l$ 12·00, $\dot{N}a$ 7·96, $\dddot{S}$ 37·70, $\dot{H}$ 41·96=99·62. Occurs on the island of Milo, at the Solfatara near Naples, and near Mendoza, on the east of the Andes.

3. **MAGNESIA ALUM.** Magnesia-alaun, *Ramm.* Pickeringite, *Hayes.* Talkerde-alaun, *Kobell.*

In white fibrous masses, and in efflorescences like the preceding. Lustre silky. Becomes opaque on exposure.

Composition.—$\dot{M}g\dddot{S}+\bar{\ddot{A}}l\dddot{S}^3+24\dot{H}$=Sulphate of magnesia 13·5, tersulphate of alumina 38·2, and water 48·3. Analysis by A. A. Hayes, (Am. J. Sci. xlvi, 360):

From near Iquique, S. A. $\bar{\ddot{A}}l$ 12·130, $\dot{M}g$ 4·682, $\dddot{S}$ 36·322, $\dot{H}$ 45·450, $\dot{F}$ and $\dot{M}n$ 0·430, $\dot{C}a$ 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, 337) for a specimen from a cave near Bosjesman river, southern Africa:

$\bar{\ddot{A}}l$ 11·515, $\dot{M}g$ 3·690, $\dot{M}n$ 2·617, $\dddot{S}$ 36·770, $\dot{H}$ 45·739, KCl 0·205=100·036.

It covers the floor of the cave to a depth of six inches. The roof is a reddish quartzose conglomerate, containing manganese and pyrites. It rests on a bed of epsom salt, 1½ inches thick.

MANGANESIAN ALUM. $\dot{M}n\dddot{S}+\bar{\ddot{A}}l\dddot{S}^3+24\dot{H}$. Occurs near Lagoa-Bay, in South Africa. Apjohn (Phil. Mag. xii, 103) obtained,

$\bar{\ddot{A}}l$ 10·65, $\dot{M}n$ 7·33, $\dddot{S}$ 32·79, $\dot{H}$ 48·15, $\dot{M}g\dddot{S}$ 1·08=100.

It is found in fine crystallizations like asbestus, with a silky lustre. The crystallization is supposed not to be tesseral.

IRON ALUM. Eisen alaun. Federalaun and Haarsaltz *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.—$\dot{F}e\dddot{S}+\bar{\ddot{A}}l\dddot{S}^3+24\dot{H}$=Protoxyd of iron 7·59, alumina 11·10, sulphuric acid 34·65, water 46·66=100. Analysis: 1, Berthier, (Ann. d. Mines v, 257); 2, Rammelsberg, (Pogg. xliii, 399); 3, B. Silliman, Jr., (private communication):

	$\bar{\ddot{A}}l$	$\dot{F}e$	$\dddot{S}$	$\dot{M}g$	$\dot{H}$
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, $\dot{K}$ 0·484=100, R.
3. Oroomiah,	10·617	9·150	33·812	——	41·611, $\dddot{S}i$ 3·340, $\bar{\ddot{F}}e$ 1·050=99·580, Sill.

Occurs at Bodenmais and at Mörsfeld in Rhenish Bavaria. Also at Oroomiah, Persia, where the inhabitants use it for making ink of fine quality. Specimens analyzed by Dr. Thomson from Hurlet and Campsie, appear to be iron-alum mixed with sulphate of iron. Occurs probably at Rossville, Richmond Co., N. Y. (Beck).

The *Hversalt* of Forchhammer (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

$\bar{\ddot{A}}l$ 11·22, $\bar{\ddot{F}}e$ 1·23, $\dot{F}e$ 4·57, $\dot{M}g$ 2·19, $\dddot{S}$ 35·16, $\dot{H}$ 45·63=100.

Formula, $(\dot{F}e, \dot{M}g)\dddot{S}+(\bar{\ddot{A}}l, \bar{\ddot{F}}e)\dddot{S}^3+24\dot{H}$. From Iceland.

VOLTAITE, (A. Scacchi, R. Acad. Sci. Nap. 1840). Voltaite is allied to iron alum, and occurs in octahedrons, but its constitution is peculiar. Its color is brown or black. Soluble in water with difficulty, and at the same time decomposes.

Composition.—$3(\dot{F}e, \dot{K})\dddot{S}+2\bar{\ddot{A}}l\dddot{S}^3+12\dot{H}$. Analysis by Dufrénoy,

$\bar{\ddot{A}}l$ 3·27, $\dot{F}e$ 28·69, $\dot{K}$ 5·47, $\dddot{S}$ 45·67, $\dot{H}$ 15·77, gangue 0·46=99·33.

Abich has obtained a similar salt artificially, in which part of the alumina is replaced by peroxyd of iron.

This species was detected at the Solfatara near Naples by Prof. A. Scacchi.

Ammonia Alum. Fibrous and in octahedrons like the preceding. H.=1—2. G.=1·56.

Composition.—$\text{NH}^4\dddot{\text{S}}+\dddot{\bar{\text{A}}}\text{l}\dddot{\text{S}}^3+24\dot{\bar{\text{H}}}$=Ammonia 3·80, alumina 11·31, sulphuric acid 35·33, water 49·56. Analysis: 1, Pfaff, (Handb. der Analyt. Chem. ii, 47); 2, Lampadius, (Gilb. Ann. lxx, 182, lxxiv, 303); 3, Stromeyer, (Pogg. xxxi, 137):

	$\dddot{\bar{\text{A}}}\text{l}$	NH^3	$\dddot{\text{S}}$	$\dot{\bar{\text{H}}}$	$\dot{\text{Mg}}$
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.

BASIC SODA ALUM. Subsesquisulphate of Alumina, *Thomson*, L. and E., Phil. Mag. xxii, 188.

In fibrous and feathery masses, with a silky lustre. Color white, with some reddish yellow spots. G.=1·584. Taste like alum.

Composition.—$2\dot{\text{Na}}\dddot{\text{S}}+3\dddot{\bar{\text{A}}}\text{l}\dddot{\text{S}}^2+10\dot{\bar{\text{H}}}$. Thomson obtained

$\dddot{\bar{\text{A}}}\text{l}$ 22·55, $\dot{\text{Na}}$ and $\dddot{\text{S}}$ 6·50, $\dddot{\text{S}}$ 32·95, $\dot{\bar{\text{H}}}$ 39·20=101·20.

From Southern Peru.

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.—$\dddot{\bar{\text{A}}}\text{l}\dddot{\text{S}}+9\dot{\bar{\text{H}}}$=Alumina 29·81, sulphuric acid 23·21, water 46·98. Analyses: 1, Simon; 2, Buchols; 3, Stromeyer, (Unters. 99); 4, Schmid, (J. f. pr. Ch. xxxii, 495); 5, Marchand, (ib.); 6, 7, Stromeyer, (loc. cit.); 8, Dufrénoy, (Min. ii, 1845, 366); 9, Dumas, (ib.); 10, Lassaigne, (Ann. Ch. Phys. xxiv, 98); 11, Marchand, (J. f. pr, Ch. xxxii, xxxiii); 12, Backs, (ib.); 13, Wolff, (ib.); 14, Marchand, (ib.); 15, Märtens, (ib.); 16, Schmid, (ib.):

	$\dddot{\bar{\text{A}}}\text{l}$	$\dddot{\text{S}}$	$\dot{\bar{\text{H}}}$
1. Halle,	32·50	19·25	47·00, $\dddot{\bar{\text{F}}}\text{e}$, $\dot{\text{Ca}}$, $\dddot{\text{Si}}$ 1·25=100, Simon.
2. “	31·00	21·50	45·00, $\dddot{\bar{\text{F}}}\text{e}$, $\dot{\text{Ca}}$, $\dddot{\text{Si}}$=99·5, Buchols.
3. “	30·268	23·365	46·372=100, Stromeyer.
4. “	29·23	23·25	46·34, $\dot{\text{Ca}}$ 1·18=100, Schmid.
5. “	30·7	22·3	47·0=100, Marchand.
6. Morl,	30·98	23·68	45·34=100, Strom.
7. New Haven,	29·87	23·37	46·76=100, Strom.
8. Lunel Vieil,	29·72	23·45	46·80=99·97, Dufrénoy.
9. Auteuil,	30·00	23·00	47·00=100, Dumas.
10. Epernay,	39·70	20·06	39·94, $\dot{\text{Ca}}\dddot{\text{S}}$ 0·30=100, Lassaigne.
11. S. of Halle,	39·50	11·45	48·80=99·75, Marchand.
12. “	37·71	12·22	49·18, $\dot{\text{Ca}}\ddot{\text{C}}$ 1·00=100·11, Backs.
13. “	38·81	12·44	47·07, $\dot{\text{Ca}}\ddot{\text{C}}$ 1·68=100, Wolff.
14. “	36·00	17·00	47·2=100·2, Marchand.
15. “	35·96	14·04	50·00=100, Märtens.
16. “	36·17	14·54	49·03=99·74, Schmid.

The formula of the analyses 1 to 9, (true websterite), is $\ddot{\bar{\text{A}}}\text{l}\bar{\text{S}}+9\dot{\text{H}}$. The others are either different compounds or impure websterite. Rammelsberg writes their constitution as follows:

No. 10, $2(\ddot{\bar{\text{A}}}\text{l}\bar{\text{S}}+9\dot{\text{H}})+\ddot{\bar{\text{A}}}\text{l}(?\dot{\text{H}})$.
Nos. 11—13, $2(\ddot{\bar{\text{A}}}\text{l}\text{S}+9\dot{\text{H}})+3\ddot{\bar{\text{A}}}\text{l}\dot{\text{H}}^6$, ($\ddot{\bar{\text{A}}}\text{l}^5\bar{\text{S}}^3+36\dot{\text{H}}$, *Marchand*).
No. 14, $3(\ddot{\bar{\text{A}}}\text{l}\bar{\text{S}}+9\dot{\text{H}})+2\ddot{\bar{\text{A}}}\text{l}\dot{\text{H}}^4, \dot{\text{H}}$, ($\ddot{\bar{\text{A}}}\text{l}^5\bar{\text{S}}^3+36\dot{\text{H}}$, *Marchand*).
Nos. 15, 16, $(\ddot{\bar{\text{A}}}\text{l}\bar{\text{S}}+9\dot{\text{H}})+\ddot{\bar{\text{A}}}\text{l}\dot{\text{H}}^6$, ($\ddot{\bar{\text{A}}}\text{l}^2\bar{\text{S}}+15\dot{\text{H}}$, *Marchand*).

And a variety from Huelgoet, analyzed by Berthier, is represented by

$$2(\ddot{\bar{\text{A}}}\text{l}\bar{\text{S}}+9\dot{\text{H}})+3\ddot{\bar{\text{A}}}\text{l}\dot{\text{H}}^4.$$

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 New Haven, 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 on the Saale in Prussia.

PISSOPHANE, *Breithaupt.*

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

	$\ddot{\bar{\text{A}}}\text{l}$	$\ddot{\bar{\text{F}}}\text{e}$	$\bar{\text{S}}$	$\dot{\text{H}}$		
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, $\ddot{\bar{\text{R}}}^3\bar{\text{S}}+15\dot{\text{H}}$, and No. 3, $\ddot{\bar{\text{R}}}^2\bar{\text{S}}+15\dot{\text{H}}$. The relation in the former is more exactly $\ddot{\bar{\text{R}}}^5\bar{\text{S}}^2+30\dot{\text{H}}$. 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 Saalfield, and at Reichenbach, Saxony, in alum slate.

ALUNITE. Alum stone. Alaunstein. Alumine sous-sulfatée alkaline, *H.*

Rhombohedral. R : R=92° 50′, fig. 113, pl. 2. Cleavage, basal, nearly perfect; rhombohedral, indistinct. Also massive, having a granular or impalpable texture.

H.=5. G.=2·58—2·752. Lustre vitreous on R, inclining to pearly on a. Streak white. Color white, sometimes grayish or reddish. Transparent—subtranslucent. Fracture flat conchoidal, uneven; of massive varieties, splintery, and sometimes earthy. Brittle.

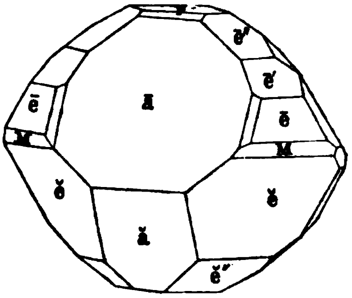
Composition.—$\dot{\text{K}}\bar{\text{S}}+3\ddot{\bar{\text{A}}}\text{l}\bar{\text{S}}+6\dot{\text{H}}$=Alumina 37·08, sulphuric acid 38·58, potash 11·35, water, 12·99. Analyses: 1, 2, Cordier, (Ann. des M. iv, 205, and v, 203; and Ann. Ch. Phys. ix, 71); 3, Descotils, (Ann. d. Mines, i, 319); 4, Berthier, (Ann. d. Mines, [4], ii, 459); 5, Sauvage, (ib., [4], x, 85.):

	$\ddot{\bar{\text{A}}}\text{l}$	$\bar{\text{S}}$	$\dot{\text{K}}$	$\ddot{\bar{\text{F}}}\text{e}$	$\dot{\text{H}}$	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	——=100, Cord.
3. Hungary,	40·0	35·6	13·8	—	10·6	——=100, Desc.
4. "	26·0	27·0	7·3	4·0	8·2	26·5=99, Berth.
5. Milo,	30·0	31·0	9·40	—	10·6	19=100, Sauv.

The silica is an impurity, and 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 Beregszasz in Hungary, on Milo, Grecian Archipelago; and at Pic de Sancy, France, Dept. du 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.

LAZULITE. Azurite, *P.* Azurestone. Hydrous diphosphate of alumina and magnesia, *Thom.* Blue spar. Feldspath bleu, *H.* Voraulite. Klaprothite. Blauspath, *W.*



Monoclinic. M : M=91° 30′; M : ē=157° 25′, M : ĕ=158° 1′, ē : ē (over ā)=100° 20′, ĕ : ĕ=99° 40′, ĕ′ : ĕ′=115° 30, Prüfer. Cleavage lateral, indistinct. Also massive.

H.=5—6. G.=3·057, Fuchs; 3·067—3·121, Prüfer. Lustre vitreous. Streak white. Color azure-blue; commonly a fine deep blue, viewed in one direction, and a pale greenish-blue, at right angles with this direction. Subtranslucent—opaque. Fracture uneven. Brittle.

Composition.—$2(\dot{Mg}, \dot{Fe})^3\ddot{P} + \bar{Al}^4\ddot{P}^3 + 6\dot{H}$, Ramm. Analyses: 1 Fuchs, (Schweig, J. xxiv, 373); 2, R. Brandes, (ib., xxx, 385); 3 to 8, Rammelsberg, (Pogg. lxiv, 260):

	$\ddot{P}$	$\bar{Al}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{H}$	
1. Rädelgraben,	41·81	35·73	9·34	2·64	—	6·06, $\ddot{Si}$ 2·1=97·68,	F.
2. Krieglach,	43·32	34·50	13·56	0·80	0·42	0·50, $\ddot{Si}$ 6·5=99·6,	Br.
3. Grats, 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.=3·02,	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,	"

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.

Occurs both massive and crystallized in narrow veins, traversing clay slate, in the torrent beds of Schlamming and Rädelgraben, near Werfen in Saltzburg, with spathic iron; and in Grats, near Vorau and elsewhere, and in Krieglach, in Styria. From the locality at Vorau it has been called voraulite. 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. For a recent article on the crystallization of lazulite, well illustrated by figures, by K. Prüfer, see Haidinger's Nat. Abhandl. Vienna, i, 169, 1847.

TURQUOIS. Calaite. Agaphite. Johnite. Kalait and Türkis *of the Germans.* 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. Streak white. Color a peculiar bluish-green. 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):

	$\ddot{\bar{A}}l$	$\dddot{\bar{P}}$	$\dot{\bar{H}}$	$\dot{C}u$	
1. Silesia,	44·50	30·90	19·00	3·75	$\dot{F}e$ 1·80=99·95, John.
2. "	54·50	38·90	1·00	1·50	$\ddot{\bar{F}}e$ 2·8=98·70, Z.
3. Blue Oriental,	47·45	27·34	18·18	2·02	" 1·10, $\ddot{\bar{M}}n$ 0·50, $\dot{C}a^3\dddot{\bar{P}}$ 3·41=100, $\dot{\bar{H}}$.

Formula from the first and last analyses, $\ddot{\bar{A}}l^2\dddot{\bar{P}}+5\dot{\bar{H}}$. The green Oriental turquois afforded Hermann only 5·64 per cent. of phosphoric acid, and is evidently a mechanical mixture, containing but little turquois.

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. Insoluble in muriatic acid, and may thus be distinguished from other species called by the name of Turquois.

This species 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 mountains in all directions.

It receives a fine polish, and is valued for ornamental purposes; 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 phosphate of lime colored with oxyd of copper.

Pliny remarks concerning the Callaïs, which appears to be identical with the turquois, that it occurred of a pale-green color, (e viridi pallens), and that its finest color was emerald. He states that its form was usually round, and also the fable that it was found in Asia projecting from the surface of inaccessible rocks, whence it was obtained by means of slings.

Fischerite, Hermann, (J. f. pr. Ch. xxxiii, 285). In crystals appearing to be six-sided prisms; also crystalline massive. G.=2·46. Colorless to dull green when massive. Translucent.

B.B. becomes white, spotted with blackish; yields much water, but no fluorine. Analysis gave

$\ddot{\bar{A}}l$ 38·47, $\dddot{\bar{P}}$ 29·03, $\dot{\bar{H}}$ 27·50, $\ddot{\bar{F}}e$ and $\ddot{\bar{M}}n$ 1·20, $\dot{C}u$ 0·80, $\dot{C}a^3\dddot{\bar{P}}$ and gangue 3·00, leading to the formula $\ddot{\bar{A}}l^2\dddot{\bar{P}}+8\dot{\bar{H}}$=Alumina 41·75, phosphoric acid 28·99, water 29·26.

From Nischne Tagilsk, where it occurs in veins in sandstone and clay slate.

Peganite of Breithaupt, according to Hermann, has the composition of Fischerite, excepting that it contains 6 $\dot{\bar{H}}$. Hermann obtained for it, (J. f. pr. Ch. xxxiii, 287),

$\ddot{\bar{A}}l$ 44·49, $\dddot{\bar{P}}$ 30·49, $\dot{\bar{H}}$ 22·82, $\dot{C}u$, $\ddot{\bar{F}}e$ and gangue 2·20=100.

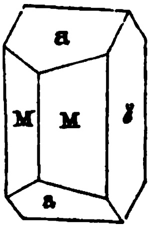
It occurs in crusts formed of small prismatic crystals, probably rhombic prisms, having the acute lateral edge truncated. Color green to white. H.=3—4. G.=2·49—2·54. Occurs at Strigis near Freiberg in Saxony.

Erdmann analysed a Strigis mineral with a very different result, as seen from the analyses under Wavellite, page 231, 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.

WAVELLITE. Subphosphate of Alumine. Devonite. Alumine Phosphatée, *H.* Lasionite, *Fuchs.*



Trimetric; M : M=122° 15', a : a (adjacent planes)=107° 26', M : ĕ=118° 53'. Cleavage lateral, perfect; also macrodiagonal. 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. Streak white. Color white, passing into yellow, green, gray, brown, and black. Translucent. Index of refraction 1·52.

Composition.—$AlF^3+3(\bar{A}l^4\dddot{P}^3+18\dot{H})$=Alumina 33·72, phosphoric acid 35·14, aluminium 1·50, fluorine 3·06, water 26·58=100.

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):

	$\bar{A}l$	$\dddot{P}$	$\dot{H}$	HF	$\bar{F}e$
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, $\dot{C}a$ 0·50=99·39, Berzelius.
4. Strigis, blue,	36·60	34·06	27·40	*trace*	100=99·06, Erd.
5. " green, yel'w	36·39	33·28	27·10	*trace*	2·69=99·46, Erd.
6. " brown,	34·90	31·55	24·01	*trace*	2·21, $\dddot{S}i$ 7·30=99·97, Erd.
7. " black,	35·39	32·46	24·00	*trace*	1·5, $\dddot{S}i$ 6·65=100, Erd.
8. Zbirow,	36·39	34·29	26·84	F 1·69	1·20=99·91, Herm.

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, but is infusible; gives the reaction of phosphorus. In a matrass yields water, the last drops of which are acid and gelatinous with silica. Reduced to powder, it dissolves in heated nitric or sulphuric acid, giving 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 Shiant isles of Scotland, at Zbirow in Bohemia; at Frankenburg, Saxony; Diensberg near Giessen, Hesse Darmstadt; on brown iron ore in the Jura limestone at Amberg in Bavaria, (a variety called *Lasionite,* by Fuchs); at Villa Rica, Minas Geraes, Brazil.

In the United States Wavellite has been found near Saxton's River, Bellows Falls, N. H.; also in the slate quarries of York Co., Pa., near the Susquehannah.

A Wavellite containing oxyd of lead occurs at Rosières in stalactites, as detected by Berthier. Wavellite is isomorphous with *cacoxene,* a species in which the alumina is mostly replaced by oxyd of iron.

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.—A wavellite with the alumina partly or wholly replaced by oxyd of iron=$(\bar{F}e, \bar{A}l)^4\dddot{P}^3+18\dot{H}$. Analyses: 1, Steinmann, (Leonh. Orykt. 750); 2, Holger, (Baumg. Zeits. viii, 129); 3, Richardson, (Thomson's Min., i, 476):

	$\bar{A}l$	$\bar{F}e$	$\dddot{P}$	$\dot{C}a$	$\dddot{S}i$	$\dot{H}$ 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 $\dot{M}g$ 7·58, $\dot{Z}n$ 1·28, $\dddot{S}$ 11·29 =99·70, Holg.
3. "	——	43·1	20·5	1·1	2·1	30·2, with $\dot{M}g$ 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. In the United States it forms tufts and coatings with specular iron ore and quartz at the Sterling iron mine, Antwerp, Jefferson Co., N. Y.; of less interest with red oxyd of iron, at Mt. Defiance near Ticonderoga, N. Y.; in Cooke Co., Tennessee, near Brush Creek; near Sundersville, Washington Co., Georgia; at Spring Mills, Montgomery Co., Pennsylvania.

AMBLYGONITE, *Breith.*

Rhombic prism, but whether right or oblique is uncertain; M : M=106° 10′; M rough. Cleavage lateral, brilliant. Also massive, columnar.

H.=6. G.=3—3·11. Lustre vitreous, inclining to pearly on M. Color pale mountain- or sea-green. Subtransparent—translucent. Fracture uneven.

Composition.—Analyses: 1, Berzelius, (Gilb. Ann. lxv, 321); 2, 3, Rammelsberg, (Pogg. lxiv, 265):

	$\bar{P}$	$\bar{A}l$	$\dot{L}$	$\dot{N}a$	$\dot{K}$	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.

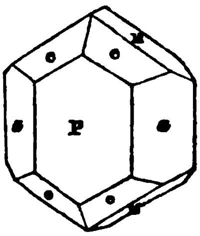
In two other trials, the alumina was found to be 36·62 and 36·87 per cent. Rammelsberg's analyses correspond nearly to the composition $(\dot{R}, R)^6\bar{P}^6\bar{A}l^6F^4$, R standing for lithium and sodium; in which an arrangement of the constituents is not attempted. Berzelius deduces, (Jahresb. xxvi, 378), from Rammelsberg's analyses, $(4RF+\dot{R}^2\bar{P})+(\bar{A}l^2\bar{P}^3+2\bar{A}l^2\bar{P})$.

In the 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. 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.*



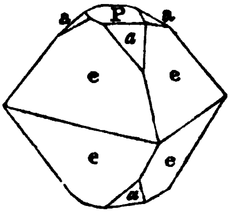
Trimetric. M : M=115° 53′, P : *a*=147° 34′, *a* : *a* (adjacent planes)=64° 51′, e : e=141° 17, M : e=128° 40′, P : e=141° 20′. Cleavage interrupted parallel to M, also traces parallel to P. Surfaces M and e very smooth, and delicately marked with lines parallel to the edge of intersection.

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, a phosphate of alumina and lime with fluorine. B.B. fuses with difficulty to a white enamel; becomes blue with cobalt solution. Dissolves in heated muriatic acid.

The only specimen of this mineral as yet found, was obtained at the tin mines of Ehrenfriedersdorf, in Saxony, imbedded in fluor spar. It much resembles the asparagus variety of apatite, for which it was mistaken till proved to be a distinct species by Haidinger, who gave it the above name in honor of Baron von Herder, the director of the Saxon mines.

CHILDRENITE, *Levy, Brooke,* Quarterly Jour. of Sci. xvi, 274.



Trimetric. e : e (adjacent planes in the same pyramid) = 97° 50′ and 102° 30′, e : e (different pyramids) = 130° 20′, a : a = 124° 54′. Cleavage octahedral; basal imperfect.

H. = 4·5—5. Lustre vitreous, inclining to resinous. Streak white. Color yellow and pale yellowish-brown, also yellowish-white. Translucent. Fracture uneven.

Composition.—According to Wollaston, contains phosphoric acid, alumina, and oxyd of iron.

Occurs in minute crystals and crystalline coats, on spathic iron or quartz, near Tavistock in Derbyshire, and in large crystals at Callington in Cumberland. It was discovered by Levy, and named in honor of Mr. Children.

CRYOLITE, *M.* Alumine Fluatée Alcaline, *H.* Kryolite. Eisstein.

Trimetric. Cleavage rectangular or nearly so; basal, perfect; lateral, less so. Occurs in granular cleavable masses.

H. = 2·25—2·5. G. = 2·816—2·943. Lustre vitreous; slightly pearly on P. Color snow-white; sometimes reddish or brownish. Subtransparent—translucent. Immersion in water increases its transparency. Brittle.

Composition.—$3NaF+Al^2F^3$ = Aluminium 13·07, sodium 33·35, fluorine 53·58, or Alumina 24·54, soda 44·79, hydrofluoric acid 56·44. Berzelius obtained, (K. V. Ac. H. 1823, 315):

Aluminium 13·00, sodium 32·93, fluorine 54·07 = 100, or Alumina 24·4, soda 31·35, hydrofluoric acid 44·25. Chodnew found, (Verh. d. K. Russ. min. Ges. 1845—46, p. 208), excluding the fluorine, Alumina 24·83, soda 43·89, $\dot{M}g$ and $\dot{M}n$ 0·83. 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 fluate of soda is absorbed by the charcoal, and a crust of alumina remains; soluble in sulphuric acid and fluorine evolved.

Found at Arksutfiord, in West Greenland, where it was discovered by Giesècké, 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.

CHIOLITE, *Hermann* and *Auerbach,* J. f. pr. Chem. xxxvii, 188.

Trimetric: M : M = 114°. Cleavage lateral, perfect. 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.—$3NaF+2Al^2F^3$ = Aluminium 18·69, sodium 23·83, fluorine 57·48 = 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.

CHODNEFFITE, *D. Chodnew*, Verh. d. K. Russ. Min. Ges. 1845—46, p. 208.

Trimetric. Massive, resembling cryolite, with a granular structure and imperfectly foliated.

H.=3·5—4. G.=2·770 in powder, (2·6209 in masses), v. Wörth; 3·003—3·077, G. Rose. Snow-white, and also grayish, yellowish. Streak snow-white. Lustre between vitreous and resinous. Translucent; more transparent in water.

Composition.—$2NaF+Al^2F^6$=Sodium 27·80, aluminium 16·36, fluorine 55·85. Chodnew obtained Sodium 26·54, aluminium 16·43, fluorine 53·61, with potassium 0·59, magnesium 0·93, yttrium 1·04 ?, loss by ignition 0·86=100. Rammelsberg (Pogg. lxxiv, 316) obtained sodium $\begin{cases} 28{\cdot}29, \\ 27{\cdot}22, \end{cases}$ aluminium $\begin{cases} 15{\cdot}40, \\ 16{\cdot}11. \end{cases}$ Fuses easily in the flame of a candle, at first decrepitating. Affords the reaction of fluorine.

At Miask, associated with lithia mica, massive fluor, and quartz.

This species was supposed to be chiolite. But the difference in the results of Hermann's and Chodnew's analyses has been investigated and confirmed by Rammelsberg.

FLUELLITE, *Levy*, Edinb. Jour. Sci. 1825, p. 178. Fluate of Alumine. Fluorid of Aluminium.

Trimetric. M : M=105° nearly. Commonly in acute rhombic octahedrons, fig. 76, pl. 2, in which a : a=109°.

H.=3. Color white. Transparent.

Composition.—Fluoric acid and alumina, according to Wollaston.

Fluellite is an extremely rare mineral, and was first discovered by Levy. The few specimens that have been obtained, were found at Stenna-gwyn, in Cornwall, with wavellite and uranite, in minute crystals, on quartz.

VI. CERIA—THORIA—YTTRIA—LANTHANA.

The oxyds of cerium, thorium, yttrium, and lanthanum enter into the constitution of a few rare species. They are combined with carbonic or phosphoric acids; or with silica, titanic, columbic, or niobic acids. There are also fluorids of the metals. The species here included are fluorids, carbonates, and phosphates. G.=3—5.

CERIUM OCHRE, *C. T. Jackson*, Proc. Bost. Soc. Nat. Hist., 1844, 167.

A yellow powder, affording, according to Dr. Jackson, oxyds of cerium and lanthanum 20, yttria 10, with water.

Dissolves readily in muriatic acid, forming a lemon-yellow solution. With borax gives easily a transparent glass, orange-red while hot, and delicate pale green, when cold.

From Whitcomb's Lime quarry, Bolton, Mass., along with pink scapolite.

PARISITE, *L. di Medici-Spada*; *Bunsen*, Ann. d. Ch. u. Pharm. liii, 147.

Hexagonal. In double six-sided pyramids, basal angles 164° 58′, pyramidal 120° 34′. Cleavage basal, very perfect.

H.=4·5. G.=4·35. Vitreous. Color browish-yellow; streak yellowish-white.

Composition.—$3\dot{R}\ddot{C}+2CaF+\dot{R}\dot{H}^2$, 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, (loc. cit.):

	$\ddot{C}$	$\dot{C}e$ (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

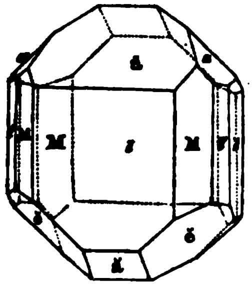
Yields on heating, carbonic acid and water, and becomes brownish, but does not fuse. A clear glass with borax, yellow while hot, and colorless cold. Dissolves slowly with effervescence in muriatic acid.

From the emerald mines of the Musso valley, New Grenada.

MONAZITE, *Breithaupt.* Mengite, *Brooke.* Edwardsite and Eremite, *Shepard.*

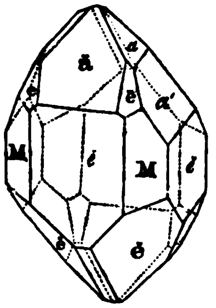
Monoclinic; M : M=93° 10′, P : M=100°—100° 25′, P (cleavage plane) : *ē*=103° 46′, P : ā=143° 6, P : ă=130° 6′, ā : ă (adjacent)=93° 12′, *ē* : ā=140° 40′, *ē* : ă=126° 8′, ē : ē (over ā)=119° 22′, *ē* : ē=131° 53′, ĕ : ĕ=106° 36′, ĕ : *ē*=118° 13′, o′ : o′ (over ā)=81° 4′, *ĕ′* : *ĕ′*, (front angle)=55° 42′, *ĕ′* : M=161° 16′, *ĕ* : *a*=131° 52′, *ĕ* : *a′*=150° 50′, *ē* : *a*=100° 13′ and 79° 47′, *ē* : *a′*=93°

1



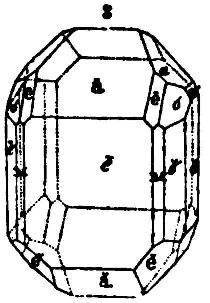
Norwich, Ct.

2



Watertown, Ct.

3



Watertown, Ct.

6′, and 86° 54′.* Descloiseaux obtained for the foreign monazite, M : *ē*=136° 30′, *ē* : P=104° 30′, *ē* : ă=126°, *ē* : ā=141° 5′. Crystals usually flattened prisms and small. Cleavage very perfect parallel with P, and affording a brilliant cleavage surface.

H.=5. G.=4·8—5·25. Lustre inclining to resinous. Color

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* See article by the author, Amer. J. Sci. xxxiii, 1838, 70. Figure 3, in that article is zircon and not monazite.

brownish-hyacinth-red, clove-brown, or yellowish-brown. Subtransparent—subtranslucent. Rather brittle.

Composition.—$(\dot{C}e, \dot{L}a, Th)\,^3\dddot{\bar{P}}$. Analyses: 1, Kersten, (Pogg. xlvii, 385); 2, Hermann, (J. f. pr. Chem. xxxiii, 90):

	$\dddot{\bar{P}}$	$\dot{C}e$	$\dot{L}a$	Th	$\ddot{S}n$	$\dot{M}n$	$\dot{C}a$
1.	28·50	26·00	23·40	17·95	2·10	1·86	1·68, $\dot{K}$ and $\ddot{T}i$ *trace*=101·49.
2.	28·05	40·12	27·41	——	1·75	——	1·46, $\dot{M}g$ 0·80=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, evolving chlorine.

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 (fig. 3) was a fine one with polished faces, well calculated for accurate measurements. Hermann gives the angle M : M 92° 30′; Breithaupt 94° 35′; Descloiseaux 93°.

Monazitoid, Hermann, J. f. pr. Chem. xl, 21. This mineral is nothing but monazite in crystallization and external characters. Hermann states that the brown color is distinct; but the author has seen monazites of this color. Hermann obtained in his analysis,

$\dddot{\bar{P}}$ 17·94, $\dot{C}e$ 49·35, $\dot{L}a$ 21·30, $\dot{C}a$ 1·50, $\dot{H}$ 1·36, subst. like tantalum 6·27, $\dot{M}g$, $\dddot{\bar{F}}e$, *a trace* =97·72. G.=5·281. B.B. infusible. With the fluxes like monazite.

CRYPTOLITE, *Wöhler*, Götting. gel. Anzeig. 1846, 19, and Pogg. lxvii, 424.

In acicular hexagonal prisms. G. about 4·6. Wine-yellow, transparent.

Composition.—$\dot{C}e^3\dddot{\bar{P}}$=Protoxyd of cerium 69·4, phosphoric acid 30·6. Analysis by Wöhler, (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. This mineral was looked for in the yellowish apatites of Snarum without success. Named from κρυπτος, *concealed*.

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 appears 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, (Fe^3S^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. 1, under zircon. G.=4·78. H.=5·0—5·5. Colorless or pale sulphur-yellow. Lustre vitreo-resinous or adamantine.

Composition.—$(\dot{C}e, \dot{L}a, \dot{D},)\,^3\dddot{\bar{P}}$. Analysis by Watts, (loc. cit.): Protoxyd of cerium, lanthanum, didymium 67·38, phosphoric acid 29·66, oxyd of iron 2·96=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 $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$.]

XENOTIME. Phosphate of Yttria. Phosphorsaure Yttererde. Ytterspath.

Dimetric. a : a over pyramidal edge 124° 44′, and over basal 82°, Scheerer. In square prisms. Cleavage parallel to M, perfect.

H.=4·25—5. G.=4·39—4·55. Lustre resinous. Color yellowish-brown; streak pale brown. Opaque. Fracture uneven and splintery.

Composition.—$\dot{\mathrm{Y}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{\mathrm{P}}}$=Yttria 62·82, phosphoric acid 37·18. Analysis by Berzelius, (K. V. Ac. H. 1824, 334):

Yttria 62·58, phosphoric acid 33·49, subphosphate of iron 3·93=100.

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 Hitterö, Sweden.

FLUOCERITE, *Haid.* Fluorcerium neutrales. Fluate of Cerium. Flucerine, *Beud.*

Hexagonal? occurs in six-sided prisms and plates. Cleavage basal the most distinct. Also massive.

H.=4—5. G.=4·7. Lustre weak. Streak white or slightly yellowish. Color dark tile-red or almost yellow; deeper when the mineral is wet. Subtranslucent—opaque.

Composition.—Analysis by Berzelius, (Afhandlingar, v, 56),

$\dddot{\bar{\mathrm{C}}}\mathrm{e}$ 82·64, $\dot{\mathrm{Y}}$ 1·12, HF 16·24=100.

B.B. infusible alone, but darkens. In borax and salt of phosphorus, it fuses slowly but completely. The globule is blood-red in the exterior flame, but becomes colorless on cooling. In the interior flame it is colorless at all temperatures. In carbonate of soda it does not fuse, but swells out and is decomposed.

Occurs at Finbo and Broddbo, near Fahlun, in Sweden, imbedded in quartz and albite, accompanying pyrophysalite and orthite.

FLUOCERINE, *Hausm.* Basic flucerine. Basicerine, *Beud.* Subsesquifluate of Cerium. Fluorcerium basisches.

Monometric. Rarely 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.—$\mathrm{Ce}^2\mathrm{F}^3+3\dddot{\bar{\mathrm{C}}}\mathrm{e}\dot{\mathrm{H}}$=Oxyd of cerium 84·35, hydrofluoric acid 10·75, water 4·90. Analysis by Berzelius, (Afhand. v, 64):

$\dddot{\bar{\mathrm{C}}}\mathrm{e}$ 84·20, HF 10·85, $\dot{\mathrm{H}}$ 4·95=100.

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 13·418, which corresponds to the formula $\mathrm{Ce}^2\mathrm{F}^3+\dddot{\bar{\mathrm{C}}}\mathrm{e}\dot{\mathrm{H}}^4$.

B.B. infusible, but blackens. On cooling, passes through dark-brown and red tints, and nearly resumes its original color, being a little redder than at first. With borax, salt of phosphorus, and carbonate of soda, it acts like the last species. It dissolves in hot sulphuric acid, forming a yellow solution. With muriatic acid chlorine is copiously evolved.

Accompanies allanite in small quantities at Bastnäs in Sweden, and at Finbo near Fahlun. A compound of the fluorids of cerium and yttrium occurs at Finbo.

LANTHANITE, *Haid.* Carbonate of Cerium. Carbocérine, *Beudant.* Ceroxydul kohlensaures, *Berz.*, *Ramm.*

Dimetric. In thin four-sided plates of a grayish-white or yellowish color. Also fine granular or earthy. H.=2·5—3. Lustre dull or pearly.

Composition.—$\dot{\mathrm{L}}\mathrm{a}^3\ddot{\mathrm{C}}+3\dot{\mathrm{H}}$. Analysis by Hisinger:

$\dot{\mathrm{C}}\mathrm{e}$ (since shown by Mosander to be $\dot{\mathrm{L}}\mathrm{a}$) 75·7, $\ddot{\mathrm{C}}$ 10·8, $\dot{\mathrm{H}}$ 13·5.

Exposed to a low red heat, it loses 19 per cent. of its weight, without changing its appearance. With the fluxes, gives the reaction of pure oxyd of cerium.

It is found coating the cerite of Bastnäs in Sweden, and is probably produced by the decomposition of that mineral.

YTTROCERITE, *Berz.*

Massive. Cleavage apparent parallel to a rhombic prism of 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):

$\dot{\mathrm{C}}\mathrm{a}$ 47·63,	$\bar{\mathrm{C}}\mathrm{e}$ 18·21,	$\dot{\mathrm{Y}}$ 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.

It 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 recently examined by J. E. Teschemacher.

An examination of the Massachusettes mineral by Dr. C. T. Jackson, (Proc. Bost. Soc. N. Hist. 1844, p. 166), gave

$\dot{\mathrm{C}}\mathrm{a}$ 34·7, $\dot{\mathrm{Y}}$ 15·5, $\bar{\mathrm{C}}\mathrm{e}$ and $\bar{\mathrm{L}}\mathrm{a}$ 13·3, $\bar{\mathrm{A}}\mathrm{l}$ and $\bar{\mathrm{F}}\mathrm{e}$ 6·5, $\dddot{\mathrm{S}}\mathrm{i}$ and silicate of cerium 10·6, F (by loss) 19·4=100. The presence of the oxyd of lanthanum was inferred from the color of the oxyd of cerium. B.B. fuses at a full red heat to a greenish yellow porous slag or glass, which is lighter colored when cold. Forms a yellowish green opaque enamel with soda. The mineral is mixed with fluor spar in the vein, and probably the specimen analyzed was not pure from it.

VI. EARTHY MINERALS.

I. SILICA.

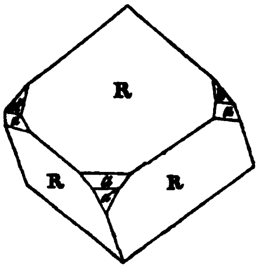
Silica in a pure state is the very abundant mineral quartz, which with its varieties constitutes a large part of the surface rocks of our globe. It occurs in various combinations, with the bases, magnesia, alumina, lime, oxyds of iron and manganese, glucina, zirconia, and rarely with oxyd of copper, of zinc, of bismuth, or of cerium; and in some aluminous or ferruginous silicates, it is united with potash, soda, lithia, baryta, strontia, yttria, or thoria. With titanic acid and lime, it forms the mineral sphene; with boracic acid and lime, the mineral datholite; and with fluorine and alumina the mineral topaz. Fluorine and boracic acid occur sparingly also in certain other silicates.

For the blowpipe tests of silica, see page 162.

QUARTZ. Flint. Silex. Chalcedony. Cacholong. Agate. Jasper. Hornstone. Cat's Eye. Amethyst. False Topaz. Rose Quartz. Prase. Chrysoprase. Cantalite. Iron Flint. Heliotrope. Eisenkiesel. Berg-crystal. Kalzedon.

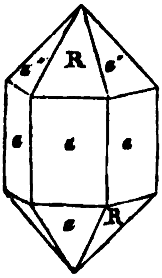
Rhombohedral; hemihedral in some of its modifications; R : R=94° 15′. Figure 124, pl. 2, from Gouverneur, New York; also the annexed figures, of which 5, 6, 7, are hemihedral. R : a= 141° 41′, R : a''=133° 48′, R : o=151° 16′, R : o''' (figure 7),=148° 40′. In figure 10, R: o=145° 22′, back face of the pyramid on o 111° 15′, R : o′ 165° 30′, Shepard. The planes on the angles between the prism and pyramidal terminations incline some-

1



Chesterfield, Mass.

2



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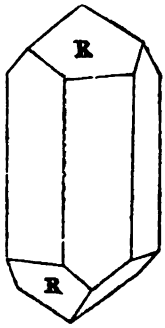
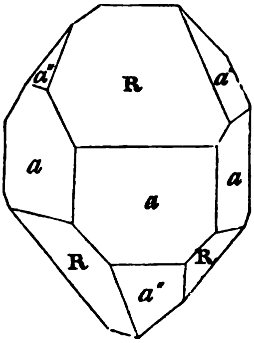


times to the right, as in fig. 7, and sometimes to the left, as in 6, and the crystals are termed right and left handed crystals.

4



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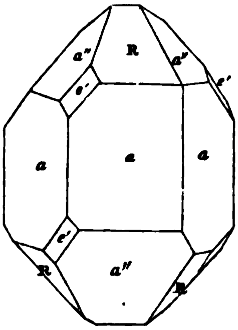

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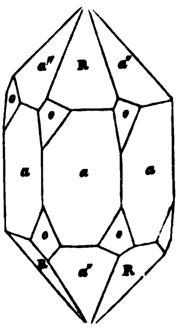
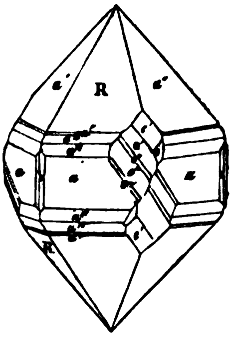


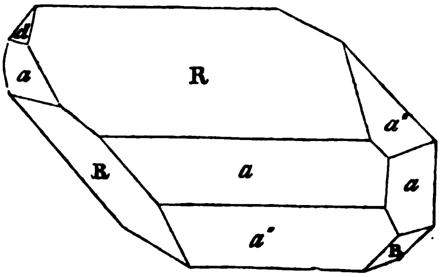
White Mts., N. H.

7



Chamouny.

8



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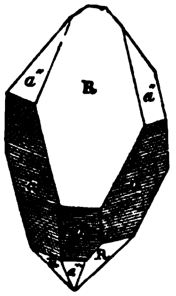

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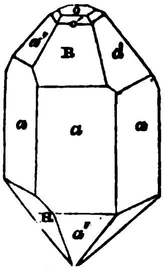
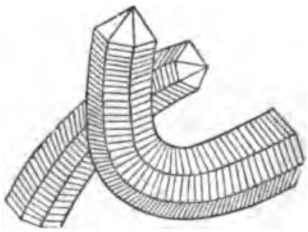


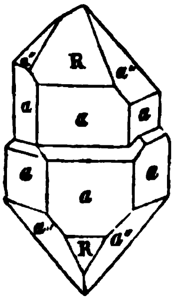
Herkimer Co., N. Y.

11

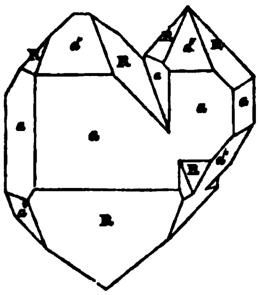


Cleavage very indistinct, parallell to R and *a*; sometimes effected by plunging a heated crystal into cold water. Compound crystals :

12



13



These are instances of postnatal twins; they are of frequent occurrence. Imperfect crystallizations: stalactitic and mammillary forms; often massive, impalpable, or coarse granular. Sometimes coarsely tabular.

H.=7. G.=2·6413—2·6541, Beudant; 2·6701, Haüy. Lustre vitreous, sometimes inclining to resinous; splendent—nearly dull. Streak white, of pure varieties; if impure, often the same as the color, but much paler. Color white, when pure; often various shades of yellow, red, brown, green, blue, black. Transparent—opaque. Fracture perfect conchoidal—subconchoidal. Tough—brittle—friable.

Composition.—Pure silica. Impure varieties contain variable quantities of iron, alumina, manganese, or 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."

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, 0·0236 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. It becomes very pale on exposure to the light. The specimens are usually massive, often of large size, and much cracked, with the usual vitreous fracture of quartz. The lustre is 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 more 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, and is either translucent or subtransparent; some milk-white varieties are opaque. It 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 (or hydrated silica) 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. It passes into common chalcedony through grayish-red varieties. Turpin has stated that the color is owing to a minute species of vegetation, (Protococcus kermesinus), which was disseminated through the chalcedony, while it was in a gelatinous state. But Heintz found no carbon, and 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 0·0048, soda 0·075.

Sard is a deep brownish-red chalcedony, of a blood-red color by transmitted light.

Agate is a variegated chalcedony. The colors are distributed in clouds, spots, or bands. When in bands, the agate consists of parallel or concentric layers of chalcedony of different colors, arranged often with the utmost delicacy and beauty. These concentric lines may occur in straight, circular, or zigzag forms. The latter 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 iron.

Onyx. Resembles agate, but the colors are arranged in flat horizontal planes. They are usually a light clear brown, and an opaque white. When the layers consist of sard and white chalcedony, the stone is called *sardonyx.*

Cat's eye. A translucent chalcedony, presenting a peculiar opalescence, or glaring internal reflections, when cut *en cabochon,* 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 is more opaque, and presents 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. The lustre is barely glistening, subvitreous. It 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, as is developed by a high magnifying power. The silica of flint, according to Fuchs, is partly soluble silica, easily taken up by a solution of potash. There is usually a per cent. or so of alumina and peroxyd of iron, with one or two of water.

Hornstone. Resembles flint, but is more brittle, and the fracture is 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, compact, nearly or quite opaque, and presenting little beauty until polished. Besides the colors mentioned, there are also blue and black varieties. When the colors are arranged in stripes or bands it constitutes the *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* has a deep green color, and contains interspersed, blood-red spots, like drops of blood.

Lydian stone, Touchstone, or *Basanite* is 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.

Granular quartz is a massive quartz rock, of a granular texture. Its colors are various, always dull. *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 trap, or basaltic rocks. Flint occurs imbedded in chalk. Hornstone is sometimes found 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 Huttenberg 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 Kosemutz 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 fine *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 that commence their rise about a mile back. It is here associated with a handsome opal, coarse carnelians, 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 Middlefield, 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 Lansingburgh, is an old but poor locality. 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. Pelham and Chesterfield, Mass., Paris and Perry, Me., and Meadow Mount, Md., are other localities of quartz crystals. At Chesterfield, small unpolished *rhombohedrons* have been found in granite; and Paris, Me., affords handsome crystals of brown or smoky quartz. Drusy quartz, of brown, apple-green, and other tints, is abundant 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 Keweena 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 Pennsylvania in East Bradford, Aston, Chester, and Providence, (one fine crystal over 7 pounds in weight), in Chester Co. 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. Belmont's lead mine, St. Lawrence Co., N. Y., has afforded fine specimens of 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.

Pseudomorphs, imitative of hexagonal and scalenohedral crystals of calcareous spar and cubic crystals of fluor, occur at West Hampton, Mass. Petrified wood consists often 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 New Hampshire at Dartmouth College weighs 147½ pounds, and four of the crystals are from 5 to 5½ inches in diameter.

Crystals often exhibit very beautiful internal irridescences, owing to fissures or fractures. This effect may be produced by heating the crystal and plunging it, while hot, into cold water. Foreign substances frequently penetrate or thoroughly permeate crystals of quartz. 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, rutile, 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, (page 83), 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 fluid dilates and fills all the cavities, and on cooling, reappears with ebullition.

Silica is held in solution in the hot waters of the Geysers of Iceland, whose solvent powers are supposed to be due to their temperature, and a small quantity of alkali present. The Geysers have covered the part of Iceland in their vicinity with a siliceous sinter.

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*, *αμεθυστος*, on account of its pretended preservative powers against 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 search 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. In Germany it is made into cups and plates. 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 *δένδρον*, *a tree*, and *achates*) was moss agate; *Hæmachates* (from *αἷμα*, *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 a necessary ingredient in the manufacture of glass and porcelain, and is often employed in the smelting of ores, and in other metallurgical operations. With lime it forms mortar. The uses of flint are well known.

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. Muller's Glass. Hydrophane. Menilite. Cacholong. Siliceous Sinter. Pearl Sinter. Fiorite. Girasol. Eisenopal, *Haus*. Manganopal. Schwimmkiesel. Quartz hyalin concretionée. Quartz rèsinite, *H.* Opalus, Pæderos, *Pliny*. ὀπάλλιος. Michaelite. Alumocalcite. Geyserite.

Massive, amorphous; sometimes small reniform, stalactitic, or large tuberose.

H.=5·5—6·5. G.=2·0—2·21. Lustre vitreous, frequently subvitreous, and often inclining to resinous, and sometimes to pearly. Streak white. Color white, yellow, red, brown, green, gray, generally pale; dark colors arise from foreign admixtures. Some specimens exhibit a rich play of colors; others present different colors by refracted and reflected light. The play of colors is destroyed by heat.

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 exhibiting the opalescence of the precious or fire opal; they are distinguished from one another by their degrees of transparency and lustre. *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. 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 a brown, opaque variety, occuring in compact reniform masses, occasionally presenting a slaty structure. *Opal jasper* contains several per cent. of iron, and is the analogue in this species of the 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 hydrated silica, and the name *Randanite* has been applied to a variety, consisting mainly of gelatinizing silica. (See analyses below).

Composition.—Hydrated silica, the amount of water varying. Damour divides them as follows:—

I. $\dddot{\mathrm{Si}}^3+\dot{\mathrm{H}}$=Silica 91·12, water 8·88. Analyses: 1, Klaproth, (Beit. iv.); 2—7, Damour, (Bull. Geol. de France, 1848, 161); 8, Klaproth; 9, Forchhammer, (Pogg. xxxv, 331); 10, Stucke, (Rose, Beschreib. p. 73); 11, Pattison, (Phil. Mag., [3], xxv, 495):

1. *Fire opal*, Mexico,	$\dddot{\mathrm{Si}}$ 92·00	$\dot{\mathrm{H}}$ 7·75 $\bar{\dddot{\mathrm{Fe}}}$ 0·25=100, Klaproth.
2. *Limpid*, " G.=2.029,	91·12	8·88=100, Damour.
3. " " "	91·11	8·89=100, "
4. *Chatoyant*, " 2·024,	89·90	10·10, and some combust., D.
5. *Geyserite, white*, "	91·23	8·77=100, Damour.
6. " *gray opaque*, 2·081,	92·59	7·41=100, "
7. *Silex resinite*, Iceland, 2·095,	92·03	7·97=100, "
8. *Menilite*, Menil Montant,	85·50	11·00 $\bar{\dddot{\mathrm{Fe}}}$ 0·5, $\bar{\dddot{\mathrm{Al}}}$ 1·5, $\dot{\mathrm{Ca}}$ 0·5, Kl.
9. *Fire opal*, Faroe,	88·73	7·97, $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$ 0·84, $\dot{\mathrm{Ca}}$ 0·49, $\dot{\mathrm{Mg}}$ 1·48, $\bar{\dddot{\mathrm{Al}}}$ 0·99, Forch.
10. *Semi-opal*, Hanau,	82·75	10·00, $\bar{\dddot{\mathrm{Fe}}}$ 3·00, $\dot{\mathrm{Ca}}$ 0·25, $\bar{\dddot{\mathrm{Al}}}$ 3·50, =99·50, Stucke.
11. *Sil. incrust*, N. Zeal. geys., G.=1·968,	77·35	7·66, $\bar{\dddot{\mathrm{Al}}}$ 9·70, $\bar{\dddot{\mathrm{Fe}}}$ 3·72, $\dot{\mathrm{Ca}}$ 1·74 =99·97, Pattison.

II. $\dddot{\mathrm{Si}}^3+\dot{\mathrm{H}}$.=Silica 93·9, water 6·1. Analysis by Damour, (loc cit.):

12. *Precious opal*, Hungary, G.=2·099,	$\dddot{\mathrm{Si}}$ 93·90	$\dot{\mathrm{H}}$ 6·10=100, Damour.

But Kobell found in this opal 10·94 per cent. of water, placing it in the above subdivision.

III. $\dddot{\mathrm{Si}}^4+\dot{\mathrm{H}}$=Silica 95·35, water 4·65. Analyses: 13, Damour, (loc. cit.); 14, Klaproth, (Beit. iv, 156):

13. *Silex resinite*, Mexico, G.=1·21,	$\dddot{\mathrm{Si}}$ 95·40	$\dot{\mathrm{H}}$ 4·60=100, Damour.
14. *Yellow opal*, (*Pechopal*), Telkebanya,	93·50	5·00, $\bar{\dddot{\mathrm{Fe}}}$ 1·0, Klaproth.

IV. $\dddot{\mathrm{Si}}^5+\dot{\mathrm{H}}$=Silica 96·85, water 3·15. Analyses: 15, 16, Damour, (loc. cit.); 17, Schaffgotsch, (Pogg. lxviii, 147); 18, Forchhammer, (loc. cit.); 19, Wrightson, (Ann. Ch. Pharm. liv, 358):

15. *Hyalite*, Waltsch, Bohemia,	$\dddot{\mathrm{Si}}$ 96·94	$\dot{\mathrm{H}}$ 3·06, Damour.
16. " Kaiserstuhl,	96·99	3·01, "
17. " Bohemia,	95·5	3·0, $\bar{\dddot{\mathrm{Fe}}}$ 0·8, $\dot{\mathrm{Ca}}$ 0·2=100, Sch.
18. *Cacholong*, Faroe,	95·32	3·47, $\dot{\mathrm{K}}$ 0·07, $\dot{\mathrm{Na}}$ 0·06, $\dot{\mathrm{Ca}}$ 0·06, $\bar{\dddot{\mathrm{Al}}}$ 0·2, $\dot{\mathrm{Mg}}$ 0·4=99·58, F.
19. *Semi-opal*, Schiffenberg,	90·20	2·73, $\dot{\mathrm{Fe}}$ 4·11. $\dot{\mathrm{Mg}}$ 0·86, $\dot{\mathrm{K}}$ 0·8, $\bar{\dddot{\mathrm{Al}}}$ 1·86, $\dot{\mathrm{Na}}$ 0·9, $\dddot{\mathrm{S}}$ 0·31, W.

The *Randanite* of Salvetat, (*silice gelatineuse*), has the formula $\dddot{\mathrm{Si}}^3\dot{\mathrm{H}}$ when dried at 16° C. and $\dddot{\mathrm{Si}}^4\dot{\mathrm{H}}$ when dried at 100° C. Fournet and Salvetat obtained, (Ann. Ch. Phys., [3], xxiv, 348):

1. Ceyssat,	Soluble $\dddot{\mathrm{Si}}$ 87·20, $\dot{\mathrm{H}}$, $\ddot{\mathrm{C}}$, and organic matters 10·00, $\bar{\dddot{\mathrm{Al}}}$ and $\bar{\dddot{\mathrm{Fe}}}$ 2·00, sand 0·89, Fournet.
2. Algiers,	Soluble $\dddot{\mathrm{Si}}$ 80, $\dot{\mathrm{H}}$ 9, insoluble $\dddot{\mathrm{Si}}$ 6·48, $\bar{\dddot{\mathrm{Al}}}$ 1·41, $\bar{\dddot{\mathrm{Fe}}}$ 0·55, $\dot{\mathrm{Ca}}$ 0·56, $\dot{\mathrm{Na}}$, $\dot{\mathrm{K}}$, and loss 2·00, Salvetat.

It occurs as a fine earth or in compact earthy masses, and consists mainly of the casts of infusoria. The *Michaelite* afforded Kobell, $\dddot{\mathrm{Si}}$ 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, with hornstone. 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 Cashau 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 exists abundantly in Hungary, in Faroe, Iceland, the Giants' Causeway, and the Hebrides. An interesting variety occurs 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. Its colors are wax-yellow and 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; also in Burke and Scriven Cos., Georgia. In the latter region 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 has almost the size of a man's fist, and weighs 17 ounces, but contains numerous fissures, and is not entirely disengaged from the matrix. This stone was used as a gem by the Greeks and Romans, and was called opalus; also *pæderos*, παιδέρως, 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. LIME—MAGNESIA:

a. Hydrous Silicates or Borosilicates of Lime.

OKENITE, *Kobell.* Dysclasite, *Connel.* Persilicate of Lime.

Trimetric. M : M=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.—$\dot{C}a^3\dddot{S}i^4+6\dot{H}$=Silica 56·99, lime 26·35, water 16·66 Analyses: 1, 2, Kobell, (Kastner's Arch. xiv, 333); 3, Connel, (Edinb. Phil. Jour. xvi, 198); 4, Würth, (Pogg. lv, 113):

	$\dddot{S}i$	$\dot{C}a$	$\dot{H}$	
1. Greenland,	55·64	26·59	17·00	$\overline{Al}$ and $\overline{Fe}$ 0·58, $\dot{K}$ *trace* =99·76, Kobell.
2. "	56·99	26·35	16·65=99·99, Kobell.	
3. Faroe,	57·69	26·83	14·71	$\overline{Mn}$ 0·22, $\overline{Fe}$ 0·32, $\dot{K}$ 0·23, $\dot{N}a$ 0·44=100·44, C.
4. Iceland,	54·88	26·15	17·94	$\overline{Al}$ 0·46, $\dot{N}a$ 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 it forms a transparent colorless glass. Gelatinizes readily in muriatic acid.

The *dysclasite* of Connel was brought from the Faroe islands by Count Varges Redemar, of Copenhagen. Okenite occurs, in amygdaloid, in Greenland.

PECTOLITE. Pektolith, *Kobell*, Kastner's Archiv, xiii, 385, xiv, 341. Stellite, *Thom.* Osmelite, *Breit.* Wollastonite, *Thom.*

In white fibrous masses, or acicular crystals, radiated or stellar. Cleavage parallel to the sides of a slightly rhombic prism.

H.=4—5. G.=2·0—2·74. Lustre of the surface of fracture silky or subvitreous. Color white or grayish. Subtranslucent to opaque. Tough like dysclasite.

Composition.—$4\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{Si}}^2+3\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$, Kobell; ($\dot{\mathrm{C}}\mathrm{a}^5\dddot{\mathrm{Si}}^4+6\dot{\mathrm{H}}$, Ramm.) Analyses: 1, Kobell, (Kastner's Arch. xiii, 385); 2, Hayes, (2d Edit. this Min. p. 336); 3—4, J. D. Whitney, (Jour. Bost. Soc. N. H. 1849, p. 36, and Am. J. of Sci., [2], vii, 434); 5, J. S. Kendall, (ib.); 6, G. J. Dickinson, (ib.):

	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1. *Pectolite*,	51·3	33·77	8·26	1·57	3·89, $\bar{\mathrm{A}}\mathrm{l}$, $\bar{\mathrm{F}}\mathrm{e}$ 0·9=99·69, K.
2. *Stellite*,	55·96	35·12	6·75	0·60	0·16, $\bar{\mathrm{A}}\mathrm{l}$, $\dot{\mathrm{M}}\mathrm{g}$ 0·08, $\dot{\mathrm{M}}\mathrm{n}$ 0·64=99·31, H.
3. "	53·45	31·21	7·37	*trace*	2·72, $\bar{\mathrm{A}}\mathrm{l}$ 4·94=99·69, W.
4. "	55·66	32·36	7·81	——	2·72, $\bar{\mathrm{A}}\mathrm{l}$ 1·45=100, W.
5. "	54·00	32·10	8·89	*trace*	2·96, $\bar{\mathrm{A}}\mathrm{l}$ 1·90=99·85, K.
6. "	55·00	32·53	9·72	——	2·75, $\bar{\mathrm{A}}\mathrm{l}$ 1·10=101·10, D.

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, forms a transparent glass. After heating gelatinizes perfectly with muriatic acid.

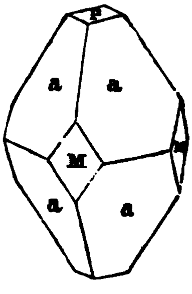
Occurs at Monte Baldo, and at Mount Monzoni in the Tyrol. Also at Bergen Hill (called stellite) in amygdaloid. The *Wollastonite* of Thomson is from Kilsyth, Scotland; it is referred here by J. D. Whitney.

The *stellite* of *Thomson*, (Min. i, 313), from Kilsyth, Scotland, afforded him

$\dddot{\mathrm{Si}}$ 48·47, $\bar{\mathrm{A}}\mathrm{l}$ 5·30, $\dot{\mathrm{C}}\mathrm{a}$ 30·96, $\dot{\mathrm{F}}\mathrm{e}$ 3·53, $\dot{\mathrm{M}}\mathrm{g}$ 5·58, $\dot{\mathrm{H}}$ 6·11=99·95.

It is white, radiated, silky; H.=3—3·5; G.=2·612.

APOPHYLLITE. Pyramidal Zeolite, *J.* Tesselite, *Brewster.* Oxhaverite, *Brewster.* Ichthyophthalmite. Albin, *Wern.* Mesotype Epointée, *H.*



Dimetric. Form similar to fig. 51, pl. 1, also the annexed: a : a=104° 2′ and 121°, P : a=119° 30′, M : a=127° 39′. Sometimes the crystals are nearly cylindrical or barrel-like shape. Cleavage basal, highly perfect; lateral less so. Also massive and lammellar.

H.=4·5—5. G.=2·335, Haidinger, a variety from Iceland; 2·359 Thomson; 1·961, from Radauthal, Hartz, Ramm. Lustre of P pearly; of the other faces vitreous. Streak white. Color white, or grayish; occasionally with a shade of green, yellow, or red. Transparent—opaque. Fracture uneven. Brittle

Composition.—$8\dot{\mathrm{C}}\mathrm{a}\dddot{\mathrm{Si}}+\dot{\mathrm{K}}\dddot{\mathrm{Si}}^2+16\dot{\mathrm{H}}$, *Berz.*;—perhaps ($\dot{\mathrm{C}}\mathrm{a}$, $\dot{\mathrm{K}}$,) $\dddot{\mathrm{Si}}+2\dot{\mathrm{H}}$, or $5\dot{\mathrm{C}}\mathrm{a}\dddot{\mathrm{Si}}+\dot{\mathrm{K}}\dddot{\mathrm{Si}}+15\dot{\mathrm{H}}$, *Ramm.* There is also a variable proportion of fluorine in the mineral, but its relation to the compound is not clearly made out. Analyses: 1, Gmelin, (K. V. Ac. H. 1816, 171); 2, 3, Stromeyer, (Unters. 268); 4, 5, Berzelius, (Afhand. vi, 181); 6, 7, 8, Rammelsberg, (2d Supp. 16, and 3d Supp. 18); 9, 10, C. T. Jackson, (communicated).

	$\dddot{Si}$	$\dot{Ca}$	$\dot{K}$	$\dot{H}$	HF
1. Disco,	53·90	25·00	6·13	15·70	——=100·73, Gm.
2. "	51·86	25·22	5·31	16·90	——=99·29, Strom.
3. Fassa,	51·86	25·20	5·14	16·04	——=98·24, Strom.
4. Utö,	52·13	24·71	5·27	16·20	0·82 (=4·82 Ca fluosil)=99·13, Berz.
5. Faroe, *Tesselite*,	52·38	24·98	5·37	16·20	0·64 (=3·53 Ca fluosil)=99·57, Berz.
6. Andreasberg,	51·33	25·86	4·90	undet.	F 1·28, Ramm.
7. "	50·20	24·52	undet.	undet.	F 1·09, Ramm.
8. Radauthal,	52·44	24·61	4·75	16·78	Ca fluosil. 1·43, Ramm.
9. Michigan, G. 2·305	52·70	23·35	4·95	16·00	CaF 1·85=98·85, Jackson.
10. " "	51·00	24·94	5·19	16·00	" 1·94=99·07, "

Yields much water in a matrass, and in an open tube some fluorine. B.B. exfoliates, and ultimately fuses to a white vesicular glass. 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, is a variety from Faroe, of a cubical form, which, upon optical examination, exhibits a mosaic-like, or 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, and Poonah 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, in large transparent crystals occupying the interior of fossil shells; with magnetic iron, at Utö in Sweden; at Puy de la Piquette in Auvergne, in crystals in a tertiary limestone, near intruded basaltic rocks. Occurs also at Dalecarlia, Sweden; in the Tyrol, near Frombach; Orawicza, Hungary; near Nertschinsk, Siberia; in New Holland; and at the Valencian Mines, Mexico.

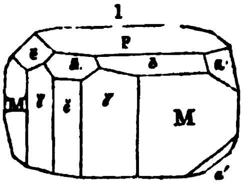
In America it has been found at Peter's Point and Partridge Island, in the Basin of Mines, Nova Scotia. It here occurs both massive and crystallized, presenting white, reddish, and greenish colors, and is associated with laumonite, thomsonite, and other minerals of trap rocks. Beautiful crystallizations occur in greenstone at Bergen Hill, N. J., associated with analcime, stellite, stilbite, datholite, &c. It is also found at Gin Cove, near Perry, Maine, with prehnite and analcime in amygdaloid; at the Cliff Mine, Michigan.

Apophyllite was so named in allusion to its tendency to exfoliate under the blowpipe, from απο and φυλλον, *a leaf*. Its pearly lustre on the face of perfect cleavage, gave rise to the name *Ichthyophthalmite*, from the Greek ιχθυς, *a fish*, and οφθαλμος, *an eye*.

DATHOLITE. Borate of Lime, *P.* Borosilicate of Lime, *Thom.* Datolith, *W.* Esmarkite, *Haus.* Humboldtite, *Levy.* Botryolite, *Haus.* Chaux Boratée Siliceuse, *H.*

Monoclinic; M : M=77° 30′, P : ĕ=91° 41′, ĕ′ : ĕ′=116° 9′, ĕ : ĕ′ =148° 4½′, M : ĕ=128° 45′, M : ė′=150° 40½′. Crystals short, small, and glassy. Cleavage parallel to M and also the orthodiagonal, but not distinct. Imperfect crystallizations: botryoidal and globular

1



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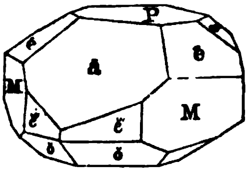
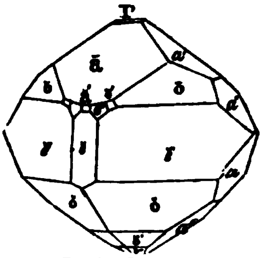


having a columnar structure; also divergent and radiating; also massive.

H.=5—5·5. G.=2·989, (from Arendal), Haidinger. Lustre vitreous, often subresinous on a surface of fracture; sometimes pearly. Streak white. Color white; sometimes inclining to gray, green, yellow, red, amethystine; rarely of a dirty olive-green or honey-yellow tinge. Translucent. Fracture uneven, subconchoidal. Brittle.



Roaring Brook, Ct.

Composition.—Under the name datholite two substances differing only in the proportion of water are included. The formula of *datholite*=$\dot{Ca}\dddot{Si}^4+3\dot{Ca}\dddot{B}+3\dot{H}$, Berz.; $2\dot{Ca}^3\dddot{Si}+\dddot{B}^2\dddot{Si}^2+3\dot{H}$, Ramm.=silica 37·91, lime 35·07, boracic acid 21·48, water 5·54; *botryolite*, $\dot{Ca}\dddot{Si}^4+3\dot{Ca}\dddot{B}+6\dot{H}$, Berz.; $2\dot{Ca}^3\dddot{Si}+\dddot{B}\dddot{Si}^2+6\dot{H}$, Ramm.=silica 35·92, lime 33·23, boracic acid 20·36, water 10·50. The former occurs in crystals and massive; the latter in botryoidal concretions. Analyses: 1, Stromeyer, (Pogg. xii, 157); 2, Du Menil, (Schweig. J. lii, 364); 3, 4, 5, 6, 7, Rammelsberg, (Pogg. xlvii, 175):

		$\dddot{Si}$	$\dot{Ca}$	$\dddot{B}$	$\dot{H}$
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. "	"	37·520	35·398	21·377	5·705=100, Ramm.
6. *Botryolite*,	"	36·085	35·215	19·340	8·635=99·275, Ramm.
7. "	"	36·390	34·270	19·342	10·224, $\bar{\ddot{Fe}}$ and $\bar{\ddot{Al}}$ 0·774=100, R.

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 at Arendal in Norway. The best European locality is in the Hartz. The variety *Humboldtite*, which was instituted as a distinct species by Levy, occurs in agate balls at the Seisser Alp, in the Tyrol, and at Sonthofen, Bavaria. Datholite is met with also in the valley of Glen Farg, Perthshire, and Salisburg Craigs; at Utö, Sweden; near Wolfstein in the Bavarian Rhine.

The trap of New Jersey, Connecticut, and Michigan contains the principal American localities of this species.

It 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, 14 miles from New Haven, where the crystals are highly modified and sometimes are half an inch long, and nearly pellucid. Bergen Hill, N. J., has afforded fine specimens, and Patterson, N. J., specimens of less interest. Occurs sparingly at Piermont, New York. On Kewenaw point it occurs in amygdaloid, and the crystals often include native copper and are sometimes amethystine in color; also on Isle Royal in fine crystals.

b. Talc and the Hydrous Silicates of Magnesia.

The hydrous silicates of magnesia, to a large extent, have a soapy feel and low degrees of hardness, with very difficult fusibility. Some of the species are distinctly foliated in structure, and thus approach the micas among the aluminous silicates. The mineral talc, one of the foliated species, appears to be at times anhydrous, and often hydrous; notwithstanding this difference in its varieties, it is retained in this division on account of its close relations to other soapy species, here included.

For the blowpipe test of magnesia, see page 163, and for the test of the presence of water, see page 161.

TALC. Soapstone. Steatite. Speckstein. Lapis ollaris.

Trimetric or monoclinic. M : M=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—2·85. Lustre pearly. Streak usually white; of dark-green varieties, lighter than the color. 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. 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.=2·65—2·58.

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.

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 or quartz.

Rensselaerite, (Emmons).—A compact fine-grained massive steatite, often translucent in thin slabs, and presenting white, gray, yellowish and dark colors, sometimes nearly black. It occurs frequently under the forms of pyroxene, and is supposed to have resulted from the alteration of that rock. H.=3—4. G.=2·874.

Composition.—Different formulas have been given. $\dot{M}g^4\dddot{S}i^3$=Silica 62·98, magnesia 37·02; $\dot{M}g^5\dddot{S}i^4$=Silica 64·47, magnesia 35·53; $\dot{M}g^6\dddot{S}i^5$=Silica 65·4, magnesia 34·6; $\dot{M}g\dddot{S}i$ gives the percentage Silica 69·6, magnesia 30·5. Analyses: 1, Klaproth, (Beit. v. 60); 2, Vauquelin, (Jour. des Mines, lxxxviii. 243); 3, 4, Kobell, (Kast. Arch., xii, 29); 5, 6, Delesse, (Rev. Scientif., &c.); 7, 8, Marignac, (Bib. Univ. de Gen. 1844); 9, Klaproth, (Beit. ii, 177); 10, Tengström, (Jahresb. iv, 156); 11 to 15, Lychnell, (Pogg. xxxviii); 16, Kersten, (J. f. pr. Chem., xxxvii, 164); 17, Delesse, (Rev. Scientif., &c., xxv):

1. *Talc or foliated varieties.*

		$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$	
1.	St. Gothard,	62·00	30·50	0.50	$\dddot{\mathrm{Fe}}$ 2·50, $\dot{\mathrm{K}}$ 2·75=98·25, Klap.
2.	"	62·0	27·0	6·0	" 3·5, $\dddot{\mathrm{Al}}$ 1·5=100, Vauq.
3.	Greiner,	62·8	32·4	2·3	$\dot{\mathrm{Fe}}$ 1·6 " 1·0=100·1, Kobell.
4.	Katherinenburg,	62·8	31·92	——	" 1·10 " 0·60, $\dot{\mathrm{Ca}}$ 1·92=98·34, K.
5.	Zillerthal,	63·0	33·6	3·4	" *trace*=100, Delesse.
6.	Rhode Island,	61·75	31·68	4·83	" 1·70=98 96, "
7.	Chamouni,	62·58	35·40	0·04	" 1·98=100, Marig.
8.	"	62·41	35·49	0·04	" 2·06=100, "

2. *Steatite varieties*, (Speckstein).

		$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$	
9.	Göpfersgrün,	59·5	30·5	5·5	$\dddot{\mathrm{Fe}}$ 2·5=98·0, Klap.
10.	Abo,	63·95	28·25	2·71	" 0·6 $\dddot{\mathrm{Al}}$ 0·78 ign. 3·94=100·23, T.
11.	Göpfersgrün,	65·64	30·80	——	$\dot{\mathrm{Fe}}$ 3·61=100·05, Lych.
12.	Sala,	63·13	34·30	——	" 2·27=99·70, "
13.	Mt. Caunegou,	66·70	30·23	——	" 2·41=99·34, "
14.	Scotland,	64·53	27·70	——	" 6·85=99·08. "
15.	China,	66·53	33·42	——	" *trace*=99·53, "
16.	Voigtsberg, G.=2·795,	66·02	31·94	——	" 0·81, ign. 0·2, $\dot{\mathrm{Na}}$, trace of $\dot{\mathrm{K}}$ 0·75 =99·72, Kersten.
17.	Nyntsch, Hung., G.=2·767,	64·85	28·53	5·22	" 1·40=100·00, Del.

B.B. talc loses color without fusing, or rarely on the edges with difficulty. 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. Other foreign localities of *potstone* are, the Vallais and Grisons, and Wald, in Styria.

Extensive beds of steatite occur in various parts 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 primitive 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 color; 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.

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.

LARDITE, *Karsten*, (J. f. pr. Chem. xxxvii, 162).

Composition.—$\dddot{\mathrm{Si}}$ 66·02, $\dot{\mathrm{Mg}}$ 31·94, $\dot{\mathrm{Fe}}$ 0·81, $\dot{\mathrm{Na}}$ and $\dot{\mathrm{K}}$ 0·75, ign. 0·20=99·72,

with traces of chlorid of sodium and sulphate of potash. This gives the formula $\dot{\mathrm{Mg}}^{6}\dddot{\mathrm{Si}}^{5}$= Silica 65·4, magnesia 34·6.

HYDROSTEATITE.—The steatite of Göpfersgrün, analyzed by Klaproth, (analysis No. 9), has been thus named. It gives the formula $\dot{\mathrm{Mg}}^{5}\dddot{\mathrm{Si}}^{4}+2\dot{\mathrm{H}}$=Silica 60·66, magnesia 33·43, water 5·91=100.

HAMPSHIRITE, *Hermann*, (J. f. pr. Chem. xlvi, 235).—Hermann distinguishes as a distinct species the steatite constituting pseudomorphs, in sepentine, at Middlefield, Hampshire Co., Mass., described and analyzed by Dewey, (Am. Jour. Sci. iv, 274, v, 249, and vi, 334, 1822, 1823), who obtained

$\dddot{\mathrm{S}}\mathrm{i}$ 50·60, $\dot{\mathrm{M}}\mathrm{g}$ 28·83, $\dot{\mathrm{F}}\mathrm{e}$ 2·59, $\dot{\mathrm{M}}\mathrm{n}$ 1·10, $\dot{\mathrm{H}}$ 15·00, $\dddot{\mathrm{A}}\mathrm{l}$ 0·15=98·27.

The specific gravity is about 2. It gives the formula $\dot{\mathrm{M}}\mathrm{g}^5\dddot{\mathrm{S}}\mathrm{i}^4+6\dot{\mathrm{H}}$. These pseudomorphs appear to have generally the form of quartz, but occasionally occur in four-sided prisms.

Other steatitic pseudomorphs occur in the United States at Newtown, N. J., imitative of quartz, scapolite, and spinel; also at Gouverneur, N. Y., imitative of scapolite; in Orange Co., N. Y., imitative of spinel and hornblende; at Bergen Hill, with the form of apophyllite. It is probable the steatites of these different pseudomorphs differ in composition. Beck (Min. N. Y., pp. 308, 318) has analyzed two of them; but the steatitic portion was probably not pure from some remaining portion of the original mineral. He obtained, for a steatitic hornblende and spinel:

	$\dddot{\mathrm{S}}\mathrm{i}$	$\dddot{\mathrm{A}}\mathrm{l}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{H}}$
1. Orange Co.,	34·66	25·33	25·22	5·09	9·09,—Steatitic hornblende.
2. "	19·07	35·00	28·58	——	7·33, $\dot{\mathrm{F}}\mathrm{e}$ 9·97,—Steatitic spinel.

Hermann unites with hampshirite the saponite of Cornwall.

SPADAITE, *Kobell*, (J. f. pr. Chem. xxx, 467).

Massive, with an imperfectly conchoidal fracture.

G.=2·5. Lustre pearly. Color reddish, approaching flesh-red.

Composition.—$\dot{\mathrm{M}}\mathrm{g}^5\dddot{\mathrm{S}}\mathrm{i}^4+4\dot{\mathrm{H}}$. Analysis by Kobell:

$\dddot{\mathrm{S}}\mathrm{i}$ 56·00, $\dot{\mathrm{M}}\mathrm{g}$ 30·67, $\dot{\mathrm{F}}\mathrm{e}$ 0·66, $\dddot{\mathrm{A}}\mathrm{l}$ 0·66, $\dot{\mathrm{H}}$ 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.

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.—$2\dot{\mathrm{M}}\mathrm{g}^2\dddot{\mathrm{S}}\mathrm{i}^3+\dddot{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+10\dot{\mathrm{H}}$ (or $6\dot{\mathrm{H}}$). Analyses: 1, Klaproth, (Beit. ii, 180, v, 22); 2, Svanberg, (K. V. Ac. H., 1840):

	$\dddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dddot{\mathrm{A}}\mathrm{l}$	$\dddot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1. Cornwall,	45·00	24·75	9·25	1·00	0·75	18·00=98·75, Klaproth.
2. "	46·8	33·3	8·0	0·4	$\dot{\mathrm{C}}\mathrm{a}$ 0·7	11·0=100·2, Svanberg.

Svanberg's analysis gives a different formula, including 21 $\dot{\mathrm{M}}\mathrm{g}$ to 2 $\dddot{\mathrm{A}}\mathrm{l}$, 13 $\dddot{\mathrm{S}}\mathrm{i}$, 15 $\dot{\mathrm{H}}$. 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. A mineral similar in external character occurs in the geodes of datholite at Roaring Brook, near New Haven, Ct.

Piotine, (Svanberg, Pogg. liv, 267, 1841). Resembles Saponite, and has the above formula with $6\dot{\mathrm{H}}$.

Composition.—Silica 50·891, magnesia 26·520, lime 0·777, alumina 9·401, peroxyd of iron 2·058, water 10·500=100·147. The name is from πιοτης, *fat.*

A saponite-like mineral from Morocco, afforded Damour the composition of meerschaum, *qu. v.*

MEERSCHAUM. Magnesite. Sea Foam.

Compact, with a smooth feel, a fine earthy texture, and flat conchoidal fracture. H.=2—2·5; impressible by the nail. Color grayish-white, or with a faint yellowish or reddish tinge. Opaque.

Composition.—$\dot{M}g\dddot{S}i+\dot{H}$=Silica 61·14, magnesia 26·95, water 11·91; sometimes with $2\dot{H}$. Analyses: 1, Lychnell, (K. V. Ac. H., 1826, 175); 2, 3, 4, Berthier, (Ann. des M. vii, 313); 5, Kobell, (J. f. pr. Chem. xxviii, 482); 6, Damour, (Ann. Chem. Ph. [3] vii, 316):

	$\dddot{S}i$	$\dot{M}g$	$\dot{H}$
1. Asia Minor,	60·87	27·80	11·29, $\ddot{\bar{F}}e$ and $\dddot{\bar{A}}l$ 0·09=100·05, Lychnell.
2. "	50·0	25·00	25·00=100, Berthier.
3. Spain,	53·8	23·8	20·0 $\dddot{\bar{A}}l$ 1·2=98·8, Berthier.
4. Coulommiers,	54·0	24·0	20·0 " 1·4=99·4, "
5. Greece,	48·00	20·06	19·60 $\ddot{\bar{F}}e$ and trace of $\dddot{\bar{A}}l$ 12·40=100·06, Kobell.
6. Morocco,	55·00	28·00	10·35 " 1·40, $\dddot{\bar{A}}l$ 1·20, $\dot{C}a$ 1·01, $\dot{K}$ 0·52, sand 1·50=98·98, Damour.

Döbereiner 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.

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. Jour. Sci. [2], vii, 286). Also found near Madrid in Spain; near Thebes in Greece; at Hrubschitz in Moravia; and at Coulommiers. Used mostly for the bowls of tobacco pipes.

Aphrodite, *Berlin*, (K. V. Ac. H. 1840). Soft and earthy like meerschaum. G.=2·21.

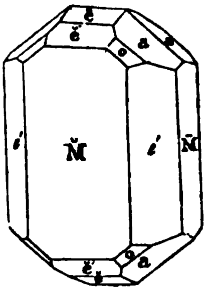
Composition.—$\dot{M}g^3\dddot{S}i^2+2\dot{H}$=Silica 53·88, magnesia 35·63, water 10·49. Berlin obtained silica 51·55, magnesia 33·72, protoxyd of manganese 1·62, protoxyd of iron 0·59, alumina 0·20, water 12·32. From Longbanshyttan, Wermland. The name is from αφρός, *foam.*

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 $\dot{M}g^2\dddot{S}i^2+3\dot{H}$. Occurs in serpentine, of a white or yellowish color, with a waxy lustre and somewhat translucent. G.=2·335.

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.

SERPENTINE, *Linn.*, *Werner*. Marmolite of *Nuttal*, Silliman's Journal, iv, 18. Οφιτης, Ophitis, *Vetruvius.* Picrolite, *Hausmann.* Baltimorite, Gymnite, *Thom.* Kypholite, *Breit.* Chrysotil, and Schillernder Asbest, *Kobell.* Metaxite.



Trimetric; rectangular, $\bar{M}$: e'=131° 14½′, e' : e'=82° 27′, $\breve{M}$: $\breve{e}$=115° 44′, $\breve{e}'$: $\breve{e}'$=92° 4′, $\breve{e}$: $\breve{e}$=128° 31′ and 51° 29′, a : a=105° 26′, 139° 39′ and 88° 26′; o : o=107° 15′, 117° 23′, 104° 6′. The forms, figs. 70, 74, and 80, pl. 2, have been observed at Rossie, N. Y., (Beck). Cleavage indistinct parallel to $\breve{M}$ and e', apparent only in a strong light. Usually massive; also fibrous and foliated.

H.=3—4. G.=2·507—2·591; some fibrous varieties 2·2—2·3. Lustre resinous—greasy; low degrees of intensity. Streak white, slightly shining. Color leek-green and blackish-green; occasionally, oil and siskin-green;

none bright. On exposure, it often becomes yellowish-gray. 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, and resembles somewhat 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. Metaxite of Delesse does not differ in composition from Chrysotile.

Marmolite.—A thin foliated variety; folia brittle, separable. G.=2·44. Of pale green color, sometimes nearly white. A lamellar variety in which the laminæ are not separable, is sometimes misnamed *Kerolite.*

Composition.—$2\dot{Mg}^6\dddot{Si}^2+3\dot{Mg}\dot{H}^2=\dot{Mg}^9\dddot{Si}^4\dot{H}^6$=Silica 43·5, magnesia 43·8, water 12·7. Analyses: 1, John; 2, Bucholz, (Schweig. J. xxi, 134); 3, Hartwall, (Jahresb. ix, 204); 4, Hisinger, (Afhand. iv, 341); 5, Mosander, (K. V. Ac. H. 1825, 227); 6, 7, 8, Lychnell, (ib. 1826, 175); 9, Scheerer, (Pogg. Ann. lxviii, 328); 10, 11, Jordan and Marchand, (J. f. pr. Chem. xxxii, 499); 12, Hermann, (ib. xlvi, 227); 13, Ivanoff, (Ann. Mines Russ. for 1841, 333); 14, Nuttal, (Am. J. Sci. iv, 18); 15, Lychnell, (loc. cit.); 16, Shepard, (Min. p. 292); 17, Vanuxem, (J. Ac. Sci. Phil. iii); 18, Beck, (Min. N. Y., 280); 19, Hermann, (J. f. pr. Ch. xlvi, 230); 20, Stromeyer, (Unters. 365); 21, Schaffgotsch, (Rose, Reise n. d. Ural, i, 245); 22, Rammelsberg, (3d suppl. 107); 23, Kobell, (J. f. pr. Chem. ii, 297); 24, Thomson, (Phil. Mag. xxii, 193); 25, Delesse, (Thése An. 24); 26, Kühn, (Ann. Ch. u. Pharm. lix, 369):

I. *Massive Serpentine.*

	$\dddot{Si}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{H}$	$\bar{Al}$
1.	42·50	38·63	——	15·20	1·00, $\bar{Fe}$ 1·50, $\bar{Mn}$ 0·62, $\bar{Cr}$ 0·25, $\dot{Ca}$ 0·25=99·95, John.
2. Waldheim,	45·4	35·5	2·6	14·0	1·9, $\dot{Ca}$ 0·8=100·2, Bucholz.
3. Snarum, *crystallized*,	42·97	41·66	——	12·02	0·87, $\bar{Fe}$ 2·48=100, Hartwall.
4. Fahlun,	43·07	40·37	1·17	12·45	0·25, $\dot{Ca}$ 0·50=97·81, Hisinger.
5. Wermland,	42·34	44·20	0·18	12·38	—, $\ddot{C}$ 0·89=99·97, Mosander.
6. Fahlun,	41·95	40·64	2·22	11·68	0·37, $\ddot{C}$ and bitumen 3·42, Lych.
7. Sjögrube,	41·58	42·41	2·17	11·29	*trace*, " " 2·38=99·33, L.
8. Massachusetts,	43·20	40·09	5·24	11·42	——=99·95, Lychnell.
9. Snarum,	40·71	41·48	2·43	12·61	2·39=99·62, Scheerer.
10. Fahlun, G.=2·53,	40·32	41·76	3·33	13·54	——=98·95, Jordan.
11. "	40·52	42·05	3·01	13·85	0·21, Coaly subst. 0·3=99·94, M.
12. L. Auschkal,	40·21	35·09	9·13	13·75	1·82=100, Hermann, G.=2·57.

II. *Foliated varieties—including Marmolite.*

	$\dddot{Si}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{H}$	$\bar{Al}$
13. Urals, G.=2·55,	40·80	40·50	2·2	12·02	3·02, $\dot{Ca}$ 0·42, $\dot{Mn}$ 0·2=99·16, Iva.
14. Hoboken,	36·0	46·0	——	15·0	—— $\dot{Ca}$ 2·0, $\bar{Fe}$ and $\bar{Cr}$ 0·5=99·5, N.
15. "	41·67	41·25	——	13·80	—— $\bar{Fe}$ 1·64, $\ddot{C}$ 1·37=99·73, Lych.
16. Blandford,	40·00	41·40	2·70	15·67	—— $\dot{Ca}$ 0·93=100·70, Shepard.
17. Bare Hills, Md.	42·69	40·00	1·16	16·11	—— $\ddot{C}$ 0·87=99·96, Vanuxem.
18. Westchester Co., N. Y.	40·50	38·00	——	21·00	——=99·50, Beck.
19. Finnland,	40·00	42·40	1·80	15·80	——=100, Hermann.

III. *Fibrous varieties*, (*including Chrysotile, Metaxite in part, Baltimorite*).

	$\dddot{Si}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{H}$	$\bar{Al}$
20. Wermland, *Picrolite*,	41·66	37·16	4·05	14·72	—— $\bar{Mn}$ 2·25=99·84, Stromeyer.
21. Gornoschit,	43·78	37·72	6·11	11·68	0·81=100, Schaffgotsch.
22. Texas, Pa. G.=2·557,	43·79	41·03	2·05	12·47	——=99·34, Rammelsberg.
23. Reichenstein, *Chrysotile*,	43·50	40·00	2·08	13·80	0·40=99·78, Kobell.
24. Bare Hills, *Baltimorite*,	40·95	34·74	10·05	12·60	1·50=99·80, Thomson.
25. Reichenstein, *Metaxite*,	42·1	41·9	3·0	13·06	0·4=100, Delesse.
26. " "	44·48	40·60	2·34	12·35	—=99·77, Kühn.

A *Serpentine Marble* from Vermont afforded Dr. Jackson, (Am. J. Sci. xxxviii, 198), $\dddot{S}i$ 45·80, $\dot{M}g$ 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. *Rhodochrome* (see under Kämmererite) may be nothing but a chromiferous serpentine.

The *Marmolite*, according to Hermann, differs in containing more water as well as in its foliated structure, and gives the formula $\dot{M}g^3\dddot{S}i^2+2\dot{M}g\dot{H}^2=\dot{M}g^5\dddot{S}i^2\dot{H}^4$.

As serpentine is to a great extent a metamorphic 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 acid.

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*.

Crystals of serpentine occur in the Fassa valley, Tyrol; in the Ural at Auschkal, Barsowka, Katharinenberg, and elsewhere; in Norway at Snarum. Fine precious serpentines come from Fahlun and Gulsjo in Sweden, the Isle of Man, the neighborhood of Portsoy in Aberdeenshire, Corsica, Siberia, and Saxony. 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 Blandford 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. 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.

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.

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. A massive serpentine-like mineral from Westchester, Chester Co., Pa., (called Williamsite by Shepard), has the same composition. It has a leek green color and is lamellar, or faintly granular. G.=2·58—2·54.

Composition.—Analyses: 1, 2, Plattner, (Prol. Löth. 2d ed.); 3, Shepard, (Am. J. Sci. [2], vi, 249):

	$\dddot{S}i$	$\dot{M}g$	$\dot{H}$	$\bar{A}l$
1. *Metaxite*,	40·0	32·8	12·6	10·7, $\bar{F}e$ 2·8=99·5, Plattner.
2. "	43·60	34·24	12·67	6·10, $\bar{F}e$ 2·8=99·41, Plattner.
3. *Williamsite*,	45·40	33·60	12·50	8·50, $\dot{N}i$ *trace*=100, Shepard.

Metaxite has been referred to Schiller spar.

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):

	$\dddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{H}}, \ddot{\text{C}}$
1.	35·80	23·70	11·33	2·25	25·20, $\dddot{\text{Al}}$ 0·42, $\dot{\text{Ca}}$ 0·83, $\dot{\text{Na}}$ 0·50=100·03.
2.	40·17	19·33	14·00	1·17	22·00, $\dddot{\text{Al}}$ 0·83, $\dot{\text{Ca}}$ 0·83, $\dot{\text{Na}}$ 1·33, $\dddot{\text{S}}$ 0·43=100·10.

Formula, $(\dot{\text{Mg}}, \dot{\text{Fe}},)^3\dddot{\text{Si}}^2+6\dot{\text{H}}$? B.B. blackens and cracks. From Waldheim in Saxony.

Retinalite—*Thomson.*

Massive, with greasy lustre. Translucent. Yellowish-brown. H.=3·75. G.=2·493.

Composition.—$\dddot{\text{Si}}$ 40·550, $\dot{\text{Mg}}$ 18·856, $\dot{\text{Na}}$ 18·832, $\dddot{\text{Al}}$ 0·30, $\dddot{\text{Fe}}$ 0·62, $\dot{\text{H}}$ 20·000=99·158=nearly $\dot{\text{Mg}}^3\dddot{\text{Si}}+2\dot{\text{Na}}\dddot{\text{Si}}+8\dot{\text{H}}$. From Granville, Canada West.*

VILLARSITE, *Dufrénoy*, Compt. Rend. xiv, 698.

Trimetric. M : M=119° 59′, corresponding to ĕ : ĕ of Picrosmine. In rhombic octahedrons of 139° 45′.

H.=3—3·5. G.=2·975. Yellowish-green, nearly like apatite. Subtransparent.

Composition.—$4(\dot{\text{Mg}}, \dot{\text{Fe}})^3\dddot{\text{Si}}+3\dot{\text{H}}$=Silica 40·51, magnesia 53·57, water 5·92. Analyses by Dufrénoy:

	$\dddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{Ca}}$	$\dot{\text{K}}$	$\dot{\text{H}}$
1.	39·40	45·33	4·30	2·86	0·54	0·46	5·80=98·69.
2.	39·61	47·37	3·59	2·42	0·53	0·46	5·80=99·78.

B.B. alone infusible. A green enamel with borax. Decomposed by strong acids. Occurs at Traversella in Piedmont, in dolomite with magnetic iron, quartz, and mica. Villarsite is isomorphous with serpentine as well as chrysolite. (See page 154).

KEROLITE, *Breithaupt.*

Massive, reniform, compact or lamellar.

H.=2—2·25. G.=2—2·2. Vitreous or resinous. White or green. Streak uncolored. Transparent—translucent. Feel greasy. Fracture conchoidal. Does not adhere to the tongue.

Composition.—$2\dot{\text{Mg}}^3\dddot{\text{Si}}^2+9\dot{\text{H}}$. Analyses: 1, 2, Kühn, (Ann. d. Ch. u. Ph. lix, 368); 3, Melling, (Ramm. Erstes Supp. p. 79):

	$\dddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$	$\dot{\text{Fe}}$	$\dddot{\text{Al}}$
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. 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.

DEWEYLITE, *Emmons.*

Massive, compact, with an impalpable structure.

H.=3—3·5. G.=2·246, Shepard. Lustre resinous. Color white, yellowish-white, yellowish-brown, and sometimes greenish. Translucent; slightly opaline or bluish on immersion in water. Very brittle, especially under water; much cracked.

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* For Scheerer's views on the isomorphism of $1\dot{\text{Mg}}$ with $3\dot{\text{H}}$, and the supposed bearing of them on the magnesian and other minerals, see the Am. Jour. Sci., [2], v, vi.

Composition.—Analyses: 1, Shepard, (Am. Jour. Sci. xviii, 83); 2, Thomson, (ib. xxxi, 174); 3, Allen, under Prof. Shepard's direction, (ib. xviii, 80); 4, G. J. Brush, (communicated to the author):

	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
1. Middlefield,	40·	40·	—	20=100, Shepard.
2. !	41·42	23·53	6·25	19·86, $\ddot{\mathrm{Al}}$ 4·47, $\ddot{\mathrm{C}}$e 3·57, $\dot{\mathrm{F}}$e trace, Th.
3. Cooptown,	43·	30·5	—	24·0, " 2·=99·5, Allen
4. Texas, Penn.,	42·60	34·16	—	20·25, " 3·13=100·14, Brush.

Thomson found in another mineral from the U. States, labelled Deweylite, (G. 2·0964),

$\dddot{\mathrm{Si}}$ 50·70, $\dot{\mathrm{Mg}}$ 23·65, $\dot{\mathrm{H}}$ 20·60, $\ddot{\mathrm{Al}}$ 3·55, $\dot{\mathrm{F}}$e 1·70, (Am. Jour. Sci., xxxi, 173).

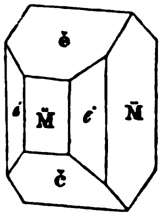
B.B. decrepitates violently; becomes opaque white, and fuses on the edges with difficulty to a white enamel. With borax forms a transparent glass.

Occurs at Middlefield, Mass., in serpentine in irregular seams. It sometimes within appears mammillary and short stalactitic, the prominences at times minutely angular, as if crystalline. It is much cracked in every direction, and under water is easily broken to fragments by the hands. The structure is sometimes a little slaty. Shepard, in his Mineralogy, i, 292, unites Deweylite with *Kerolite*, a species to which he also attached *Marmolite*, a variety of serpentine. A similar mineral occurs at Texas, Lancaster Co., Penn., (Anal. 4).

An allied mineral from Cooptown, Harford Co., Md., has a honey-yellow to dark chestnut-brown color, with often a shade of red by transmitted light, and a yellowish-white streak; translucent or subtransparent in thin pieces. G.=2·19—2·21. Scratches glass, but may be scraped with a knife.

In external appearance these minerals much resemble the *retinalite* of Thomson.

PICROSMINE. Pikrosmin, *Haidinger*.



Trimetric. $\breve{\mathrm{M}} : e' = 153° 26'$, $e' : e' = 126° 52'$, $\breve{\mathrm{M}} : \breve{e} = 121° 6'$, $\breve{e} : \breve{e}$ (over $\breve{\mathrm{M}}$) $= 62° 11'$, adjacent 117° 49′. Cleavage brachydiagonal, perfect; macrodiagonal, less so; traces parallel with ĕ. Occurs 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.

Composition.—$2\dot{\mathrm{Mg}}^3\dddot{\mathrm{Si}}^2+3\dot{\mathrm{H}}$=Silica 55·33, magnesia 36·58, water 8·08. Analysis by Magnus, (Pogg. vi, 53):

$\dddot{\mathrm{Si}}$ 54·886, $\dot{\mathrm{Mg}}$ 33·348, $\ddot{\mathrm{Al}}$ 0·793, $\ddot{\mathrm{F}}$e 1·399, $\dot{\mathrm{Mn}}$ 0·420, $\dot{\mathrm{H}}$ 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 at Englesburg near Presnitz in Bohemia. The fibrous variety resembles asbestus. The name is from πικρος, *bitter*, and οσμη, *odor*.

MOUNTAIN CORK. Bergholz of Sterzing.

The Mountain Cork from Sterzing afforded Thaulow on analysis, (Pogg. xli, 635), Silica 55·506, peroxyd of iron 19·560, magnesia 14·410, lime 0·121, alumina 0·041, water [illegible]=99·996, from which is deduced the formula,

$$\ddot{\mathrm{F}}\mathrm{e}\dddot{\mathrm{Si}}^3+\dot{\mathrm{Mg}}^3\dddot{\mathrm{Si}}^2+5\dot{\mathrm{H}}; \text{ or } \ddot{\mathrm{F}}\mathrm{e}\dddot{\mathrm{Si}}^3+2\dot{\mathrm{Mg}}\dddot{\mathrm{Si}}+\dot{\mathrm{Mg}}\dot{\mathrm{H}}^5 (=\dddot{\mathrm{Si}}^5\dot{\mathrm{Mg}}^3\ddot{\mathrm{F}}\mathrm{e}\dot{\mathrm{H}}^5).$$

PICROPHYLL, *Svanberg*, Pogg. l, 662.

Massive and foliated. Color deep greenish-gray. 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, $\dddot{\bar{\mathrm{Al}}}$ 1·11, $\dot{\mathrm{H}}$ 9·83=98·48.

Yields water in a matrass. B.B. like Picrosmine.
This species is from Sala, Sweden.

MONRADITE, *Erdmann*, K. V. Ac. H. 1842, p. 103.

Massive and 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.—$4(\dot{\mathrm{Mg}}, \dot{\mathrm{Fe}})^3\dddot{\mathrm{Si}}^2+3\dot{\mathrm{H}}$=Silica 57·66, magnesia 38·13, water 4·21. 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.

HYDROPHITE, *Svanberg*, K. V. Ac. H. 1839.

Massive, rarely fibrous.

H.=3·5. G.=2·65. Color mountain-green. Streak paler.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$! Analysis by L. Svanberg, (Pogg. li, 535):

$\dddot{\mathrm{Si}}$ 36·193, $\dot{\mathrm{Fe}}$ 22·729, $\dot{\mathrm{Mn}}$ 1·660, $\dot{\mathrm{Mg}}$ 21·082, $\dddot{\bar{\mathrm{Al}}}$ 2·895, $\dddot{\mathrm{V}}$ 0·115, $\dot{\mathrm{H}}$ 16·080=100·754.

Yields water in a matrass.
Occurs with picrolite at Taberg in Småland.

XYLITE, *Hermann*, J. f. pr. Chem. xxxiv, 180.

Asbestus-like in structure.

H.=3. G.=2·935. Color nut-brown. Opaque.

Composition.—$(\dot{\mathrm{Ca}}, \dot{\mathrm{Mg}})\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{Fe}}}\dddot{\mathrm{Si}}+\dot{\mathrm{H}}$. Analysis by Hermann, (loc. cit.):

$\dddot{\mathrm{Si}}$ 44·06, $\dddot{\bar{\mathrm{Fe}}}$ 37·84, $\dot{\mathrm{Ca}}$ 6·58, $\dot{\mathrm{Mg}}$ 5·42, $\dot{\mathrm{Cu}}$ 1·36, $\dot{\mathrm{H}}$ 4·70=99·96.

Yields in a matrass some water. B.B. fuses on the edges to a black mass. Reaction of iron with the fluxes. Slightly acted on by the acids.

Probably from the Urals.

PYRALLOLITE, *Nordenskiöld.*

Triclinic. P : M=140° 49′, M : T=94° 36′. Occurs with the obtuse lateral edges replaced. Cleavage distinct parallel to M and T; also in the direction of *e*. Usually granular massive.

H.=3·5—4. G.=2·555—2·594. Lustre dull, sometimes slightly resinous. Streak white. Color white, sometimes greenish. Subtranslucent—opaque. Fracture earthy.

Composition.—Principally $\dot{\mathrm{Mg}}^3\dddot{\mathrm{Si}}^2$, with water. Analysis by Nordenskiöld, (Schweig. J. xxxi, 386):

$\dddot{\mathrm{Si}}$ 56·62, $\dot{\mathrm{Mg}}$ 23·38, $\dddot{\bar{\mathrm{Al}}}$ 3·38, $\dot{\mathrm{Ca}}$ 5·58, $\dot{\mathrm{Mn}}$ 0·99, $\dddot{\bar{\mathrm{Fe}}}$ 0·99, $\dot{\mathrm{H}}$ 3·58.

B.B. becomes black, then white again; afterwards intumesces, and melts on the edges to a white enamel. With borax yields a transparent glass. With soda fuses easily to a yellowish-green transparent glass. With salt of phosphorus there is a slight effervescence, but fusion is obtained with difficulty. The analysis afforded also 6·38 of bituminous matter and loss.

Occurs at Storgord in Pargas, Finland, in a limestone bed, with feldspar, pyroxene, scapolite, moroxite, and sphene. Discovered by Count Steinheil. The name is from πυρ, *fire*, αλλος, *other*, λιθος, *stone*, in allusion to the change of color before the blowpipe.

SCHILLER SPAR. Schillerstein, *W.* Talkartiger Diallag, *Haus.* Bastite, *Haid.* Spath Chatoyant. Diallage Metalloide, (in part), *H.*

Triclinic or monoclinic. Usually cleavable, massive, yielding broad lamellæ; cleavage in two directions, in one highly perfect, the other in traces; angle of inclination, 135°—145°.

H.=3·5—4. G.=2·5—2·652; 2·76, Ramm. Lustre metallic pearly on cleavage faces, elsewhere sub-vitreous. Color dark-green, inclining to pinchbeck-brown. Streak grayish-white, or faint yellowish. Subtranslucent. Fracture uneven, splintery.

Composition.—$3\dot{M}g\dot{H}^4+4\dot{R}^3\dddot{S}i^2$, Köhler, (=$15\dot{R}\,12\dot{H}\,8\dddot{S}i$); perhaps $3\dot{R}\dddot{S}i+2\dot{R}\dot{H}^2$, Ramm. (=$5\dot{R}\,4\dot{H}\,3\dddot{S}i$). Analyses by Köhler, (Pogg. xi, 192), and Rammelsberg, (3d Supp., 106):

	$\dddot{S}i$	$\dot{M}g$	$\dot{C}a$	$\dot{F}e$, $\bar{C}r$	$\dot{M}n$	$\bar{A}l$	$\dot{H}$
1. Baste, (*Bastite*),	43·90	25·86	2·64	13·02	0·53	1·28	12·48=99·66, Köhler.
2. "	43·08	26·16	2·75	10·91 2·37	0·57	1·73	12·43=100, "
3. Radauthal,	41·48	27·24	—	$\dot{F}e$ 16·61	—	6·49	10·13=101·95, Ramm.

Yields ammoniacal water in a matrass. B.B. in platinum forceps, becomes pinchbeck-brown, and metallic in lustre, and thin pieces magnetic; fuses only on thinnest edges. A glass with borax, with some difficulty, which is colored with iron when hot and with chrome when cold. Imperfectly dissolved in muriatic acid, and perfectly in sulphuric.

From Baste in the Hartz, with serpentine. At Blandford, Mass., a blackish green variety occurs with serpentine.

The *Metaxite* of Kühn has been referred to this species. See page 255, where the analyses are given.

ANTIGORITE, *Schweizer*, Pogg. Ann. xlix, 595.

Trimetric. In foliated masses, laminæ easily separating.

H.=2·5. G.=2·622. Brownish and leek-green, with uncolored streak. Transparent in thin laminæ. Feel smooth, but not greasy. Mutual inclination of the two optical axes about 22°, Haidinger.

Composition.—$\dot{R}^3\dddot{S}i^2+\dot{M}g\dot{H}$, Schw. Analyses by Schweizer, (loc cit.):

	$\dddot{S}i$	$\dot{M}g$	$\dot{F}e$	$\bar{A}l$	$\dot{H}$
1.	46·22	34·39	13·05	2·08	3·70=99·44.
2.	46·18	35·19	12·68	1·89	3·80=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 from Mount Albrun between Oberwallis and Piedmont, where masses 5 inches long and over 2 thick have been obtained.

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.—Analyses by Scheerer, (loc. cit.):

	$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{H}}$
1.	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.

Neolite is a recent formation produced in one of the mines of Näskil, through the agency of infiltrating waters that have passed over rocks containing magnesia.

CHLORITE, *Werner*. Leuchtenbergite, *Komonen*.

Rhombohedral; R : R=104° 15′, highly perfect. Crystals often tabular and crested. Cleavage basal. Usually massive granular, also foliated.

H.=1·5. G.=2·65—2·85; 2·673, Ala, Piedmont. Lustre vitreous to 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.—$3\dot{R}^3\dddot{Si}+\bar{\dddot{R}}^2\dddot{Si}+9\dot{H}(=\dddot{Si}^4\bar{\dddot{R}}^2\dot{R}^9\dot{H}^9)$, Rammelsberg. 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):

	$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{H}}$
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	$\bar{\dddot{\mathrm{Fe}}}$ 4·81	—	12·52=99·60, Marignac.
8. Slatoust,	30·27	19·89	33·13	$\bar{\dddot{\mathrm{Fe}}}$ 4·42	—	12·54=100·25, Marignac.
9. Slatoust, (*white*),	30·80	17·27	37·07	$\bar{\dddot{\mathrm{Fe}}}$ 1·37	—	12·30=98·82, Hermann.
10. *Leuchtenbergite*,	32·35	18·00	32·29	$\dot{\mathrm{Fe}}$ 4·37	—	12·50=99·51, Hermann.

Rammelsberg finds that the iron is often partly peroxyd and partly protoxyd. In analysis No. 5, he makes $\dot{\mathrm{Fe}}$=2·95, $\bar{\dddot{\mathrm{Fe}}}$=3·36; for the Achmatowsk chlorite he finds 4·55 of $\dot{\mathrm{Fe}}$, and no $\bar{\dddot{\mathrm{Fe}}}$. Examinations on this point have led him to the formula above given, (Pogg. Ann. lxxvii, 414, 1849).

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. Octahedral crystals of magnetic iron and hornblende are the most common minerals in chlorite and chlorite slate.

Chlorite occurs in various parts of the Eastern United States. In Pennsylvania, near Unionville, crystals are found imbeded in massive chlorite, sections of which are often triangular.

It is a common mineral in various parts of Europe. The Leuchtenbergite is from near Slatoust, in the Ural.

The *Pihlite* of Sefstrom from Fahlun, is a doubtful species between talc and mica. The *Talc Zographique* of Haüy is a *green earth*: see under *Iron*.

RIPIDOLITE, *G. Rose*. Chlorite, *in part*.

Hexagonal. Cleavage basal, eminent. Crystals from Tyrol in double pyramids, pyramidal edges 132° 40′, basal 106° 50′, Descloiseaux.

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.—$3\dot{R}^3\dddot{Si}+\bar{\bar{R}}^2\dddot{Si}+9\dot{H}(=\dddot{Si}^4\bar{\bar{R}}^3\dot{R}^9\dot{H}^9)$, Rammelsberg. Analyses: 1, Varrentrapp; 2, 3, 4, Kobell, (J. f. pr. Ch. xvi); 5, 6, Marignac, (Ann. Ch. Phys. xiv, [3], 59); 7, Hermann.

	$\dddot{Si}$	$\bar{\bar{Al}}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{H}$
1. St. Gothard,	25·37	18·50	17·09	28·79	—	8·96=98·70, Varrentrapp.
2. Zillerthal,	26·51	21·81	22·83	15·00	—	12·00=98·15, Kobell.
3. "	27·32	20·69	24·89	15·23	0·47	12·00=100·60, "
4. Rauris,	26·06	18·47	14·69	26·87	0·62	10·45, gangue 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	$\bar{\bar{Fe}}$ 5·00	—	13·43 with 2·25 undecomp. and magnetic iron, Hermann.

B.B. like chlorite. Rammelsberg makes the St. Gothard ripidolite, (anal. 1), to contain 16·89 $\dot{Fe}$ and 13·22 $\bar{\bar{Fe}}$, and finds reason for changing other analyses correspondingly; and thence he deduces the above formula, (Pogg. Ann. lxxvii, 421, 1849).

Ripidolite occurs at the localities above mentioned, and also in Scotland, &c.

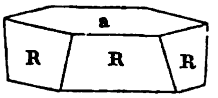
In subdividing the species chlorite, Kobell gave the name *ripidolite*, to the preceding species, and *chlorite* to this. But as the former was the more common mineral and was known in better crystallisations, G. Rose, and with him Rammelsberg and others, retain for it the original name and give the new one to the species before less known.

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):

$\dddot{Si}$ 38·45	$\bar{\bar{Al}}$ 11·75	$\dot{Fe}$ 12·82	$\dot{Mg}$ 28·19	$\dot{H}$ 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 strongly greasy feel of talc.

PENNINE, *Fröbel* and *Schweizer*, Pogg. l, 523, 526. Hydrotalk, *Necker*.



Rhombohedral. R : R=63° 15′, Descloiseaux; 62° Fröbel. In large tabular crystals. a : R=79° 30′ and 100° 30. Cleavage basal, eminent. Sometimes macled.

H. of a=2·5, of R=3. G.=2·653—2·659. Blackish-green laterally, emerald green in the direction of the axis. Laminæ flexible, inelastic; powder greasy to the feel.

Composition.—$\dot{R}^3\dddot{Si}+2\bar{\bar{Al}}\dddot{Si}+2\dot{H}$, according to Marignac's analyses. But Rammelsberg says part of the iron is peroxyd, and places the species with chlorite. Analyses: 1, Schweizer, (loc. cit.); 2, 3, 4, Marignac, (Ann. Chem. Ph. [3], x, 428):

	$\dddot{Si}$	$\bar{\bar{Al}}$	$\dot{Fe}$	$\dot{Mg}$	$\dot{H}$
1. Zermatt,	33·07	9·69	11·36	32·34	12·58=99·08, Schweizer.
2. "	33·36	13·24	$\bar{\bar{Fe}}$ 5·93	34·21	12·80, $\ddot{\bar{Cr}}$ 0·20=99·74, M.
3. "	33·40	13·41	" 5·73	34·57	12·74, " 0·15=100, M.
4. Binnen,	33·95	13·46	" 6·12	33·71	12·52, " 0·24=100, M.

B.B. fuses with difficulty to a grayish enamel. Dissolved if boiled long in muriatic acid.

From the valleys of Zermatt and Binnen in the Vallais, in chlorite schist among serpentine rocks; also from the foot of the Simplon.

EPICHLORITE, *Rammelsberg*, Pogg. Ann. lxxvii, 437, 1849.

Fibrous or columnar.

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.—$3\dot{R}^3\dddot{Si}+\dddot{\bar{R}}^2\dddot{Si}^3+9\dot{\bar{H}}$, Rammelsberg. Analysis:

$\dddot{Si}$ 40·88 $\dddot{\bar{Al}}$ 10·96 $\dddot{\bar{Fe}}$ 8·72 $\dot{Fe}$ 8·96 $\dot{Mg}$ 20·00 $\dot{Ca}$ 0·68 $\dot{\bar{H}}$ 10·18=100·38.

B.B. fuses only in thin fibres and with difficulty. With the fluxes reaction of silica and iron. In a matrass yields water.

From near Neustadt in the Radauthal, with garnet, epidote, and feldspar, in an impure serpentine consisting of

$\dddot{Si}$ 41·85 $\dddot{\bar{Al}}$ 6·19 $\dot{Fe}$ 18·94 $\dot{Mg}$ 16·50 $\dot{Ca}$ 7·87 $\dot{K}$ 3·17 $\dot{\bar{H}}$ 5·90=100·42.

PYROSCLERITE, *Kobell.*

Trimetric? cleavage basal perfect, also less perfect in one direction at right angles to base. Occurs massive.

H.=3. G.=2·74. Lustre weak, pearly. Color green, apple-green, grayish. Translucent. Fracture uneven and splintery.

Composition.—$2\dot{R}^3\dddot{Si}+\dddot{\bar{Al}}\dddot{Si}+4\frac{1}{2}\dot{\bar{H}}$=Silica 39·3, magnesia 34·6, alumina 14·6, water 11·5. Analysis by Kobell:

$\dddot{Si}$ 37·03, $\dot{Mg}$ 31·62, $\dddot{\bar{Al}}$ 13·50, $\dot{Fe}$ 3·52, $\dddot{\bar{Cr}}$ 1·43, $\dot{\bar{H}}$ 11·00=98·10.

In a matrass yields water. B.B. fuses with difficulty to a grayish glass, and with borax forms a chrome-green pearl. Wholly decomposed by concentrated muriatic acid, without forming a jelly.

From Elba, in serpentine. A kind of *Serpentine* from Aker in Sudermanland has according to Lychnell the same composition.

Chonikrite has the same composition according to Scheerer, (Pogg. lxx, 552). It occurs massive of a white color, glistening lustre and weak translucence. Sectile. It occurs at Elba with pyrosclerite.

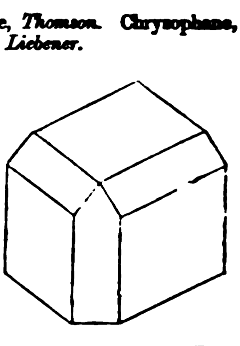
Kämmererite is similar in constitution. It is described as occurring in hexagonal prisms, of a reddish-violet color like lepidolite. Cleavage basal, perfect. H.=1·5—2. G.=2·76. Lustre pearly. Translucent. Sectile and flexible. Feel greasy. In a matrass yields water. B.B. exfoliates, but does not fuse even on the edges. Formula $2\dot{R}^3\dddot{Si}+\dddot{\bar{Al}}\dddot{Si}+6\dot{\bar{H}}$. Found with chromic iron at Bissersk, Siberia.

Analyses: 1, Lychnell, (K. V. Ac. H. 1826); 2, Kobell, (J. f. pr. Ch. ii, 51); 3, Hartwall, (Jabresb. xxiii, 266):

	$\dddot{Si}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{Fe}$	$\dddot{\bar{Al}}$	$\dot{\bar{H}}$	
1. Aker, *Serpentine*,	35·28	35·35	——	1·79	13·73	7·33,	$\ddot{C}$ and bitum. 6·28=99·76, L.
2. *Chonikrite*,	35·69	22·50	12·60	1·46	17·12	9·00=98·37, Kobell.	
3. *Kämmererite*,	37·0	31·5	1·5	1·5	14·2	13·0,	$\dddot{\bar{Cr}}$ 1·0=99·7, Hartwall.

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. Contains silica, magnesia, oxyd of chrome, some alumina and no lime. Yields water in a matrass and becomes grayish-white. 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. A mineral similar in color and external characters occurs at Texas, in the State of Pennsylvania, along with chromic iron in serpentine.

CLINTONITE, *Mather*. Seybertite, *Clemson*. Holmesite, *Thomson*. Chrysophane, *Breit*. Xanthophyllite, *Rose*. Brandisite, *Liebener*.



Hexagonal. Usually in tabular crystals, or foliated massive; sometimes lamellar radiate. Structure, thin foliated or micaceous parallel to the base.

H.=4—5. G.=3·098. Lustre pearly submetallic. Color redish-brown, yellowish, copper-red. Streak uncolored, or slightly yellowish or grayish. Folia brittle.

Composition.—$\dot{R}\dddot{Si}+2\dot{R}\ddot{\bar{A}}l+\dot{R}\dot{H}$! from Meitzendorf's analysis. Clemson's analysis affords the oxygen ratio for the silica, peroxyd, protoxyd, and water, 6 : 12 : 9 : 2, whence we deduce the formula $\dot{R}^3\dddot{Si}^2+2\dot{R}^3\ddot{\bar{A}}l^2+2\dot{H}$ (in which the 9 $\dot{R}$=(nearly) $6\dot{Mg}+2\dot{Ca}+1\dot{Fe}$)=Silica 17·4, alumina 38·8, magnesia 23·0, lime 10·6, protoxyd of iron 6·8, water 3·4.

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):

	$\dddot{Si}$	$\ddot{\bar{A}}l$	$\dot{Mg}$	$\dot{Ca}$	$\dot{Fe}$	$\dot{H}$
1. Amity,	17·0	37·6	24·3	10·7	5·0	3·6=98·2, Clemson.
2. "	19·35	44·75	9·05	11·45	$\ddot{\bar{F}}e$ 4·80	4·55, $\dot{Mn}$ 1·35, $\ddot{\bar{Z}}r$ 2·05, H F 0·9=98·25, R.
3. Slatoust,	16·55	43·73	19·04	13·12	$\dot{Fe}$ 2·62	ign. 4·33, $\dot{Na}$ 0·67=100·06, M.
4. "	16·41	43·17	19·47	14·50	2·23	" 4·45, $\dot{Na}$ 0·62=100·85, M.
5. "	16·20	44·96	19·43	12·15	2·73	" 4·33, $\dot{Na}$ 0·55=100·35, M.
6. Fassa,	20·00	43·22	25·01	4·00	$\ddot{\bar{F}}e$ 3·60	$\dot{H}$ 3·60, $\dot{K}$ 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; this variety occurs in implanted globules about an inch and a half through, consisting within of the mineral; and also in columnar and lamellar individuals, which sometimes contain within thin tabular crystals of a hexagonal form, secondary apparently to a rhombic prism. Cleavage basal, highly perfect. Also (the *Disterite*, called also *Brandisite*) in the valley of Fassa, Tyrol, occurring in hexagonal prisms with perfect basal cleavage, and pearly lustre on a cleavage surface; H. of base 5, of sides 6—6·5. G.=3·042—3·051; Kobell deduces for it the formula $\dot{Mg}^3\dddot{Si}^2+4\dot{Mg}\ddot{\bar{A}}l$, and obtains besides the above constituents, traces of manganese, oxyd of copper ,and chlorine.

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. The figure above given is by Mr. Horton, as published by Beck in the Mineralogy of New York, p. 362. Breithaupt makes the crystallization monoclinic, and gives the angle between the lateral planes 94°.

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. 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).

BOWENITE, *D.* Nephrite, *Bowen*, Amer. J. Sci., vi, 1822, 346.

Massive, with a fine granular texture.

H.=6. G.=2·594—2·787. Color bright apple-green. Lustre faint vitreous. Highly translucent. Fracture splintery. Tough.

Composition.—$2(\dot{\mathrm{Mg}}, \dot{\mathrm{Ca}})^2\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$=Silica 45·1, magnesia 34·8, lime 6·9, water 13·2. Analysis by Bowen, (loc. cit.):

$\dddot{\mathrm{Si}}$ 44·688, $\dot{\mathrm{Mg}}$ 34·631, $\dot{\mathrm{Ca}}$ 4·250, $\dot{\mathrm{Fe}}$ 1·747, $\overline{\dddot{\mathrm{Al}}}$ 0·562, $\dot{\mathrm{Mn}}$ *trace* $\dot{\mathrm{H}}$ 13·417=99·295. B.B. alone infusible. Boiled with sulphuric or nitromuriatic acid wholly decomposed.

Occurs at Smithfield, Rhode Island, imbedded in large nodules in white granular limestone.

This mineral, as Bowen states, differs from nephrite in containing a large percentage of water. It affords so exactly the above formula that we feel authorized in thus noticing it as a separate species.

c. *Anhydrous Silicates of Lime and Magnesia, and of isomorphous bases.*

The anhydrous silicates of magnesia have nothing of the soapy feel so common among the hydrous species—excepting the species *talc*, which is usually anhydrous. The bases lime, magnesia, protoxyds of iron and magnesia are mutually replaceable in many of these magnesian silicates, and the species therefore are subject to great variations in color, density, and other characters. Some of the species, as hornblende and augite, are extremely abundant, each being an essential constituent of many rocks.

WOLLASTONITE, *H.* Tabular Spar. Table Spar. Grammite. Schaalstein, *W.* Tafelspath, *M.*

Monoclinic. M : M=95° 38′ and 84° 22′; P : M=104° 48′. Cleavage orthodiagonal, perfect and easily obtained; lateral less so; indistinct parallel with P. Usually cleavable massive, with the surface appearing long fibrous; also true 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. Streak white. Color white, inclining to gray, yellow, red or brown. Subtransparent—translucent. Fracture uneven. Brittle.

Composition.—$\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}^2$=Silica 52·5, lime 47·5, being an augite in which $\dot{\mathrm{R}}^3=\dot{\mathrm{Ca}}^3$, as stated by Frankenheim. Analyses: 1, Stromeyer, (Untersuch., 1, 356); 2, Brandes, (Schweig. J. xlvii, 246); 3. H. Rose, (Gilb. Ann. lxxii, 70); 4, Kobell, (J. f. pr. Ch. xxx, 469); 5, Weidling, (K. V. Ac. Förh., 1844, 92); 6, Bonsdorff, (Schw. xxxiii, 368); 8, Seybert, (Am. Jour. Sci. iv, 320); 8, Vanuxem, (J. Ac. Nat. Sci. Philad. ii, 182); 9, Beck, (Min. N. Y. 271); 10, 11, J. D. Whitney, (Bost. J. Nat. Hist. v, 486):

		$\dddot{Si}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{H}$
1.		51·445	47·412	——	0·401	0·076, $\dot{Mn}$ 0·257=99·591, Str.
2.	Bannat,	50·0	46·6	——	——	2·0, $\ddot{C}$ 1·5=99·1, Brandes.
3.	Perhoniemi,	51·60	46·41	——	——	—— gangue 1·11=99·12, Rose.
4.	C. di Bove,	51·50	45·45	0·55	——	2·00=99·50, Kobell.
5.	Göckum,	50·724	43·802	0·879	0·849	——$\dot{Mn}$ 0·334, $\dot{Ca}\ddot{C}$ 2·782=99·320, Weidling.
6.	Skräbböle,	52·58	44·45	0·68 $\dddot{\overline{Fe}}$	0·13	0·99=99·83, Bonsdorff.
7.	Willsborough,	51·0	46·0	*trace*, "	1·3	1·0=99·3, Seybert.
8.	"	51·67	47·00	—— "	1·35	——=100·02, Vanuxem.
9.	Diana,	51·90	47·55	—— "	0·25	——=99·70, Beck.
10.	Kewenaw Pt.,	49·09	46·38	0·14	——	2·96, $\dot{Mn}$ 0·48, $\dddot{\overline{Al}}$ 0·23, $\ddot{C}$ and loss 0·72=100, Whitney.
11.	"	49·06	44·87	——	——	2·96, $\dot{Mn}$ 0·93, $\dddot{\overline{Al}}$ 1·28, $\ddot{C}$ and loss 0·90=100, Whitney.

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 of 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, which traverses gneiss; abundantly 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, Lower Canada, associated with green coccolite. It is found in large tabular masses of a fibrous structure, in Bucks Co., Penn., three miles west of Attleboro', associated with scapolite, pyroxene, and sphene. Also abundant of a red color at Kewenaw Point, Lake Superior, and on Isle Royal.

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, $\dot{Na}\dddot{Si}+\dot{Ca}^3\dddot{Si}^2$, or near acmite. It is referred by J. D. Whitney, to Pectolite, p. 248.

EDELFORSITE. Neutral Silicate of Lime. Ædelforsite, *Kobell.*

Fibrous or feathery, and massive.

H.=6. (?) G.=2·58. Lustre shining. Color white or grayish. Transparent.

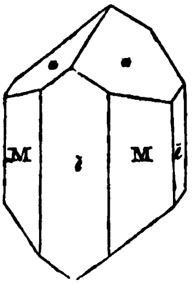
Composition.—$\dot{Ca}\dddot{Si}$=Silica 62·2, lime 37·8. B.B. fuses to a white translucent glass. Gelatinizes.

Edelforsite is found at Aedelfors in Smaoland, Cziklowa in the Bannat, and at Gjelleback in Norway.

PYROXENE, *Haüy.* Augite. Coccolite. Diopside. Sahlite. Alalite. Mussite. Pyrgom. Fassaite. Pentaclasite. Jeffersonite, *Keating.* Asbestus, *in part.* Bronzite. Paulite. Green Diallage. Kokkolit, Baikalit, Omphazit, *W.* Pentaklasit, *Haus.* Malacolithe, *Haüy.* Funkite. Hudsonite, *Beck.* Polylite, *Thom.*

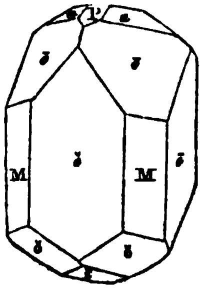
Monoclinic. M : M=87° 6′, P : M=100° 25′, P : *a*=150° 2′, *a* : *a* =120° 38′, $\bar{o}:\bar{o}$=95° 28′, $\breve{o}:\breve{o}$ (adjacent planes)=81° 46′, M : $\grave{e}$=136° 5′, M : $\breve{e}$=133° 55′, P : $\breve{a}$=147° 45′. Cleavage lateral, rather perfect, often interrupted; also parallel to each diagonal. Compound crystals; fig. 14, pl. 3. Often coarse lamellar, in large masses, parallel to P or ĕ, arising from an aggregation of separate individuals.

1



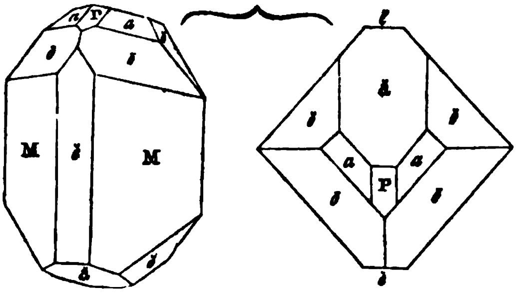
Gouverneur, N. Y.

2



Fassa, Tyrol; and Long Pond, Essex Co., N. Y.

3



Bytown, L. C.; and Ala, Piedmont.

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; sometimes pearly. Streak white—gray. Color green of various shades, verging on one side to white or grayish-white, and on the other to brown and black. Transparent—opaque. Fracture conchoidal—uneven. Brittle.

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. When R=Ca, the mineral is *Wollastonite*, and has a white color. 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*. R 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. When alumina enters into the constitution, it apparently replaces the silica.

There are other varieties 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, $(\dot{C}a, \dot{M}g)^3\dddot{S}i^2$. G.=3·23—3·26.

Sahlite resembles diopside, but has a dingy greenish color, and is coarse foliated, arising from composition parallel to P; from Sahla, Sweden. *Baikalite* is a green variety, from Lake Baikal. *Pyrgom* is a dingy variety of sahlite. *Omphazite* is a foliated leek-green variety. The same constitution as above, but usually with some iron. G.=3·23—3·3.

Pyroxene.—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. *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, $(\dot{C}a, \dot{M}g, \dot{F}e)^3\dddot{S}i^2$. G.=3·25—3·3.

Jeffersonite is a dark green foliated variety, from Franklin, New Jersey: it has the same constitution as the last, with some oxyd of zinc. $(\dot{C}a, \dot{F}e, \dot{M}g, \dot{Z}n)^3 \dddot{S}i^2$. G.=3·5.

Augite includes the black and greenish-black crystals, common in basaltic and volcanic rocks. It contains the same bases as the last, together with alumina. $(\dot{C}a, \dot{F}e, \dot{M}g)^3(\dddot{S}i, \ddot{\bar{A}}l)^2$. 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.

Hedenbergite is a black pyroxene, containing largely of iron, little or no magnesia, and no alumina. $(\dot{C}a, \dot{F}e)^3\dddot{S}i^2$. G.=3·5.

Hudsonite is black and cleavable like Hedenbergite, but differs in having a considerable part of the silica replaced by alumina, $(\dot{C}a, \dot{F}e),^3(\dddot{S}i, \ddot{\bar{A}}l)^2$. 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.

Diallage.—Thin foliated and easily cleavable; laminæ brittle; color various shades of green, gray, and brown, and sometimes bronze or pearly-metallic. G.=3·11—3·27, 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, Gulsen in Styria.

Hypersthene 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 35) is between diallage and hypersthene in composition, but has the pale colors of diallage, passing into brass-yellow.

Analyses: 1, Laugier, (Ann. du Mus. xi, 158); 2, Nordenskiöld, (Schweig. J. xxxi, 427); 3, H. Rose, (Schw. xxxv, 86); 4, T. Wachtmeister, (Schw. J. xxx, 334); 5, Hermann, (J. f. pr. Ch. xxxvii, 190); 6, Wackenroder, (Kastn. Archiv. xiii, 84); 7, Seybert, (Am. J. Sci. iv, 320); 8, 9, 10, 11, H. Rose, (loc cit.); 12, Wolff, (J. f. pr. Ch. xxxiv, 236); 13, Berzelius, (Afh. i, Fisik i, 110, iv, 382); 14, 15, 16, 17, 18, Kudernatsch, (Pogg. xxxvii, 577); 19, Gmelin, (Leonh. u. Bronn, N. Jahrb. 1840, 549); 20, Delesse, (Ann. d. Mines, [4], xii, 293); 21, Brewer, (Am. J. Sci. ix); 22, Beck, (Min. N. Y., 405); 23, Thomson, (Min i, p. 495); 24, 25, Köhler, (Pogg. xiii, 101); 26, 27, 28, Regnault, (Ann. des M. [3], xiii, 147); 29, Kobell, (J. f. pr. Ch xxxvi, 303); 30, Schafhäutl, (Ann. d. Ch. u. Ph. li, 254); 31, Beck, (Min. N. Y., p 310); 32, Seybert; 33, Muir, (Thom. Min. i, 202); 34, Damour, (Ann. des Mines, [4], v, 157); 35, Köhler, (as above); 36, Meitzendorf, (Pogg. lii, 626); 37, Grüner, (Compt. Rend. xxiv, 794):

I. *White or pale green, containing little or no iron.*—Analyses 3 to 6 correspond nearly to the formula $(\frac{1}{2}\dot{C}a+\frac{1}{2}\dot{M}g)^3\dddot{S}i^2$=Silica 55·95, magnesia 18·50, lime 25·55:

	$\bar{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\bar{\text{Al}}$	
1. Mussa Alp,	57·50	18·25	16·50	6·00		——	=98·25, Laugier.
2. Pargas, *bh-gn.*	55·40	22·57	15·70	2·50	2·83	——	$\bar{\text{Mn}}$ 0·43=99·43, Nord.
3. Wermland, *ysh.*	55·32	16·99	23·01	——	——	——	$\bar{\text{Fe}}$ 2·16, $\bar{\text{Mn}}$ 1·59=99·07, Rose.
4. Norway, *wh.*	57·40	16·74	23·10	——	——	0·43	" 0·20=97·87, Wacht.
5. Achmato'sk, *wh.*	53·97	17·86	25·60	2·00	0·57	——	=100, Herm. G.=3·28.
6. Fassa, "	54·15	18·22	24·74	2·51	——	0·20,	$\bar{\text{Mn}}$ 0·18=100, Wack.

II. *Dark green to black, containing lime and iron, with more or less magnesia and no alumina.* Analyses 8 and 9 correspond nearly to the formula $(\frac{4}{9}\dot{\text{Ca}}+\frac{4}{9}\dot{\text{Mg}}+\frac{1}{9}\dot{\text{Fe}})^3\bar{\text{Si}}^2$= Silica 54·08, magnesia 18·40, lime 24·67, protoxyd of iron 7·90. Analyses 11 and 12, to the formula $(\frac{1}{2}\dot{\text{Ca}}+\frac{1}{2}\dot{\text{Fe}})^3\bar{\text{Si}}^2$=Silica 49·52, lime 22·37, protoxyd of iron 28·11.

	$\bar{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\bar{\text{Al}}$	
7. L. Champl. *gn.*	50·38	6·83	19·33	20·40	*trace*	1·83	=98·77, Seybert.
8. Dalecarlia "	54·08	11·49	23·47	10·02	——	——	$\bar{\text{Mn}}$ 0·61=99·67, Rose.
9. " "	54·55	15·25	20·21	8·14	——	0·14,	" 0·73=99·02, "
10. Wermland, *bk.*	53·36	4·99	22·19	17·38	0·09	——	=98·01, Rose.
11. Tunaberg, *bk.* *Hedenbergite,*	49·01	2·98	20·87	26·08	——	——	=98·94, Rose.
12. Arendal, *bk.*	47·78	——	22·95	27·01	——	——	=97·74, Wolff.

III. *Containing manganese.* The formula is $\dot{\text{Mn}}^3\bar{\text{Si}}^2$=Silica 46·4, manganese 53·6. (See further Rhodonite).

	$\bar{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\bar{\text{Al}}$	
13. *Langbanshytta,*	48·00	0·22	3·12	——	49·04	——	=100·38, Berzelius.

IV. *Black or brownish-black, containing alumina, with magnesia, lime and iron;* mostly from basalt and porphyry.

	$\bar{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\bar{\text{Al}}$	
14. Rhone,	50·11	15·72	18·66	7·55	——	6·68	=98·72, Kudernatsch.
15. Vesuvius,	50·90	14·48	22·96	6·25	——	5·37	=99·91, "
16. Etna,	50·55	13·01	22·29	7·96	——	4·85	=98·66, "
17. Fassa,	50·15	13·48	19·57	12·04	——	4·02	=99·26, "
18. Eifel,	49·39	13·93	22·46	7·39	——	6·00	=99·25, "
19. Wetterau, G, 2·705,	56·80	5·05	4·85	12·06	——	15·32,	$\bar{\text{Mn}}$ 3·72, $\dot{\text{Na}}$ 3·14, $\dot{\text{K}}$ 0·34=101·28, Gmelin.
20. Vosges,[a]	49·16	15·95	18·87	7·19	*trace*	5·08,	H 2·26=98·51, D.

[a] This augite forms with the feldspathic mineral Vosgite, the porphyry of Ternuay.

V. *Black, containing alumina, with iron and lime without magnesia. Hudsonite* (Analysis 21) corresponds to the formula $\dot{\text{R}}^3(\bar{\text{Si}}, \bar{\text{Al}})^2$, or, stating the bases and their proportions,

$$\left(\frac{8}{12}\dot{\text{Fe}}+\frac{0\cdot5}{12}\dot{\text{Mn}}+\frac{3\cdot5}{12}\dot{\text{Ca}}\right)^3\left(\frac{6\cdot33}{8}\bar{\text{Si}}+\frac{1\cdot66}{8}\bar{\text{Al}}\right)^2$$

	$\bar{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\bar{\text{Al}}$	
21. *Hudsonite,*	36·94	——	12·71	36·03	2·24	11·22	=99·14, Brewer.
22. "	37·90	1·92	11·40	36·80[b]	——	12·70	=100·72, Beck.
23. *Polylite,*	40·04	——	9·42	34·08	6·60	11·54,	$\dot{\text{H}}$ 0·4=102·08, Th.

[b] The iron in Beck's analysis is stated as "oxyd of iron," but from the accompanying remarks protoxyd appears to have been meant.

VI. *Thin foliated.* Nos. 24, 25, *Diallage;* 26, 27, 28, 29, *Bronzite;* 30, *Vanadiferous Bronzite;* 31, 32, a kind of *Hypersthene;* 33, 34, *Hypersthene;* 35, *Diaclasite* of Hausmann.

	$\bar{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\bar{\text{Al}}$	
24. Hartz,	53·71	17·55	17·06	8·08		2·825,	$\dot{\text{H}}$ 1·040=100·27, K.
25. Florence,	53·20	14·91	19·09	8·67	0·38	2·47,	$\dot{\text{H}}$ 1·773=100·49, K.
26. Piedmont,	50·05	17·24	15·68	11·98	——	2·58,	" 2·13=99·61, Reg.
27. Ural,	52·60	16·43	20·44	5·35	——	3·27,	" 1·59=99·68, "
28. Ultenthal,	55·84	30·37	——	10·78	——	1·09,	" 1·80=99·88, "
29. Greenland,	58·00	29·66	——	10·14	1·00	1·33	=100·13, Kobell.
30. 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=99·74, Schafhäutl.

		$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\bar{\dddot{\mathrm{A}}}\mathrm{l}$
31.	Lake George,	45·45	18·00	24·33	11·49	——	——=99·27, Beck.
32.	Wilmington,	52·17	11·33	20·00	10·73	——	4·00, $\dot{\mathrm{H}}$ 1·0=99·28, Seyb.
33.	Skye,	51·35	11·09	1·84	33·92	——	——, " 0·5=98·70, Muir.
34.	Labrador,	51·36	21·31	3·09	21·27	1·32	0·37=98·72, Damour.
35.	Baste,	53·74	25·09	4·78	11·51	0·28	1·34=100·40, Köhler.

VII. *Asbestiform varieties.* Analysis 36 has the composition of a diopside. Analysis 37 is an iron-augite, with the formula $\dot{\mathrm{F}}\mathrm{e}^3\dddot{\mathrm{S}}\mathrm{i}^2$=Silica 46·1, protoxyd of iron 53·9; G.=3·713.

36.	Zillerthal,	55·87	20·33	17·76	4·31	1·12	——=99·39, Meitzendorf.
37.		43·9	1·1	0·5	52·2	——	1·9=99·6, Grüner.

Jeffersonite afforded Keating, (Jour. Acad. Nat. Sci. Philad. ii, 194, and iv, 3, and Troost, ibid. iii, 105), and more recently, Hermann, (J. f. pr. Chem. xlvii, 13, 1849):

38. $\dddot{\mathrm{Si}}$ 56 $\dot{\mathrm{Ca}}$ 15·1 $\dot{\mathrm{Mn}}$ 13·5 $\dot{\mathrm{Zn}}$ 1·0 $\bar{\dddot{\mathrm{F}}}\mathrm{e}$ 10·0 $\bar{\dddot{\mathrm{A}}}\mathrm{l}$ 2·0, moisture 2·0=98·6, K.
39. 49·91 15·48 7·00 4·39 $\dot{\mathrm{F}}\mathrm{e}$ 10·53 1·93, $\dot{\mathrm{Mg}}$ 8·18, ign. 1·20=98·62, Hermann.

These different varieties afford very nearly the same atomic volume; calculating it as explained in the American Journal of Science, vol. ix, 1850.

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 rocks; and hypersthene with feldspar and quartz forms *hypersthene rock*, which occurs extensively in some districts of crystalline rocks.

Foreign localities are numerous and hardly need mention.

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 transparent crystals from this locality are sometimes polished and worn as gems. Sahlite is met with in granitic 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.

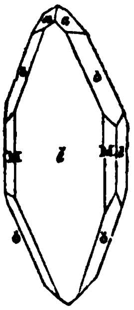
White subtransparent crystals are met with at Bytown, Lower Canada, in limestone, often measuring an inch by one and a half inches. White flattened prismatic crystals, two or three inches long by one or two in breadth, occur in dolomite at Canaan, Conn.; large green crystals in the limestone of Trumbull; small transparent crystals with granular pyroxene, are found 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, where it crosses the island at its north extremity, and also at 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. The most noted are that at Two-ponds, in Monroe, where it occurs in simple or grouped crystals, often of large size, and is 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; and two and a half miles north of Edenville, gray crystals of interesting forms. Near Amity and Fort Montgomery, are other good localities. Dark-green or black crystals occur in limestone a mile northwest of Edenville. In Putman Co., near Patterson, grayish-white crystal are abundant, strewed over the surface and in limestone. In Westchester Co., a white variety occurs at the Sing Sing quarries. Other good localities in New York, are at Rogers's Rock, Lake George, crystallized, 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. Franklin, N. J., also affords good pyroxene. Massive varieties occur at most of the above mentioned localities. A beautiful green coccolite occurs 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 beautiful 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 several of the massive varieties, diopside, sahlite, &c. At Berkshire, Mass., a white variety is abundant. A broad lamellar sahlite of a white color is found 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 are found near Attleboro', Penn. Diopside occurs in Burnet's quarry, Pennsbury. Diallage occurs in serpentine in Westfield and Blanford, Mass., at Deer Isle, Maine, Cooptown, Harford Co., Md.

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 31, 32), and still more from the foreign hypersthene, (analysis No. 34). The Hudsonite of Beck (analyses 21 and 22) 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, strange, in allusion to its occurrence in lavas, where Haüy conceived it did not belong, or was a stranger. Augite is from αὐγη, *lustre*.

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.

ACMITE, *Haidinger*. Akmit. Achmite.



Monoclinic; M : M=86° 56′, M : *ĕ*=133° 28′, M : *ē*=136° 32′, *a* : *a*=119° 30′. Cleavage: lateral distinct; diagonal less so. Plane *ĕ* often longitudinally striated. Compound crystals: composition parallel to *ĕ*. These forms are of common occurrence.

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.

Composition.—$\dot{N}a\dddot{S}i+\bar{F}e\dddot{S}i^2$=Silica 55·8, peroxyd of iron 31·6, soda 12·6. Analyses: 1, Ström; 2, Berzelius, (K. V. Ac. H. 1821, p. 160):

	$\dddot{S}i$	$\bar{F}e$	$\bar{M}n$	$\dot{N}a$	$\dot{C}a$
1.	54·27	34·44		9·74	—— Loss by ignition 1·88=100·38, St.
2.	55·25	31·25	1·08	10·40	0·72, titanic acid, *trace*, =98·70, Berzelius.

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, 54·18 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. Not attacked by acids.

Acmite occurs at Rundemyr, about *four* miles north of Dunserud, near Kongsberg in

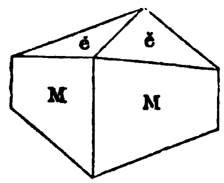
Norway. It is there met with in crystals, nearly a foot long, imbedded in feldspar and quartz. They are often macled and bent, and are detached with difficulty, on account of their frangibility.

The name of this species is derived from *ακμη*, *a point*, in allusion to the pointed extremities of the crystals. It has been improperly spelt *achmite*. The species is near augite in crystallization, but differs in composition.

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*. Breislakite, *Brocchi*. Raphilite, *Thom.* Arfvedsonite, *Brooke.* Ægirin, *Tamnau.* Kymatin, *Breit.* Diastatite, *Breit.*

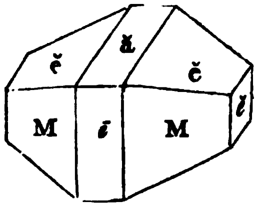
Primary form: an oblique rhombic prism: M : M=124° 30′, P : M=103° 1′. Secondary forms: ĕ : ĕ=148° 30′, ă : ĕ=164° 15′, ă : ĕ=104° 45′, M : ĕ=152° 15′, M : ĕ=117° 45′. Cleavage lateral highly perfect; sometimes distinct parallel to the diagonals. Lateral planes often longitudinally striated.

1



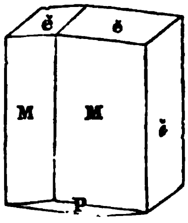
Edenville, N. Y.

2



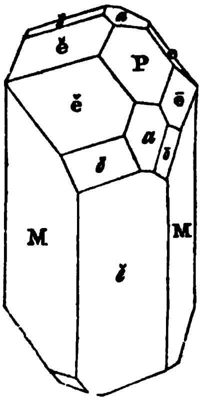
Gouverneur, N. Y.

3

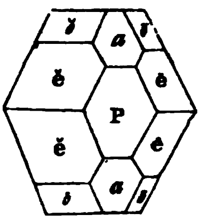


Teplitz, Bohemia, and Sterling Mine, Or. Co., N. Y.

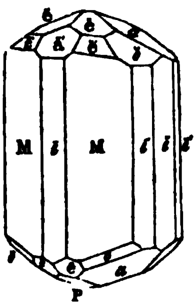
4



4a

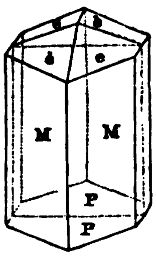


5



Vesuvius.

6



Compound crystals: composition parallel to the obtuse edge M : M, as shown in fig. 6. The simple crystals of this form are represented in fig. 3. Imperfect crystallizations: fibrous or columnar, coarse or fine, often filiform; sometimes lamellar: also granular, coarse or fine, and usually strongly coherent; sometimes friable.

H.=5—6. G.=2·9—3·4. Lustre between vitreous and pearly on cleavage faces; occasionally true pearly; vitreous on P; some fibrous varieties silky. Color various shades of green, inclining to blackish green; a pure black on one side, and white on the other. Streak uncolored or paler than color. Occasionally, almost transparent; usually subtranslucent—opaque. Fracture subconchoidal, uneven.

Composition.—$\dot{R}^4\overline{Si}^3$ or $\dot{R}\overline{Si}+\dot{R}^3\overline{Si}^2$.

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, Grammatite.—White, grayish, greenish, or yellowish-white specimens. The crystals are often in long slender blades, either distinct and traversing the gangue, or aggregated in columnar and radiated masses. G.=2·93. Transparent—translucent. *Calamite* is asparagus green in crystals. *Raphilite* is an asbestiform tremolite, as the author finds from the examination of specimens. Formula, $\dot{Ca}\overline{Si}+\dot{Mg}^3\overline{Si}^2$—Silica 60·5, lime 12·4, magnesia 27·1.

Actinolite, (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. 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, $\dot{Fe}\overline{Si}+\dot{Mg}^3\overline{Si}^2$=Silica 58·8, magnesia 26·34, protoxyd of iron 14·9.

Asbestus, 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*.—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, or Pargas hornblende, includes crystallized varieties 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 a larger proportion of iron and alumina, than either of the above varieties, and has a sp. gr. from 3·1 to 3·4.

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 M : M=123° 55′. Lustre vitreous, inclining to resinous. G.=3·44. Formula, $\dot{Na}\overline{Si}+\dot{Fe}^3\overline{Si}^2$=Silica 50·34, protoxyd of iron 38·30, soda 11·36.

Ægirine resembles black hornblende, and is considered an impure variety.

Hornblende Rock and *Amphibolite* are names of rocks consisting of hornblende, and having a crystalline granular texture.

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 has the cleavage structure and composition of hornblende, (anal. 24), 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); 6, Rammelsberg, (1st Sup. 73); 7, Murray, (Ramm. 2d. Sup. 60); 8, Bonsdorff; 9, Vopelius, (Pogg. xxiii, 355); 10, L. Gmelin, (Leonh. Handb. d. Oryk.); 11, 12, Thomson, (Rec. Gen. Sci. xvii); 13, Lappe, (Kastner's Arch. vi, 321); 14, Heintz., (Pogg. lviii, 168); 15, Kobell, (J. f. pr. Ch. xiii, 3); 16, Thomson; 17, Plantamour, (J. f. pr. Ch. xxiv, 300); 18, 19, Bonsdorff; 20, 21, Hisinger, (Schw. J. xxxi, 289); 22, Bonsdorff; 23, Hisinger; 24, Kudernatsch, (Pogg. xxxvii, 585); 25, Bonsdorff; 26, Arfvedson, (Jahresb. iv, 149); 27, Göschen, (Ramm. 2d Sup. 61); 28, Clausbruch, (Ramm. 1st Sup. 72); 29, 30, Klaproth, (Beit. v, 150); 31, Hisinger.

I. *Tremolite and actinolite, containing lime and magnesia, without alumina.*

		$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\ddot{\bar{\mathrm{Al}}}$	
1.	Wermland, *w.*	59·75	25·00	14·11	0·50	——	*trace*	HF 0·94, $\dot{\mathrm{H}}$ 0·10=100·40, Bonsdorff.
2.	Fahlun, *w.*	60·10	24·31	12·78	1·00	0·47	0·42	HF 0·83, $\dot{\mathrm{H}}$ 0·10=100·01, Bonsdorff.
3.	Taberg, *gnh.*	59·75	21·10	14·25	3·95	0·31	——	HF 0·76=100·12, B.
4.	Concord, Pa. *gn.*	58·33	24·00	10·67	4·30	——	1·67,	$\dot{\mathrm{H}}$ 1·03=100, Seyb.
5.	St. Gothard,	58·07	24·46	12·99	1·82	——	——	=97·34, Damour.
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, $\dot{\mathrm{H}}$ 0·14=100·08, Bons.

II. *Anthophyllite, containing magnesia and iron, without alumina.*

9.	Kongsberg,	56·74	24·35	——	13·94	2·38	——,	$\dot{\mathrm{H}}$ 1·67=99·08, Vop.
10.		56·00	23·00	2·00	13·00	4·00	3·00	=101, L. Gmelin.
11.	Perth, C. E.,	57·60	29·30	3·55	2·10	——	3·20,	$\dot{\mathrm{H}}$ 3·55=99·30, Th.
12.	Tyrol, *asbestus,*	54·92	26·08	——	12·60	——	1·64,	$\dot{\mathrm{H}}$ 5·28=100·52, Th.
13.	Koruk, "	58·48	31·38	0·04	9·22	$\dot{\mathrm{Mn}}$ and $\ddot{\bar{\mathrm{Al}}}$ 0·88=100, Lappe.		
14.	Ural, "	59·23	31·02	——	8·27	——	0·19,	ign. 1·31=100, H.

III. *Arfvedsonite, containing soda and iron, without alumina.*

15.	Greenland,	49·27	0·42	1·50	36·12	$\dot{\mathrm{Mn}}$ 0·62	2·00,	$\dot{\mathrm{Na}}$ and trace $\dot{\mathrm{K}}$ 8·00, Cl 0·24=98·17, Kobell.
16.	Faroe, (!)	50·51	——	1·56	31·55	" 8·92	2·45,	$\dot{\mathrm{H}}$ 0.96=95·96, Thom.
17.	Brevig, *Ægirine,*	46·57	5·88	5·91	24·38	2·07	3·41,	$\dot{\mathrm{Na}}$ 7·79, $\dot{\mathrm{K}}$ 2·96, $\ddot{\mathrm{T}}\mathrm{i}$ 2·02, F undetermined=100·97, Plantamour.

IV. *Containing alumina, with lime and magnesia.*

18.	Aker, *Grammatite,*	47·21	21·86	12·73	2·28	0·57	13·94,	HF 0·9, $\dot{\mathrm{H}}$ 0·44=99·93, Bonsd.

V. *Containing alumina, with iron, lime, and magnesia.*

19.	Pargas,	45·69	18·79	13·83	7·32	0·22	12·18,	HF 1·50=99·53, B.
20.	"	41·50	19·40	14·09	7·75	0·25	15·75,	$\dot{\mathrm{H}}$ 0·5=97·24, H.
21.	Fahlun,	47·62	14·81	12·69	15·78	0·32	7·38	=98·60, Hisinger.
22.	Nordmark,	48·83	13·61	10·16	18·75	1·15	7·48,	HF 0·41, $\dot{\mathrm{H}}$ 0·5=100·89, Bonsd.
23.	Westmanland,	45·38	16·34	13·92	7·74	1·50	13·82,	$\dot{\mathrm{H}}$ 0·23=98·92, H.
24.	Katherinenburg,	53·08	12·90	12·47	16·37	——	4·56	=99·35, Kud.
25.	Wetterau,	42·24	13·74	12·24	14·59	0·33	13·92	=97·06, Bonsd.
26.	Greenland, *Arfved.*	41·81	11·20	11·55	19·50	1·47	12·14	=97·67, Arfv.
27.	Wolfsberg, Boh.	40·27	13·38	13·80	$\dddot{\bar{\mathrm{F}}}$15·34	——	16·36,	$\dot{\mathrm{H}}$ 0·46=99·61, Gös.
28.	Carinthia, *Carin.,*	46·03	13·48	10·23	$\dot{\mathrm{F}}$17·44	——	8·37	=100·35, Clausbruch.

VI. *Containing alumina, with iron and lime.*

29.	Westmanland,	42·00	2·25	11·00	30·00	0·25	12·00,	$\dot{\mathrm{H}}$ 0·75=98·25, Klap.
30.	Fuldaischen,	47·00	2·00	8·00	15·00	——	26·00,	$\dot{\mathrm{H}}$ 0·5=98·50, Klap.

VII. *Containing alumina, with iron and magnesia.*

31.	Garpenberg,	53·50	11·35	4·65	22·52	0·35	4·40,	$\dot{\mathrm{H}}$ 0·6=97·10, His.

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 fluorine in many hornblendes is supposed to be combined as fluorid of calcium, and this ingredient, according to Bonsdorff, constitutes 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 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.

The variety hornblende of this species 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.

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 primitive limestones 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. *Ægirine* is from the zircon syenite of Brevig, where it is associated with magnetic iron and thorite. *Raphilite* comes from the Lanark range, Canada.

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. Interesting crystals of a dark green color occur near the 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 in good crystals is found at Bryam, N. J., and other interesting varieties at Franklin and Newton of the same State. Large flattened crystals of a white color occur abundantly 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 Newburg, Mass. Glassy actinolite in beautiful 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 occurs at the same localities; also at Unity, Me.; at Brown's serpentine quarry, three miles northwest of Carmel, Putnam Co., N. Y.; at Franklin, N. J.; at Carlisle, Pelham, and Windsor, Mass.; in Buckingham Co., Willis's Mt., Va. Other localities of actinolite occur in Pennsylvania, in Providence, Mineral Hill, Delaware Co.; at Unionville; at Kennett, Chester Co., often in fine crystals. Radiated and asbestiform tremolite occurs abundantly in the dolomite of New England and New York; the principal localities are 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 Chestnut Hill, near the Wihiccon; near Philadelphia, at London Grove, Chester Co.; at the Bare Hills, Md.

Asbestus is met with at many of the above localities, besides others; at West Farms, Winchester, Wilton, and Milford, Conn.; at Brighton, Sheffield, Pelham, Newbury, and Dedham, Mass.; in New York, near Greenwood Furnace, Rogers's farm in Patterson, Colton rock and Hustis's farm in Phillipstown, (both asbestus and amianthus,) near the quarantine, Richmond Co., asbestus and a straw-colored amianthus 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.

A variety of hornblende, on the island of Corsica, admits of a high polish, and is known to the Italian lapidaries under the name of *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, and was convenient for this purpose on account of the ease with which it was cleansed; it was merely necessary to throw them into the fire. This material was also employed for the wicks of lamps in the ancient temples, and because it maintained a perpetual flame without being consumed, was named *ασβεστος*, (*asbestus*), *unextinguished.* It is now used for the same purpose by the natives of Greenland. The ancients also called it *αμιαντος*, (*amiantus*), *undefiled*, because of the simplicity of the means of restoring it, when soiled, to its original purity. The best U. S. locality for collecting it for this purpose is near the quarantine, Richmond Co., New York. It is extensively used in making safes.

Hornblende was thus named in allusion to its extreme toughness; in this respect slightly resembling horn. The radiating, or divergent structure, frequently presented by *actinolite*, suggested this name from *ακτιν*, *a ray.* *Tremolite* was first found at Tremola in Switzerland, and *Pargasite*, at Pargas in Finland.

BREISLAKITE, (Brocchi).—In wool-like capillary aggregations, in lava at Vesuvius and Capo di Bove, near Rome; fibres flexible; color reddish or chestnut-brown. It contains silica, alumina, and no copper, although so supposed when described. It is placed near Hornblende.

CUMMINGTONITE, (C. Dewey, Am. J. Sci., viii, 59).—This mineral is probably nothing but a variety of hornblende, although the analysis by Muir favors a different conclusion. He obtained

$\dddot{\mathrm{Si}}$ 56·548, $\dot{\mathrm{Fe}}$ 21·669, $\dot{\mathrm{Mn}}$ 7·802, $\dot{\mathrm{Na}}$ 8·439, $\dot{\mathrm{H}}$ 3·178=97·631, whence Kobell derives the formula $\dot{\mathrm{Na}}\,\dddot{\mathrm{Si}}+3\,(\dot{\mathrm{Fe}}, \dot{\mathrm{Mn}})\,\dddot{\mathrm{Si}}=(\dot{\mathrm{Na}}, \dot{\mathrm{Fe}}, \dot{\mathrm{Mn}})\dddot{\mathrm{Si}}$.

Its structure is fibrous or thin columnar, the fibres resembling those of anthophyllite, but often scopiformly or stellularly arranged; rather incoherent. Color ash-gray, and lustre somewhat silky. Brittle. B.B. alone fuses with great difficulty; with borax forms a black glass. It occurs in mica slate with garnet at Cummington and Plainfield, Mass.

GEDRITE.—Resembles anthophyllite. Dufrénoy obtained $\dddot{\mathrm{Si}}$ 38·81, $\bar{\dddot{\mathrm{Al}}}$ 9·81, $\dot{\mathrm{Fe}}$ 45·83, $\dot{\mathrm{Mg}}$ 4·13, $\dot{\mathrm{Ca}}$ 0·67, $\dot{\mathrm{H}}$ 2·30. From Gedré in the Pyrenees.

NOTE.—The union of augite and hornblende was proposed by M. Gustavus Rose in 1831, on the ground both of crystallization and composition. The crystalline forms of one were shown to be possible secondaries of the other, though unlike in cleavage, and the case of *uralite* was instanced as having the form of augite with the structure of hornblende. They are similar in their ingredients, and also in the range of varieties arising from isomorphism. But in more recent investigations, this distinguished chemist has shown that the species are properly distinct, their chemical formulas being in no way convertible, and the cleavage structure always different, except in certain cases attributable to pseudomorphism. Notwithstanding the difference of constitution, it may be, as Rose suggested, that the two are formed at different temperatures, or more probably under different rates of cooling. Augite occurs in lavas, and the more recent basalts, which is not true of hornblende.

BABINGTONITE, *Levy*, Ann. Phil. 2d ser. vii, 275.

Triclinic; P : M=92° 34′, P : T=88°, M : T=112° 30′, P : e =150° 25′, M : ē=137° 5′, M : ĕ=142° 15′, ē : ĕ=89° 20′, Levy. Cleavage perfect, and easily obtained parallel with P, less perfect in the direction of T.

H.=5·5. G.=3·4—3·5. Lustre vitreous, splendent. Color dark greenish-black; thin splinters green perpendicular to P, and brown parallel to the same; faintly translucent. Large crystals, opaque, or faintly subtranslucent. Fracture imperfectly conchoidal.

Composition.—$3\dot{R}\overline{Si}+\bar{R}^2\overline{Si}^3(=\bar{R}^6\overline{Si}^5)$. Analyses: 1, Arppe, (Berz. Jahresb. xxii, 205); 2, R. D. Thomson, (Phil. Mag. xxvii, 123):

	$\overline{Si}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{Fe}$	$\dot{Mn}$	$\bar{Al}$
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 farther investigation. G. of No. 2=3·355.

B.B. fuses easily to a black magnetic bead. With borax it 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 in honor of Dr. Babington by Mr. Levy, who first distinguished it as a species; 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.; and has been reported as occurring also at Athol, Mass.

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.

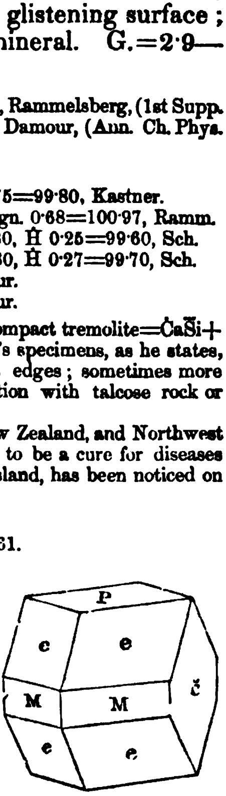
Composition.—Analyses: 1, Kastner, (Gehlen's J. ii, 459); 2, Rammelsberg, (1st Supp. 105); 3, 4, Schafhäutl, (Ann. d. Ch. u. Pharm., xlvi, 338); 5, 6, Damour, (Ann. Ch. Phys. [3], xvi):

	$\overline{Si}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{Fe}$	$\bar{Al}$	$\overline{Fe}$
1.	50·50	31·00	——	——	10·00	5·50, $\overline{Cr}$ 0·05, $\dot{H}$ 2·75=99·80, Kastner.
2.	54·68	26·01	16·06	2·15	——	——, $\dot{Mn}$ 1·39, loss ign. 0·68=100·97, Ramm.
3.	58·91	22·42	12·28	——	1·32	2·70, $\dot{Mn}$ 0·91, $\dot{K}$ 0·80, $\dot{H}$ 0·25=99·60, Sch.
4.	58·88	22·39	12·15	——	1·56	2·81, $\dot{Mn}$ 0·83, $\dot{K}$ 0·80, $\dot{H}$ 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—prove to be compact tremolite=$\dot{Ca}\overline{Si}+\dot{Mg}^3\overline{Si}^2$. Schafhäutl obtained a similar result. Rammelsberg's specimens, 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, has been noticed on page 265.

FORSTERITE, *Levy*, Ann. Phil. [2], vii, 61.



Trimetric. M : M=128° 54′. Secondary form: M : e=143° 54′, P : e=126° 6′, e : e (adjacent planes)=139° 14′, e : ĕ=110° 23′. Cleavage basal, perfect, and easily obtained. Occurs only in crystals.

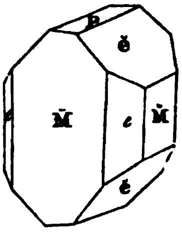
Scratches quartz Lustre vitreous, splendent. Streak white or uncolored. Colorless. Translucent.

According to Children, it contains silica and magnesia.

This species was first noticed by Levy in small crystals, accompanying spinel and olive green pyroxene, on Mount Vesuvius. Its angles are nearly identical with those of chrysoberyl, but its cleavage parallel with P is quite peculiar.

CHRYSOLITE. Peridot, *H.* Olivine, Chusite, Limbelite, *Saussure.* Krisolith, *W.* Hyalosiderite. Batrachite, *Breit.* Glinkite, *Romanowski.*

Trimetric; rectangular. P : ĕ=130° 27′, $\breve{M}$: ĕ=139° 33′, ĕ : ĕ=99° 7′, $\bar{M}$: *e*=155° 5′, *e* : *e*=130° 10′. $\breve{M}$: *e*=114° 55′. Cleavage brachydiagonal, rather distinct, massive and compact, or granular: usual in imbedded grains.



H.=6·5—7. G.=3·33—3·5; 3·441 of chrysolite, Haidinger; 3·3386—3·3445, (olivine), Stromeyer; 3·3514, (chrysolite), Stromeyer. Lustre vitreous. Color green, of various shades, commonly olive green; sometimes inclining to brown. Streak uncolored. Transparent—translucent. Fracture conchoidal.

Chrysolite includes usually the transparent crystals of paler color, while *olivine* is applied to imbedded masses or grains of inferior color and clearness.

Composition.—$\dot{\text{R}}^3\dddot{\text{Si}}$, in which $\dot{\text{R}}$ may be $\dot{\text{Mg}}$, $\dot{\text{Fe}}$, $\dot{\text{Mn}}$, $\dot{\text{Ca}}$, alone or in combination. Common chrysolite is usually $(\dot{\text{Mg}}, \dot{\text{Fe}})^3\dddot{\text{Si}}$. Analyses: 1, 2, 3, 4, Walmstedt, (K. V. Ac. H. 1824, ii, 359); 5, 6, 7, Stromeyer, (Gött. gelehrt. Anz. 1824, 208; Pogg. iv, 193); 8, Lappe, (Pogg. xliii, 669); 9, Walchner, (Schw. J. xxxix, 65); 10, W. v. Beck, (Verh. Russ. Min. Ges. St. Petersb. 1847); 11, Rammelsberg, (Pogg. li, 446); 12, Klaproth, (Beit. v, 222):

	$\dddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dddot{\text{Al}}$
1. Iserwiese,	41·54	50·04	8·66	0·06, $\dot{\text{Mn}}$ 0·25=100·55, Walmstedt.
2. Bohemia,	41·42	49·61	9·14	0·15, " 0·15=100·47. "
3. Vivarais,	41·44	49·19	9·72	0·16, " 0·13, $\dot{\text{Ca}}$ 0·21=100·85, Walmstedt.
4. Mt. Somma,	40·08	44·22	15·26	0·18, " 0·48=100·24, Walmstedt.
5. *Orient. chrys.*	39·73	50·13	9·19	0·22, $\dot{\text{Mn}}$ 0·09, $\dot{\text{Ni}}$ 0·32=99·68, Stromeyer.
6. Vogelsberg,	40·09	50·49	8·17	0·19, " 0·20, " 0·37=99·51, "
7. Bohemia,	40·45	50·67	8·07	0·19, " 0·18, " 0·33=99·89, "
8. Greenland,	40·00	43·09	16·21	0·06, $\dot{\text{Mn}}$ and $\dot{\text{Ni}}$ 0·55=99·91, Lappe.
9. Kaiserstuhl, *Hyalosiderite,*	31·63	32·40	28·49	2·21, $\dot{\text{Mn}}$ 0·48, $\dot{\text{K}}$ 2·79, Chrome *trace*=98·004, Walchner.
10. *Glinkite,*	39·21	44·06	17·45=100·72, Beck.	
11. *Batrachite,*	37·69	21·79	2·99, $\dot{\text{Ca}}$ 35·45, $\dot{\text{H}}$ 1·27=99·19, Rammelsberg.	
12. *Volc. glass,*	29·50	——	66·00, $\dddot{\text{Al}}$ 4·0 $\dot{\text{K}}$ 0·25=99·75, Klaproth.	

No. 11 is a mineral from the Tyrol, affording the formula $(\dot{\text{Ca}}, \dot{\text{Mg}}, \dot{\text{Fe}})^3\dddot{\text{Si}}$. Scacchi has detected a yellowish olivine in the limestone of Somma, having the formula $(\frac{1}{2}\dot{\text{Ca}}+\frac{1}{2}\dot{\text{Mg}})^3\dddot{\text{Si}}$; it has the usual form, but inferior hardness. No. 9, *Hyalosiderite* is $(\frac{1}{2}\dot{\text{Mg}}+\frac{1}{2}\dot{\text{Fe}})^3\dddot{\text{Si}}$, with an excess of $\dot{\text{Mg}}^3\dddot{\text{Si}}$. No. 12 is the compound $\dot{\text{Fe}}^3\dddot{\text{Si}}$=Silica 30·47, protoxyd of iron 69·53; it occurs as a volcanic glass at Vesuvius. The obsidians are mixtures often approaching this composition. *Fayalite* (Eisenperidot) is one of this kind from Fayal, one of the Azores. Such substances have nearly the same composition as the stony lava with which they are associated, being portions of the lava that have rapidly cooled and taken on a glassy form. Besides these varieties of chrysolite, *tephroite* (see under manganese) is a manganesian chrysolite, with the formula $\dot{\text{Mn}}^3\dddot{\text{Si}}$; and Knebelite contains manganese and iron=$(\frac{1}{2}\dot{\text{Mn}}+\frac{1}{2}\dot{\text{Fe}})^3\dddot{\text{Si}}$.

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.

The olivine of meteorites has the same composition as above. That of the Pallas meteorite afforded Walmstedt:

$\dddot{\overline{\mathrm{S}}}\mathrm{i}$ 40·83 $\dot{\mathrm{M}}\mathrm{g}$ 47·74 $\dot{\mathrm{F}}\mathrm{e}$ 11·53 $\dot{\mathrm{M}}\mathrm{n}$ 0·29, with a *trace* of $\dot{\mathrm{C}}\mathrm{a}$ and $\dddot{\overline{\mathrm{A}}}\mathrm{l}$=100·39;

and Berzelius detected in the same 0·17 of oxyd of zinc.

Chrysolite and serpentine are isomorphous; to compare the figures it should be noted that *e* of the figure above corresponds to ĕ of serpentine.

The perfectly crystallized chrysolite is brought from Constantinople: its locality is not known. Less distinct crystallizations occur imbedded in lava, at Vesuvius and the Isle of Bourbon; imbedded in obsidian, at Real del Monte in Mexico; among sand at Expaillie in Auvergne, in pale green transparent crystals. Olivine is more abundant, being of frequent occurrence in basalt and lavas. Crystals, several inches in length, occur in greenstone at Unkel, on the Rhine; spheroidal masses are met with at Kapfenstein in Lower Styria; and at Hecla and Vesuvius. Olivine is common in the lavas and basalt of the Sandwich and other Pacific Islands. It is a frequent ingredient of meteoric stones.

Olivine is commonly very fragile and often filled with cavities, and is therefore unfit for an ornamental stone. Chrysolite, also, is usually too much intersected by flaws to be valued as a gem, and is so soft as to require the greatest care to retain its polish.

The word *chrysolite* is derived from χρυσος, *gold*, and λιθος, *stone*, in allusion to its color.

Glinkite is from talcose slate in Perm, district of Katherinenburg; it is nothing but chrysolite, as shown by Beck.

The minerals *Chusite* and *Limbelite* of Saussure, from the volcanic district of Limbourg, appear to be decomposed varieties of this species. In the first stages of decomposition chrysolite becomes iridescent; it afterwards turns red and opaque, from the development of the iron it contains.

Hyalosiderite, *Walchner*, (Schw. J. xxxix, 65), is a variety of this species. According to Walchner, it occurs in crystals of a yellowish or reddish-brown color in amygdaloid, in the Kaiserstuhl, near Sasbach in Brisgau. Its crystals are flat rectangular tables, with the terminal edges deeply replaced, ĕ : ĕ=99° 22′; cinnamon-brown; internal lustre vitreous, external submetallic; subtranslucent. H.=5·5. G.=2·875. B.B. it becomes black, and then melts to a black bead, which is attracted by the magnet. The name is derived from ὑαλος, *glass*, and σιδηρος, *iron*.

Tautolite is another variety resembling Hyalosiderite, as appears from Breithaupt's description. H.=6·5. G.=3·865. Its crystals are trimetric and have the same dimensions. From volcanic rocks near Laacher-see.

Monticellite, (*Brooke*, Ann. Phil. Oct. 1831, 265), occurs in small yellowish crystals in granular limestone at Vesuvius. According to Scacchi it is nothing but chrysolite, and he names it *peridot blanc*. Brooke makes the angle M : M=132° 34′. Gelatinizes with muriatic acid. B.B. fuses with difficulty.

CHLADNITE, *Shepard*, Am. J. Sci. [2], ii, 381.

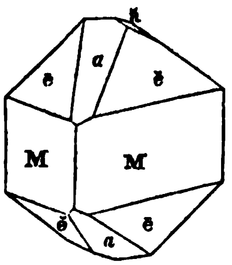
Triclinic. Occurs in oblique prisms with perfect cleavage in two directions, mutually inclined at an angle of 120°; also massive. H.=6—6·5 G.=3·116. Color snow-white or grayish. Lustre pearly to vitreous. Very brittle.

Composition.—According to Shepard, it is a "tersilicate of magnesia."

B.B. on charcoal fuses easily and with phosphorescence to a white enamel. With borax forms slowly a transparent glass.

Occurs in the Bishopville (S. Carolina) meteorite, in which it constitutes more than two-thirds of the whole mass. It resembles albite in appearance.

CHONDRODITE, *d'Ohsson.* Condrodite, *H.* Maclurite, *Seybert.* Silliman's J. v, 336. Brucite, *Oleaveland*, Am. J. Sci., v, 336. Humite, *Bournon.*



Orange Co., N. Y.

Monoclinic; M : M=112° 12′? Haüy. In the annexed fig. of a specimen from Orange Co., N. Y., measured with the common goniometer, M : M=112° and 68°, M : ĕ=136°, M : ē=157°, ĕ : ĕ (adjacent)=80°, *a* : *a* (over the summit)=85°, ė : ē=89°, ĕ : ē (over *a*)= 127°, ă on the edge ĕ : ĕ=167°. Cleavage indistinct. Usually in disseminated grains or small masses, granular in texture.

H.=6—6·5. G.=3·118, from New Jersey, Thomson; 3·199, Finland, Haidinger. Lustre vitreous—resinous. Color pale yellow or brown; sometimes red, apple-green, black, gray. Streak white, or slightly yellowish or grayish. Transparent—subtranslucent. Fracture subconchoidal —uneven.

Composition.—$MgF+2\dot{M}g^3\dddot{S}i$, (Ramm.)=Silica 37·28, magnesia 50·06, magnesium 5·11, fluorine 7·55=100; but more exactly $MgF+\dot{M}g^7\dddot{S}i^3$, Ramm. =Silica 34·69, magnesia 53·53, magnesium 4·64, fluorine 7·14. Analyses: 1, Seybert, (Am. J. Sci., v, 336); 2, 3, 4, 5, Rammelsberg, (Pogg. liii, 130, and 1st Supp. 38); 6, Thomson, (Ann. Lyc. Nat. Hist., N. Y., iii); 7, W. Fisher, (Am. J. Sci., [2], ix, 85); 8, 9, Marignac, (J. d. Pharm., et de Ch. [3], xii, 150):

	$\dddot{S}i$	$\dot{M}g$	$\dot{F}e$	$\ddot{\overline{F}}e$	$\dot{K}$	
1. New Jersey,	32·666	54·00	——	2·333	2·108,	HF 4·086, $\dot{H}$ 1·000=96·193, S.
2. " *yellow*,	33·06	55·46	3·65	——	——	F 7·60=99·77, Ramm.
3. " "	33·97	56·97	3·48	——	——	F 7·44=101·68, Ramm.
4. Pargas, *yellow*,	33·10	56·61	2·35	——	——	F 8·69=100·75, Ramm.
5. " *gray*,	33·19	54·50	6·75	——	——	F 9·69=104·13, Ramm.
6. Edenville, N. Y.	36·00	53·64	——	3·97	——	HF 3·75, $\dot{H}$ 1·62=98·98, Thom.
7. New Jersey, *red*,	33·35	53·05	5·50	——	——	F 7·60=99·50, W. Fisher.
8. *Humite*,	30·88	56·72	2·19	——	——	loss 10·21=100, M.
9. "	29·07	55·96	4·20	——	——	loss 10·77=100, M.

B.B. on charcoal infusible, but color becoming paler in varieties containing little iron. With borax dissolves slowly but perfectly to a transparent glass slightly tinged by iron; and if the glass is saturated it becomes cloudy by flaming. With salt of phosphorus dissolves, becoming a siliceous skeleton, and the glass is opalescent on cooling.

B.B. loses color and becomes opaque, and shows traces of fusion on the thinnest edges. With soda on charcoal, fuses with difficulty to a light gray slag. With borax it fuses easily with some effervescence to a yellowish-green glass. With salt of phosphorus there is a siliceous residue; in an open tube gives traces of 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 perovskite, and in the mines of Schischimsk with red apatite.

It is found in great abundance in the adjoining 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.

This mineral was first described and analyzed by Count d'Ohsson, in the Memoirs of the Stockholm Academy, for 1817, p. 206. An American locality was first observed by Dr. Bruce, after whom it has been called Brucite. The name chondrodite is derived from χονδρος, *a grain*, alluding to its granular structure.

Humite occurs in minute highly modified crystals of pale yellowish color, among the ejected masses of Mt. Somma, associated with mica and pleonaste. G.=3·1—3·2.

BOLTONITE, *Shepard.*

Triclinic? 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.—3 $(\dot{Mg}, \dot{Fe}, \dot{Ca})^3\dddot{Si}+\dot{Mg}^3\bar{\dddot{Al}}$ or $\dot{R}^2(\dddot{Si}, \bar{\dddot{Al}})$=(calling the protoxyds all magnesia) Silica 46·5, alumina 6·4, magnesia 47·1. Analysis by Silliman, Jr., (Am. J. Sci., [2], viii, 392):

$\dddot{Si}$ 46·062, $\bar{\dddot{Al}}$ 5·667, $\dot{Mg}$ 38·149, $\dot{Fe}$ 8·632, $\dot{Ca}$ 1·516=100·026.

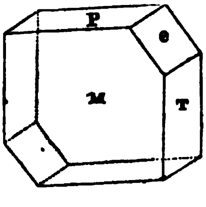
B.B. alone, it is bleached and rendered transparent, but does not fuse. With borax it forms a transparent glass.

Boltonite is disseminated through white limestone at Bolton, Mass., and also at Boxborough 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, a conclusion implied in the name given the mineral by Thomson.

DANBURITE, *Shepard*, Am. Jour. Sci. xxxv, 139.



Triclinic. 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.=2·83, Shepard; 2·95, Silliman, Jr.; 2·97, Brush. Color pale yellow, whitish. Lustre vitreous, but usually rather weak. Translucent to subtranslucent. Very brittle.

Composition.—The oxygen ratio of the $\dddot{Si}$, $\dddot{B}$ and protoxyds, is 12 : 3 : 5=$\dot{R}\dddot{B}+4\dot{R}\dddot{Si}$. The amount of mineral analyzed was so small that the boracic acid was determined only by the loss. Analyses by H. Erni in the Yale Laboratory:

1. $\dddot{Si}$ 49·74 $\dot{Ca}$ 22·80 $\dot{Mg}$ 1·98 $\dot{Na}$ 9·82 $\dot{K}$ 4·31 $\bar{\dddot{Fe}}$, $\bar{\dddot{Al}}$ 2·11 $\dddot{B}$ (loss) 9·24=100.
2. 49·71 22·38 1·30 *undetermined* 1·65

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, page 166, as strongly as borax. Affords easily a transparent bead with soda or borax. Yields no water.

Occurs in feldspar with dolomite at Danbury, Connecticut. Some specimens recently obtained, have afforded the author the above crystallographic characters. It has some resemblance to Chondrodite in color, lustre, and brittleness, but is distinctly cleavable, although the planes of cleavage are often irregular.

III. ALUMINA

a. Hydrous compounds with Silica.

Many of the following hydrous silicates of alumina have a clay-like aspect, and uncrystalline structure, and are therefore of doubtful title to the rank of species. *Common clay* is sometimes here included, though not properly a mineral. It consists of alumina and silica, besides water, and usually about one part of the former to two of the latter; and there are often various other ingredients, as carbonate of lime, oxyd of iron in some state of combination, some magnesian compounds, &c. It owes its plasticity to the amount of alumina. Clay for pottery is a variety free from iron, an ingredient that gives the red color to bricks. Acids attack it but slightly, proving that the water present is not to any great amount in chemical combination forming hydrous silicate of alumina. But there are clays containing water in combination: they are less plastic, easily attacked by acids, and yield in the fire; and consequently in making pottery of them, they require a mixture with other earths. Such clays possess the property of combining with oil or grease, and are used in cleaning woollens, and are hence called Fuller's earth, (argiles smectiques, terre a foulon). The amount of water is 22 to 25 per cent. These clays are sometimes found in beds in limestone, and are a result, in part at least, of chemical deposition. Silesia affords a variety which is largely exported. The Halloysites are of this character, and properly the type of them. *Kaolin* or porcelain clay is a mixture of more or less free silica with a hydrous silicate of alumina, resulting from the decomposition of a feldspar.

A *second* division of the hydrous silicates includes some micaceous species, as pyrophyllite and ottrelite related to mica in structure and appearance, but differing in being hydrous.

A *third* division embraces some species which have arisen from the alteration of anhydrous aluminous silicates and the attending absorption of water. These species, like fahlunite, are proper pseudomorphs; the external form is that of the original unaltered mineral, and not that of the new species which has resulted from the alteration.

A *fourth* division in this section contains the zeolites and allied species, —compounds of silica with alumina and some alkali or earth, (potash, soda, lime, baryta, or strontia); they occur crystallized, and usually in cavities or seams in rocks, though occasionally disseminated.

Many anhydrous silicates of alumina afford at times a small percentage of water. This water is generally considered either hygrometric or a result of a partial alteration like that producing the fahlunite series. The feldspars, micas, and many other species, are examples. Some chemists however consider the water a true constituent replacing part of the bases.

PHOLERITE.

In soft nacreous scales of a white color, massive.

H.=0·5—1. G.=2·35—2·57.

Composition.—$\bar{\rm A}{\rm l}\dddot{\rm Si}+2\dot{\rm H}$=Silica 39·96, alumina 44·46, water 15·57. Analyses by Guillemin, (Ann. des Mines, xi, 489):

1. Fins,	$\dddot{\rm Si}$ 41·65	$\bar{\rm A}{\rm l}$ 43·35	$\dot{\rm H}$ 15·00=100.
2.	42·93	42·07	15·00=100.
3. Rive de Gier,	40·75	43·87	15·36=100.

In a matrass yields water. B.B. infusible. Blue with cobalt solution.

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.

COLLYRITE, *Freisleben.* Kollyrite.

Compact, fine earthy, like clay.

H.=1—2. G.=2—2·15. Snow-white, with a dull or glimmering lustre. Translucent—opaque. Feels greasy, and adheres to the tongue; hardly soils the fingers.

Composition.—$\bar{\rm A}{\rm l}^2\dddot{\rm Si}+15\dot{\rm H}$=Silica 13·77, alumina 45·97, water 40·26. Analyses: 1, Klaproth, (Beit. i, 257); 2, Berthier, (Ann. des M. ii, 476); 3, Kersten, (Schw. J. lxi, 24):

1. Schemnitz,	$\dddot{\rm Si}$ 14·0	$\bar{\rm A}{\rm l}$ 45·0	$\dot{\rm H}$ 42·0=101, Klaproth.
2. Ezquerra, Pyrenees,	15·0	44·5	40·5=100, Berthier.
3. Weissenfels, Saxony,	23·8	42·8	34·7=100·8, Kersten.

In a matrass yields water. B.B. infusible, but separates when calcined into columnar masses like starch, after which, it will absorb water and become faintly transparent. Forms a saline magma with nitric acid, the silica gelatinizing.

Occurs in the mountains of Ezquerra, in the French Pyrenees, in porphyry at the shaft of Stephanus near Schemnitz, Hungary, and a nearly allied substance at Weissenfels in Saxony.

HALLOYSITE. Halloysite, *Berthier*, Ann. de Ch. et de Ph. xxxii, 382, and Ann. des Mines, 3d ser. ix, 500. Tuesite, *Thom.* Lenzinite, *John.* Severite, *Dufour.*

Compact massive, amorphous. Yields to the nail, and may be polished by it. G.=1·8—2·1. Lustre waxy. Streak white. Color white, generally with a bluish tint. Subtranslucent. Fracture conchoidal, like that of wax. Adheres to the tongue. Small pieces put in water, become transparent, like hydrophane; air is disengaged, and they increase in weight.

Different substances are here included, consisting of $\bar{\rm A}{\rm l}$, $\dddot{\rm Si}$, $\dot{\rm H}$.

Analyses: 1, 2, Berthier, (Ann. Chim. Phys. xxii, 382, 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, R. D. Thomson, (Thom. Min. i, 244); 8, Richardson, (ibid.); 9, John; 10, Sauvage, (Ann. M. [3], xx, 204):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{H}}$	
1. Anglar,	44·94	39·06	16·00	=100, Berthier.
2. Housecha, near Bayonne,	46·7	36·9	16·0	=99·6, Berthier.
3. New Granada,	45·0	40·2	14·8	=100, Boussingault.
4. La Vouth,	40·66	33·66	24·83	=99·15, Dufrénoy.
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=99·75, Oswald.
7. *Tuesite*, Tweed,	44·30	40·40	13·50,	$\dot{\mathrm{C}}\mathrm{a}$ 0·75, $\dot{\mathrm{M}}\mathrm{g}$ 0·50=99·45, Thomson.
8. " "	43·80	40·10	14·21,	$\dot{\mathrm{C}}\mathrm{a}$ 0·64, $\dot{\mathrm{M}}\mathrm{g}$ 0·55, $\dot{\mathrm{F}}\mathrm{e}$ 0·94=100·24, R.
9. *Lenzinite*, Eifel,	37·5	37·5	25·0	=100, John.
10. Ecogne,	42·	34·	24·	=100, Sauvage.

The Halloysite of Housecha results, according to Brongniart, from the decomposition of graphic granite.

A mineral from Montmorillon, described by Damour, (Bull. Soc. Geol. de Fr. [2], iv, 464), is amorphous and fragile; color rose red; falls to pieces readily in water, but does not become plastic. Contains

$\dddot{\mathrm{Si}}$ 50·04, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 20·16, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·68, $\dot{\mathrm{C}}\mathrm{a}$ 1·46, $\dot{\mathrm{M}}\mathrm{g}$ 0·23, $\dot{\mathrm{K}}$ 1·27, $\dot{\mathrm{H}}$ 26·0=99·84.

A halloysite from the pumiceous tufa of Milo, afforded Sauvage, (Ann. d. Mines, [4], x, 77),

$\dddot{\mathrm{Si}}$ 31·6, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 23·2, $\dot{\mathrm{M}}\mathrm{g}$ and alkali 3·20, Quartz 29·30, $\dot{\mathrm{H}}$ 12·70.

Cereolite is a name given to globules of a yellowish-green color, rather tender, and structure like steatite, from an altered lava near Lisbon. It is supposed to be a hydrous silicate of alumina and magnesia.

The following are other allied species:—

Smelite, *Glocker*, J. f. pr. Chem. xxxv, 39.—Amorphous, grayish-white, with a tinge of blue. H.=2·5. G.=2·168. Tough; fracture conchoidal. Analysis:

$\dddot{\mathrm{Si}}$ 50·0, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 32·0, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 2·0, $\dot{\mathrm{N}}\mathrm{a}$ 2·1, $\dot{\mathrm{H}}$ 13·0=99·1.

The name is from σμηλη, soap. Occurs in a trachytic porphyry near Telkibanya, Hungary.

Scarbroite. Amorphous, earthy, white, with an argillaceous odor when breathed on, and highly adhesive to moist surfaces; admits of being polished by the nail. G.=1·48. Does not fall to pieces in water or increase in weight. Analysis by Vernon, (Phil. Mag. and Ann. v, 178):

$\dddot{\mathrm{Si}}$ 10·50, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 42·50, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·25, $\dot{\mathrm{H}}$ 46·75=100.

Occurs between laminæ of oxyd of iron in a calcareous rock on the coast of Scarborough.

Smectite, *Breit.* An earthy mineral from Cilly in Lower Styria. It afforded L. A. Jordan, (Pogg. Ann. lxxvii, 591),

$\dddot{\mathrm{Si}}$ 51·21, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 12·25, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 2·07, $\dot{\mathrm{M}}\mathrm{g}$ 4·89, $\dot{\mathrm{C}}\mathrm{a}$ 2·13, $\dot{\mathrm{H}}$ 27·89,

from which is deduced the formula $\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}^3+\dot{\mathrm{R}}\dddot{\mathrm{Si}}+12\dot{\mathrm{H}}$. The mineral is found also at Zeug in Croatia.

Rasoumoffskin, *John.* Like Halloysite. *Composition.*—$\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{Si}}^2+3\dot{\mathrm{H}}$. Zellner obtained, (Schw. J. xviii, 340),

$\dddot{\mathrm{Si}}$ 54·50, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 27·25, $\dot{\mathrm{C}}\mathrm{a}$ 2·00, $\dot{\mathrm{M}}\mathrm{g}$ 0·37, $\dot{\mathrm{F}}\mathrm{e}$ 0·25, $\dot{\mathrm{H}}$ 14·25=98·62.

From Kosemuts in Silesia.

Bole. Massive, earthy. H.=1—2. G.=1·60, Klaproth; 1·977, Breit. Lustre weak. Color brown, yellowish, reddish. Streak shining, greasy. Subtranslucent—opaque. Feel greasy. Adheres to the tongue. Analyses: 1, 2, Löwig, (Leonh. Oryk.); 3, Wackenroder, (Kast. Arch. xi, 466); 4, Zellner, (Leonh. N. Jahrb., 1835, 467); 5, Rammelsberg, (Pogg. xlvii, 180):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{H}}$	
1. Ettingshausen,	42·00	24·04	10·03	0·52	0·43	24·03	=101·05, Löwig.
2. C. de Prudelles,	41·05	25·08	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*	25·86	=97·83, Ramm.

B.B. burns hard, and fuses on charcoal with intumescence to a white or dull yellow enamel. Yields water in a matrass; imperfectly dissolved in muriatic acid. The first two analyses give the formula $\overline{\text{R}}^2\dddot{\text{Si}}^3+9\dot{\text{H}}$, and the last nearly $\overline{\text{Al}}\dddot{\text{Si}}^3+6\dot{\text{H}}$.

Bolus, Ochran, Fettbol, Bergseife or Rock Soap. Analyses: 1, Klaproth, (Beit. iv, 345); 2, 3, Kersten, (Schw. J. lxvi, 31); 4, Bucholz, (Gehlen's N. J. iii, 597); 5, Berthier, (Ann. des M. [3], xi, 479):

	$\dddot{\text{Si}}$	$\overline{\text{Al}}$	$\overline{\text{Fe}}$	$\dot{\text{H}}$
1. *Bolus*, Sinope,	32·0	26·5	21·0	17·0, NaCl 1·5=98·0, Klaproth.
2. *Ochran*, Orawitza,	31·3	43·0	1·2	21·0, and trace of $\dddot{\text{B}}$=96·5, Kersten.
3. *Fettbol*, Halsbrücke,	46·40	3·01	23·50	24·50=97·41, Kersten.
4. *Bergseife*, Thuringia,	44·0	26·5	8·0	20·5, $\dot{\text{Ca}}$ 0·5=99·5, Bucholz.
5. " Plombières,	44·0	22·0	——	25·0, $\dot{\text{Mg}}$ 2·0, sand 6·0=99·0, Berth.

Malthacite, *Breithaupt*, (J. f. Pr. Chem. x, 510).—In thin plates and massive, fracture uneven and conchoidal. Soft like wax. G.=1·99—2·01. White or yellowish. Lustre waxy, weak. Streak shining. Translucent. Analysis by Meissner:

$\dddot{\text{Si}}$ 50·2, $\overline{\text{Al}}$ 10·7, $\overline{\text{Fe}}$ 3·1, $\dot{\text{Ca}}$ 0·2, $\dot{\text{H}}$ 35·8.

It is near the Bole of Stolpen. In a matrass yields much water. B.B. infusible. Occurs at Steindörfel in basalt, and in greenstone near Beraun in Bohemia.

Cimolite.—Massive, earthy, very soft. G.=2·18—2·30. Color white, grayish. Lustre of streak greasy. Absorbs water, but does not fall to pieces.

Composition.—$\overline{\text{Al}}\dddot{\text{Si}}^3+3\dot{\text{H}}$, (or $2\dot{\text{H}}$). Analyses: 1, Klaproth, (Beit. i, 291); 2, 3, Ilimoff, (Ann. du J. des M. de Russ. for 1841, 336); 4, Khretschatitzki, (ib. for 1842, 386); 5, Klaproth, (Beit. vi, 283):

	$\dddot{\text{Si}}$	$\overline{\text{Al}}$	$\overline{\text{Fe}}$	$\dot{\text{H}}$
1. Argentiera,	63·00	23·00	1·25	12·00=99·25, Klaproth.
2. Alexandrowsk,	66·00	24·18	——	9·47=99·65, Ilimoff. G, 2·277.
3. "	63·52	23·55	——	12·10=99·17, "
4. "	63·53	23·706	——	12·420=99·656, Khretschatitzki.
5. Argentiera,	54·00	26·50	1·50	12·0, $\dot{\text{K}}$ 5·5=99·5, Klaproth.

Rammelsberg obtained the same result for a decomposed augite, and considers the species a result of alteration of some feldspathic or allied rock, and of doubtful merit.

B.B. darkens and then whitens, but infusible. Forms a clear dull brown pearl with borax, and a colorless glass with salt of phosphorus.

The original cimolite is from Cimolis, on the island of Argentiera, Greece.

Lithomarge, (Steinmark, W.) Compact earthy, and probably not a distinct mineral species. White, yellow or red; feel greasy; texture fine earthy, streak shining; adheres more or less to the tongue. H.=2·5—3. G.=2·4—2·6. Opaque or subtranslucent.

Analyses: 1, 2, Klaproth, (Beit. vi, 285); 3, Zellner, (Isis, 1834, 637); 4, 5, Rammelsberg, (Pogg. lxii, 152, and 3d Supp. 117); 6, Dumenil, (Chem. Anal. i, 1823, p. 35):

	$\dddot{\text{Si}}$	$\overline{\text{Al}}$	$\overline{\text{Fe}}$	$\dot{\text{H}}$
1. Rochlitz, Sax.	45·25	36·50	2·75	14·00, $\dot{\text{K}}$ trace=98·50, Klaproth.
2. Silesia,	58·	32·	2·	7·00=99, Klaproth.
3. Buchberge,	49·2	36·2	0·5	14·0=99·9, Zellner.
4. Zorge, Hartz,	49·75	29·88	6·61	5·48, $\dot{\text{Ca}}$ 0·43, $\dot{\text{Mg}}$ 1·47, $\dot{\text{K}}$ 6·85=99·97, Rammelsberg.
5. Schlackenwald,	43·46	41·48	——	13·49, $\dot{\text{Ca}}$ 1·20, $\dot{\text{Na}}$ 0·37=100, Rammelsberg. Some $\overline{\text{Fe}}$ and $\overline{\text{Mn}}$ with the $\overline{\text{Al}}$.
6. Clausthal,	43·00	40·25	0·48	15·50, $\dot{\text{Ca}}$ 0·47=99·70, Dumenil.

The variety from Rochlitz is red, and is called *carnat* by Breithaupt. The second, as Rammelsberg states, is probably altered feldspar.

The *Talksteinmark* of Freisleben, (*myelin* of Breithaupt), from Rochlitz, occurs in porphyry, and is yellowish or reddish in color. B.B. infusible. Kersten obtained, (Schw. J. lxvi, 16):

$\dddot{\text{Si}}$ 37·62, $\overline{\text{Al}}$ 60·50, $\dot{\text{Mg}}$ 0·82, $\overline{\text{Mn}}$ 0·63, $\overline{\text{Fe}}$ *trace*=99·57.

The *melopsite* of Breithaupt is a yellowish or greenish white lithomarge from Neudeck, Bohemia.

TERATOLITE, *Glocker*. Hard Lithomarge, Eisensteinmark, *W*.—Compact, dull, opaque, and earthy. H.=2·5—3. G.=2·5. Color lavender to plum-blue, often with reddish-white veins or spots. Feel rough and meagre. B.B. infusible. Schüler obtained, (Freisl. Mag. Oryct. v, 209):

$\dddot{Si}$ 41·66, $\bar{\dddot{Al}}$ 22·85, $\bar{\dddot{Fe}}$ 12·98, $\dot{Ca}$ 3·04, $\dot{Mg}$ 2·55, $\dot{K}$ 0·93, $\bar{\dddot{Mn}}$ 1·68, $\dot{H}$ 14·20=99·89.

From the coal formation near Zwickau, Saxony. It is the *Terra miraculosa Saxoniæ* of old authors.

PIMELITE.—A clay colored with nickel. Klaproth found 15·63 per cent. of oxyd of nickel in one specimen, (Beit. ii, 134). It is often associated with chrysophrase or green quartz.

MILOSCHIN, *Herder*. Serbian, *Breit*.—Compact and earthy with a smooth conchoidal fracture. Adheres to the tongue. B.B. infusible. Partly soluble in muriatic acid. Analysis by Kersten, (Pogg. xlvii, 485):

$\dddot{Si}$ 27 50, $\bar{\dddot{Al}}$ 45·01, $\bar{\dddot{Cr}}$ 3·61, $\dot{Ca}$ 0·30, $\dot{Mg}$ 0·20, $\dot{H}$ 23·30 with traces of $\dot{K}$ and $\bar{\dddot{Fe}}$= 99·92. From Rudniak in Serbia.

CATLINITE.—This substance is retained as a mineral in some works, yet seems to be no more entitled to it than a lump from any bed of clay or fragment of clay-slate. Dr. C. T. Jackson obtained for its composition, (Am. J. Sci. xxxv, 388):

$\dddot{Si}$ 48·2, $\bar{\dddot{Al}}$ 28·2, $\dot{Mg}$ 6·0, $\bar{\dddot{Fe}}$ 5·0, $\bar{\dddot{Mn}}$ 0·6, $\dot{Ca}\ddot{C}$ 2·6, $\dot{H}$ 8·4, loss (probably magnesia) 1. From the Coteau de Prairies, west of the Mississippi.

Another *pipestone* from northern Oregon, of a grayish color, analyzed by Dr. Thomson, (Min. i, 287), afforded

$\dddot{Si}$ 56·11, $\bar{\dddot{Al}}$ 17·31, $\bar{\dddot{Fe}}$ 6·96, $\dot{Mg}$ 0·20, $\dot{Na}$ 12·48, $\dot{Ca}$ 2·16, $\dot{H}$ 4·58=99·80.

G.=2·607. It is a kind of argillite.

AGALMATOLITE. Figure Stone. Bildstein. Pagodite. Lardite.—Probably a mineral aggregate or rock, and not a distinct mineral. Occurs massive, with a greasy feel, and is cut into images. H.=2. G.=2·815—2·9. Color white, greenish, grayish, brownish, and sometimes mottled. Streak uncolored.

Analyses: 1, Vauquelin, (Ann. de Ch. xlix, 83); 2, Klaproth, (Beit. v, 19); 3, John, (Ann. Phil. iv, 214); 4, Thomson, (Min. i, 343); 5, Walmstedt, (Ofv. K. V. Ak. Förh. 1848, 111); 6, Lychnell, (K V. Ac. H. 1834, 101):

	$\dddot{Si}$	$\bar{\dddot{Al}}$	$\bar{\dddot{Fe}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\dot{H}$
1.	56·	29·	1·	2·	——	7·	5· =100, Vauquelin.
2.	54·50	34·0	0·75	——	——	6·25	4· =99·50, Klaproth.
3.	55·	30·	1·	1·75	——	6·25	5·5=99·5, John.
4.	49·82	29·60	1·50	6·00	——	6·80	5·5=99·21, Thomson.
5.	65·96	28·58	0·09	0·18	0·15	——	5·16=100·12, Walm.
6.	72·40	24·54	2·85	——	*trace*	——	——=99·79, Lychnell.

B.B. on charcoal, whitens and shows traces of fusion on the edges. From China, Nagyag, and Saxony. Another figure stone from China examined by Wackenroder proved to be magnesian.

ONKOSIN, *Kobell*.—Massive in roundish pieces, having an apple-green color, sometimes grayish or brownish, and a weak greasy lustre. Translucent. H.=2. G.=2·8. Fracture fine splintery.

Composition.—According to Kobell, (J. f. pr. Chem. ii, 295), Silica 52·52, alumina 30·88, magnesia 3·82, protoxyd of iron 0·80, potash 6·38, water 4·60=99. Fuses with intumescence to a white blebby glass. Soluble in sulphuric acid and not in muriatic. From Salzburg.

Berzelius is disposed to consider it a mechanical mixture.

NACRITE resembles a soft earthy talc, consisting of minute grains or scales, white and pearly, with a greasy feel. Different compounds are here included. Analyses: 1, Vauquelin; 2, Thomson, (Rec. Gen. Sci. May, 1836); 3, Short, (Thom. Min. i, 244); 4, Tennant:

	$\dddot{\text{Si}}$	$\bar{\dddot{\text{Al}}}$	$\bar{\dddot{\text{Fe}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Mn}}$	$\dot{\text{H}}$	
1. Alps,	50·0	26·0	5·0	1·5	——	——	——	$\dot{\text{K}}$ 17·5=100, Vauquelin.
2. Brunswick, Me.	64·44	28·84	—	—	——	——	1·0,	$\dot{\text{Fe}}$ 4·43=98·71, Thomson.
3. *Talcite*,	46·00	35·20	—	9·61	——	3·94	2·0,	$\dot{\text{Fe}}$ 2·88=99·63, Short.
4. “	44·55	33·80	—	1·30	3·30	2·25	6·25,	$\dot{\text{Fe}}$ 7·70=99·55, Tennant.

Vauquelin's mineral is considered a mica by Rammelsberg. The last two are Talcite, from Wicklow, Ireland.

Kaolin. The following are analyses of Kaolin or porcelain clay by Brongniart and Malagutti, who in each instance separated the free silica before going on with their investigation. They were also careful to free the kaolin from the undecomposed feldspar and other minerals with which it is often mixed, forming what is called kaolin rock. The analyses as here given are exclusive of the non-argillaceous residue. The specific gravity is 2·21—2·26.

	Free $\dddot{\text{Si}}$	$\dddot{\text{Si}}$	$\bar{\dddot{\text{Al}}}$	$\dot{\text{H}}$	
1. Limoges,	10·98	31·09	34·65	12·17	$=\bar{\dddot{\text{Al}}}\dddot{\text{Si}}+2\dot{\text{H}}$.
2. Mercus, Ariège,					“
3. Clos de Madame, Allier,	2·67	37·24	36·37	12·94	“
4. Chabrol, Puy-de-Dome,	7·79	25·14	29·88	10·73	“
5. Plympton, Devonshire,	10·19	34·07	36·81	12·74	“
6. Piedmont,	6·62	17·32	21·14	7·42	“
7. Diendorf, Passau,	7·17	21·44	25·75	9·60	“
8. Rama, Passau,	9·71	36·77	37·38	12·83	“
9. Auerbach, Passau,	7·13	25·35	29·45	10·50	“
10. Seilitz, near Meissen,	9·10	31·68	34·16	12·10	“
11. Aue, near Schneeberg,	1·76	34·22	34·12	11·09	“
12. Morl, near Hall,	4·44	21·69	22·50	7·55	“
13. Munschoff, Carlsbad,	2·40	41·72	40·61	13·56	“
14. Bornholm, Scandinavia,	7·04	31·53	34·99	12·52	“
15. Oporto, Portugal,	3·72	36·90	43·93	14·62	“
16. Newcastle, Delaware,	9·39	20·34	25·59	8·94	“
17. Galicia,	6·48	36·77	37·38	12·83	“
18. Near Bayonne,					
19. Near Cherbourg,	2·43	39·88	34·51	12·09	$\bar{\dddot{\text{Al}}}^3\dddot{\text{Si}}^4+6\dot{\text{H}}$. $\bar{\dddot{\text{Al}}}^4\dddot{\text{Si}}^6+8\dot{\text{H}}$.
20. Kaschna, near Meissen,	1·82	27·60	25·00	9·80	$\bar{\dddot{\text{Al}}}^4\dddot{\text{Si}}^3+9\dot{\text{H}}$.
21. Zetlitz, Carlsbad,	4·95	26·03	26·66	9·55	$\bar{\dddot{\text{Al}}}^3\dddot{\text{Si}}^4+6\dot{\text{H}}$.
22. Elba,	1·16	43·87	32·24	11·36	$\bar{\dddot{\text{Al}}}^2\dddot{\text{Si}}^3+4\dot{\text{H}}$.
23. Tretto, near Scio,					$\bar{\dddot{\text{Al}}}^2\dddot{\text{Si}}^3+2\dot{\text{H}}$.
24. China,					$\bar{\dddot{\text{Al}}}^2\dddot{\text{Si}}^3+3\dot{\text{H}}$.
25. Wilmington, Delaware,	12·23	20·46	35·01	12·12	$\bar{\dddot{\text{Al}}}^3\dddot{\text{Si}}^2+6\dot{\text{H}}$.
26. Cornwall,	1·27	45·36	24·06	8·74	$\bar{\dddot{\text{Al}}}\dddot{\text{Si}}^2+2\dot{\text{H}}$.
27. Schletta, near Meissen,	0·67	38·48	20·92	7·26	“
28. Hungary,	1·00	25·76	15·17	5·22	“

The Newcastle, Wilmington, Devonshire, and China Kaolin afforded by the ordinary mode of analysis:

	$\dddot{\text{Si}}$	$\bar{\dddot{\text{Al}}}$	$\dot{\text{H}}$	$\dot{\text{Ca}}$, $\dot{\text{Mg}}$, $\dot{\text{K}}$	$\dot{\text{Ca}}$, $\dot{\text{Mg}}$, $\dot{\text{Na}}$			
1. Newcastle,	29·73	25·59	8·94	——	——	Residue not	argillaceous	34·99.
2. Wilmington,	32·69	35·01	12·12	1·14	0·72	“	“	22·31.
3. Limoges,	42·07	34·65	12·17	1·33	——	“	“	9·76.
4. Devonshire,	44·26	36·81	12·74	1·55	——	“	“	4·30.
5. China,	23·72	9·80	2·62	$\dot{\text{K}}$ 3·08	$\bar{\dddot{\text{Fe}}}$ 0·43	“	“	68·18.

The 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 mainly of quartz.

PALAGONITE, *Waltershausen.*

Amorphous. H.=nearly 5. G.=2·4296. Lustre resinous, subvitreous. Color wine-yellow to yellowish-brown. Sometimes dark-brown by reflected light, and honey-yellow by transmitted. Translucent. Fracture conchoidal, uneven.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+2\bar{\mathrm{R}}\dddot{\mathrm{Si}}+9\dot{\mathrm{H}}$! but as it is amorphous, it may be doubted if it be a simple species. Analyses by Bunsen, (Ann. d. Ch. u. Pharm. lxi, 265):

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\bar{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1. Seljadalr,	37·42	11·16	14·18	8·77	6·04	0·65	0·68	17·15, undis. 4·108=100·156.
2. Hekla,	32·91	8·92	12·87	7·55	4·24	1·28	0·99	14·64, undis. 9·57, Hygroscopic moisture 7·102=100·08.

Yields water in a matrass and becomes dull brown. B.B. fuses easily to a shining magnetic pearl. Dissolves easily in muriatic acid, with a separation of the silica.

From Sicily, in the tufa of Palagonia; also from Iceland.

SAMOITE, *D.*

In stalactites having a lamellar concentric structure, or consisting of a series of closely adhering layers.

H.=4—4·5. G.=1·894, and 1·689 to 1·813, Silliman, Jr. Lustre of surface vitreo-pearly; of cross fracture resinous. Color white, or grayish, brownish.

Composition.—$\bar{\mathrm{Al}}\dddot{\mathrm{Si}}+5\dot{\mathrm{H}}$=Silica 32·4, alumina 36·0, water 31·6. Analyses by Silliman, Jr., (Dana's Geol. Rep. Exp. Exped., p. 324):

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\dot{\mathrm{H}}$	
1. G.=1·894,	35·14	31·95	30·80,	$\dot{\mathrm{Mg}}$ 1·05, $\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$ 1·21, F *trace*, $\dot{\mathrm{Na}}$ *trace*=100·15.
2. G.=1·689—1·813,	31·25	37·21	30·45,	$\dot{\mathrm{Mg}}$ 0·06, $\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$ 0·01, F *trace*, $\dot{\mathrm{Na}}$ 0·06=99·04.

In a matrass yields water abundantly. B.B. alone in the platinum forceps becomes opaque, but does not fuse. Gelatinizes in nitric or muriatic acid.

These aluminous stalactites cover the roof of a lava cavern on the south side of the island of Upolu, one of the Samoan or Navigator Group. They are short cones, or flattened hemispheres, some of them 3 inches in width.

The amount of water varied nearly 10 per cent. in different portions, and the silica and alumina 5 or 6 per cent.; the exact nature of the mineral is therefore somewhat doubtful; the most probable composition is expressed in the above formula, which corresponds to the second analysis.

ANAUXITE, *Breithaupt.*

Massive, granular; cleavage perfect in one direction. H.=2—3. G.=2·26. Pearly; greenish-white; translucent.

Composition.—An imperfect analysis by Plattner (J. f. pr. Chem. xv, 325) afforded silica 55·7, much alumina, a little magnesia, protoxyd of iron, and 11·5 water. B.B. whitens and fuses on the edges. A blue color with cobalt solution.

From Bilin in Bohemia, forming irregular veins in a whitish rock approaching a siliceous limestone.

SCHRÖTTERITE, *Glocker.* Opal allophane. Opalin-allophan.

Resembles allophane. H.=3—3·5. G.=1·95—2·05. Color greenish, yellowish, or at times spotted with brown.

Composition.—$\overline{\dddot{Al}}^4\dddot{Si}+18\dot{H}$=Silica 11·17, alumina 49·66, water 39·17. Analyses by Schrötter, (J. f. pr. Chem., xi, 380):

	$\dddot{Si}$	$\overline{\dddot{Al}}$	$\dot{H}$	$\overline{\dddot{Fe}}$	$\dot{Ca}$	$\dot{Cu}$	$\dddot{S}$
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.

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. Streak white. Color pale-blue; sometimes green, brown, or yellow. Translucent. Fracture conchoidal and shining. Very brittle.

Composition.—Analyses: 1, Stromeyer, (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):

	$\dddot{Si}$	$\overline{\dddot{Al}}$	$\dot{H}$	$\dot{Cu}$
1. Grafenthal,	21·92	32·20	41·30	——$\dot{Cu}\ddot{C}$ 3·06, $\dot{Ca}$ 0·73, Gyps. 0·52, hyd. $\overline{\dddot{Fe}}$ 0·27=99·89, Stromeyer.
2. Gersbach,	24·11	38·76	35·75	2·33=100·95, Walchner.
3. Fermi,	23·76	39·68	35·74	0·65=99·83, Guillemin.
4. Friesdorf,	21·05	30·37	40·23	—— $\dot{Cu}\ddot{C}$ 2·39, $\overline{\dddot{Fe}}$ 2·74, $\dot{Mg}\ddot{C}$ 2·06=98·84, Bunsen.
5. Beauvais,	21·90	29·20	44·20	—— Clay 4·7=100, Berthier.
6. Richmond, Ma.	22·65	38·77	35·24	—— $\dot{Mg}$ 2·83=99·49, Silliman, Jr.

The formula from analyses 2, 3, and 6, is $\overline{\dddot{Al}}^2\dddot{Si}^2+15\dot{H}$=Silica 24·22, alumina 40·39, water 35·39; from 1 the same except $20\dot{H}$ in place of $15\dot{H}$.

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, 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.

The name allophane is derived from *ἄλλος, other,* and *φαίνω, to appear,* in allusion to its change of appearance under the blowpipe.

PYRARGILLITE, *Nordenskiöld,* Jahresb. 1838, 174.

Massive; occasionally presenting the form of a four-sided prism, with truncated angles or bevelled edges; frequently traversed with minute chlorite particles. Cleavage not observable.

H.=3·5 G.=2·5. Color partly black and shining, or bluish and dull; also liver-brown or brick-red. Lustre dull resinous. Translucent—opaque. Emits an argillaceous odor.

Composition.—$\dot{R}\dddot{Si}+\overline{\dddot{Al}}\dddot{Si}+4H$.—Analysis by Nordenskiöld:

$\dddot{Si}$ 43·93, $\overline{\dddot{Al}}$ 28·93, $\dot{Fe}$ 5·30, $\dot{Mg}$ and $\dot{Mn}$ 2·90, $\dot{K}$ 1·05, $\dot{Na}$ 1·85, $\dot{H}$ 15·47=99·43.

In a matrass yields water. B.B. infusible, in a strong heat becoming a little glazed. A gray slag with soda. Slowly fuses with borax. Entirely soluble in muriatic acid.

Occurs in granite near Helsingfors in Finland. It was named as above by Nordenskiöld, on account of its argillaceous odor when heated, from πῦρ, *fire*, and ἄργιλλος, *clay*.

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 transparent. Color rose-red. Streak paler. Fracture splintery.

Composition.—$\dot{R}^3\dddot{Si}^2+2\bar{Al}\dddot{Si}+3\dot{H}$, Svanberg; $\dot{R}^3\dddot{Si}+\bar{R}\dddot{Si}+2\dot{H}$, Ramm. Analysis by Svanberg:

$\dddot{Si}$	$\bar{Al}$	$\bar{Fe}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\dot{Na}$	$\dot{H}$
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, p. 292.

From a limestone at Gropptrop in Sweden.

ROSITE. Rosellan, *Svanberg*, K. V. Ac. H. 1840—Pogg. liv, 268, and lvii, 170. Polyargite, *Svanberg*.

In small grains, without crystallization; also in larger grains and foliated masses, with a pearly cleavage surface.

H.=2·5—4. G.=2·72—2·751. Color red, faint rose-red to brownish-red; the former more common; sometimes violet. Subtansparent. Fracture splintery, and in the larger grains somewhat foliated, with the surface of fracture, shining.

Composition.—$\dot{R}^3\dddot{Si}^2+6\bar{Al}\,\dddot{Si}+6\dot{H}$. Svanberg obtained

	$\dddot{Si}$	$\bar{Al}$	$\bar{Fe}$	$\bar{Mn}$	$\dot{K}$	$\dot{Na}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{H}$
1. *Rosite*,	44·901	34·506	0·688	0·191	6·628	*trace*	3·592	2·448	6·538=99·476
2. *Polyargite*,	44·128	35·115	0·961	*trace*	6·734	——	5·547	1·428	5·292=99·205

The red color is attributed by Svanberg to the manganese. The second analysis is of Svanberg's *Polyargite*, which includes the variety in larger foliated grains or masses.

In a matrass it gives off water and becomes colorless. B.B. in the forceps, thin splinters fuse, but do not form a globule. Dissolves in borax with intumescence, slowly in salt of phosphorus and readily in soda; the quantity of the last flux may be increased without affecting the fusibility. With cobalt affords a dark blue glass.

Rosite is disseminated through a limestone in Södermanland, containing spinels. It approaches amphodelite in composition. The name alludes to its rose color.

DAMOURITE, *Delesse*, Ann. Ch. Phys. xv, 248.

Massive, usually with a scaly structure. H.=2·5—3. G.=2·792. Color yellow or yellowish-white. Lustre pearly. Translucent; but scales transparent.

Composition.—$\dot{K}\,\dddot{Si}+3\bar{Al}\,\dddot{Si}+2\dot{H}$. Analysis by Delesse, $\dddot{Si}$ 45·22, $\bar{Al}$ 37·85, $\bar{Fe}$ *trace*, $\dot{K}$ 11·20, $\dot{H}$ 5·25=99·52. B.B. becomes opaque-white and fuses with difficulty to a white enamel. A fine blue with cobalt solution. Dissolves easily with borax, and forms a glass slightly tinged with iron; and a colorless glass with salt of phosphorus, soluble in concentrated sulphuric acid, but not in muriatic; does not gelatinize.

Appears to be related to nacrite. Occurs at Pontivy in Brittany, and is the gangue of kyanite. A yellowish amorphous substance found with the kyanite of Leiperville, Pa., and the tourmaline, albite, &c., of Chesterfield, Mass., has been identified with the damourite by J. E. Teschemacher.

PYROPHYLLITE, *Hermann.*

Foliated, like talc ; often radiated lamellar.

H.=1. G.=2·7—2·8. Lustre pearly, inclined to greasy. Color white, apple-green, grayish and brownish-green, ochre-yellow. Subtransparent—subtranslucent. Thin laminæ flexible.

Composition.—$\bar{\mathrm{Al}}\dddot{\mathrm{Si}}^3+\dot{\mathrm{H}}$, (from Rammelsberg's analysis)=Silica 69·65, alumina 25·73, water 4·62. Analyses: 1, Hermann, (Pogg. xv, 592); 2, Rammelsberg, (Pogg. lxviii, 518); 3, Sjögren, (Ofv. K. V. Ak. Förh., 1848, 110); 4, Thomson, (Min. i, 378):

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\bar{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
1. Siberian,	59·79	29·46	1·80	4·00	5·62, silver *trace*=100·67, Herm.
2. Spas,	66·14	25·87	——	1·49	5·59, $\dot{\mathrm{C}}$a 0·39=99·48, Ramm.
3. Westana, Sw.	67·77	25·17	0·82	0·26	5·82, $\dot{\mathrm{C}}$a 0·66, $\dot{\mathrm{M}}$n 0·50=101, Sj.

From Hermann's analysis comes the formula $\dot{\mathrm{Mg}}^3\dddot{\mathrm{Si}}^2+9\ \bar{\mathrm{Al}}\ \dddot{\mathrm{Si}}^2+9\ \dot{\mathrm{H}}$.

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. It was considered a radiated talc. It is reported by Prof. Shepard as occurring near Crowder's Mt., N. C., in white stellate aggregations.

VERMICULITE, *T. H. Webb*, Am. J. Sci., vii, 1824, 55.—This mineral from Milbury, Mass. has hitherto been supposed to be related to pyrophyllite. But an analysis by Mr. Richard Crossley, (just completed while these pages were going through the press, and communicated to the author by Dr. C. T. Jackson, with a new description of the species,) shows that it has the composition of *pyrosclerite*, p. 263. Mr. Crossley obtained

$$\dddot{\mathrm{Si}}\ 35{\cdot}74,\quad \bar{\mathrm{Al}}\ 16{\cdot}42,\quad \dot{\mathrm{Fe}}\ 10{\cdot}02,\quad \dot{\mathrm{Mg}}\ 27{\cdot}44,\quad \dot{\mathrm{H}}\ 10{\cdot}30=99{\cdot}92,$$

whence he deduces the oxygen ratio (approximately) 6 : 2 : 4 : 3, leading to the formula, $2(\dot{\mathrm{Mg}},\dot{\mathrm{Fe}})^3\dddot{\mathrm{Si}}+\bar{\mathrm{Al}}\dddot{\mathrm{Si}}+4\frac{1}{2}\dot{\mathrm{H}}$=Silica 37·7, alumina 13·9, magnesia 27·7, protoxyd of iron 9·8, water 10·9. The mineral is in scales or foliated grains disseminated through a mealy magnesian substance; and Mr. Crossley carefully separated the two before commencing the analysis, a precaution not taken by Dr. Thomson, who arrived at a very different result, (Min. 378). The characters of the species are given as follows by Dr. Jackson :

Highly foliated. Scales not of distinct form, but probably hexagonal; separate easily into laminæ, which are flexible but not elastic. H.=1. G.=2·756, Crossley, after drying. Color dark olive-green; pale apple-green by transmitted light. Lustre pearly. Thin scales translucent to subtranslucent. B.B. a thin scale suddenly exfoliates (at 500 to 600 F) and swells out to a cylinder or vermicular thread nearly a hundred times its 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. 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.

The mineral, as obtained in the mass, looks like a half decomposed steatite.

If the silica and alumina may be considered as mutually replaceable in this mineral as in some augites and other species, we have quite exactly the formula $2\dot{\mathrm{R}}^3(\dddot{\mathrm{Si}},\bar{\mathrm{Al}})^2+4\frac{1}{2}\dot{\mathrm{H}}$.

Dr. Thomson obtained in his analysis,

$$\dddot{\mathrm{Si}}\ 49{\cdot}080,\quad \bar{\mathrm{Al}}\ 7{\cdot}28,\quad \dot{\mathrm{Mg}}\ 16{\cdot}964,\quad \bar{\mathrm{Fe}}\ 16{\cdot}120,\quad \dot{\mathrm{H}}\ 10{\cdot}276=99{\cdot}720.$$

He gives for the specific gravity 2·5252, and observes that it is infusible alone before the blowpipe.

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.—$(\dot{Fe}, \dot{Mn})^3\dddot{Si}^2+2\bar{\dddot{Al}}\dddot{Si}+3\dot{H}$, Ottrelite. Analyses: 1, Damour, (Ann. des Mines, [2], ii, 357); 2, Thomson, (Ann. Lyc. Nat. Hist. N. Y. iii):

	$\dddot{Si}$	$\bar{\dddot{Al}}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{K}$	$\dot{H}$
1. *Ottrelite,*	43·34	24·63	16·72	8·18	——	5·66=98·53, Damour.
2. *Phyllite,*	38·40	23·68	$\bar{\dddot{Fe}}$ 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 elliptical, 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."

DIPHANITE, *Nordenskiöld,* Bull. Acad. St. Petersb., v, 17; J. f. pr. Chem. xxxix, 114.

Hexagonal. Crystals hexagonal prisms. Cleavage basal, very perfect. Also massive, micaceous.

H.=5—5·5. G.=3·04—3·07. Lustre vitreous. Color bluish; white. Transparent—translucent.

Composition.—$2\dot{R}^3\dddot{Si}+3\bar{\dddot{Al}}^2\dddot{Si}+4\dot{H}$. Analysis by Jevreinoff:

$\dddot{Si}$ 34·02, $\bar{\dddot{Al}}$ 43·33, $\dot{Ca}$ 13·11, $\dot{Fe}$ 3·02, $\dot{Mn}$ 1·05, $\dot{H}$ 5·34=99·87.

B.B. becomes opaque and fuses with intumescence in the inner flame to an enamel. With little soda gives a blebby glass; with more an infusible enamel.

From the emerald mines of the Ural, where it is associated with chrysoberyl and phenacite. Much resembles apatite.

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. Color dark-gray, grayish-green, greenish-black; streak uncolored, or slightly greenish. Lustre weak, pearly.

Composition.—$\dot{R}^3\dddot{Si}+\bar{\dddot{Al}}^2\dddot{Si}+3\dot{H}$, Bonsdorff.—$\dot{R}^3\dddot{Si}+\bar{\dddot{Al}}^2\dddot{Si}+2\dot{H}$, Whitney, for the masonite,=Silica 28·56, alumina 32·06, protox. of iron 33·60, water 5·60. Rammelsberg deduces a different formula $(3\dot{R}^3\dddot{Si}+2\bar{\dddot{Al}}^2\dddot{Si}+6\dot{H})$ from a more exact consideration of Bonsdorff's analysis; but Whitney's result appears to sustain the above by Bonsdorff. Analyses: 1, Bonsdorff, (G. Rose, Reisen. d. Ural i, 252); 2, J. D. Whitney, (Proc. Bost. Soc. N. Hist. Jan. 1849, p. 100):

	$\dddot{Si}$	$\bar{\dddot{Al}}$	$\dot{Fe}$	$\dot{Mg}$	$\dot{Mn}$	$\dot{H}$
1. *Chloritoid,*	27·48	35·57	27·05	4·29	0·30	6·95=101·64, Bonsdorff.
2. *Masonite,*	28·27	32·16	33·72	0·13	——	5·00=99·28, Whitney.

In a matrass yields water. B.B. infusible, but becomes darker and magnetic. The masonite fuses with difficulty to a dark green enamel.

Occurs at Koroibrod near Katharinenburg in the Ural, associated with mica and kyanite. The masonite occurs in compact argillite, near Natic village, Rhode Island.

SISMONDINE, *Delesse*, (Ann. de Ch. et de Phys., [3], ix, 385).—This mineral occurs at St. Marcel, in chlorite slate, and resembles chloritoid. Color dark grayish-green. Structure foliated. G.=3·565.

Composition.—According to Delesse,

$\dddot{\mathrm{Si}}$ 24·1, $\bar{\mathrm{Al}}$ 43·2, $\dot{\mathrm{Fe}}$ 23·8, $\dot{\mathrm{H}}$ 7·6, and *trace* of titanic acid=98·7.

B.B. infusible, but becomes of a pinchbeck-brown color. Yields water. With borax dissolves and affords the reaction of iron. Dissolves in strong muriatic acid.

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 $\dddot{\mathrm{Si}}$ 24·90, $\bar{\mathrm{Al}}$ 46·20, $\dot{\mathrm{Fe}}$ 28·89, which is equivalent to $\dddot{\mathrm{Si}}^3\ \bar{\mathrm{Al}}^3\ \dot{\mathrm{Fe}}^3$.

PINITE, *W.* FAHLUNITE, *Hisinger.* HYDROUS IOLITE, *Bonsdorff.* ESMARKITE, *Erdmann.* CHLOROPHYLLITE, *Jackson.* GIGANTOLITE, *Nordenskiöld.* ASPASIOLITE, *Scheerer.* PRASEOLITE, *Erdmann.* OOSITE.

The species here enumerated appear to be results of the alteration and hydration of iolite. They occur in six and twelve-sided prisms, with transverse foliated structure, a somewhat pearly lustre, and a gray, grayish-green, or brownish color. The prismatic form is properly the form of iolite, and not that of the altered mineral although often so stated; the crystals are proper pseudomorphs, but have a characteristic foliated structure, a result of the change undergone.

H.=2—3. G.=2·7—2·9. Translucent in thin laminæ to opaque. The gigantolite is less perfectly foliated than the others, and the color has a slightly submetallic appearance, evidently due to the alteration of the iron or manganese in the original mineral. Aspasiolite also is imperfectly foliated, with some resemblance to serpentine. G.=2·764.

Analyses: 1, Gmelin, (Kastn. Arch. i, 226); 2, Gillet de Laumont, (Beud. Min.); 3, Ficinus, (Schw. J. xxvi, 280); 4. Massalin, (Trommsdorff's N. J. iv, 2, 324); 5, Scott, (Ramm. Handw. ii, 61); 6, 7, Rammelsberg, (3d Supp. 94); 8, 9, 10, Marignac, (J. d. Pharm. Ch. [3], xii, 150); 11, 12, Trolle Wachtmeister, (K. V. Ac. H. 1827, p. 21); 13, Bonsdorff; 14, Erdmann, (Jahresb. 1841, 174); 15, C. T. Jackson, (Last Edit. p. 306); 16, Trolle Wachtmeister, (Pogg. xlv, 558); 17, 18, Marignac, (J. de Pharm. et de Chem. [3], xii, 150); 19, Scheerer, (Pogg. lxviii, 328); 20, Erdmann, (K. V. Ac. H. 1840); 21, Wachtmeister, (K. V. Ac. H. 1827):

I. *Pinite.*

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\bar{\mathrm{Fe}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
1. Auvergne,[a]	55·96	25·48	5·51	7·89	3·76	1·41, $\dot{\mathrm{Na}}$ 0·39=100·42, Gmelin.
2. "	49·08	33·92	8·90	——	——	5·50, $\dot{\mathrm{Ca}}$ 1·50=98·90, Laumont.
3. Neustadt, *red*,	54·60	23·60	——	11·20	0·80	1·2, $\dot{\mathrm{Fe}}$ 7·8, $\bar{\mathrm{Mn}}$ 1·6=100·8, Fic.
4. "	45·00	30·00	12·60	12·40	——	——=100, Massalin.
5. Penig,	48·00	28·00	9·66	11·35	——	3·0, $\dot{\mathrm{Ca}}$ 0·75=100·76, Scott.
			$\dot{\mathrm{Fe}}$			
6. "	47·00	28·36	7·08	10·74	2·48	3·88, $\dot{\mathrm{Ca}}$ 0·79, $\dot{\mathrm{Na}}$ 1·07=101·35, R.
7. Aue,	46·83	27·65	7·84	6·52	1·02	7·80, $\dot{\mathrm{Ca}}$ 0·49, $\dot{\mathrm{Na}}$ 0·40=98·55, R.
8. Auvergne,	47·50	31·80	3·92	9·05	1·78	5·03, $\dot{\mathrm{Na}}$ 0·92=100, Marignac.
9. Saxony,	46·10	32·46	4·27	9·00	2·26	5·45, $\dot{\mathrm{Na}}$ 0·46=100, "
10. Chamouny,	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.

II. *Fahlunite*, (Triklasit).

	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dot{Fe}$	$\dot{K}$	$\dot{Mg}$	$\dot{H}$
11. Grafen, *b'k*,	44·60	30·10	3·86	1·98	6·75	9·35, $\ddot{\bar{Mn}}$ 2·24, $\dot{Na}$ *trace*, $\dot{Ca}$ 1·35, HF *trace*=100·23, Wachtmeister.
12. " *cryst.*	44·95	30·70	7·22	1·38	6·04	8·65, $\ddot{\bar{Mn}}$ 1·90, $\dot{Ca}$ 0·95=101·79, Wachtmeister.

III. *Bonsdorffite*, (13); *Esmarkite*, (14); *Chlorophyllite*, (15).

13. Abo,	45·05	30·05	5·30	—	9·00	10·60, (some $\ddot{\bar{Mn}}$ with $\dot{Mg}$)=100,B.
14. Brevig,	45·97	32·08	3·83	—	10·32	5·49, $\dot{Mn}$ 0·41=$\dot{Ca}$, Pb, Cu, Co, Ti, 0·45=98·55, Erdmann.
15. Unity, Maine,	45·20	27·60	8·24	—	9·60	3·60, $\dot{Mn}$ 4·08, $\dddot{\dot{P}}$ *trace*=98·32, J.

IV. *Gigantolite.*

16. Tamela,	46·27	25·10	14·04[a]	2·70	3·80	6·00, $\dot{Mn}$ 0·89, $\dot{Na}$ 1·20, F *trace*=100, Wachtmeister.
17. "	42·59	26·78	14·21	*und.*	2·72	5·70, $\dot{Mn}$ 1·07, Marignac.
18. "	*und.*	26·47	14·10	5·44	2·54	6·08, $\dot{Mn}$ 0·83, $\dot{Na}$ 0·86 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.

V. *Aspasiolite.*

19. Krageroe,	50·40	32·38	2·34	—	8·01	6·73=99·86, Scheerer.

VI. *Praseolite.*

20. Bräkke,	40·94	28·79	6·96	—	13·73	7·38, $\ddot{\bar{Mn}}$ 0·32, $\dot{Pb}$, $\dot{Cu}$, $\dot{Ca}$, $\dot{Co}$, 0·50=98·62, Erdmann.

VII. *Weissite.*

21. Fahlun.	53·69	21·70	1·43	4·10	8·99, $\dot{H}$ and NH^3 3·20, $\ddot{\bar{Mn}}$ 0·63, $\dot{Na}$ 0·68, $\dot{Zn}$ 0·3=100·72, Wachtmeister.	

The formulas that have been deduced for these substances are as follows:

Pinite, fr. analysis 6. $\dot{R}^3\dddot{Si}^2+3\dddot{\bar{R}}\dddot{Si}+2\dot{H}$, *Ramm.*=Iolite$+2\dot{H}$. From analyses 8, 9, 10, Marignac, the same with 3 of water, or the formula of Esmarkite; from analysis 7, $(\dot{R}^3\dddot{Si}^2+3\dddot{\bar{R}}\dddot{Si})+(\dddot{\bar{Al}}\dddot{Si}^2+6\dot{H})$, *Ramm.*

Bonsdorffite and *Fahlunite.* $\dot{R}^3\dddot{Si}^2+3\dddot{\bar{R}}\dddot{Si}+6\dot{H}$=Iolite$+6\dot{H}$.

Esmarkite. $\dot{R}^3\dddot{Si}^2+3\dddot{\bar{R}}\dddot{Si}=3\dot{H}$+Iolite$+3\dot{H}$.

Chlorophyllite. $\dot{R}^3\dddot{Si}^2+3\dddot{\bar{R}}\dddot{Si}$=Iolite$+2\dot{H}$.

Gigantolite, (from the above). $\dot{R}^3\dddot{Si}^2+2\dddot{\bar{Al}}\dddot{Si}+3\dot{H}$.

Aspasiolite. $(\dot{R}^3\dddot{Si}^2+3\dddot{\bar{R}}\dddot{Si})+(\dddot{\bar{Al}}\dddot{Si}^2+5\dot{H})$ *Ramm.*, =Iolite+a hydrated bisilicate of alumina.

Praseolite. $\dot{R}^3\dddot{Si}^2+\dddot{\bar{Al}}\dddot{Si}+\dddot{\bar{Al}}\dot{H}^3$.

Weissite. $\dot{R}^3\dddot{Si}^2+2\dddot{\bar{R}}\dddot{Si}^2$.

These substances yield water in a matrass. B.B. alone they fuse on the thinnest edges, or not at all, excepting gigantolite, which fuses readily with some intumescence, but does not form a globule.

Pinite occurs in decomposed feldspar porphyry, at Puy de Dôme, Auvergne; in granite at Aue near Schneebourg, Saxony; at Lisens in the Tyrol; at Neustadt near Stolpen; Penig in Saxony; in Auvergne; at Mount Brévent near Chamouny; in Cornwall and Aberdeenshire. *Oosite* from Oos, near Baden, Baden in Baden, is considered a somewhat decomposed pinite.

Fahlunite is from chlorite slate at the mine of Eric Matts, near Fahlun, Sweden, where it is associated with iolite. The *Bonsdorffite* is from Abo. *Esmarkite* is from granite, near Brevig, Norway. *Chlorophyllite* occurs in very large prisms and tabular crystals at Neal's mine in Unity, N. H., along with iolite, the one graduating into the other; and the same mineral, found under similar circumstances at Haddam, has been called *Pinite*. *Gigantolite* is met with in very large prisms at Tamela, Finland. *Aspasiolite* is from Krageröe, Norway. *Prasεolite* comes from Bräkke near Brevig in Norway, and is associated with iolite, the two passing into one another. *Weissite* is from Fahlun, and is described as occuring in chlorite slate in small masses as large as hazlenuts.

Tennant has analyzed a mineral of allied constitution to the weissite from Canada East, (Rec. Gen. Sci. 1836, May, 332); it contained

$\dddot{Si}$ 55·05, $\dddot{\bar{Al}}$ 22·60, $\dot{Mg}$ 5·70, $\dot{Fe}$ 12·60, $\dot{Mn}$ *trace*, $\dot{Ca}$ 1·40, $\dot{H}$ 2·25=99·60.

It is doubtful whether this species has any real relations to the Weissite.

In the changes undergone from filtrating waters or atmospheric agency some ingredients of the original mineral are often to a greater or less extent removed in solution, and we should not expect to find in all the iolite pseudomorphs the original elements of this mineral added to water; the analyses show that they are not always present.

IBERITE, *Svanberg*, Ofv. af. K. V. Ac. Förh. 1844, 219.

Hexagonal. In large dull grayish-green hexagonal crystals. Cleavage basal, and also parallel to alternate lateral planes.

H.=2·5. G.=2·89. Lustre between vitreous and pearly. Opaque.

Composition.—$(\dot{Fe}, \dot{K})^3\dddot{Si}+3\dddot{\bar{Al}}\dddot{Si}+3\dot{H}$. Analysis by Norlin, (loc. cit.):

$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\dot{Na}$	$\dot{H}$
40·901	30·741	15·467	1·327	0·397	0·806	4·571	0·043	5·567=99·820.

In a matrass yields water. B.B. fuses to a dark pearl. With the fluxes gives the reaction of a ferruginous silicate, and with soda a weak manganese color. A dull blue with cobalt solution.

From Montalvan near Toledo, Spain, and named from Iberia, ancient name of Spain. From the description of the mineral some relation to fahlunite might be inferred.

WŒRTHITE, *Hess*, Pogg. Ann. xxi, 73.

Massive, structure foliated. H.=7·25. G. above 3. Lustre like that of kyanite. White. Translucent.

Composition.—$5\dddot{\bar{Al}}\dddot{Si}+\dddot{\bar{Al}}\dot{H}^3$, (Hess)=Silica 40·79, alumina 54·45, water 4·76. Analysis by Hess:

	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dot{Mg}$	$\dot{H}$
1.	40·58	53·50	1·00	4·63=99·71.
2.	41·00	52·63	0·76	4·63=99·02.

Yields water in a matrass. B.B. infusible. With borax gives with difficulty a clear glass; in salt of phosphorus a silica skeleton; with cobalt solution a clear blue.

From near St. Petersburg, where it was discovered by Mr. von Wörth. It has been considered a variety of kyanite.

MONROLITE, *Silliman, Jr.*, Am. J. Sci. [2], viii.

This mineral has nearly the constitution of Wœrthite, yet appears to be distinct. It has a columnar radiating structure, (somewhat like bucholzite). H.=7—7·25. G.=3·045—3·096. Vitreous and translucent, with a green, greenish-gray or whitish color. Cleavage diagonal like sillimanite, which mineral it resembles.

Composition.—$\ddot{\bar{A}}l^{3}\dddot{S}i^{4}$, excluding the water; or $3\ddot{\bar{A}}l\dddot{S}i+\ddot{\bar{A}}l^{3}\dot{H}^{3}$=Silica 40·59, alumina 56·45, water 3·04. Analyses by Silliman, Jr. (loc. cit.):

1.	$\dddot{S}i$ 40·920	$\ddot{\bar{A}}l$ 56·618	$\dot{M}g$ 0·285	$\dot{H}$ 3·091.
2.	40·389	56·610	0·285	2·785.

The water varies, and in another analysis only 2 per cent. were found; it is possible that in other specimens it may be in still smaller proportion, showing that it is not an essential ingredient. B.B. alone, whitens but infusible. With soda slowly dissolves; with borax more readily. In a matrass yields water.

Monrolite occurs in Monroe, Orange Co., where it was first found by Mr. Silas R. Horton.

HYDROBUCHOLZITE, *Thomson.*—A clear translucent greenish blue mineral of granular structure, consisting of shining scales and vitreous; H. below calc spar; G.=2·855.

Composition.—According to Thomson, (Min. i, 237), Silica 41·35, alumina 49·55, water 4·85; sulphate of lime 3·12=98·87. B.B. becomes white and falls to powder. Probably from Sardinia. It has not been admitted as a true species.

ZEUXITE, *Thomson*, Mineralogy, i, 320.

In small rectangular prismatic crystals, promiscuously arranged; loosely coherent. H.=4·25. G.=3·051. Lustre vitreous, glistening. Color brown, with a slight shade of green, when viewed in mass. Opaque.

Composition.—According to Thomson, Silica 33·48, alumina 31·848, protoxyd of iron 26·01, lime 2·456, water 5·28=99·074. B.B. in a glass tube gives out water, and emits an odor which may be called bituminous. Color deepened by the blowpipe, and the edges of the crystals rendered of a scoriaceous appearance. With borax it effervesces, and forms a dark brown glass.

It occurs in the Huel Unity Mine, three miles east of Redruth in Cornwall, and hence named by Dr. Thomson, from ζευξις, *union.*

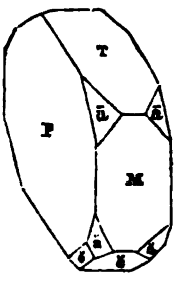
ZEOLITE FAMILY.

The zeolite family includes hydrous silicates of alumina and some alkali, either soda, potassa, baryta, strontia or lime. They intumesce in general before the blowpipe, and hence the name from ζεω, *to boil.* They fuse easily, and yield a silica skeleton with salt of phosphorus. They are found crystallized, fibrous, or massive, in cavities or seams in various igneous rocks, especially amygdaloidal trap or basalt, and sometimes in sandstones, in the vicinity of these rocks, and occasionally in metalliferous veins.

HEULANDITE. Foliated Zeolite, *J.* and *W.* Stilbite, (in part). Stilbite anamorphique, *Haüy.* Blättriger Stilbit, *Haus.* Blätterzeolit, *W.* Euzeolith. Lincolnite, *Hitchcock.* Beaumontite, *Levy.*

Monoclinic, M : T=130° 30′; M : ā=147° 8′, T : ā=147° 22′, M : ĕ=114° 5′, ā : ā=135° 52′, ŏ : ĕ=138° 49′, Levy. Cleavage parallel with P eminent. Also in globular forms; also granular.

1.



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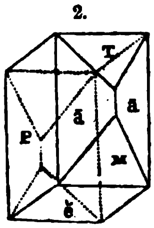


Beaumontite.
Baltimore, Md.

H.=3·5—4. G.=2·2, Haidinger; 2·195, Thomson, a crystal from the Faroe Islands. Lustre of P pearly; of other faces, vitreous. Streak white. Color various shades of white passing into red, gray, and brown. Transparent—subtranslucent. Fracture subconchoidal, uneven. Brittle.

Composition.—$3\dot{C}a\bar{\bar{\bar{S}}}i+4\bar{\bar{A}}l\bar{\bar{\bar{S}}}i^3+18\dot{H}$, Ramm.=Silica 60·5, alumina 17·4, lime 7·4, water 14·2; or with $21\dot{H}$. $(\dot{C}a, \dot{N}a, \dot{K})\, \bar{\bar{\bar{S}}}i+\bar{\bar{A}}l\bar{\bar{\bar{S}}}i^3+5\dot{H}$, Damour=(reckoning $\dot{N}a$ and $\dot{K}$, detected by Damour, as $\dot{C}a$) Silica 59·8, alumina 16·6, lime 9·1, water 14·5.

Analyses: 1, Walmstedt, (Ed. Phil. J. vii, 11); 2, Thomson, (Min. i, 347); 3, Rammelsberg, (Handw. i, 302); 4, Damour, (Compt. Rend. xxii, 926):

	$\bar{\bar{\bar{S}}}i$	$\bar{\bar{A}}l$	$\dot{C}a$	$\dot{H}$	$\bar{\bar{F}}e$
1.	60·07	17·08	7·13	15·10	0·20= 99·38, Walmstedt.
2. Faroe,	59·15	17·92	7·65	15·40	——=100·12, Thomson.
3. Iceland,	58·20	17·60	7·20	16·00	——= 99·00, Rammelsberg.
4.	59·64	16·33	7·44	14·33	——$\dot{K}$ 0·74, $\dot{N}a$ 1·16=99·64, D.

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.

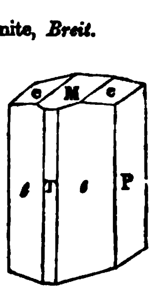
The finest specimens of this species come from Iceland and the Faroe Islands, and from the Vendayah mountains in Hindostan. Red varieties occur at Campsie in Sterlingshire, with stilbite of the same color, and brown in ore beds, at Arendal. It also occurs in the Kilpatrick hills, near Glasgow.

At Peter's Point, Nova Scotia, it occurs in trap, presenting white and flesh-red colors, and associated with laumonite, 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 it has been observed 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; also at Kipp's Bay, New York Island, on gneiss, along with stilbite; in fine crystals on the north shore of Lake Superior at Prince's Mine; and also 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 P and ĕ, 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 T: a, according to Levy, equals 147° 18′, which is near the same angle in this species. Levy makes a : a=132° 20′. 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).

This species was named by Brooke in honor of Mr. Heuland, of London. It may be distinguished from stilbite by its crystalline form, and its more perfectly pearly lustre.

BREWSTERITE, *Brooke*, Edinb. Phil. Jour. vi, 112. Diagonite, *Breit.*



Monoclinic. Right rhomboidal prism; M : T=93° 40′, *e* : *e*=136°; M : e=176°, e : e=172°. Cleavage highly perfect parallel to P.

H.=4·5—5. G.=2·12—2·432; the latter according to Thomson. Lustre of P pearly; of other faces, vitreous. Streak white. Color white, inclining to yellow and gray. Transparent—translucent. Fracture uneven.

Composition.—$(\dot{Sr},\dot{Ba})\bar{Si}+\bar{\bar{Al}}\bar{Si}^3+5\dot{H}$=(including the $\dot{Ca}$ under the $\dot{Ba}$ and $\dot{Sr}$) Silica 54·2, alumina 15·0, baryta 7·5, strontia 10·1, water 13·2. It is identical with Damour's formula for Heulandite, excepting the substitution of strontia and baryta for lime. But Damour's formula gives too little alumina. The oxygen relation for the silica, alumina, protoxyds, and water, (as stated by Rammelsberg), is near 12 : 3¼ : 1 : 5, which gives however the improbable formula, $5\dot{R}\bar{Si}+3\bar{\bar{Al}}^3\bar{Si}^5+25\dot{H}$. Analyses by Connel and Thomson, (Min. i, 348):

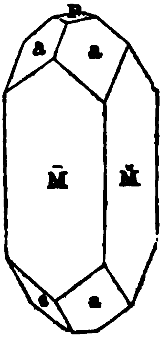
	$\bar{Si}$	$\bar{\bar{Al}}$	$\dot{Ba}$	$\dot{Sr}$	$\dot{Ca}$	$\dot{H}$	$\bar{\bar{Fe}}$
1. Strontian,	53·67	17·49	6·75	8·32	1·35	12·58	0·29=100·45, C.
2. "	53·04	16·54	6·05	9·01	0·80	14·73	——=100·17. T.

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 in honor of Sir David Brewster.

STILBITE, *H.* Radiated Zeolite, *J.* Foliated Zeolite. Strahlzeolith, *W.* Blättrich strahliger Stilbite, *Haus.* Sphærostilbite, *B.* Hypostilbite, *B.* Desmine.



Trimetric; a : a=119° 50′, and 114°, P : a=131° 59′. Frequently the lateral edges are replaced, and $\bar{M}$: *e*=137° 67′, *e* : *e*=94° 11′. Cleavage parallel to $\breve{M}$ perfect, to $\bar{M}$ less so. Compound crystals of a cruciform character are rarely met with. Common in sheath-like aggregations of crystals; globular, divergent, and radiated forms; also columnar or thin lamellar.

H.=3·5. G.=2·094—2·205; 2·161, Haidinger; 2·203, Münster. Lustre of $\breve{M}$, both as face of crystallization and cleavage, pearly; of other faces, vitreous. Color white; occasionally yellow, brown, or red. Streak uncolored. Subtransparent—translucent. Fracture uneven. Brittle.

Composition.—$\dot{Ca}\bar{Si}+\bar{\bar{Al}}\bar{Si}^3+6\dot{H}$=Silica 58·1, alumina 16·1, lime 8·8, water 17·0. Analyses: 1, Fuchs and Gehlen, (Schw. J. viii, 253); 2, Hisinger, (ib. xxiii, 63); 3, Retzius, (Jahresb. iv, 153); 4, 5, Moss, (Pogg. lv, 114); 6, Riegel, (J. f. pr. Chem. xl, 317); 7, Hermann, (Bull. Soc. Nat., Moscow, 1848, 318); 8, Münster, (Pogg. lxv, 297); 9, 10, Sjögren, (Ofv. K. V. Ak. 1848, 111); 11, 12, Beudant, (Traité de Min., ii, 119, 120):

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
1. Iceland,	55·07	16·58	7·58	1·5		19·30=100·04, F. and G.
2. "	58·00	16·10	9·70	—	—	16·40=99·70, Hisinger.
3. Faroe,	56·08	17·22	6·95	—	2·17	18·35=100·77, Retzius.
4. "	56·93	16·54	7·55	0·20	1·54	17·79=100·55, Moss.
5. "	57·18	16·44	7·74	0·32	1·11	17·79=100·58, Moss.
6. Niederkirchen,	58·33	16·66	7·16	—	1·62	14·50, $\ddot{\bar{\mathrm{Fe}}}$ 0·26=98·53, Riegel.
7. Ilmen Mts.; G.=2·19,	56·31	16·25	7·66	—	1·08	17·75, $\dot{\mathrm{Fe}}$, $\dot{\mathrm{Mn}}$ 1·0=100, H.
8. Christiania; G.=2·203,	58·53	15·73	7·02	—	—	17·05. $\dot{\mathrm{Mg}}$ and alkali 3·07, $\ddot{\bar{\mathrm{Fe}}}$ 0·5=101·9, Münster.
9. Gustafsberg,	57·41	16·14	8·97	1·04	1·21	16·60, $\dot{\mathrm{Mg}}$ *trace*=101·40, Sjög.
10. Barbro, Norway,	58·41	16·56	7·89	—	—	16·53, $\dot{\mathrm{Mg}}$, $\dot{\mathrm{Mn}}$ 0·59=99·93, S.
11. *Sphærostilbite*,	55·91	16·61	9·03	—	0·68	17·84, Beudant.
12. *Hypostilbite*,	52·43	18·32	8·10	—	2·41	18·70, Beudant.

The analysis of *Sphærostilbite* gives the formula $\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}^2+3\ddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}^3+18\dot{\mathrm{H}}$; and that of *Hypostilbite*, $\dot{\mathrm{Ca}}^3\dddot{\mathrm{Si}}+3\ddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}^3+18\dot{\mathrm{H}}$. The latter, from Faroe, is considered a partially altered stilbite. Two specimens from Dumbarton, analyzed by Thomson, (Min. i, 345), approximate to hypostilbite.

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 on granite and gneiss.

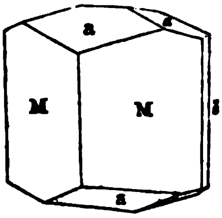
Abundant on the Faroe Islands, in Iceland, and on the Isle of Skye, in trap; at Andreasberg in the Hartz, and Kongsberg and Arendal in Norway, with iron ore; in the Vendayah Mts., Hindostan, in large translucent crystals, having a reddish tinge; in fine crystals, of a brick-red color, in porphyritic amygdaloid, near Kilpatrick in Dumbartonshire; a brown variety on granite, at the copper mines of Gustafsberg, near Fahlun in Sweden. At 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. It is accompanied with wine-colored carbonate of lime.

In the United States, occurs 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 on 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, N. Y., 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 Kewenaw Point, Lake Superior, in trap.

The name stilbite is derived from *στιλβη*, *lustre*.

Stilbite is easily distinguished from the preceding species, by its property of not gelatinizing with acids; and from gypsum, which it sometimes resembles, by its superior hardness.

EPISTILBITE, *G. Rose*, Pogg. vi, 183, and Brewster's Jour. iv, 283. Monophan, *B.*



Trimetric. M : M=44° 50′ and 135° 10′; M : ĕ=112° 25′, *a* : ĕ=106° 10′, a : a=109° 46′, M : a=122° 9′. Cleavage parallel to the shorter diagonal, very perfect; indistinct in other directions. Face M mostly uneven. Presents occasionally twin crystals. Also granular.

H.=4. G.=2·249—2·25. Lustre pearly upon the cleavage face; upon M vitreous. Streak and color white. Transparent—subtranslucent. Fracture uneven.

Composition.—($\dot{\mathrm{Ca}}$, $\dot{\mathrm{Na}}$) $\dddot{\mathrm{Si}}+\ddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}^3+5\dot{\mathrm{H}}$=Silica 59·8, alumina 16·6, lime 9·1, water 14·5, which is identical essentially with the formula of laumonite (Damour's) and brewsterite, and also with heulandite, taking Damour's formula; it differs from that of stilbite in containing 1 atom less of water. Analyses by G. Rose, (loc. cit.):

	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\overline{\mathrm{H}}}$
1.	58·59	17·52	7·56	1·78	14·48=99·93.
2.	60·28	17·36	8·32	1·52	12·51 (loss)=100.

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, and at Poonah in India. Occurs 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.

Levy has however shown that the crystals of epistilbite may be modifications of heulandite; for the angle M : M of the former equals nearly ǎ : ǎ in the latter. The chemical formulas of the two moreover are probably the same. Descloiseaux however observes, after his examinations, that the aspect of the crystals is very different.

RETZITE, *D.* Edelforsite, *Retzius.* Red Zeolite of Ædelfors.

Fibrous.

G.=2·6. Color red, light gray, or nearly white.

Composition.—$\dot{\mathrm{Ca}}\dddot{\mathrm{Si}}+\dddot{\overline{\mathrm{Al}}}\dddot{\mathrm{Si}}^3+4\dot{\overline{\mathrm{H}}}$. Analysis by Retzius:

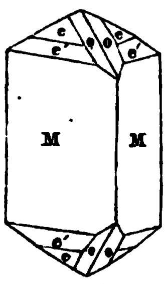
$\dddot{\mathrm{Si}}$ 60·280, $\dddot{\overline{\mathrm{Al}}}$ 15·416, $\dot{\mathrm{Ca}}$ 8·180, $\dddot{\overline{\mathrm{Fe}}}$ 4·160, $\dot{\mathrm{Mg}}$ and $\dddot{\overline{\mathrm{Mn}}}$ 0·420, $\dot{\overline{\mathrm{H}}}$ 11·070=99·526.

B.B. intumesces. Dissolves in the acids and forms a jelly.

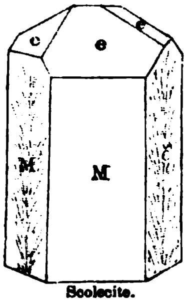
From Ædelfors, Sweden.

MESOTYPE, *H.* NATROLITE, *W.* Soda Mesotype. Feather Zeolite. Bergmannite. Spreustein. Radiolite. Fäserzeolite, *W.* Natron-Mesotyp, *R.* Lehuntite, *Thom.*—SCOLECITE. Lime-mesotype. Needlestone. Kalk-mesotype.—MESOLITE. Lime-and-soda-mesotype.

Trimetric. M : M=91° 22′; for Scolecite 91° 22′, Rose; for Mesolite 91° 05′, Rose, 91° 22′, Levy; for Natrolite 91° 20′, Levy, Fuchs; e : e=142° 47′—143° 33′; o : o=145° 44′, Brooke. Crystals usually slender, often acicular; frequently interlacing, divergent, or stellate. Also fibrous, radiating, and massive.



Natrolite.



Scolecite.

H.=5—5·5. G.=2·17—2·27; of natrolite 2·17—2·24; of scolecite 2·2—2·27; of mesolite 2·25. Lustre vitreous; sometimes inclining to pearly, especially in fibrous varieties; most vitreous in scolecite. Color white, or colorless, also grayish, yellowish; streak uncolored. Transparent—translucent.

Composition.—$\dot{\mathrm{Na}}\dddot{\mathrm{Si}}+\overline{\dddot{\mathrm{Al}}}\dddot{\mathrm{Si}}+2\dot{\mathrm{H}}$=Silica 47·86, alumina 26·61, soda 16·20, water 9·33, Natrolite; $(\dot{\mathrm{Ca}}, \dot{\mathrm{Na}})\dddot{\mathrm{Si}}+\overline{\dddot{\mathrm{Al}}}\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$=Silica 46·87, alumina 25·79, lime 14·30, water 13·54 =100, Scolecite. Rose makes the two, distinct species.

Analyses: 1, Klaproth, (Beit. v, 44); 2—5, Fuchs, (Schw. J. viii and xviii); 6, Thomson, (Min. i, 317); 7, Kobell, (J. f. pr. Chem. xiii, 7); 8, Riegel, (Jahrb. Pharm. xiii); 9, 10, 11, Scheerer, (Pogg. lxv, 276); 12, Thomson, (Min. i, 338); 13—15, Fuchs and Gehlen, (Schw. J.); 16, Guillemin, (Ann. d. Mines, xii, 8); 17, Riegel, (J. f. pr. Chem. xl, 317); 18, Gibbs, (Pogg. lxxi, 565); 19, Gülich, (Pogg. lix, 373); 20, Berzelius, (Jahresb. iii, 147); 21—24, Fuchs and Gehlen, (Schw. J.); 25, Riegel, (loc. cit.); 26, Thomson, (Phil. Mag. 1840).

I. *Natrolite, or Soda-mesotype.*

	$\dddot{\mathrm{Si}}$	$\overline{\dddot{\mathrm{Al}}}$	$\overline{\dddot{\mathrm{Fe}}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
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. " "	48·17	26·51	—	16·12	9·17, $\dot{\mathrm{Ca}}$ 0·17=100·10, Fuchs.
5. Tyrol, *massive,*	48·63	24·82	0·21	15·69	9·60=98·95, Fuchs.
6. Antrim, *cryst.*	47·56	26·42	0·58	14·93	10·44, $\dot{\mathrm{Ca}}$ 1·4=101·33, Thomson.
7. Greenland, *massive,*	46·94	27·00	—	14·70	9·60, $\dot{\mathrm{Ca}}$ 1·8=100·04, Kobell.
8. Högau,	48·05	25·80	2·10	15·75	9·00=100·70, Riegel.
9. *Bergmannite, red,*	47·97	26·66	0·73	14·07	9·77, $\dot{\mathrm{Ca}}$ 0·68, $\dot{\mathrm{K}}$ *trace*=99·88, S.
10. " *white,*	48·12	26·96	0·22	14·23	10·48, " 0·69, $\dot{\mathrm{K}}$ " =100·7, S.
11. *Radiolite,*	48·38	26·42	0·24	13·87	9·42, " 0·44, $\dot{\mathrm{K}}$ 1·54=100·31, S.
12. *Lehuntite,*	47·33	24·00	—	13·20	13·60, " 1·52=99·65, Thomson.

II. *Scolecite, or Lime-mesotype.*

	$\dddot{\mathrm{Si}}$	$\overline{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
13. Iceland,	48·94	25·99	10·44	—	13·90=99·26, Fuchs and Gehlen.
14. Faroe, *cryst.*	46·19	25·88	13·86	0·48	13·62=100·03, " "
15. Staffa, *feathery,*	46·75	24·82	14·20	0·39	13·64=99·80, " "
16. Auvergne,	49·00	26·50	15·30	—	9·00=99·80, Guillemin.
17. Niederkirchen,	48·16	23·50	14·50	0·80	13·50=99·96, Riegel.
18. Iceland,	46·72	25·90	13·71	—	13·67=100, Gibbs.
19. "	46·76	26·22	13·68	—	13·94=100·6, Gülich.

III. *Mesolite, or Lime-and-soda-mesotype.*

20. Faroe,	46·80	26·50	9·87	5·40	12·30=100·87, Berzelius.
21. " *cryst.*	47·00	26·13	9·35	5·47	12·25=100·20, Fuchs and Gehlen.
22. Iceland, *feathery,*	46·78	25·66	10·06	4·79	12·31=99·60, " "
23. "	47·46	25·35	10·04	4·87	12·41=100·13, " "
24. Tyrol,	46·04	27·00	9·61	5·20	12·36=100·21, " "
25. Niederkirchen,	46·65	27·40	9·26	4·91	12·00=100·22, Riegel.
26. Giant's Causeway,	48·88	26·36	7·64	4·20	12·32, $\dot{\mathrm{Mg}}$ 2·46=101·86, Thomson.

The *Lehuntite* of Thomson contains $3\dot{\mathrm{H}}$, like the scolecites, although a soda-mesotype.

B.B. natrolite becomes opaque and is often phosphorescent; it fuses quietly to a glassy globule. 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 translucent bead. Both varieties gelatinize readily with acids, and natrolite even after ignition. Scolecite is pyro-electric.

This species occurs in cavities in amygdaloidal trap, basalt, and other allied rocks; and sometimes in seams in granite or gneiss. Natrolite occurs 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.

Scolecite occurs at Tiegerhottue, 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; and at Pargas, Finland; also in veins in Kilpatrick hills.

In North America, natrolite occurs in the trap of Nova Scotia; at Cheshire, Ct., sparingly; at Washington, Ct. in seams between hornblende rock and gneiss; at Bergen Hill, N. J.

Poonahlite, (Brooke, Ann. Phil. Aug. 1831).—Trimetic, M : M 92° 20′, or like mesotype, and probably the same species. H.=5—5·5. G.=2·1622. Vitreous and white; transparent and translucent.

Composition.—$3\dot{\mathrm{C}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}+5\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+12\dot{\mathrm{H}}$=Silica 45·07, alumina 31·33, lime 10·43, water 13·17. Analysis by Gmelin, (Pogg. xlix, 538, 1840):

$\dddot{\mathrm{S}}\mathrm{i}$ 45·120, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 30·446, $\dot{\mathrm{C}}\mathrm{a}$ 10·197, $\dot{\mathrm{N}}\mathrm{a}$ and *trace* of $\dot{\mathrm{K}}$ 0·657, $\dot{\mathrm{H}}$ 13·386=99·806.

From Poonah, Hindostan.

Mesole. Brevicite. Harringtonite.—Mesole occurs in implanted globules, with a flat columnar radiate structure. H.=3·5. G.=2·35—2·4. Lutre 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 $(\dot{\mathrm{N}}\mathrm{a}, \dot{\mathrm{C}}\mathrm{a})^3\dddot{\mathrm{S}}\mathrm{i}^2+3\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+8\dot{\mathrm{H}}$ (or $6\dot{\mathrm{H}}$).

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, Sonden, (Pogg. xxxiii, 112); 7, 8, Thomson, (Min. i, 329):

	$\dddot{\mathrm{S}}\mathrm{i}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{H}}$
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. *Brevicite*,	43·88	28·39	6·88	10·32	9·63, $\dot{\mathrm{M}}\mathrm{g}$ 0·21, Sonden.
7. *Harringtonite*,	44·96	26·85	11·01	5·56	10·28 $\dot{\mathrm{F}}\mathrm{e}$ 0·88=99·54, T.
8. "	44·89	28·48	10·68	5·56	10·28=99·85, Thomson.

Brevicite and Harringtonite contain $6\dot{\mathrm{H}}$.

Brevicite is from Brevig in Norway, and is supposed to be the same as radiolite, p. 201. Harringtonite occurs in amygdaloid in the north of Ireland. Mesole occurs at the Faroe Islands; also at Disco Island, Greenland; in Iceland, and elsewhere.

Antrimolite, (Thomson, Min. i, 326).—In white silky fibrous stalactites, about as large as the finger, hanging in cavities in amygdaloid. The stalactites often contain a central nucleus of calc spar. Fibres diverging from the central axis, opaque and with little lustre. H.=3·75. G.=2·096.

Composition:

$\dddot{\mathrm{S}}\mathrm{i}$ 43·47, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 30·26, $\dot{\mathrm{C}}\mathrm{a}$ 7·50, $\dot{\mathrm{K}}$ 4·10, $\dot{\mathrm{F}}\mathrm{e}$ 0·19, Cl 0·098, $\dot{\mathrm{H}}$ 15·32.

B.B. forms an enamel without intumescence. Yields water in a matrass. Gelatinizes with muriatic acid.

Occurs in Antrim, Ireland, on the seashore at Bengane, about four miles east from the Giant's Causeway.

Ozarkite, (Am. J. Sci. [2], ii).—The *Ozarkite* of Shepard is referred by J. D. Whitney to Scolecite. The mineral is white or flesh-red, with at times some appearance of lamination, and occurs in veins or masses in Elæolite, from which it is separated by a portion hard and siliceous, and then a thin red layer, which is jasper-like in appearance. It gave the blowpipe and acid tests of scolecite. It appears to be mixed at times with apatite, massive or crystallized. A specimen of this character examined by Mr. G. J. Brush in the Yale Laboratory, afforded considerable phosphoric acid. A somewhat different specimen of a pure white color, associated with the Brookite (Arkansite) of the same locality, and closely zeolitic in appearance, with some acicular crystallizations, proved to be apatite in minute hexagonal prisms thickly aggregated and imbedded in an uncrystallized material of the same color, which was not sufficient in quantity for examination. Trials afforded scarcely any alumina. Shepard inferred from his trials that the ozarkite was a siliceous hydrate of lime and yttria, with possibly traces of thorina.

The ozarkite comes from the Ozark Mts., Arkansas.

LAUMONITE, *Haüy*. Lomonite, *W.* Laumontit, *L.* Efflorescing Zeolite.

Monoclinic; M : M=86° 15′; 84° 30′ and 95° 30′, Dufrénoy; P : M=114° 54′. Forms similar to fig. 97, pl. 2: also with the edge between each M and ă replaced. Cleavage orthodiagonal, perfect; also parallel to M. 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; streak uncolored. Transparent—translucent; becomes opaque and usually pulverulent on exposure. Fracture scarcely observable, uneven. Not very brittle.

Composition.—$\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{S}}\mathrm{i}^2+4\ddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}^2+18\dot{\mathrm{H}}$, Berz.=Silica 50·49, alumina 22·47, lime 9·34, water 17·70, which seems to prove the species to be chemically identical with Harmotome and Phillipsite, except in the value of $\dot{\mathrm{R}}$. $\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{S}}\mathrm{i}+3\ddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}^2+12\dot{\mathrm{H}}$, Gerhardt,=Silica 51·58, alumina 21·49, lime 11·92, water 15·06=100.

Analyses: 1, Vogel, (J. de Phys. lxxi, 64); 2. Gmelin, (Leonh. Tasch. Min. xiv, 408); 3, 4, Dufrénoy, (Ann. d. Mines, [3], viii, 503); 5, Connel, (Edinb. Jour. 1829, 282); 6, 7, Babo and Delffs, (Poggendorff's Ann. lix, 339); 8, Malaguti and Durocher, (Ann. d. Mines, [4], ix, 325):

	$\dddot{\mathrm{S}}\mathrm{i}$	$\ddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{H}}$
1. Huelgoet,	49·00	22·00	9·00	17·5, $\ddot{\mathrm{C}}$ 2·5=100, Vogel.
2. "	48·30	33·70	12·10	16·0=99·1, Gmelin.
3. Phipsburg, Me.,	51·98	21·12	11·71	15·05=99·86, Dufrénoy.
4. Cormayeur,	50·38	21·43	11·14	16·15=99·10, Dufrénoy.
5. Skye,	52·04	21·14	10·62	14·92=98·72, Connel.
6.	52·30	22·30	12·00	14·2=100·8, Babo.
7.	51·17	21·23	12·43	15·17 (loss)=100, Delffs.
8. Huelgoet, G.=2·290.	52·47	22·56	9·41	15·56=100, M. and D.

Malaguti and Durocher state that as part of the water is hygroscopic, 15$\dot{\mathrm{H}}$ will more correctly represent it in the first of the above formulas.

B.B. intumesces and fuses to a frothy mass. With borax forms a transparent globule. Gelatinizes with nitric or muriatic acids, but is not affected by sulphuric acid, unless heated.

Laumonite 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.

Good laumonite is obtained at Phipsburg, Maine, and the Charlestown quarries, Mass., in gneiss; also 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 also at Kewenaw Pt., Lake Superior, in amygdaloid; on north shore of Lake Superior, between Pigeon Bay and Fond du Lac; 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 exceedingly liable, may be prevented by dipping the specimen in a thin solution of gum Arabic, by means of which it is preserved from contact with the air. The change consists in a loss of 1 to 2 per cent. of hygroscopic water. By heat to 300° cent. one half the water is expelled, as ascertained by Malaguti and Durocher. Some varieties do not undergo this change.

Leonhardite, *Blum*, (probably a variety of Laumonite).—Monoclinic. M : M=83° 30′ and 96° 30′; P : M=114°. Cleavage parallel with M, 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. Whitens on exposure like Laumonite.

Composition.—$3\dot{\mathrm{Ca}}\overline{\mathrm{Si}}+4\overline{\overline{\mathrm{Al}}}\overline{\mathrm{Si}}^{2}+15\dot{\mathrm{H}}$—Silica 54·45, alumina 22·03, lime 9·06, water 14·46=100.

Analysis by Babo and Delffs, (Pogg. lix, 336, 339):

	$\overline{\mathrm{Si}}$	$\overline{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{H}}$
1.	56·128	22·980	9·251	11·641=100, Delffs.
2.	55·00	24·36	10·50	12·30=102·16, Babo.

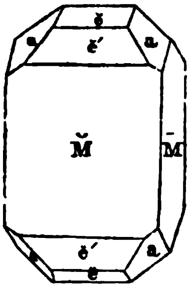
Delffs' analysis was made after drying the mineral at 100° cent.; dried at the ordinary temperature it gave 13·547—13·807 water, which corresponds to the above formula. B.B. exfoliates, froths, and easily melts to an enamel. Dissolves in acids.

From a trachytic rock at Schemnitz in Hungary.

HARMOTOME, *H.* Baryt-Harmotome. Staurolite, *Kirwan.* Andreolite. Andreasbergolite. Kreuzstein, *W.* Morvenite, *Thom.*

Trimetric. In modified rectangular prisms; a : a in same pyra-

1



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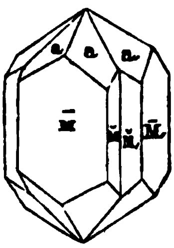


mid=121° 30′ and 89° 30′, ĕ : a=149° 33′, ĕ : ĕ=110° 30′, Descloiseaux, 110° 20′, Levy, M̆ : ĕ=124° 45′, a : a in different pyramids 119° 06′, Descloiseaux. Cleavage parallel to M̆ and M̄ imperfect. Compound crystals like fig. 2, composed of four individuals of frequent occurrence. Also in twins consisting of three individuals crossing at 90°, and producing nearly the form of the rhombic dodecahedron. Rarely massive.

H.=4—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.

Composition.—$\dot{\mathrm{Ba}}^{3}\overline{\mathrm{Si}}^{2}+4\overline{\overline{\mathrm{Al}}}\overline{\mathrm{Si}}^{2}+18\dot{\mathrm{H}}$, Kobell=Silica 48·14, alumina 17·85, baryta 19·94, water 14·07. Analyses: 1, 2, 3, Köhler, (Pogg. xxxvii, 561); 4, 5, Rammelsberg, (Handw. i, 290); 6, Connel, (Ed. N. Phil. J. 1832, July, 33); 7, Damour, (Ann. des M. [4], ix, 336, and Compt. Rend. xxii, 745); 8, 9, Damour, (Ann. d. Mines, [4], ix, 345):

	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dot{Ba}$	$\dot{Ca}$	$\dot{K}$	$\dot{\bar{H}}$
1. Andreasberg,	46·63	16·82	20·32	0·26	1·02	15·03=100·08, Köhler.
2. Strontian,	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. "	48·68	16·83	20·09	—	—	14·68=100·28, "
6. Strontian,	47·04	15·24	20·85	0·10	0·88	14·92, $\dot{Na}$ 0·84, $\dddot{\bar{Fe}}$ 0·24=100·11, C.
7. "	47·74	15·68	21·06	—	0·78	13·19, $\dot{Na}$ 0·80, $\dddot{\bar{Fe}}$ 0·51=99·76, D.
8. *Morvenite*,	47·60	16·39	20·86	—	0·81	14·16, $\dot{Na}$ 0·74, $\dddot{\bar{Fe}}$ 0·65=101·21, D.
9. "	47·59	16·71	20·45	—	—	14·16, $\dddot{\bar{Fe}}$ 0·56=99·47, Damour.

Damour endeavors to make out the formula $\dot{R}\dddot{Si}+\dddot{\bar{Al}}\dddot{Si}^3+6\dot{\bar{H}}$, corresponding to that of Stilbite, which requires 50·38 silica, and but 14·02 alumina, with 20·87 baryta, and 14·73 water.

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, also on gneiss and in metalliferous veins traversing gray-wacke.

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. Fine crystallizations occur on Isle Royal, Lake Superior, often on datholite.

Morvenite occurs with harmotome at Strontian, Scotland, and is distinguished by its more brilliant crystals. Damour and Descloiseaux have proved its identity with harmotome. (Ann. d. M. [4], ix, 339).

PHILLIPSITE, *Levy*, Ann. Phil. 2d ser. x, 362. Lime-Harmotome. Christianite, *Descloiseaux*.

Trimetric. Simple and compound crystals like those of harmotome. a : a=120° 4′, 121° 20′, and 88° 40′, Marignac; 122° 54′ and 85° 2′, Brooke; 122° 58′ and 85° 40′, Phillips.

H.=4—4·5. G.=2—2·2; 2·213, Marignac. Lustre vitreous. Color white, sometimes reddish. Streak uncolored. Translucent —opaque.

Composition.—$(\dot{Ca}, \dot{K})^3\dddot{Si}^2+4\dddot{\bar{Al}}\dddot{Si}^2+18\dot{\bar{H}}$, Köhler; $\dot{R}^3\dddot{Si}^2+3\dddot{\bar{Al}}\dddot{Si}^2+15\dot{\bar{H}}$, Rammelsberg, after Connel's analysis; $2(\dot{Ca}, \dot{K})\dddot{Si}+2\dddot{\bar{Al}}\dddot{Si}+7\dot{\bar{H}}$, Marignac, (giving $\dddot{Si}$ 43·41).

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):

	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dot{Ca}$	$\dot{K}$	$\dddot{\bar{Fe}}$	$\dot{\bar{H}}$
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	$\dot{Na}$ 3·70	16·96=100·21, Connel.
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	0·24	16·62, $\dot{Na}$ 0·63, $\dot{Ba}$ *trace*=100·35, G.

The oxygen relation in these analyses varies, (see Rammelsberg, 3d Supp. p. 51):

	$\dot{R}$	$\dddot{\bar{Al}}$	$\dddot{Si}$	$\dot{\bar{H}}$
1. Vesuvius, *Marignac*,	1	: 3·05	: 6·08	: 3·59
2. Ireland, *Connel*,	1	: 3·14	: 7·66	: 4·65
3. Marburg, *Genth*,	1	: 3·05	: 7·82	: 4·56
4. " *Gmelin*,	1	: 3·45	: 8·36	: 5·04
5. " *Köhler*,	1	: 4·04	: 10·4	: 5·9
6. Cassel, "	1	: 4·02	: 9·24	: 5·76

B.B. intumesces somewhat, and fuses like other zeolites. Pulverized, dissolves very easily in muriatic acid and gelatinizes.

This species was united with the preceding, which it very much resembles, until Levy pointed out its peculiarities, and gave it the name it bears, in honor of Mr. W. Phillips. It differs chemically from harmotome in containing lime and potash, instead of baryta.

Phillipsite occurs in large translucent crystals in the cavities of amygdaloid, in the Giant's Causeway in Ireland, and in sheaf-like aggregations at Capo di Bove, near Rome; also in long crystals aggregated in radiating masses, at Aci Reale on the eastern coast of Sicily; among the Vesuvian lavas; and in the island Magee, county Antrim, in minute flesh-red crystals, coating cavities of amygdaloid.

Descloiseaux has proposed to separate the Marburg harmotome, and unite it with crystals from an amygdaloid in Iceland, under the name of *christianite.*

To phillipsite, Kobell and Brooke have referred the *seagonite*, from Capo di Bove near Rome. But Marignac infers that Kobell must have analyzed phillipsite mixed with seagonite, and shows that Brooke cannot be right in his deduction.

FAUJASITE, *De Dree.*

Dimetric. In square octahedrons, having the angles 111° 30′ and 105° 30′. Scratches glass easily. G.=1·923. Colorless—brown. Fracture vitreous and uneven.

Composition.—$(\dot{C}a, \dot{N}a)^2\dddot{S}i^4+3\bar{A}l\dddot{S}i^2+24\dot{H}$.

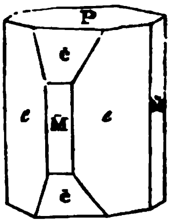
Analysis by Damour, (Ann. des Mines, [4], i, 395):

$\dddot{S}i$ 49·36, $\bar{A}l$ 16·77, $\dot{C}a$ 5·00, $\dot{N}a$ 4·34, $\dot{H}$ 22·49=97·96.

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 Breisgau. It was named by Damour, in honor of Faujas de Saint Fond.

THOMSONITE, *Brooke.* Mesotype (in part) of *Haüy.* Needle Zeolite (in part) of *Werner.* Comptonite. Chalilite, *Thom.* Triploklas, *Br.*



Trimetic; $\bar{M}$: e=135° 20′, $\breve{M}$: e=134° 40′, P : $\bar{e}$ =125°. Cleavage parallel to $\bar{M}$ and $\breve{M}$ easily obtained. Also columar, structure radiated; also amorphous.

H.=5. G.=2·3—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.—$(\dot{C}a, \dot{N}a)^3\dddot{S}i+3\bar{A}l\dddot{S}i+7\dot{H}$, [or $7\frac{1}{2}\dot{H}$], Ramm., from his own analysis and that by Retzius=Silica 37·8, alumina 31·5, lime 13·0, soda 4·8, water 12·9.

Analyses: 1, Berzelius, (Jahresb. ii, 96); 2, 3, 4, Thomson, (Min. i, 315); 5, Retzius, (Jahresb. iv, 154); 6, Zippe, (Verh. Ges. Mus. Böhm., v. 1836, 39); 7, Rammelsberg, (Pogg. xlvi, 288); 8, Melly, (Bib. Univ. N. S. xv, 193):

	$\dddot{S}i$	$\bar{A}l$	$\dot{C}a$	$\dot{N}a$	$\dot{K}$	$\dot{H}$
1. Kilpatrick,	38·30	30·70	13·54	4·53	——	13·10=100·17, Berzelius.
2. "	37·08	33·02	10·75	3·70	——	13·00=97·55, Thomson.
3. Lochwinnoch,	36·80	31·36	15·40	——	——	13·00, $\dot{M}g$ 0·2, $\dot{F}e$ 0·6=97·36, T.
4. "	37·56	31·26	15·10	——	——	13·20, $\dot{M}g$ 1·08, $\dot{F}e$ 0·72=99·62, T.
5. Faroe,	39·20	30·05	10·58	8·11		13·40, $\dot{F}e$ 0·5=101·84, Retzius.
6. Seeberg,	38·25	32·00	11·96	6·53	——	11·50=100·24, Zippe.
7. "	38·74	30·84	13·43	3·85	0·54	13·10=100·50, Ramm.
8. Elbogen,	37·00	31·07	12·60	6·25	——	12·24=99·16, Melly.

According to Frankenheim, Thomsonite is isomorphous with Harmotome.

Intumesces before the blowpipe, 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 (shown by Rammelsberg to be thomsonite) 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, and in Faroe.

Long slender prismatic crystallizations of a grayish white color are obtained at Peter's Point, Nova Scotia, where it is associated with apophyllite, mesotype, laumonite, and other trap minerals.

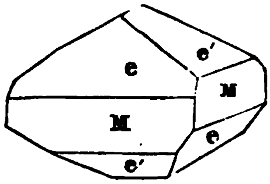
Chalilite of Thomson (Min. i, 324) may be an impure massive thomsonite. It contains

$\dddot{\mathrm{Si}}$ 36·56, $\bar{\dddot{\mathrm{Al}}}$ 26·20, $\dot{\mathrm{Ca}}$ 10·28, $\dot{\mathrm{Na}}$ 2·72, $\dot{\mathrm{H}}$ 16·66, $\bar{\dddot{\mathrm{Fe}}}$ 9·28=101·70.

From the Donegore Mountains, in the county of Antrim. Color deep reddish-brown.

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. 1840, Dec. 402).

EDINGTONITE, *Haid.*, Brewster's Edingburgh Jour. Sci. iii, 316. Antiedrit, *Breit.*



Dimetric. Form hemihedral, the upper and lower basal edges of the same lateral face being differently modified. M : e'=115° 26', e' : e' (over the summit) =129° 8', M : e=133° 39½', e : e (over the summit)=92° 41'. Cleavage parallel to M perfect.

H.=4—4·5. G.—2·7—2·75. Vitreous. Grayish-white. Streak uncolored. Translucent. Brittle.

Composition.—According to an imperfect analysis by Dr. Turner, (Brewster's J. iii 318):

$\dddot{\mathrm{Si}}$ 35·09, $\bar{\dddot{\mathrm{Al}}}$ 27·69, $\dot{\mathrm{Ca}}$ 12·68, $\dot{\mathrm{H}}$ 13·32, with probably 10·0—11·0 $\dot{\mathrm{K}}$ or $\dot{\mathrm{Na}}$.

The quantity of the mineral subjected to analysis was too small to afford confident results. At a high heat, before the blowpipe, it fuses to a colorless mass, having first given off water, and become white and opaque.

Edingtonite was first observed by Haidinger, in small but distinct crystals, on a specimen of thomsonite from Dumbartonshire, in the collection of Mr. Edington, of Glasgow. It is extremely rare.

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.—($\dot{\mathrm{Ca}}$, $\dot{\mathrm{Na}}$) $^{2}\dddot{\mathrm{Si}}$+2($\bar{\dddot{\mathrm{Al}}}$, $\bar{\dddot{\mathrm{Fe}}}$) $\dddot{\mathrm{Si}}$+3$\dot{\mathrm{H}}$=Silica 38·26, alumina 24·31, peroxyd of iron 6·31, lime 19·97, soda 3·70, water 7·45=100.

Analysis by Whitney, (loc. cit.):

$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\bar{\dddot{\mathrm{Fe}}}$, little $\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
36·99	25·49	6·48	19·90	8·70	0·40	7·22=100·18.

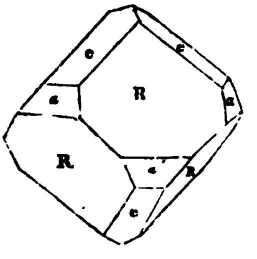
In an open tube yields water and becomes white. B.B. fuses easily with intumescence to a grayish blebby glass. Soluble in muriatic acid, giving a flocky precipitate of silica. Forms a transparent glass readily with borax, tinged with iron; a blue with cobalt solution.

Occurs on the shores of Isle Royale, Lake Superior, in small rounded pebbles. It receives a fine polish, and may be used in jewelry.

CHABAZITE. Chabasie, *P. L.* and *H.* Schabasit, *W.* Chabasin, *Haid.* Levyne. Gmelinite, *Brewster.* Mesolin. Hydrolite, *De Dree.* Sarcolite, *Vauq.* Phacolite, *Breit.* Ledererite, *Jackson.* Acadiolite, *Alger* and *Jackson.*

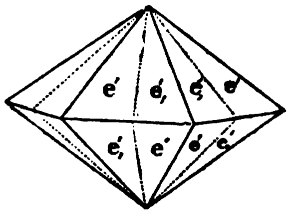
Rhombohedral. R : R=94° 46′. Usual forms rhombohedrons nearly like cubes, more or less modified, double six-sided pyramids, and six-sided pyramids with pyramidal terminations. R : e=137° 23′, e : e=125° 18′; R : a=126° 26½′, R : e (over *a*)=83° 31′, e′ : e′ (over basal edge, fig. 2)=71° 48′, e′ : e′ (over a terminal edge)=145° 54′. The inclination of R on a'' (over *a*) in Gmelinite (fig. 3) is stated by Brewster at 83° 36′, by Rose at 80° 54′.

1



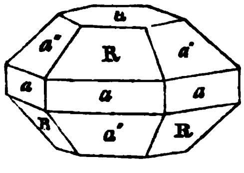
Chabazite.

2



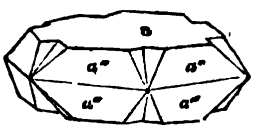
Chabazite, Phacolite.

3



Gmelinite.

4



Levyne.

Compound crystals: composition parallel with a, and often several times repeated, as in figure 4; a‴ : a‴ (over the base)=125° 12′; also in twins compounded parallel with R. Plane a often curved or striated, and *a* in figure 3 horizontally striated; the edges of the pyramids, (figs. 2 and 3), often a series of striæ. Cleavage rhombohedral, rather indistinct.

H.=4—4·5. G.=2·08—2·17, var. chabazite, Tamnau; 2·076, 2·088, two chabazites, Thomson; 2·06, var. gmelinite, Rammelsberg, and herschelite, Damour; 2·161, levyne, Thomson; 2·169, ledererite, Hayes. Lustre vitreous. Color white, flesh-red; streak uncolored. Transparent—translucent. Fracture uneven. Brittle.

Composition.—$(\dot{Ca}, \dot{Na}, \dot{K})^3\bar{Si}^2+3\ddot{\bar{Al}}\bar{Si}^3+18\dot{H}$; for herschelite, hydrolite, and some levynes, the same with $15\dot{H}$; for the Parsboro and Gustafsberg chabazite, and also the acadiolite, $(\dot{Ca}, \dot{Na}, \dot{K})\bar{Si}+\ddot{\bar{Al}}\bar{Si}^3+6\dot{H}$. 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, Connel, (Edinb. J. Sci. 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, Arfvedson, (Jahresb. iii, 147); 15, 16, Berzelius, (ib. 146, and v, 216); 17, Connel, (Phil. Mag. v, 50); 18, 19, Rammelsberg, (Pogg. lxii, 149); 20, Anderson, (Jameson's Jour. 1843, 23); 21, 22, Damour, (Ann. d. Mines, [4], ix, 333); 23, 24, Vauquelin, (Ann. d. Mus. ix and xi); 25, Connel, (Edinb. New Phil. J. 1838); 26, 27, Rammelsberg, (Pogg. xlix, 211); 28, 29, Damour, (Ann. Ch. Phys. [3], xiv, 97); 30, A. A. Hayes, (Am. J. Sci. xxv, 78):

	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dot{Ca}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
I. *Chabazite, Acadiolite.*						
1. Parsboro, N. S.	51·46	17·65	8·91	1·09	0·17	19·66, $\dddot{\bar{Fe}}$ 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=99·98, 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=99·68, Durocher.
9. Annerode,	47·00	19·71	10·63	0·65	0·33	22·29, $\dddot{\bar{Fe}}$ 0·15=100·76, Genth.
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, $\dot{Mg}$ 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, "
II. *Levyne, Mesolin, Phacolite.*						
14. Faroe, *Levyne,*	48·38	19·28	8·70	—	2·50	21·14=100, Arf.
15. " "	48·00	20·00	8·35	2·86	0·41	19·30, $\dot{Mg}$ 0·4=99·32, Berz.
16. " *Mesolin,*	47·50	21·40	7·90	4·80	—	18·19=99·79, Berz.
17. Skye, *Levyne,*	46·30	22·47	9·72	1·55	1·26	19·51, $\dot{Fe}$, $\dot{Mn}$ 0·96=102·07, C.
18. Leipa, *Phacolite,*	46·46	21·45	10·45	0·95	1·29	19·40=100, Rammelsberg.
19. " "	46·20	22·80	10·34	1·77		19·05, $\dot{Mg}$ 0·34=100, Ramm.
20. " "	45·63	19·48	13·30	1·68	1·31	17·98, $\dot{Mg}$ 0·14, $\dddot{\bar{Fe}}$ 0·43=99·96, Rammelsberg.
21. Iceland, *Levyne,*	45·04	21·04	9·72	1·42	1·63	17·49=99·34, Damour.
22. " "	45·76	23·56	10·57	1·36	1·64	17·33=100·22, Damour.*
III. *Gmelinite, (Sarcolite, Hydrolite), Herschelite.*						
23. Mont. Maggiore,	50·0	20·0	4·5	4·5	—	21·0=100, Vauquelin.
24. Castel,	50·00	20·00	4·25	4·25	—	20·00=98·50, Vauquelin.
25. Glenarm,	48·56	18·05	5·13	3·85	0·39	21·66, $\dddot{\bar{Fe}}$ 0·11=98·75, Con.
26. "	46·40	21·09	3·67	7·29	1·60	20·41=100·47, Rammelsberg.
27. "	46·56	20·19	3·89	7·09	1·87	29·41=100·02, "
28. *Herschelite,*	47·39	20·90	0·38	8·33	4·39	17·84=99·23, Damour.†
29. "	47·46	20·18	0·25	9·35	4·17	17·65=99·06, "
IV. *Ledererite.*						
30. Nova Scotia,	49·47	21·48	11·48	3·94	—	8·58, $\dddot{P}$ 3·48, $\dddot{\bar{Fe}}$ 0·14=98·57, Hayes.

B.B. intumesces and fuses to a blebby glass, nearly opaque. Dissolves in muriatic acid, when pulverized; and Gmelinite gelatinizes.

The crystals of *Levyne*, a compound form of which is shown in fig. 4, afford faces of the three rhombohedrons 106° 4′, 70° 7′, and 79° 29′, of which the last was taken for the primary; but all may be secondaries to chabazite. *Gmelinite* included crystals presenting the form of double six-sided pyramids, (figs. 2 and 3). The *Ledererite* of Jackson, from Cape Blomidom, presents the same form as Gmolinite; as Rammelsberg states, it

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* Damour deduces the formula $\dot{R}\dddot{Si}+\dddot{\bar{Al}}\dddot{Si}+4\dot{H}$, which gives but 43·68 silica. The lime is to the alkalies as 5 : 1. He considers the species distinct from Chabazite.

† The analysis affords the formula, $(\dot{Na}, \dot{K})^3\dddot{Si}^2+3\dddot{\bar{Al}}\dddot{Si}^2+15\dot{H}$.

has the same chemical formula as chabazite, excepting one-third the amount of water. *Phacolite* also has nearly the same form as Gmelinite, (fig. 2). R : R for Phacolite is given at 94° by Breithaupt.

Herschelite occurs in double six-sided pyramids, with the angles at the pyramidal edges 124° 45′, and the base on the pyramidal faces 132° nearly. Fracture vitreous, with no trace of cleavage, Damour. Fuses slowly to a white enamel. Attacked by acids, which leave a siliceous residue. It contains soda and potash in place of lime, and 15$\dot{\text{H}}$.

The *Acadiolite* has the simple rhombohedral form of chabazite; the color is red though passing into white. In some crystals it is arranged in a tesselated manner, the angles being nearly colorless.

Chabazite occurs mostly in trap, basalt, or amygdaloid, and occasionally in gneiss, syenite, and mica slate.

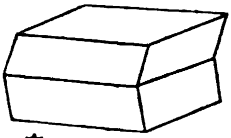
Fine crystallizations occur at the Faroe Islands, Greenland, and Iceland, associated with chlorite and stilbite; also at Aussig in Bohemia, in a kind of greenstone, (the *graustein* of Werner); at Annerode near Giessen; also at the Giant's Causeway, Kilmalcolm, Renfrewshire, Isle of Skye, &c. In Nova Scotia it occurs in fine crystals, often highly modified, of a wine-yellow or flesh-red color, and is associated with heulandite, analcime, and calcareous spar. The variety *Levyne* occurs in trap at the little Deer Park of Glenarm, Scotland; also at Skagastrand, Iceland; at Dalsnypen, Faroe, with chabazite, analcime, and Heulandite; at Godhavn, Disco Island, Greenland, and occasionally in large crystals at Hartfield Moss, in Renfrewshire. *Gmelinite* is found at Montecchio Maggiore and at Castel in the Vicentine, in the cavities of amygdaloidal rocks; also in the county of Antrim, at the Deer Park of Glenarm, of a white color, and at the Island Magee, near Larne, of a pale flesh-red. *Ledererite* was obtained by Jackson and Alger at Cape Blomidon, Nova Scotia, where it occurs in basalt associated with stilbite, mesotype, and analcime; the crystals are usually implanted on analcime or stilbite. *Phacolite* occurs at Leipa in Bohemia.

Herschelite occurs in the cavities of trap, at Aci Reale near Catania, Sicily, along with Phillipsite. The crystals are generally aggregated in a manner similar to those of Prehnite.

Acadiolite comes from Nova Scotia, where it was first procured by Jackson and Alger.

Chabazite occurs both massive and crystallized at the Paugatuck stone-quarry, Stonington, Conn., associated with scapolite, sphene, and apatite; also of a yellowish-red color 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 sometimes having the edges and angles rounded; and in the same rock at Piermont, N. Y.

Phacolite has been reported from New York Island.



HAYDENITE, *Cleaveland*.—This is probably nothing but chabazite. Levy reports the crystals as oblique rhombic prisms, with P : M=96° 5′, and M : M=98° 22′. They are often compounded as in the figure. The lustre is vitreous, and the color a brownish, greenish, or wine-yellow.

Composition.—According to Delesse, (Revue Scientifique xxv, 107); and Silliman, (Last Edit. 617):

$\dddot{\text{Si}}$ 49·5, $\ddot{\bar{\text{A}}}\text{l}$ and $\ddot{\bar{\text{F}}}\text{e}$ 28·5, $\dot{\text{Ca}}$ 0·27, $\dot{\text{Mg}}$ *trace*, $\dot{\text{K}}$ 0·25, $\dot{\text{H}}$ 21·0=99·2, D.
56·83, " 12·34, $\dot{\text{Fe}}$ 8·04, 8·42, 3·96, 2·39, 8·90=100·88, S.

It occurs coating hornblendic gneiss in fissures at Jones' Falls, a mile and a half from Baltimore. The crystals seldom exceed a line in length, and are nearly rhombs in shape. They are usually coated with a brownish-green hydrate or iron, which is easily separated, and leaves the surface smooth and bright. Occasionally crystals are met with, consisting wholly of this hydrate of iron. The haydenite is associated with heulandite in minute crystals.

CAPORCIANITE, *Savi*, *Anderson*, Jameson's Jour., 1842, p. 21.—Grayish-red, and forming radiating masses.

Composition.—Perhaps $\dot{\text{Ca}}^3\dddot{\text{Si}}^2+3\ddot{\bar{\text{A}}}\text{l}\dddot{\text{Si}}^2+9\dot{\text{H}}$, or a chabazite with half the usual water. More exactly $2\dot{\text{Ca}}\dddot{\text{Si}}+\ddot{\bar{\text{A}}}\text{l}^2\dddot{\text{Si}}^3+6\dot{\text{H}}$=Silica 51·93, alumina 23·11, lime 12·81, water 12·15. Analysis by Anderson:

$\dddot{\text{Si}}$ 52·8, $\ddot{\bar{\text{A}}}\text{l}$ 21·7 $\ddot{\bar{\text{F}}}\text{e}$ 0·1, $\dot{\text{Ca}}$ 11·3, $\dot{\text{Mg}}$ 0·4, $\dot{\text{K}}$ 1·1, $\dot{\text{Na}}$ 0·2, $\dot{\text{H}}$ 13·1=100·7.

From Tuscany, near Monti Catini.

ZEAGONITE, *Gismondi.* Gismondine, *Beud.* Abrazite, *Breislak.*

Probably dimetric. In octahedrons, either separate or clustered into mammillated forms with a drusy surface; A : A basal 92° 30′, pyramidal 118° 30′, Marignac.

H.=4·5. G.=2·265. Bluish white, grayish, reddish. Lustre splendent. Transparent to translucent.

Composition.—$(\dot{\mathrm{C}}\mathrm{a}, \dot{\mathrm{K}})\,{}^3\dddot{\mathrm{Si}}+2\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{Si}}+9\dot{\bar{\mathrm{H}}}$. Analysis by Marignac, (Ann. Ch. Phys. xiv, 41):

$\dddot{\mathrm{Si}}$ 35·88, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 27·23, $\dot{\mathrm{C}}\mathrm{a}$ 13·12, $\dot{\mathrm{K}}$ 2·85, $\dot{\bar{\mathrm{H}}}$ 21·10=100·18.

Easily dissolves in acids. 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; he found the angle at the base to vary from 93° 30′ to 89°, and the pyramidal edges from 117° to 122°; he consequently was not fully assured that the base was square. 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 with a different result, (J. f. pr. Chem. xviii, 105), and his specimen is supposed to have been a mixture of the two species. He found

$\dddot{\mathrm{Si}}$ 42·60, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$ 25·50, $\dot{\mathrm{C}}\mathrm{a}$ 7·50, $\dot{\mathrm{K}}$ 6·80, $\dot{\bar{\mathrm{H}}}$ 17·66=100·06.

Carpi must have examined some other species, (Pogg. v, 174).

ANALCIME. Cubizit, *W.* Cuboite, *Breit.* Analzim, *L.*

Monometric. Prevalent form the trapezohedron, fig. 16, pl. 1; also figs. 14, 15, 2, and 2 and 5 combined. Cleavage cubic, in traces. Also massive granular.

H.=5—5·5. G.=2·068, Haidinger; 2·278, Thomson. Lustre vitreous. Streak white. Color white; sometimes colorless; occasionally grayish, greenish, yellowish, or reddish-white. Transparent —nearly opaque. Fracture imperfectly subconchoidal, uneven. Brittle.

Composition.—$\dot{\mathrm{N}}\mathrm{a}^3\dddot{\mathrm{Si}}^2+3\dddot{\bar{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{Si}}^2+6\dot{\bar{\mathrm{H}}}$=Silica 55·08, alumina 22·96, soda 13·97, water 8·04. Analyses: 1, 2, H. Rose, (Gilb. Ann. lxxii, 181); 3, Henry, (Pogg. xlvi, 264); 4, Connel, (Edinb. J. Sci. 1829, 262); 5, Thomson, (Min. i, 438); 6, Awdejew, (Pogg. lv, 107); 7, 8, Riegel, (J. f. pr. Chem. xl, 317); 9, C. T. Jackson, (communicated):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\bar{\mathrm{H}}}$
1. Fassathal,	55·12	22·99	13·53	——	8·27=99·91, Rose.
2. "	56·47	21·98	13·78	——	8·81=100·99, Rose.
3. Blagodat, *Cuboite,*	57·34	22·58	11·86	0·35	9·00, $\dot{\mathrm{K}}$ 0·55=101·68, Henry.
4. Kilpatrick,	55·07	22·23	13·71	——	8·22=99·23, Connel.
5. Giant's Causeway,	55·60	23·00	14·65	——	7·90=101·15, Thomson.
6. Brevig,	55·16	23·55	14·23	——	8·26, $\dot{\mathrm{K}}$, $\dot{\mathrm{C}}\mathrm{a}$ *trace*=101·20, Awd.
7. Neiderkirchen,	57·50	23·15	6·45	5·63	8·00, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·10=100·83, Riegel.
8. "	56·12	24·00	6·45	5·82	8·00, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$ 0·15=100·54, Riegel.
9. Michigan,	53·40	22·40	8·52	3·00	9·70=97·02, J. G.=2·25—2·26.

B.B. fuses on charcoal, without intumescence, to a clear blebby glass. Gelatinizes in muriatic acid. Tinges flame yellow.

A variety of this species, having the last two forms above mentioned, has been called *Sarcoite;* and the *Cuboite* of Breithaupt has a similar form, a greenish-gray color, with distinct cleavage. G.=2·24—2·28.

The Cyclopean Islands, near Catania on the Sicilian coast, afford pellucid crystals of this species, of the form in figure 14; also the Tyrol; trapezohedral crystals occur in Dumbartonshire, the Kilpatrick Hills, Glen Farg; they are generally opaque, and sometimes have a diameter of three or four inches. Other localities are the Faroe Islands, Iceland, the Vicentine, 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 of this mineral. Crystals of the forms in figures 14 and 16, plate 1, occur at Bergen Hill, New Jersey. The gneiss near Yonkers, Westchester Co., N. Y., affords small trapezohedrons. Analcime occurs also at Perry, Maine, with apophyllite, in greenstone, and abundant in fine crystals, with prehnite, datholite, and calc spar, at Kewenaw Pt., Lake Superior.

The name *Analcime* is from *ἀναλκις*, *weak*, and alludes to its weak electric power when heated or rubbed.

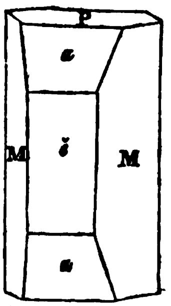
The *Cluthalite* of Thomson, (Min. i, 339), occurs in flesh-red vitreous crystals in amygdaloid at the Kilpatrick Hills. H.=3·5. G.—2·166. Opaque or subtranslucent. Fragile.

Composition:

$\dddot{\mathrm{Si}}$ 51·266, $\ddot{\bar{\mathrm{Al}}}$ 23·560, $\ddot{\bar{\mathrm{Fe}}}$ 7·306, $\dot{\mathrm{Na}}$ 5·130, $\dot{\mathrm{Mg}}$ 1·233, $\dot{\mathrm{H}}$ 10·553=99·048.

Berzeline is a doubtful species, found in minute white vitreous crystals, slightly translucent, along with black garnet in an augitic rock near La Ricia, in the Roman States. Fuses with difficulty to a pale glass. Gelatinizes with acids, (Necker de Saussure, Leonh. Jahrb. ii, 441).

PREHNITE, *Werner*. Koupholite. Edelith. Chiltonite, *Emmons*.



Trimetric. M : M=99° 56′, M : ĕ=130° 2′, P : a=106° 30′, ĕ : a=163° 30′. Cleavage basal, distinct. Tabular crystals often united by P, producing what appears to be a single crystal broken in several places, and somewhat rounded at its extremities. Often reniform, globular, and stalactitic shapes, with a crystalline surface. Structure columnar or lamellar, strongly coherent; also compact granular or impalpable.

H.=6—6·5. G.=2·8—2·953. Lustre vitreous, excepting P, which is pearly. Color various light shades of green, passing into white and gray. Subtransparent—translucent; streak uncolored. Fracture uneven. Somewhat brittle. Pyroelectric.

Composition.—$\dot{\mathrm{Ca}}^2\dddot{\mathrm{Si}}+\ddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}+\dot{\mathrm{H}}$=Silica 44·05, alumina 24·50, lime 27·16, water 4·29 =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); 10, 11, Leonhard, (Pogg. liv, 579):

	$\dddot{\mathrm{Si}}$	$\ddot{\bar{\mathrm{Al}}}$	$\ddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{H}}$
1. Tyrol,	43·00	23·25	2·00	26·00	4·00, $\ddot{\bar{\mathrm{Mn}}}$ 0·25=98·50, Geh.
2. Tyrol, Fassa,	42·88	21·50	3·00	26·50	4·62, $\ddot{\bar{\mathrm{Mn}}}$ 0·25=98·75, Geh.
3. Mt. Blanc, *Kouph.*	44·71	23·99	—	25·41	4·45, $\ddot{\bar{\mathrm{Mn}}}$ 0·19, $\dot{\mathrm{Fe}}$ 1·25=100, Walm.
4. Dumbarton,	44·10	24·26	—	26·48	4·18, $\dot{\mathrm{Fe}}$ 0·74=99·71, Walm.
5. Edelfors,	43·03	19·30	6·81	26·28	4·43, $\ddot{\bar{\mathrm{Mn}}}$ 0·15=100·20, Walm.
6. Glasgow, *green*,	43·60	23·00	2·00	22·33	6·40=97·33, Thomson.
7. Glasgow, *white*,	43·05	23·84	—	26·16	4·60, $\dot{\mathrm{Fe}}$ 0·64, $\dot{\mathrm{Mn}}$ 0·42, $\dot{\mathrm{K}}$ and $\dot{\mathrm{Na}}$ 1·03=99·74, Lehunt.
8. Bourg d'Oisans,	44·50	23·44	4·61	23·47	4·44=100·46, R.
9. Radauthal, Hartz,	44·74	18·06	7·38	27·06	4·13, $\dot{\mathrm{Na}}$ 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.

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, without gelatinizing. *Kouph-olite*, 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. It has since been discovered at numerous places in Europe, in Asia, and America, in granite, gneiss, and trap rocks.

At St. Christophe, in Dauphiny, it is associated with axinite and epidote; it also occurs in 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.

In the United States, finely crystallized specimens have been obtained at Farmington, Woodbury, and Middletown, Conn., and West Springfield, Mass., and Patterson and Bergen Hill, N. J. It occurs in small quantities in gneiss, at Bellows Falls, Vt., and in syenite, at Charlestown, Mass., Milk Row quarry, often in minute tabular crystals, associated with chabazite; also at Palmer (Three River) and Turner's Falls on the Connecticut, Mass., in greenstone, and at Perry, above Loring's Cove, Maine; on north shore of Lake Superior, between Pigeon Bay and Fond du Lac; and in large veins at Kewenaw Point, Lake Superior, and often there including strings or leaves of native copper.

Handsome polished slabs of this mineral have been cut from the masses brought from China.

The *Anhydrous Prehnite* of Whitney (Bost. Jour. Nat. Hist. v. 487) is described as having the constitution of prehnite, without the water. It occurs massive and compact, with traces of a radiate or lamello-radiate texture in the mass. Color white, with a tinge of green; lustre vitreous; translucent. H.=6. G.=2·881. Whitney obtained (loc. cit.)

$\dddot{\mathrm{Si}}$ 46·12, $\dddot{\overline{\mathrm{Al}}}$ and a little $\dddot{\overline{\mathrm{Fe}}}$ 25·91, $\dot{\mathrm{Ca}}$ 27·03, $\dot{\mathrm{Na}}$ 0·85=99·91.

This mineral has since been examined by Dr. C. T. Jackson, (as communicated to the author), who finds it to contain in two trials 4·7 and 4·15 per cent. of water; and according to an examination by Mr. G. J. Brush in the Yale Laboratory, the amount of water is 4·865 per cent. The mineral appears therefore to be identical with ordinary prehnite. It occurs with wollastonite and chlorastrolite at Kewenaw Point and Isle Royale, Lake Superior, and is often implanted in the former of these minerals.

HURONITE, (Thomson, Min. i, 384).—In spheroidal masses; granular or with an imperfect cleavage. H.=3·25. G.=2·86. Lustre pearly to greasy. Color light yellowish-green. Streak gray. Translucent.

Composition.—According to Thomson:

$\dddot{\mathrm{Si}}$ 45·80, $\dddot{\overline{\mathrm{Al}}}$ 33·92, $\dot{\mathrm{Fe}}$ 6·32, $\dot{\mathrm{Ca}}$ 8·04, $\dot{\mathrm{Mg}}$ 1·72, $\dot{\mathrm{H}}$ 4·16=97·96.

Infusible. With borax a greenish glass. Not attacked by acids. From the vicinity of Lake Huron.

CARPHOLITE, *W.* Karpholith.

In radiated and stellated tufts; fibres rather incoherent.

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.—$(\dot{\mathrm{Fe}},\dot{\mathrm{Mn}})^3\dddot{\mathrm{Si}}+3\dddot{\overline{\mathrm{Al}}}\dddot{\mathrm{Si}}+6\dot{\mathrm{H}}$. Analyses: 1, Stromeyer, (Untersuch. 410); 2, Steinmann, (Schweig. Jour. xxv, 413):

	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dddot{\overline{\mathrm{Mn}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{H}}$	
1.	36·15	28·67	19·16	2·29	10·78,	$\dot{\mathrm{Ca}}$ 0·27, HF 1·47=98·79, Strom.
2.	37·53	26·47	18·33	—	11·36,	$\dddot{\overline{\mathrm{Fe}}}$ 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.*

ALGERITE, *T. S. Hunt*, Am. J. Sci. 2d series, viii, 103.

Monoclinic. In rhombic prisms, long, slender, and imbedded; M : M=94: sometimes with the lateral edges replaced.

H.=3—3·5. G.=2·697—2·712; coarser crystals 2·948. Lustre vitreous or partly subpearly. Color straw-yellow, changing on exposure to brownish-yellow. Translucent. Brittle. Friable after exposure.

Composition.—$(\dot{K}, \dot{Mg})\dddot{Si}+(\dddot{\overline{Al}}, \dddot{\overline{Fe}})^2\dddot{Si}^3+3\dot{H}$=Silica 51·45, alumina 27·19, peroxyd of iron 2·18, magnesia 1·15, potash 10·51, water 7·52=100. Analysis by T. S. Hunt, (loc. cit.):

	$\dddot{Si}$	$\dddot{\overline{Al}}$	$\dddot{\overline{Fe}}$	$\dot{Mg}$	$\dot{K}$	$\dot{H}$
A. Result obtained,	49·82	24·91	1·85	1·15	10·21	7·57, $\dot{Ca}$ 2·20, $\ddot{C}$ 1·74=99·45.
B. Same, $\dot{Ca}\ddot{C}$ excl.	52·16	26·08	1·94	1·20	10·69	7·92=99·99.

In a matrass yields much water. B.B. intumesces and at a high temperature fuses to a white porous enamel. With cobalt solution a fine blue frit.

Occurs disseminated singly in granular limestone, in Franklin, Sussex Co., N. Jersey, in slender, often curving crystals, sometimes two or even three inches long, and never more than one-eighth of an inch thick.

Mr. Hunt gives the formula, (according with Gerhardt's system),

$$5SiO^3+4HO+KO+6\tfrac{6}{10}Al\beta O+\tfrac{4}{10}Fe\beta O=5SiO^3+12MO,$$

which, taking silica as SiO, becomes $Si^5M^4O^9$, a typical form among the silicates, as laid down by Laurent. Calculated, it affords Silica 52·08, alumina 26·11, potash 10·88, peroxyd of iron and magnesia 2·45, water 8·33=99·85.

This species differs in mode of occurrence from the true zeolites, being an imbedded mineral, disseminated through limestone.

LIEBNERITE, *Marignac.*

In hexagonal prisms. Cleavage not distinct.

H.=3·5. G.=2·814. Lustre somewhat greasy. Color greenish-gray. Fracture splintery.

Composition.—$\dot{R}^3\dddot{Si}^2+6\dddot{\overline{Al}}\dddot{Si}+\dot{H}$. Analysis by Marignac:

$\dddot{Si}$ 44·66, $\dddot{\overline{Al}}$ 36·51, $\dot{Fe}$ 1·75, $\dot{Mg}$ 1·40, $\dot{K}$ 9·90, $\dot{Na}$ 0·92, $\dot{H}$ and $\ddot{C}$ 4·49=99·63.

In a matrass yields a little water. B.B. whitens and intumesces, but does not fuse to a globule.

From a red feldspar porphyry at Mount Viesena, Fassa valley.

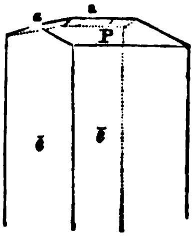
It is said to resemble the species Rosite, and also the Gieseckite.

b. Anhydrous Silicates of Alumina.

KYANITE. Cyanite. Disthene, *H.* Sappare. Rhœtizite. Fibrolite, *Bournon.* Bucholzite. Xenolite, *Nordenskiöld.* Sillimanite, *Bowen.*

Triclinic. P : M (Kyanite)=93° 15′, P : T=100° 50′, M : T=106° 15′. Crystals usually long and slender; flattened nearly rectangular prisms, and sometimes with the lateral edges replaced, (Kyanite), M : $\breve{e}$=145° 30′, T : $\breve{e}$=140° 45′, T : $\breve{e}$=122° 40′, M : $\breve{e}$=131°

5′; *ē* : *ĕ*=96° 35′, P : *ē*=98° 58′, P : *ĕ*=96° 42′, and 83° 8′; also rhombic prisms (Sillimanite) formed of the planes *ē* and *ĕ* with the angle *ē* : *ĕ*=98°, but varying to 110° and larger when the faces are much striated; P : *ĕ*=105°, P : a=133° 30′, *ĕ* : a=120° 30′; P : *a* =132°, D., (but only approximations, as the terminal planes, as in kyanite, were rough and uneven.) Cleavage perfect parallel with the longer diagonal in Sillimanite and the smoother lateral surface in kyanite; often affording brilliant surfaces. Also compact or loose fibrous; and columnar massive.



H.=6—7·25. G.=3·559, white kyanite; 3·675, blue transparent; 3·124, from Röraas; 3·661, Tyrol, Erdmann; 3·238, sillimanite of Norwich, Dana; 3·259, ib. of Yorktown, Norton; 3·2—3·6, bucholzite; 3·58, xenolite; 3·239, bucholzite of Chester, Del., Erdmann. Lustre vitreous—pearly. Color blue, white, blue with white margins, hair-brown, grayish; also gray, green, black. Streak uncolored. Translucent—transparent.

VARIETIES.—*Kyanite* is generally in bladed crystallizations, though occasionally in short prisms; and these prisms or blades are bounded by the planes M and T, with cleavage parallel to the larger face. The specific gravity is usually between 3·5 and 3·7. The prevalent color is a 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 extremity P.

Sillimanite presents a pale brown color, and occurs in rhombic prisms with cleavage perfect in the direction of the longer diagonal. There is a passage into a fibrous compact variety. G.=3·2—3·3.

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. G.=3·193—3·6. *Xenolite* does not differ from bucholzite.

Composition.—$\bar{\text{A}}\text{l}^3\dddot{\text{S}}\text{i}^2$=Silica 37·5, alumina 62·5, Kyanite. Sillimanite in many analyses gives the same formula; and so also bucholzite and the fibrolite of Bournon, according to Silliman, Jr. The larger part of the analyses of bucholzite give more silica and afford the formula $\bar{\text{A}}\text{l}\dddot{\text{S}}\text{i}$=Silica 47·35, alumina 52·65. Bowen's and Hayes's analyses of sillimanite correspond nearest to $\bar{\text{A}}\text{l}^6\dddot{\text{S}}\text{i}^5$=Silica 42·85, alumina 57·15. The author has shown in another place that the different formulas $\bar{\text{A}}\text{l}^3\dddot{\text{S}}\text{i}^2$, $\bar{\text{A}}\text{l}\dddot{\text{S}}\text{i}$, $\bar{\text{A}}\text{l}^6\dddot{\text{S}}\text{i}^5$, are closely related in atomic volume, and therefore the existence of distinct compounds is fully as probable as that chemists have erred. But more investigation is required before these compounds can be separated in a satisfactory manner.

Analyses:—I, of KYANITE.—1, Saussure, Jr., (Obs. Phys. xxxiv, 213); 2, Laugier, (Ann. du Mus. v, 17); 3—5, Arfvedson, (K. V. Ac. H. 1821, i, 148, and Schw. J. xxxiv, 203); 6, Rosales, (Pogg. lviii, 160); 7, Marignac, (Ann. Ch. Phys. xiv, 49); 8, 9, A. Erdmann, (Jahresb. xxiv, 311); 10, Jacobson, (Pogg. lxviii, 416).

II, of SILLIMANITE.—11, Bowen, (Am. J. Sci. viii, 113); 12, Thomson, (Phil. Mag. xxiv, 586); 13, Hayes, (Alger's Min. p. 601); 14, Muir, (Thomson's Min. i, 424); 15, Connel, (Jameson's J. xxxi, 232);) 16, Norton, (last ed. of this work, 378); 17, Staaf, (Jahresb. xxv, 348); 18, B. Silliman, Jr., (Am. J. Sci. [2], viii, 386).

III, of BUCHOLZITE.—19, Brandes, (J. de Pharm. xci, 237); 20, Thomson, (Min. i, 235); 21, A. Erdmann, (K. V. Ac. H. 1842, 19); 22, Komonen, (Act. Soc. Sci. Fennica, i, 372, and Pogg. lvi, 643); 23, B. Silliman, Jr., (Am. J. Sci. [2], viii, 386).

IV, of FIBROLITE.—24, 25, B. Silliman, Jr., (Am. J. Sci. [2], viii, 388); 27, Vanuxem, (J. Acad. Nat. Sci. Philad. vi, 41); 27, Chenevix:

I. *Kyanite.*

	$\bar{S}i$	$\bar{A}l$	$\bar{F}e$
1.	30·62	54·50	6·00, $\dot{C}a$ 2·02, $\dot{M}g$ 2·30, $\dot{H}$ and loss 4·56=100, S.
2.	38·50	55·50	2·75, $\dot{C}a$ 0·50, $\dot{H}$ 0·75=98·00, Laugier.
3. Röraas, Norway,	36·4	63·8	——=100·2, Arfvedson.
4. St. Gothard,	34·33	64·89	——=99·22, "
5. "	36·9	64·7	——=101·6, "
6. "	36·67	63·11	1·19=100·97, Rosales.
7. "	36·60	62·66	0·84=100·60, Marignac. G.=3·6.
8. Röraas,	34·40	61·86	0·52, $\dot{C}u$ 0·19=96·97, Erd. G.=3·124.
9. Tyrol,	37·36	62·09	0·71=100·16, Erd. G.=3·661.
10. Greiner, Tyrol,	37·30	62·60	1·08—100·98, Jacobson. G.=3·678.

II. *Sillimanite.*

11. Chester, Ct.,	42·66	56·111	1·999, $\dot{H}$ 0·510=99·286, Bowen. G.=3·410.
12. "	45·65	49·50	4·55=99·70, Thomson.
13. "	42·60	54·90	1·10, $\dot{C}a$ 0·81, $\dot{M}g$ 0·4=99·31, Hayes.
14. "	38·670	35·106	7·216, $\bar{Z}r$ 18·510=99·502, Muir.
15. "	36·75	58·94	0·99=96·68, Connell.
16. Fairfield, N. Y.,	37·700	62·750	2·287=102·739, Norton.*
17. Chester, Ct.,	37·362	58·622	2·174, $\dot{M}g$ 0·398, $\dot{H}$ 0·428=98·984, Staaf.
18. "	37·653	62·411	——=100·064, Silliman.

III. *Bucholzite.*

19. Tyrol,	46·0	50·0	2·5, $\dot{K}$ 1·5=100, Brandes.
20. Chester, Pa.,	46·40	52·92	*trace*=99·32, Thomson.
21. "	40·08	58·88	0·74=99·67, Erdmann=$\bar{A}l^4\bar{S}i^3$. G.=3·239.
22. *Xenolite*,	47·44	52·54	——=99·98, Komonen.
23. Chester, Pa.,	35·96	64·43	—— $\dot{M}g$ 0·52=100·910, Silliman.

IV. *Fibrolite.*

24. Carnatic,†	36·309	62·415	—— $\dot{M}g$ 0·702=99·426, Silliman.
25. Brandywine Spr.	36·159	63·525	——=99·684, Silliman.
26. "	42·77	55·50	——=98·27, Vanuxem.
27. 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.

The zirconia found in sillimanite by Muir has not been since detected; the amount in Muir's analysis, added to that of the alumina and peroxyd of iron, gives the same sum as other analyses obtain for the alumina alone.

Klaproth found 43 $\bar{S}i$, 55 $\bar{A}l$, 0·5 $\bar{F}e$ in the Kyanite of Airolo, St. Gothard; and Vanuxem 42·56 $\bar{S}i$, 57·00 $\bar{A}l$, in that of Chesterfield, Mass.

This species occurs principally in gneiss and mica slate. Transparent crystals of *Kyanite* 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 fine specimens near Philadelphia, on the Schuylkill road near the Darby bridge; it also occurs near the Schuylkill on the Ridge road, back of Robin Hood Tavern; also 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 mills; near Wilmington, Delaware; in Willis's Mt.,

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[*] In Prof. Norton's analysis, as he has recently stated, 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.

[†] One of Bournon's own specimens; received by Col. Gibbs (from whom the Yale Cabinet was obtained) from Count Bournon himself.

Buckingham Co., and two miles north of Chancellorville, Spotsylvania Co., Va. In North Carolina, on the road to Cooper's gap in Rutherford Co., and in Lincoln 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.

Sillimanite 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.

Xenolite is from Petershoff, in Finland.

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. *Sillimanite* was named in honor of Prof. Silliman; and *bucholzite* after Bucholz.

The *Monrolite* of Silliman, Jr. (see page 295) has a resemblance to kyanite, but contained a small percentage of water. Excluding the water, which we think should not be estimated, its constitution, as ascertained by Silliman, corresponds to $\bar{A}l^5\ddot{S}i^4$=Silica 41·85, alumina 58·15. Less than one per cent. of water has been found in other specimens by Mr. G. J. Brush, while these pages were going through the press.

The species *Wörthite* (p. 295) is also near kyanite, and may prove to be that species. The analyses give 4 per cent. of water.

ANDALUSITE. Feldspath Apyre, *H.* Macle, *H.* Chiastolite. Hohlspath. Crucite. Stanzait.

Trimetric; M : M=91° 20′, and 88° 40′. The angle varies with the purity of the crystals, and is nearly a right angle in some chiastolites from Lancaster. ē : ē=128° 6′, P : *a*=144° 44′; P : a, figure 2, 144° 50′, Teschemacher. Cleavage lateral, distinct. Imperfect crystallizations; indistinctly columnar and granular.

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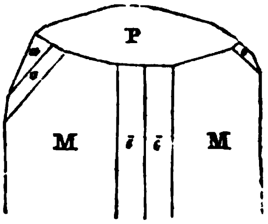

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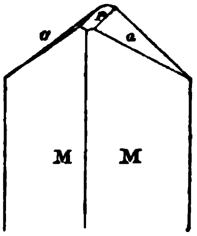
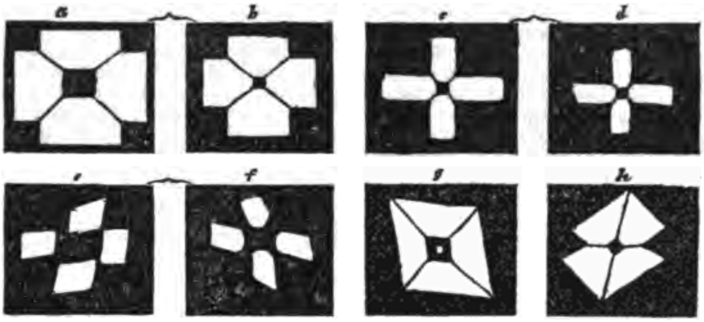


Westford, Mass.

H.=7·5. G.=3·1—3·32. Lustre vitreous. Streak white. Color flesh-red, pearl-gray; sometimes showing trichroism, green in one direction, and hyacinth-red in another transverse. Subtranslucent—nearly opaque. Fracture uneven. Tough.

The variety chiastolite varies in hardness from 3 to 7·5, owing to impurities. The crystals have a tesselated appearance, as shown in the following figures, which are here copied from a memoir by Dr. C. T. Jackson, (Jour. Bost. Soc. Nat. Hist. i, 55), in which the author proposes the union of andalusite and chiastolite in one species. The same had been previously suggested by F. S. Beudant, (Traité de Min. p. 156, 1824). The hypothesis of Beudant, to account for these freaks in nature, appears to be the most consistent with the appearances presented, that is, that they are simple crystals, with extraneous matter, regularly arranged by the process of crystallization. The irregularity of the whitish prisms, in the different parts of the same crystals, (figs. *a* and *b*, are from opposite extremities of the same crystal; so also *c* and *d*, and *e* and *f*), appear to oppose the hypotheses of the compound nature of these crystals. The chemical constitution of this variety, as determined by Dr. Jackson, is sufficient to settle the question of their identity.



Composition.—$\mathrm{\bar{A}l}^2\mathrm{\bar{\bar{S}}i}^2$=Silica 37·5, alumina 62·5. Perhaps $\mathrm{\bar{A}l}^4\mathrm{\bar{\bar{S}}i}^3$=Silica 40·3, alumina 59·7. **Analysis**: 1, Vauquelin, (Brongn. T. de Min. i, 365); 2, Bucholz, (v. Moll's Ephemer. iv, 190); 3, Brandes, (Schw. J. xxv, 113); 4, Thomson, (Min. i, 332); 5, Kersten, (J. f. pr. Chem. xxxvii, 162); 6, Svanberg, (Jahresb. xxiii, 279); 7, Bunsen, (Pogg. xlvii, 186); 8, A. Erdmann, (Jahresb. xxiv, 311); 9, Bunsen; 10, Jackson, (Bost. J. Nat. Hist. i, 55):

	$\mathrm{\bar{\bar{S}}i}$	$\mathrm{\bar{A}l}$	$\mathrm{\bar{F}e}$	
1. Spain,	38·	52·	2·	$\dot{\mathrm{K}}$ 8=100, Vauquelin.
2. Herzogau,	36·5	60·5	4·0=101·0, Bucholz.	
3. Lisens, Tyrol,	34·00	55·75	3·37,	$\dot{\mathrm{K}}$ 2·0, $\mathrm{\bar{M}n}$ 0·63, $\dot{\mathrm{C}}\mathrm{a}$ 2·12, $\dot{\mathrm{M}}\mathrm{g}$ 0·38, $\dot{\mathrm{H}}$ 1=99·25, B.
4. 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.
5. 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.
6. Fahlun,	37·65	59·37	1·87,	$\dot{\mathrm{C}}\mathrm{a}$ 0·58, $\dot{\mathrm{M}}\mathrm{g}$ 0·38=100·35, Svanberg.
7. Lisens, Tyrol,	40·17	58·62	——	$\mathrm{\bar{M}n}$ 0·51, $\dot{\mathrm{C}}\mathrm{a}$ 0·28=99·58, Bunsen.
8. " "	39·99	58·60	0·72,	$\mathrm{\bar{M}n}$ 0·83=100·14, Erdm. G.=3·154.
9. *Chiastolite*,	39·09	58·56	——	$\mathrm{\bar{M}n}$ 0·58, $\dot{\mathrm{C}}\mathrm{a}$ 0·21. ign. 0·99=99·38, Bunsen.
10. *Chiastolite*,	33·0	61·0	4·0,	$\dot{\mathrm{H}}$ 1·5=99·5, Jackson.

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.

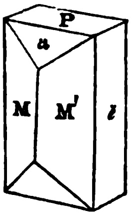
Andalusite occurs in crystalline schists, especially mica and clay slate. It was first observed in the province of Andalusia, in Spain. In the Lisens valley, above Innspruck, in the Tyrol, it occurs in large crystallizations; other foreign localities are Bräunsdorf, in Saxony; Galdenstein, in Moravia; in Bavaria; in Siberia; at Killiney Bay, Ireland, in mica slate; and near Balahulish, Argyleshire. The chiastolite variety occurs at Jago di Compostella in Spain, Barèges in the Pyrenees, Bayreuth, and Cumberland in England.

At Westford, Mass., it is found abundantly, both crystalline and massive, and sometimes of a rose color. Litchfield and Washington, Conn., have afforded fine crystals; also Mt. Abraham, Bangor, and Searsmont, Me. In Pennsylvania, near Leiperville, it occurs in large crystals; also at Marple. Chiastolite is very abundant in the towns of Lancaster and Sterling, Mass.; and at the former place occasionally in quartz, presenting all the essential characters of andalusite. It is met with, also, near Bellows Falls, Vermont; at the White Mountain Notch, N. H.; and at Camden in Maine, and Charlestown, N. H.

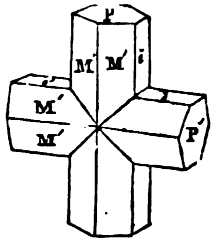
STAUROTIDE, *Haüy*. Grenatite. Staurolith, *W.*

Trimetric; M : M=129° 20′. Usual forms as in the following figures:

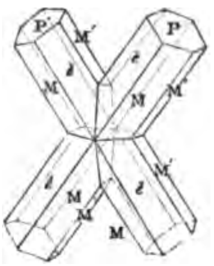
1



2



3



P : a=124° 38′, M : ĕ=115° 20′. Cleavage parallel to ĕ, but interrupted: parallel to M less distinct. Crystals thick; surface P often rough. Compound crystals: figures 2 and 3, of common occurrence. Massive varieties have not been observed.

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.—$(\bar{\text{Al}}, \bar{\text{Fe}})^2\ddot{\text{Si}}$=Silica 29·25, alumina 54·28, peroxyd of iron 16·52. But the crystals from Airolo in St. Gothard and Polewskoi in the Ural, are irreconcilable with this formula; one affording $\bar{\text{R}}^3\ddot{\text{Si}}^2$, and the last $\bar{\text{R}}^3\ddot{\text{Si}}^4$, unless part of the $\ddot{\text{Si}}$ is isomorphous with $\bar{\text{Al}}$.

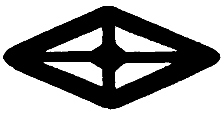
Analyses: 1, 2, Klaproth, (Beit. v, 80); 3, 4, 5, 6, Jacobson, (Pogg. lxii, 419); 7, Marignac, (Ann. Ch. Phys. [3], xiv, 49); 8, 9, 10, 11, 12, 13, Jacobson, (Pogg. lxviii, 414):

	$\ddot{\text{Si}}$	$\bar{\text{Al}}$	$\bar{\text{Fe}}$	$\bar{\text{Mn}}$	$\dot{\text{Mg}}$		
1. St. Gothard,	27·00	52·25	18·50	0·25	——	=98·00, Klaproth.	
2. "	37·50	41·00	18·25	0·50	0·50	=97·75, "	
3. "	30·31	46·80	18·08	——	2·16,	$\dot{\text{Ca}}$ 0·13=97·48, Jac.	G.=3·787,
4. "	30·91	48·68	15·37	——	1·33,	$\dot{\text{Mn}}$ 1·19=97·48, Jac.	in pieces,
5. "	29·72	54·72	15·69	——	1·85	=101·98, Jac.	3·744
6. "	29·13	52·01	17·58	——	1·28	=100, Jac.	pulverized.
7. "	28·47	53·34	17·41	0·31	0·72	=100·25, Marig.	G.=3·737—3·744.
8. Airolo, "	33·45	47·23	16·51	——	1·99	=99·18, Jac.	G.=3·66—3·73.
9. " "	32·99	47·92	16·65	——	1·66	=99·22, Jac.	" "
10. Brittany,	39·19	44·87	15·09	——	0·82,	$\dot{\text{Mn}}$ 0·17=99·64, Jac.	G.=3·528.
11. "	40·35	44·22	15·77	——	——	$\dot{\text{Mn}}$ 0·10=100·44, Jac.	"
12. Polewskoi, Ural,	38·68	47·43	15·06	——	2·44	=103·61, Jac.	G.=3·547—3·588.
13. "	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; and the Greiner mountain, Tyrol, affords simple crystals of this species, associated with kyanite. Their connection with kyanite is sometimes very peculiar; they occur, apparently, as a continuation of its crystals, and also parallel with them. Twin crystals of a large size occur in Brittany; also at Oporto and St. Jago de Compostella, &c.

Staurotide is very abundant throughout the mica slate of New England. Franconia, Vt., affords large brownish-red opaque crystals, often presenting compound forms; also a brownish-black variety. At Windham, Me., near the bridge, the mica slate is filled with large crystals of staurotide; at Mt. Abraham, Hartwell, and Winthrop, Me., are other localities. In New Hampshire, at Lisbon, abundant in mica slate, and on the shores of Mink Pond, loose in the soil; at Grantham of a gray color. In Vermont, at Cabot. At Chesterfield, Mass., fine crystals are obtained; also at Bolton, Vernon, Stafford, and Tolland, Conn. Small crystals occur at the Foss ore bed in Dover, Dutchess Co., N. Y.; also three and a half miles from New York city, on the Hudson. Reddish-brown crystals are abundant on the Wihiccon, about eight miles from Philadelphia.



Dr. C. T. Jackson has described a variety of staurotide in tessellated 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.

Staurolite is derived from *σταυρος, a cross*, and *λιθος, a stone*.

BAMLITE, *Erdmann*, J. f. pr. Chem., xxxi, 165.

Monoclinic? In slender rhomboidal prisms, striated; also columnar massive, radiated.

H.=6·5. G.=2·984. White, grayish-white, or faint greenish, and translucent. Lustre silky. Fracture uneven, splintery.

Composition.—$\bar{\mathrm{A}}\mathrm{l}^2\dddot{\mathrm{Si}}^3$=Silica 57·41, alumina 42·59. Analysis by Erdmann, (loc. cit.):

$\dddot{\mathrm{Si}}$ 56·90, $\bar{\mathrm{A}}\mathrm{l}$ 40·78, $\bar{\mathrm{F}}\mathrm{e}$ 1·04, $\dot{\mathrm{C}}\mathrm{a}$ 1·04, F *traces*=99·71.

B.B. infusible. A fine blue with cobalt solution.

From Bamle, Norway, where it occurs in gneiss in radiated masses, and rarely in prismatic crystals.

SAPPHIRINE.

In small foliated grains.

H.=7—8. G.=3·428, Stromeyer; 3·473, Damour. Pale blue or green, vitreous, and transparent to translucent. Fracture subconchoidal.

Composition.—$3\dot{\mathrm{M}}\mathrm{g}\bar{\mathrm{A}}\mathrm{l}+\bar{\mathrm{A}}\mathrm{l}\dddot{\mathrm{Si}}$ (=$\dot{\mathrm{M}}\mathrm{g}^3\,\bar{\mathrm{A}}\mathrm{l}^4\,\dddot{\mathrm{Si}}$)=Silica 14·8, alumina 65·7, magnesia 19·5. Analyses: 1, Stromeyer, (Untersuch. i, 391); 2, 3, Damour, (Bull. Soc. Geol. de Fr., 1849, 317):

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{A}}\mathrm{l}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{C}}\mathrm{a}$	
1.	14·51	63·11	16·85	0·38	$\bar{\mathrm{M}}\mathrm{n}$ 0·53, $\dot{\mathrm{F}}\mathrm{e}$ 3·92, ign. 0·49=99·78, Strom.
2.	14·88	63·31	19·06, $\dot{\mathrm{F}}\mathrm{e}$ 2·09=99·34, Damour.		
3.	14·84	63·20	19·50 " 1·90=99·44, Damour.		

B.B. alone and with borax infusible, and unaltered.

Associated with mica and brown anthophyllite at Fiskenaes in Greenland, where it was discovered by Giesecké. It was distinguished from sapphire, which it somewhat resembles, by Stromeyer.

FELDSPAR FAMILY.

The feldspar family includes a number of anhydrous silicates of alumina and an alkali, presenting mostly clinometric crystallization, but also occurring monometric and hexagonal; and if the scapolites and spodumene should be included which are related in composition and general aspect, a dimetric and trimetric character must be added. The crystals of the clinometric feldspars are usually thick or tabular. The lustre of the species is vitreous or vitreo-pearly; specific gravity between 2·4 and 2·9; hardness 5·5—7; colors usually some light shade, and never black. Among the feldspars there are five cases of dimorphism. *Orthoclase* (or common feldspar) monoclinic, is dimorphous with *albite* triclinic; *loxoclase* monoclinic, with *oligoclase* triclinic; *ryacolite* monoclinic, with *labradorite* triclinic; *andesine* triclinic, with *leucite* monometric. The crystals of the triclinic species, when placed with the corresponding planes in front, may incline to the right or to the left. Thus anorthite inclines to the right and lepolite to the left. This is the main point of distinction laid down for these two species; for they are chemically alike, and make the fifth of the cases of dimorphism alluded to.

The species thus far recognized have the following formulas, and oxygen ratios for the protoxyd bases, peroxyd bases, and silica:

I. *Monometric.*

	Oxygen ratio.	Formula.
Leucite,	1 : 3 : 8	$\dot{R}^3\dddot{Si}^2+3\dddot{\bar{Al}}\dddot{Si}^2$.

II. *Hexagonal.*

Nepheline,	1 : 3 : 4½	$\dot{R}^2\dddot{Si}+2\dddot{\bar{Al}}\dddot{Si}$.
Davyne,		$\dot{R}^2\dddot{Si}+2\dddot{\bar{Al}}\dddot{Si}+\dot{R}\ddot{C}$.

III. *Monoclinic.*

Orthoclase, (common feldspar),	1 : 3 : 12	$\dot{R}\dddot{Si}+\dddot{\bar{Al}}\dddot{Si}^3$.
Loxoclase,	1 : 3 : 9	$\dot{R}\dddot{Si}+\dddot{\bar{Al}}\dddot{Si}^2$.
Ryacolite,	1 : 3 : 6	$\dot{R}\dddot{Si}+\dddot{\bar{Al}}\dddot{Si}$.

IV. *Triclinic.*

Albite, (soda feldspar),	1 : 3 : 12	$\dot{R}\dddot{Si}+\dddot{\bar{Al}}\dddot{Si}^3$.
Oligoclase,	1 : 3 : 9	$\dot{R}\dddot{Si}+\dddot{\bar{Al}}\dddot{Si}^2$.
Labradorite,	1 : 3 : 6	$\dot{R}\dddot{Si}+\dddot{\bar{Al}}\dddot{Si}$.
Andesine,	1 : 3 : 8	$\dot{R}^3\dddot{Si}^2+3\dddot{\bar{Al}}\dddot{Si}^2$.
Anorthite, and Lepolite,	1 : 3 : 4	$\dot{R}^3\dddot{Si}+3\dddot{\bar{Al}}\dddot{Si}$.
Vosgite,	1 : 3 : 5	$3\dot{R}\dddot{Si}+\dddot{\bar{Al}}^2\dddot{Si}^3$.
Petalite,	1 : 4 : 20	$\dot{R}^3\dddot{Si}^4+4\dddot{\bar{Al}}\dddot{Si}^4$.

V. *Less perfectly known species, here referred,* (*Clinometric*).

Baulite, monoclinic,	1 : 3 : 24	$\dot{R}\dddot{Si}^2+\dddot{\bar{Al}}\dddot{Si}^6$.
Thiorsauite, monoclinic?	2 : 5 : 9	$\dot{R}^3\dddot{Si}^2+2\tfrac{1}{2}\dddot{\bar{Al}}\dddot{Si}$.
Couzeranite,	1 : 2 : 3	$\dot{R}^3\dddot{Si}+2\dddot{\bar{Al}}\ \dddot{Si}$.
Saussurite,	(?) 1 : 2 : 3	$\dot{R}^3\dddot{Si}+2\dddot{\bar{Al}}\dddot{Si}$.
Latrobite,	1 : 4 : 5	$\dot{R}^3\dddot{Si}+4\dddot{\bar{Al}}\dddot{Si}$.
Hyposclerite,	1 : 2 : 6	$3\dot{R}\dddot{Si}+\dddot{\bar{Al}}^2\dddot{Si}^3$.
Castor, monoclinic,	1 : 6 : 27	$\dot{Li}\dddot{Si}^3+2\dddot{\bar{Al}}\dddot{Si}^3$.

VI. *Spodumene Group,* (*Trimetric*).

Spodumene,	1 : 4 : 12	$\dot{R}^3\dddot{Si}^4+4\dddot{\bar{Al}}\dddot{Si}^2$.

VII. *Scapolite Group,* (*Dimetric*).

Scapolite,	1 : 2 : 4	$\dot{R}^3\dddot{Si}^2+2\dddot{\bar{Al}}\dddot{Si}$.
Meionite,	1 : 2 : 3	$\dot{Ca}^3\dddot{Si}+2\dddot{\bar{Al}}\dddot{Si}$.
Wernerite,	1 : 3 : 4	$\dot{Ca}^3\dddot{Si}+3\dddot{\bar{Al}}\dddot{Si}$.
"	1 : 3 : 4½	$\dot{Ca}^3\dddot{Si}+2\dddot{\bar{Al}}\dddot{Si}$.
Dipyre,	4 : 9 : 21	$4\dot{R}\dddot{Si}+3\dddot{\bar{Al}}\dddot{Si}$.
Barsowite,	1 : 3 : 5	$\dot{R}^3\dddot{Si}^2+3\dddot{\bar{Al}}\dddot{Si}$.
Gehlenite,	3 : 3 : 4	$3\dot{R}^3\dddot{Si}+\dddot{\bar{R}}^3\dddot{Si}$.
Humboldtilite,	2 : 1 : 3	$2\dot{R}^3\dddot{Si}+\dddot{\bar{R}}\dddot{Si}$.

Nepheline and one Wernerite; Anorthite and another Wernerite; Vosgite and Barsowite; Meionite and Couzeranite, are *four* other cases of *dimorphism*. Moreover *Epidote* has the formula of Meionite; *Acmite* that of Oligoclase; and *Iolite* that of Barsowite (and Bytownite), making (with that of Anorthite, Lepolite, and Wernerite) four cases of *trimorphism*.

Abich, in his memoir on the true feldspars, (Pogg. li, 125, 341), shows that in all these species, as far as then ascertained, the relation between the oxygen of the protoxyds and peroxyds is as 1 to 3, (see table, divisions 1 to 4 inclusive), and this point of union is the only one as regards proportion of constituents, which has seemed to be general. Deville observes, (Comptes Rendus, xx, 182), that in some of the species, the third term in the ratio is a multiple of 3, and in others, as leucite and andesine, a multiple of 4: and he consequently divides the feldspars into two groups, the Feldspar and the Leucite groups, ("Feldspathides" and "Amphigenides"). But new species, since described, seem to require that on this ground other groups should be recognized.

A true and fundamental relation based on atomic volume is shown on page 145; and this relation diminishes somewhat the seeming importance of the principles deduced by Abich and Delesse. On this new ground, petalite, in which the first ratio is 1 : 4, falls properly with the feldspars, where its crystallization and other characters would place it: while the other lithia species, spodumene, is, for the same reasons, (crystallographic as well as atomic volume), more closely related to andalusite. Dufrénoy writes for petalite the same formula essentially as for albite, and for spodumene, in like manner, the formula of oligoclase. The former ($\mathrm{Li}\dddot{\mathrm{S}}\mathrm{i}+\bar{\mathrm{A}}\mathrm{l}\,\dddot{\mathrm{S}}\mathrm{i}^3$) gives only 73·7 per cent. of silica, in place of 77 or 78, which the analyses require, and there is a like discrepancy as regards the latter.

Among the true feldspars the protoxyd bases are either *potash*, *soda*, *lime* or *lithia*, which in many species mutually replace one another.

a. The *potash species* (which also include often some soda) are Common Feldspar or Orthoclase and Leucite.

b. The *soda species*, or *soda* and *potash*, are Albite, Ryacolite, Oligoclase, Loxoclase, Nepheline.

c. The *soda* and *lime species*, (containing also some potash,) Andesine, Vosgite, Davyne.

d. The *lime species*, Anorthite, Labradorite, Thiorsauite.

e. The *lithia species*, Petalite.

Magnesia also enters very sparingly into some of the species, and peroxyd of iron ($\bar{\mathrm{F}}\mathrm{e}$) sometimes replaces 1 or 2 per cent. of the alumina.

LEUCITE, *Werner*. Amphigene, *H.*

Monometric. Usual form the trapezohedron. Cleavage hexahedral, very imperfect. Surfaces of crystals even, but seldom shining. Often in disseminated grains; rarely granular massive.

H.=5·5—6. G.—2·483—2·49. Vitreous. Ash-gray or smoke-gray, white. Streak uncolored. Translucent to nearly opaque. Fracture conchoidal. Brittle.

Composition.—$\dot{K}^3\dddot{Si}^2+3\dddot{\overline{Al}}\dddot{Si}^2$=Silica 55·55, alumina 23·17, potash 21·28=100. Analyses: 1—4, Klaproth, (Beit. ii, 39); 5, Arfvedson, (Afhandl. i Fys. vi, 139); 6, Awdejew, (Pogg. lv, 107):

	$\dddot{Si}$	$\dddot{\overline{Al}}$	$\dot{K}$
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, "
4. Albano,	54·	23·	22=99, "
5. Vesuvius,	56·10	23·10	21·15, $\dddot{\overline{Fe}}$ 0·95=101·30, Arfvedson.
6. "	56·05	23·03	20·40, $\dot{Na}$ 1·02, $\dot{Ca}$ *trace*=100·50, Awdejew.

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 the ancient lavas of the Rieden country, between the Laacher See and Andernach, on the Rhine. Vesuvius, however, presents the finest and largest crystallizations. In the vicinity of Rome, at Borghetta to the north, and Albano and Frescati to the south, some of the older lavas appear 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.

Leucite is derived 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.

NEPHELINE, *D.* Sommite, *P.* Nefelina, *Monticelli.* Cavolinite, *Mont.* Beudantin, Beudantite, *Mont.* Elæolite. Fettstein, *W.* Pierre Grasse.

Hexagonal. Figure 125, plate 2. M : e=150°, P : e=134° 3′. Cleavage lateral and basal, 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. Color white or yellowish, dark green, greenish or bluish-gray, brownish and brick-red. Transparent—opaque. Fracture subconchoidal.

Nepheline includes the crystallised varieties from Vesuvius.

Elæolite the coarse massive varieties having a strongly greasy lustre.

Composition.—$(\dot{Na}, \dot{K})^2\dddot{Si}+2\dddot{\overline{Al}}\dddot{Si}$=Silica 44·67, alumina 33·12, soda 16·12, potash 6·09.

Analyses: 1, Arfvedson, (Jahresb. ii, 97); 2, 3, 4, 5, 7, 8, 9, 10, 11, Scheerer, (Pogg. xlvi, 291, xlix, 359); 6, Gmelin, (Neph. im Dolerit, &c., Heidelberg, 1822); 12, 13, Bromeis, (Pogg. xlviii, 577):

I. *Nepheline.*

	$\dddot{Si}$	$\dddot{\overline{Al}}$	$\dddot{\overline{Fe}}$	$\dot{Ca}$	$\dot{Na}$	$\dot{K}$
1. Vesuvius,	44·11	33·73	——	——	20·46	——, H 0·62=98·92, Arfved.
2. "	44·03	33·28	0·65	1·77	15·44	4·94, $\dot{H}$ 0·21=100·32, Scheer.
3. "	44·29	33·04	0·39	1·82	14·93	4·72, H 0·21=99·40, "
4. "	44·04	34·06	0·44	2·01	15·91	4·52, H 0·21=101·19, "
5. Odenwald,	43·70	32·31	1·07	0·84	15·83	5·60, H 1·39=100·74, "
6. "	43·36	33·49	1·50	0·90	13·36	7·13, H 1·39=101·13, Gmelin.
II. *Elæolite.*						
7. Fredericksvärn, *gn.*	45·31	32·63	0·45	0·33	15·95	5·45, $\dot{H}$ 0·60=100·72, Scheer.
8. "	45·15	32·70	0·67	0·34	15·48	5·88, $\dot{H}$ 0·63=100·85, "
9. Brevig, *bn.*	44·59	32·14	0·86	0·28	15·67	5·10, $\dot{H}$ 2·05=100·69, "
10. "	44·48	32·08	1·30	0·24	15·76	5·24, $\dot{H}$ 2·06=101·11, "
11. Miask, *white*,	44·30	33·25	0·82	0·32	16·02	5·82, $\dot{Mg}$ 0·07=100·60, "
12. " "	42·51	33·73	*trace*	0·20	14·01	6·91, $\dot{Mg}$ 0·77=98·13, Brom.
13. " "	42·33	34·39	*trace*	0·47	16·26	5·95, $\dot{Mg}$ 0·45, $\dot{H}$ 0·92=100·77, Bromeis.

The potash and soda have the relation of 1 : 4. 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 at 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.

Elæolite occurs massive and crystallized at Litchfield, Me., with cancrinite; in the Ozark Mts., Arkansas, with brookite.

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.

Giesæckite occurs in 6-sided prisms of a greenish-gray color and greasy lustre, and is considered a pseudomorph after nepheline. From Greenland.

DAVYNE, *Monticelli and Covelli*. Cancrinite, *G. Rose*. Stroganowite, *Hermann*.

Hexagonal. In 6 and 12-sided prisms, sometimes with basal edges replaced; P : e′=154° 27′, M : e′=115° 33′, e′ : e′=51° 46′. Cleavage lateral, very perfect; basal 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; 2·79, Stroganowite. Color white, gray, yellow, green, blue, reddish; streak uncolored. Lustre subvitreous, or a little pearly or greasy. Translucent.

Composition.—$\dot{\mathrm{N}}\mathrm{a}^2\dddot{\mathrm{S}}\mathrm{i}+2\dddot{\overline{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+(\dot{\mathrm{N}}\mathrm{a},\dot{\mathrm{C}}\mathrm{a})\ddot{\mathrm{C}}+\dot{\mathrm{H}}$, Whitney=Silica 38·00, carbonic acid 6·03, alumina 28·19. lime 3·86. soda 21·45, water 2·47=100. Rose found no water, which makes the formula $\dot{\mathrm{N}}\mathrm{a}^2\dddot{\mathrm{S}}\mathrm{i}+2\dddot{\overline{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+(\dot{\mathrm{N}}\mathrm{a},\dot{\mathrm{C}}\mathrm{a})\ddot{\mathrm{C}}$, which gives 39·11 per cent. of silica. Hermann obtained for stroganowite, $(\dot{\mathrm{C}}\mathrm{a},\dot{\mathrm{N}}\mathrm{a})^2\dddot{\mathrm{S}}\mathrm{i}+2\dddot{\overline{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}+\dot{\mathrm{C}}\mathrm{a}\ddot{\mathrm{C}}$. Excepting the carbonate, this is the formula of nepheline, which davyne and cancrinite closely approach in crystallization.

Analyses: 1, Monticelli and Covelli, (Prod. Min. Vesuv., 375); 2, 3, G. Rose, (Pogg. xlvii, 779); 4—7, J. D. Whitney, (Pogg. lxx, 431); 8, Hermann, (J. f. pr. Chem. xxxiv, 177):

	$\dddot{\mathrm{S}}\mathrm{i}$	$\ddot{\mathrm{C}}$	$\dddot{\overline{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$	
1. Vesuvius, *Dav.*	42·91	—	33·28	12·02	—	—	7·48,	$\overline{\mathrm{F}}\mathrm{e}$ 1·25=96·89, M. and C.
2. Ural, *Canc.*	40·59	6·38	28·29	7·06	17·38	0·57	—	=100·27, G. Rose.
3. " "	40·26	6·38	28·24	6·34	17·66	0·82	—	=99·70, "
4. Litchfield, *yellow*,	37·42	5·95	27·70	3·91	20·98	0·67	2·82,	$\overline{\mathrm{M}}\mathrm{n}$, $\overline{\mathrm{F}}\mathrm{e}$ 0.86=100·31, Whit.
5. " "	37·89	5·95	27·39	3·88	21·24		2·82,	$\overline{\mathrm{M}}\mathrm{n}$, $\overline{\mathrm{F}}\mathrm{e}$ 0·64=99·81, "
6. " "	37·84	5·95	28·26[a]	3·82	20·94		2·82	=99·53, Whit. ([a] With $\overline{\mathrm{M}}\mathrm{n}$.)
7. " *greenish*,	37·20	5·92	27·59	5·26	20·46	0·50	3·28,	$\overline{\mathrm{M}}\mathrm{n}$, $\overline{\mathrm{F}}\mathrm{e}$ 0·27=100·48, W.
8. *Stroganowite*,	40·58	6·40	28·57	20·20	3·50	—	—	$\dot{\mathrm{F}}\mathrm{e}$, $\dot{\mathrm{M}}\mathrm{n}$ 0·89=100·14, Her.

Whitney found a trace of chlorine in his analyses. In the stroganowite lime replaces the most of the soda.

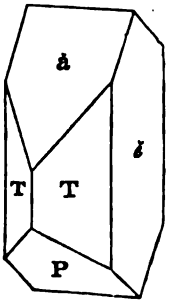
B.B. loses color and fuses easily with intumescence to a white blebby glass. Effervesces with muriatic acid and forms a jelly on heating, but not before. Stroganowite dissolves without gelatinizing.

Davyne occurs at Vesuvius in oblong 6 and 12-sided prisms. *Cancrinite* is found in the Ilmen Mountains; and also in crystals and massive at Litchfield, Maine, with sodalite and zircon. *Stroganowite* comes in crystalline masses, of a clear green color, from the Slüdänka, a river in Dauria. According to Hermann, it has a foliated structure and cleaves in two directions at right angles with one another, yielding four-sided prismatic fragments.

ORTHOCLASE. Feldspar. Potash-Feldspar. Ice-spar. Felsite. Adularia. Murchisonite. Leelite. Amausite. Amazonstone. Sunadin. Moonstone. Napoleonite. Necronite. Pegmatolite. Mikroklin, *Breit.* Feldstein, *Haus.* Feldspath, *H.* Eisspath, *W.* Erythrite, Peristerite, and Perthite of *Thomson.*

Monoclinic. T : T=118° 48′, Kupffer; 118° 58′, Levy; 120°, G. Rose; P : T=67° 44′, K.; 67° 25′, L.; 67° 59′, R; P : ă=99° 37′ or 80° 23′, (99° 16′, L.) P : ă′=129° 40′, K., (129° 30′, L.) P : *a*=135° 3½′, *ĕ* : *a*=134° 46½′, T : *ĕ*=120° 40′, *ĕ*′ : *ĕ*′(over *ĕ*)=121° 21′, (121° 11′, L). Cleavage parallel with P perfect; with *ĕ*,

1



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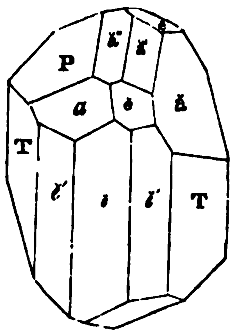

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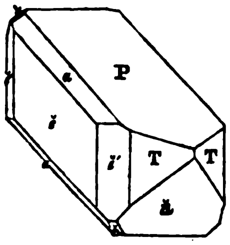

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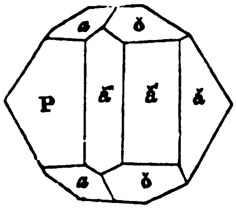

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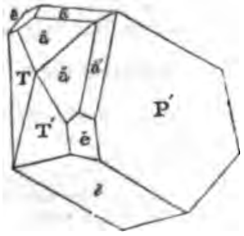

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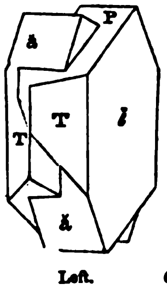

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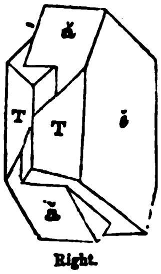

Left. Carlsbad. Right.

or the clinodiagonal, less distinct. Compound crystals: in figs. 5 and 6, composition is parallel with *ĕ*. In fig. 4 it is parallel to a plane on a lateral angle, (plane *a*). Often massive, cleavable, or granular; sometimes coarse lamellar.

H.=6. G.=2·4—2·6. 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.—$\dot{K}\dddot{Si}+\overline{\dddot{Al}}\dddot{Si}^3$=Silica 65·21, alumina 18·13, potash 16·66.

Analyses: 1, 2, Klaproth, (Beit. v, vi); 3, Val. Rose, (Scheerer's J. viii, 244); 4, G. Rose, (Pogg. xxviii, 143); 5, Schnedermann, (Stud. Götting. V. b. Freunde, v, Hft. 1); 6, Delesse, (Ann. Ch. Phys. [3], xxv); 7, 8, 9, Abich, (Pogg. li, 528, and Berg. und hüttenm. Zeitg. Jahrg. 19); 10, Domeyko, (Ann. d. Mines, [4], ix, 529); 11, Brongniart and Malaguti, (Ann. Mines, [4], ii, 465); 12, Kröner, (Pogg. lxvii, 421); 13, Kersten, (J. f. pr. Chem. xxxvii, 162); 14, Plattner, (Pogg. xlvi, 299); 15, Evreinoff, (Pogg. xlvii, 196):

	$\dddot{Si}$	$\overline{\dddot{Al}}$	$\overline{\dddot{Fe}}$	$\dot{Ca}$	$\dot{K}$	$\dot{Na}$
1. Karlsbad,	64·50	19·75	1·75	*trace*	11·50	——=97·50, Klaproth.
2. Fredericksvärn,	65·00	20·00	1·25	*trace*	12·25	——, $\dot{H}$ 0·5=99, Klaproth.
3. Lomnitz,	66·75	17·50	1·75	1·25	12·00	——=98·25, G. Rose.
4. *Glassy*, Vesuv.	65·52	19·15	——	0·60	14·74, with some $\dot{Na}$, G. Rose.	
5. " Dransfeld,	64·86	21·46	*trace*	*trace*	2·62	10·29=99·23, Schnedermann.
6. Chamouni,	66·48	19·06	*trace*	0·63	10·52	2·30=98·99, Delesse.
7. *Adul*, St. Gothard,	65·69	17·97	——	1·34	13·99	1·01=100, Abich. G.=2·576.
8. Baveno,	65·72	18·57	——	0·34	14·02	1·25, $\dot{Mg}$ 0·1=100, Ab. G. 2·55.
9. Siberia, *green*,	65·32	17·89	0·30	0·10	13·05	2·81, $\dot{Mg}$ 0·09, $\overline{\dddot{Mn}}$ 0·19, $\dot{Cu}$ *trace*=99·75, Ab. G.=2·58.
10. Chili, *rose*,	65·37	20·47	——	2·60	6·30	4·00=98·74, Dom. G.=2·596.
11. *Moonstone*, Ceyl.	64·00	19·43	——	0·42	14·81	——, $\dot{Mg}$ 0·2, $\dot{H}$ and loss 1·14=100, B. and M.
12. Marienberg,	66·43	17·03	0·49	1·03	13·96	0·91=99·85, Krön. G.=2·44.
13. Saxony,	65·52	17·61	0·80	0·94	12·98	1·70=99·55, Kersten.
14. *Valencianite*,	66·82	17·58	0·09	——	14·80	——=99·29, Plattner.
15. *Microcline*,	65·76	18·31	*trace*	1·20	14·06	——=99·33, Evreinoff.

The *Perthite* (Thomson) has been found by Mr. Hartley, aided by T. S. Hunt, to be identical in composition with common feldspar, (Rep. Geol. Canada, 1849, 135). The *Peristerite* (Thomson) is also this species, as confirmed by Mr. Hunt. It is an iridescent variety. The feldspar of the Chilian Andes (analysis 10) contains largely of soda, as well as potash.

Abich finds one or more per cent. of soda in all the feldspars analyzed by him.

B.B. feldspar fuses with difficulty, and only on the edges, to a semi-transparent blebby glass. With borax it forms slowly a transparent glass, and with soda slowly a vesicular glass. Not acted upon 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 of the varieties of this species.

Common Feldspar includes the subtranslucent varieties, the common constituent of granite.

Necronite is a variety of feldspar, which 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.

Moonstone is a variety of adularia, presenting, when polished, chatoyant or pearly reflections. *Sunstone* is a similar variety, containing minute particles disseminated through it. The opalescence is seen only in the direction of a plane replacing the edge T : T somewhat obliquely.

Aventurine Feldspar is less pellucid, and has yellow and reddish internal reflections.

But neither of these are exclusively common feldspar. A Siberian sunstone has been shown by Scheerer to be oligoclase.

. *Glassy Feldspar* is a transparent variety found in trachytic and volcanic rocks, having a perfect vitreous lustre. 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, which is a yellowish-gray variety from Dawlish and Arran; *Amazon stone*, a verdigris-green variety colored by copper; 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 Drae river in France.

Kaolin is a term applied to a clay resulting from the decomposition of feldspar. In the formation of Kaolin, the principal change consists in the removal of the alkali of the feldspar, with part of the silica, and the addition of water, (see page 287).

The *Microcline* of Breithaupt is a variety of this species from Arendal, (Pogg. xlvii, 196). The *Erythrite* 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 *Peristerite* and *Perthite* of Thomson (Phil. Mag. xxii, 189) are from Perth in Upper Canada.

Feldspar in fine crystals is found at Carlsbad and Elbogen in Bohemia. The twins, figs. 5, 6, are abundant at the former place, where they occur two to four inches in length, scattered over the fields, from the decomposition of the granite of the region. 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 1802. 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, neatly modified, 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 De Long's mill in the town of Hammond, with apatite and zircon; in Lewis Co., feldspar occurs both crystallized and massive in white limestone near Natural Bridge, associated with scapolite and sphene; in Orange Co., crystals presenting the primary form occur near West Point; more abundant and interesting forms are found at Rocky Hill, in Warwick, associated with tourmaline and zircon; and at Amity and Edenville. In Saratoga Co., N. Y., the Greenfield chrysoberyl locality affords white translucent crystals, which are usually coated with silvery mica. In Connecticut, the gneiss quarries of Haddam and the feldspar quarries of Middletown occasionally afford crystals a foot in length, and six or eight inches in thickness; near Bradleysville, in the western part of Litchfield, crystals two to three inches long are abundant. In Massachusetts at South Royalston and Barre, in interesting crystals often of large size; 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, Delaware Co.; chatoyant (moonstone) and also aventurine, and a green variety, at Mineral Hill; a sunstone in Kennett Township; fine crystals of green feldspar occur on the island, Mt. Dessert, Me.

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 iolite locality at Haddam, at the Falls of the Yantic, near Norwich, Conn., at Brimfield, Mass., with iolite, and at Parsonsfield, Me.; and sunstone at Lyme, Conn. 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.

Feldspar and the clay (*Kaolin*) resulting from its decomposition, are used in making pottery. Moonstone and sunstone are employed as gems.

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, 15·8 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.

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.

Granulite, *Eurite*, or *Leptynite*, (Weisstein), is a granular compound of feldspar and quartz.

The *Hornfels* of the Germans is a massive compound of quartz and feldspar breaking with a smooth flinty fracture.

Pyroxenite consists of feldspar and lamellar pyroxene.

Porphyry consists of a compact feldspathic base, (*cornite* or *porphyrite*), with crystals of feldspar: 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 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.

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 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 the feldspar the rock is called *diorite* and *diabase*.

Basalt 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. It passes into lavas, which often have the same constitution and are of the same origin. When the feldspar in combination with augite is labradorite, the rock is called *dolerite*. *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

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). G.=2·3—2·4.

The following are analyses of pumice and obsidian; 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, Trommsdorff, (N. J. d. Pharm. iii, 301); 7, Erdmann, (loc. cit.); 8, Ficinus, (Schw. J. xxix, 136); 9, Erdmann, (loc. cit.); 10, Forchhammer; 11, Klaproth, (Beit. ii, 62, iii, 262); 12, Berthier, (Ann. d. Mines, vii); 13, 14, B. Silliman, Jr., (Dana's Geol. Rep. p. 200):

	$\dddot{Si}$	$\overline{\dddot{Al}}$	$\overline{\dddot{Fe}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\dot{Na}$	
1. *Obsidian*, Pasco,	69·46	2·60	2·60	7·54	2·60	7·12	5·08,	$\dot{\bar{H}}$ 3·00=100, Berth.
2. " Mexico,	78·	10·	2·	1·	—	6·	—	$\dot{Mn}$ 1·6=98·6, Vauq.
3. " Telkebanya,	74·80	12·40	2·03	1·96	0·90	6·40	—	$\dot{Mn}$ 1·31=99·80, E.
4. *Pitchstone*, Meissen,	75·60	11·60	1·20	1·35	6·69	2·77,		$\dot{\bar{H}}$ 4·78=103·95, E.
5. " Arran,	63·50	12·74	$\dot{F}$ 3·80	4·46	—	—	6·22,	ign. 8·0=98·71, Th.
6. " *bk.* Dresden,	74·00	17·00	$\overline{\dddot{F}}$ 2·75	1·50	—	—	—	$\dot{Li}$ 3·00=98·25, Tr.
7. *Pearlstone*, Hungary,	72·87	12·05	1·75	1·30	1·10	6·13,		$\dot{\bar{H}}$ 3·0=98·20, Erd.
8. " "	79·12	12·00	2·45	—	1·10	3·58,		$\dot{\bar{H}}$ 1·76=100·01, F.
9. *Spherulite*, "	77·20	12·47	2·27	3·34	0·78	4·27		=100·28, Erdmann.
10. *Krablite*, Iceland,	74·83	13·49	4·40	1·98	0·17	*trace*	5·56	=100·43, F.; G.2·389.
11. *Pumice*, Lipari,	77·50	17·50	1·75	—	—			3·00=99·75, Klaproth.
12. " "	70·00	16·00	0·50	2·50	—	6·50	—	$\dot{\bar{H}}$ 3·00=98·50, B.
13, 14. *Pélé's Hair*,	51·19	—	—	—	18·16	—	—	$\dot{Fe}$ 30·26=99·61, S.
Hawaii, *volc. glass*,	39·74	10·55	—	2·74	2·40	—	21·62,	$\dot{Fe}$ 22·29, $\dot{\bar{H}}$ 0·33= 99·67, Silliman, Jr.

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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	29·288
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	1·084
Potash,	9·519	4·244	0·085	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 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.

LOXOCLASE, *Breithaupt*, Pogg. Ann. lxvii, 419.

Monoclinic, and resembling orthoclase, T : T=120° 15′. Cleavage basal, perfect; macrodiagonal also perfect; brachydiagonal indistinct.

H.=6—6·5. G.=2·609—2·620. Color whitish, yellowish-gray, bluish-gray.

Composition.—$\dot{\mathrm{R}}\dddot{\mathrm{Si}}+\dddot{\mathrm{\bar{A}l}}\dddot{\mathrm{Si}}^3$, or like *Oligoclase.* Analysis by Plattner, (Pogg. lxvii, 419):

$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{\bar{A}l}}$	$\dddot{\mathrm{\bar{F}e}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	
63·50	20·29	0·67	3·22	*trace*	8·76	3·03	FSi, $\dot{\mathrm{H}}$ 1·23=100·7.

B.B. fuses with difficulty, coloring the flame intensely yellow.

Occurs at Hammond, N. Y., associated with pyroxene, graphite, and calc spar.

BAULITE, *Forchhammer*, Skand. Nat. Samm. i Stockholm, July, 1842.

Monoclinic. Cleavage as in feldspar, according to Forchhammer.

H.=5·5—6. G.=2·623, Forchhammer; 2626, Genth. Vitreous. Whitish. Transparent to translucent.

Composition.—$\dot{\mathrm{R}}\dddot{\mathrm{Si}}^3+\dddot{\mathrm{\bar{A}l}}\dddot{\mathrm{Si}}^6$. Analyses: 1, Forchhammer, (loc. cit.); 2, Genth, (Ann. d. Ch. u. Pharm. lxvi, 270):

$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{\bar{A}l}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Mn}}$	
76·65	11·57	0·05	3·73	8·26	0·20	——	$\dot{\mathrm{Fe}}$ 0·68=99·09, Forch.
80·23	12·08	0·95	2·26	4·92	*traces*		=100·44, Genth.

B.B. in thin splinters fuses to a clear glass; the same with borax and salt of phosphorus, the latter affording a silica skeleton. Insoluble in muriatic acid.

From Mt. Baula and from Krabla, Iceland, mixed with quartz.

RYACOLITE, *Rose.* Ice-spar, *in part.* Glassy Feldspar.

Monoclinic; T : T=119° 21′. Cleavage parallel with P and the clinodiagonal. Occurs in glassy crystals.

H.=6. G.=2·55—2·62. Lustre vitreous, vitreo-pearly. Color grayish-yellow to white, or colorless. Transparent. Fracture conchoidal.

Composition.—$(\dot{\mathrm{Na}}, \dot{\mathrm{K}})\dddot{\mathrm{Si}}+\dddot{\mathrm{\bar{A}l}}\dddot{\mathrm{Si}}$=Silica 51·6, alumina 28·7, soda 13·2, potash 6·5. Analysis by G. Rose, (Pogg. xxviii, 143):

$\dddot{\mathrm{Si}}$ 50·31, $\dddot{\mathrm{\bar{A}l}}$ 29·44, $\dddot{\mathrm{\bar{F}e}}$ 0·28, $\dot{\mathrm{Ca}}$ 1·07, $\dot{\mathrm{Mg}}$ 0·23, $\dot{\mathrm{K}}$ 5·92, $\dot{\mathrm{Na}}$ 10·56=97·81.

BB. acts like orthoclase, but fuses more easily and tinges the flame a deeper yellow. In acids dissolves slowly and silica is deposited.

Occurs in the dolomite of Somma, with mica and pyroxene; also in the Eiffel.

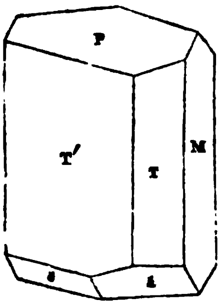
ALBITE, *D.* Cleavelandite, *Brooke.* Periklin, *Breit.* Tetartine. Kieselspath, *Haus.*

Triclinic. Face M inclining to the left, as in lepolite, oligoclase and andesine.

	Levy.	*Rose.*	*Descloizeaux.*	*Breithaupt.*
P : T′	=115° 0′	115° 5′	114° 40′	114° 45′
P : T	=111° 16′	110° 51′	111° 10′	110° 37′
T : T′	=121°	122° 15′	120° 45′—122°	120° 37′
T′ : M	=119° 30′	117° 53′	120°	119° 5′
P : M	= 93° 30′	93° 36′	93° 30′	93° 19′

Cleavage perfect, parallel with M and P, with T′ less so. Compound crystals: similar to the annexed figure; but usually flattened parallel to M, which face is consequently much enlarged. Also lamellar and granular; the laminæ sometimes divergent; the granular varieties occasionally quite fine, approaching to impalpable.

1



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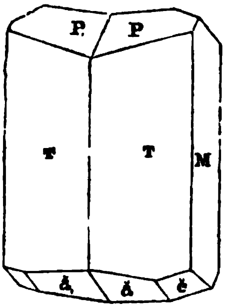


H.=6; some granular varieties 7. G.=2·59—2·65; 2·612, Finbo, Eggertz; 2·619, Broddbo; 2·641, variety Pericline. Lustre pearly upon a cleavage face; vitreous in other directions. Color white; also occasionally bluish, gray, reddish, greenish, and green; it sometimes exhibits a bluish opalescence. Streak uncolored. Transparent—subtranslucent. Fracture uneven. Brittle.

Composition.—$\dot{N}a\dddot{S}i+\bar{A}l\dddot{S}i^{3}$=Silica 69·09, alumina 19·22, soda 11·69=100.

Analyses: 1, G. Rose, (Gilb. Ann. lxxiii, 178); 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, Redtenbacher, (Pogg. lii, 468); 9, Brooks, (Pogg. lxi, 392); 10, Kersten, (Leonh. Jahrb. 1845, 648); 11, 12, Brush and Weld, (Am. J. Sci. [2], viii, 390):

	$\dddot{S}i$	$\bar{A}l$	$\bar{F}e$	$\dot{K}$	$\dot{N}a$	$\dot{C}a$
1. Arendal,	68·46	19·30	0·28	—	9·12	0·68=97·84, G. Rose.
2. Chesterfield, Mass.,	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, $\dot{M}g$ 0·18, $\dot{M}n$ *trace*=100, Abich. G.=2·624.
6. Brevig,	69·11	19·34	0·62	0·65	10·98	*trace*, $\dot{M}g$, $\dot{M}n$ *trace*=100·7, E.
7. *Pericline*, in trachyte, Pantellaria,	68·23	18·30	1·01	2·53	7·99	1·26, $\dot{M}g$ 0·51=99·83, Abich.
8. Pennsylvania,	67·20	19·64	—	1·57	9·91	1·44, $\dot{M}g$ 0·31=100·07, Redt.
9. St. Gothard, *white*,	67·39	19·24	—	6·77	6·23	0·31, $\dot{M}g$ 0·61=100·55, Brooks, (mean of 2 analyses).
10. Marienbad,	68·70	17·92	0·72	1·18	11·01	0·24=99·77, Kers. G.=2·612.
11. Lancaster Co., Pa.,	66·65	20·79	—	—	9·36	2·05, $\dot{M}g$ 0·52=99·42, Brush, G.=2·619.
12. Unionville, Pa.,	66·86	21·89	—	—	8·78	1·79, $\dot{M}g$ 0·48, $\dot{H}$ 0·48=100·27, Weld.

B.B. acts like feldspar, but colors the flame distinctly yellow. Acted on by hot acids.

The species *Pericline* has been found to be identical with albite, both in composition and crystallization. *Cleavelandite* is a white lamellar variety from Chesterfield, Mass., the lamellæ of which often form wedge-shaped masses.

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. Such is the case in the rocks about Edinburgh.

In Massachusetts, U. S., at Chesterfield, it occurs in lamellar masses, (Cleavelandite), having a slightly bluish tint; also at the same locality finely granular, and rarely in small crystals, and containing red and blue tourmalines. It contains the same minerals at Paris, Maine, and at Goshen, Mass., at Acworth and Alstead, N. H. At Haddam, Conn., it accompanies chrysoberyl, beryl, columbite, and black tourmalines. Fine transparent or translucent crystallizations occur at the Middletown feldspar quarry. Granville, Washington Co., N. Y., affords white transparent crystals. At Monroe, Conn., a fine granular variety occurs, containing beryl. In Delaware Co., Pennsylvania, at Unionville, a granular variety occurs as the matrix of the corundum, (see analyses 11 and 12), having the hardness of quartz, (7—7·25). It has 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. The variety from Chesterfield was denominated Cleavelandite by Mr. Brooke, in honor of Prof. Cleaveland.

OLIGOCLASE. Soda Spodumene. Natron-Spodumen, *Berz.*

Triclinic. P : M=93° 15′; M : T′=115° 30′. Cleavage very distinct parallel with P; less so parallel to the clinodiagonal; indistinct parallel to T′.

H.=6. G.=2·63—2·69. Lustre vitreous, vitreo-pearly or greasy. Color yellowish, grayish, reddish, greenish-white, white. Transparent, subtranslucent. Fracture conchoidal—uneven.

Composition.—$(\dot{\mathrm{C}}\mathrm{a}, \dot{\mathrm{N}}\mathrm{a})\dddot{\mathrm{S}}\mathrm{i}+\bar{\dddot{\mathrm{A}}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}^2$=Silica 62·64, alumina 23·23, soda 14·13=100. Analyses: 1, 2, Berzelius, (Jahresb. iv, 147, xix, 302); 3, Laurent, (Ann. Ch. Phys. lix); 4, R. Hagen, (Pogg. xliv, 329); 5, Rosales, (Pogg. lv, 109); 6, Francis, (Pogg. lii, 470); 7, Chodnew, (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. i Stockholm, 1842); 14, L. Svanberg. (Œfv. K. V. Ak. Fœrh. iii, 111); 15, Rammelsberg, (Pogg. lvi, 617); 16, Delesse, (Ann. Ch. Ph. [3], xxiv); 17, Kerndt, (J. f. pr. Ch. xliii, 218):

	$\dddot{\mathrm{S}}\mathrm{i}$	$\bar{\dddot{\mathrm{A}}}\mathrm{l}$	$\bar{\dddot{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{K}}$
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. Arriège,	62.6	24·6	0·1	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, *yellowish-white*,	62·70	23·80	—	4·60	0·02	8·00	1·05, $\dot{\mathrm{F}}\mathrm{e}$ 0·62=100·79, R.
6. Ajatakaja,	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.; G. 2·63.
8. Schleswig Holstein,	64·30	22·34	—	4·12	—	9·01	—=99·77, W.; G. 2.651.
9. *Sunstone*, from Tvedenstand, G. 2·656,	61·30	23·77	0·86	4·78	—	8·50	1·29=100, Scheerer.
10. Near Freiberg,	62·97	23·48	0·51	2·83	0·24	7·24	2·42=99·69, K.; G. 2·65.
11. Marienbad,	63·20	23·50	0·31	2·42	0·25	7·42	2·22=99·82, K.; G. 2·631
12. Teneriffe,	62·97	22·29	—	2·06	0·54	8·45	3·69=100, D.; G.=2·59.
13. *Hafnefjordite*,	61·22	23·32	2·40	8·82	0·36	2·56	*trace*=98·68, Forch.
14. "	59·66	23·28	1·18	5·17	0·36	5·61	1·75, ign. 1·02, undecomp. 0·82=98·85, Sv.; G.=2·69.
15. Warmbrunn,	63·94	23·71	*trace*	2·52	*trace*	7·66	2·17=100, Ramm.
16. Mer-de-glace,	63·25	23·92	*trace*	3·23	0·32	6·88	2·31, $\bar{\mathrm{M}}\mathrm{n}$ *trace*=99·91, D.
17. Boden,	61·96	22·66	0·35	2·03	0·10	9·43	3·03, $\bar{\mathrm{M}}\mathrm{n}$ 0·40=100, K. G.=2·653.

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.

It occurs at Danvikszoll near Stockholm; at Arriège, and Arendal, with calcite; 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, as shown by Scheerer.

LABRADORITE. Labrador Feldspar. Anhydrous Scolecite. Silicite, *Thom.*

Triclinic. P : M=86° 32′, P : T=114° 48′, M : T=119° 16′. Secondary forms, similar to those of albite. Cleavage parallel with P perfect; M distinct; T′ indistinct. Also massive, with distinct cleavage.

H.=6. G.=2·68—2·76. Lustre of P pearly, passing into vitreous; elsewhere vitreous. Color gray, brown, or greenish; usually a beautiful 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.—$\dot{\mathrm{R}}\dddot{\mathrm{Si}}+\dddot{\overline{\mathrm{Al}}}\dddot{\mathrm{Si}}$=Silica 53·42, alumina 29·71, lime 12·35, soda 4·52=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, 9, Karsten, (Pogg. lxiii, 123); 10, Nordenskiöld, (Schweig. J. xxxi, 417); 11, Bergemann, (Pogg. ix, 267); 12, Giwartowsky, (Bull. Soc. Nat. Moscow, 1848, 548); 13, Thomson, (Phil. Mag. 1843, 190); 14, 15, Delesse, (Ann. d. Mines, [4], xii, 251, 253):

	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	
1. Labrador,	55·75	26·50	1·25	11·00	4·00,	$\dot{\mathrm{H}}$ 0·5=99·00, Klaproth.
2. Campsie,	54·67	27·89	0·81	10·60	5·05,	$\dot{\mathrm{K}}$ 0·49, $\dot{\mathrm{Mg}}$ 0·18=99·19, Lehunt.
3. Glasgow,	52·34	29·97	0·87	12·10	3·97,	$\dot{\mathrm{K}}$ 0·30=99·55, Lehunt.
4. Etna,	53·48	26·46	1·60	9·49	4·10,	$\dot{\mathrm{K}}$ 0·22, $\dot{\mathrm{Mg}}$ 1·74, $\dot{\mathrm{Mn}}$ 0·89, $\dot{\mathrm{H}}$ 0·42=98·40, Abich.
5. Dalarne,	52·15	26·82	1·29	9·14	4·64,	$\dot{\mathrm{K}}$ 1·79, $\dot{\mathrm{Mg}}$ 1·02, ign. 1·75=98·60, Sv.
6. Faroe,	52·52	30·03	1·72	12·58	4·51,	$\dot{\mathrm{Mg}}$ 0·19=101·55, F. G.=2·68.
7. Egersund,	52·30	29·00	1·95	11·69	4·01,	$\dot{\mathrm{K}}$ 0·5, $\dot{\mathrm{Mg}}$ 0·15=99·6, K. G.=2·71.
8. "	52·45	29·85	1·00	11·70	3·90,	$\dot{\mathrm{K}}$ 0·6, $\dot{\mathrm{Mg}}$ 0·16=99·66, K. G.=2·72
9. "	52·20	29·05	0·80	12·10	4·70,	$\dot{\mathrm{Mg}}$ 0·13=98·98, K. G.=2·705.
10. *Scolexerose*,	54·13	29·23	—	15·45	—,	$\dot{\mathrm{H}}$ 1·07=99·88, Nordenskiöld.
11. *Glaucolite*,	50·58	27·60	—	10·27	2·97,	$\dot{\mathrm{K}}$ 1·27, $\dot{\mathrm{Mg}}$ 3·78, $\dot{\mathrm{Fe}}$ 0·1, $\dot{\mathrm{Mn}}$ 0·87, ign. 1·73=99·11, Berg.
12. "	50·49	28·12	—	11·31	3·10,	$\dot{\mathrm{Mg}}$ 2·68, $\dot{\mathrm{K}}$ 1·01, $\dot{\mathrm{Mn}}$ 0·60, $\dot{\mathrm{Fe}}$ 0·40, $\dot{\mathrm{H}}$ 1·79=96·00. Giw.
13. *Silicite*,	54·8	28·4	—	12·4	—,	$\dot{\mathrm{Fe}}$ 4·0, $\dot{\mathrm{H}}$ 0·6=100·2, T. G.=2·666.
14. Greece,	53·20	27·81	1·08	8·02	3·52,	$\dot{\mathrm{K}}$ 3·40, $\dot{\mathrm{H}}$ 2·51, $\dot{\mathrm{Mg}}$ 1·01=100·63, Del.
15. Tyrol,	53·23	27·73	1·50	8·28	alkalies 7·38,	$\dot{\mathrm{Mg}}$ 0·93, $\dot{\mathrm{H}}$ 0·95=100, Del.

No. 7, brown massive variety; 8, with blue opalescence; 9, with violet opalescence.

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 14), 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 15). On the coast of Labrador, whence it was originally brought, it is associated with hornblende, hypersthene, and magnetic iron ore.' It occurs abundantly in 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, Schoharie, 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.

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. Color white, gray, greenish. Lustre subvitreous, inclining to pearly.

Composition.—$\dot{R}^{3}\dddot{Si}^{3}+3\overline{Al}\dddot{Si}^{3}$. Analyses: 1, Abich, (Pogg. li, 523); 2, 3, 4, Delesse, (Mem. Soc. d'Emulation du Doubs); 5, Schmidt, (Pogg. lxi, 385):

	$\dddot{Si}$	$\overline{Al}$	$\overline{Fe}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\dot{Na}$
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, $\dot{H}$ 1·27=99·55, D.
3. " *red*,	58·91	24·59	0·99	4·01	0·39	2·54	7·59, $\dot{H}$ 0·98=100, D.
4. Chagey,*	59·95	24·13	1·05	5·65	0·74	0·81	5·39, $\dot{H}$ 2·28=100, D.
5. *Saccharite*,	58·93	23·50	1·27	5·67	0·56	0·05	7·42, $\dot{Ni}$ 0·39, $\dot{H}$ 2·21=100, S.

Andesine fuses in thin splinters before the blowpipe. Saccharite melts only on thin edges; with borax forms a clear glass. Imperfectly soluble in acids.

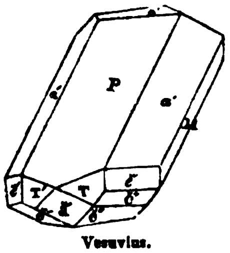
Andesine occurs in the Andes, at Marmato, in the rock called *Andesite*, a whitish syenite. Delesse has found the same mineral in the syenite of Alsace in the Vosges. G.=2·683, white of Servance; 2·651, red of Coravillers; and also in the porphyry near Chagey, Haute Saône; G.=2·736. Saccharite is a granular mineral, having traces of cleavage in one direction, occurring in veins in serpentine at the chrysoprase mines near Frankenstein, in Silesia.

If the water in Saccharite is an essential ingredient, the species is not identical with Andesine.

ANORTHITE, *Rose*, 1823. Amphodelite, *Nord.* Indianite, *Bournon.* Biotina, *Mont.*

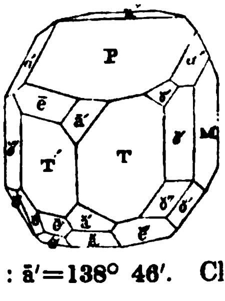
Triclinic. P : T′=101° 39′; P : T=110° 57′, P : M=85° 48′,

1



Vesuvius.

2



T′ : T=120° 30′; P : *a*′=133° 13′, P : ā′=138° 46′. Cleavage

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* Delesse takes the ground that the water in this and other feldspars is a constituent he mineral.

parallel with P and M perfect. Face M oblique to the *right* as in labradorite and hyposclerite. Structure granular, columnar, or coarse lamellar.

H.=6—7. G.=2·65—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.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+3\dddot{\overline{\mathrm{Al}}}\dddot{\mathrm{Si}}$=Silica 43·9, alumina 36·3, lime 19·8.

Analyses: 1, G. Rose, (Gilb. Ann. lxxiii, 173); 2, 3, Abich, (Pogg. li, 519); 4, Reinwardt, (Pogg. l, 351); 5, Forchhammer, (Jahresb, xxiii, 284); 6, Nordenskiöld, (Pogg. xii, 174); 7, Svanberg, (Jahresb. xx, 238); 8, Chenevix; 9, Laugier; 10, G. J. Brush, under the direction of Silliman, Jr. (Am. J. Sci. [2], viii); 11, Erdmann, (Ofv. K. V. Ak. Förh. 1846, 67):

	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$
1. Monte Somma,	44·49	34·46	0·74	15·68	5·26	—	—=100·63, G. Rose.
2. " "	44·12	35·12	0·70	19·02	0·53	0·25	0·27=100·01, 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	—	14·5	—	—	0·6 =98·1, Reinw.
5. Faroe,	47·63	32·52	2·01	17·05	1·30	0·29	1·09=101·89, F.; G. 2·70.
6. *Amphodelite*, from Finland,	45·80	35·45	—	10·15	5·05	—	—, $\dot{\mathrm{Fe}}$ 1·70, $\dot{\mathrm{H}}$ 1·85=100, Nord.
7. *Amphodelite*, from Tunaberg,	44·55	35·91	0·07	15·02	4·08	—	—, ign. 0·6=100·23, S.
8. *Indianite, red*,	42·00	34·00	3·20	15·00	—	—	3·35, $\dot{\mathrm{H}}$ 1·0=98·55, Ch.
9. " *white*,	43·0	34·5	1·0	15·6	—	—	2·6, $\dot{\mathrm{H}}$ 1·0=97·7, Laug.
10. "	42·09	38·89	—	15·78	—	—	4·08=100·84, Brush.
11. *Anorthite*,	43·34	35·37	—	17·41	0·35	0·52	0·89, $\dot{\mathrm{Fe}}$ 1·35, ign. 0·39, undec. 0·57=100·19, E.

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 is a reddish gray or dingy peach-blossom-red variety, occurring crystallized and massive, with the angle P : M=85° 40′ and 94° 20′, and cleavage parallel to P and M. *Indianite* has a granular texture something like statuary marble, a glistening surface of fracture, and occurs massive. The grains cleave parallel to two planes inclined to one another 95° 15′, which is not far from the angle of anorthite, considering the difficulty in this case of obtaining perfectly accurate measurement.

The *Biotine* of Monticelli is shown by Brooke to be this species, (Phil. Mag. x, 1837).

The *Christianite* of Monticelli is referred here by Scacchi.

Anorthite 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 Indianite is from the gangue of the corundum in the Carnatic, and is associated with garnet, kyanite, and hornblende. A mineral from Bytown, U. C., analyzed by Tennant, has been referred to amphodelite. He obtained

$\dddot{\mathrm{Si}}$ 45·30, $\dddot{\overline{\mathrm{Al}}}$ 26·15, $\dot{\mathrm{Ca}}$ 16·25, $\dot{\mathrm{Mg}}$ 2·95, $\dot{\mathrm{Fe}}$ 4·70, Loss by ignition 2·00=97·35.

Biotine is found among the volcanic debris of Vesuvius. Indianite occurs as the gangue of the corundum of the Carnatic. The specimen analyzed under the direction of Silliman was originally from the hands of Count Bournon, and came from the Indian locality.

LEPOLITE, *Nordenskiöld; Breit.*, Handb. iii, 530; *Hermann*, J. f. pr. Chem. xlvi, 337.

Triclinic, and resembling anorthite, but differing from it in being oblique to the left. T : T′=120° 30′, P : M=93°, which is the angle between the cleavage planes. Crystals highly modified.

H.=6. G.=2·75—2·77. Vitreous and transparent; colorless, grayish, greenish, often brownish externally.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+3\bar{\mathrm{Al}}\dddot{\mathrm{Si}}$, like anorthite. Analyses by R. Hermann, (loc. cit.):

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\bar{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$
1. Lojo,	42·80	35·12	1·50	14·14	2·27	1·50, ign 1·56=99·69.
2. Orrijervfi,	42·50	33·11	4·00	10·87	5·87	1·69, ign 1·50=99·54.

B.B. fuses with difficulty on the edges. Decomposed by concentrated acids.

From Lojo and Orrijervfi, in Finland, in large crystals, sometimes two inches long, with smooth faces.

The *Lindsayite* (or *Linseite*) of Komonen, of the same locality, which is described as a distinct species by Hermann, (J. f. pr. Chem. xlvi, 396), is identical with Lepolite, except that it contains 1$\dot{\mathrm{H}}$. Breithaupt states that it is properly a pseudomorph after Lepolite, (J. f. pr. Chem. xlvii, 286).

VOSGITE, *Delesse*, Ann. des Mines, 4th ser. xii, 284.

Triclinic; but seldom in distinct crystals. Cleavage in one direction easy; also a second, somewhat less easy. Also massive or in thin tables.

H.=6. G.=2·737, Corsica; 2·771, Vosges. Lustre greasy to pearly. Color whitish, with a shade of green; also slightly grayish or bluish. Translucent. Fracture conchoidal or uneven.

Composition.—$3\dot{\mathrm{R}}\dddot{\mathrm{Si}}+\bar{\mathrm{Al}}^2\dddot{\mathrm{Si}}^3$. Analyses by Delesse, (loc. cit., and Ann. Ch. Phys. xxiv):

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\bar{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1. Vosges,	49·32	30·07	0·70	0·60	4·25	1·96	4·85	4·45	3·15=99·35.
2. Corsica,	48·62	34·66	0·66	—	12·02	0·33	2·55	1·06	0·49=100·39.

In a matrass the Vosges mineral yields water, which Delesse suggests may be in chemical combination. B.B. fuses with intumescence to a white blebby glass, with about the same facility as labradorite. A transparent pearl with borax. Attacked by muriatic acid more easily than labradorite, and in very fine powder the solution is complete, especially if sulphuric acid is employed; the silica separates in grains.

Constitutes the porphyry of Ternuay in the Vosges; also enters into the constitution of the orbicular diorite of Corsica, the other ingredient being augite.

THIORSAUITE, *F. A. Genth.*

Monoclinic? Massive, with one perfect cleavage.

H.=6. G.=2·688. Lustre vitreous, pearly on the cleavage face. Color white to grayish. Streak uncolored. Transparent.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+2\frac{1}{4}\bar{\mathrm{Al}}\dddot{\mathrm{Si}}$. Analysis by Genth, (Amer. Jour. Sci. [2], vii, 114):

$\dddot{\mathrm{Si}}$ 48·36, $\bar{\mathrm{Al}}$ 30·59, $\bar{\mathrm{Fe}}$ 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.

B.B. in thin splinters it fuses to a glass; in borax, dissolves. Insoluble in muriatic acid. Fracture somewhat conchoidal.

Occurs in the lava of Thjorsa, Hekla, Iceland, along with chrysolite. In composition it differs from Scapolite in containing 2¼ instead of 2 $\bar{\mathrm{Al}}\dddot{\mathrm{Si}}$.

COUZERANITE, *Charpentier; Dufrénoy*, Ann. Ch. Phys. xxxviii, 280.

Monoclinic. M : M=96°. Crystals long and vertically striated. Cleavage clinodiagonal.

H.=6—6·5. G.=2·69. Vitreous. Gray, greenish-gray, black. Cross fracture uneven.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+2\bar{\mathrm{Al}}\dddot{\mathrm{Si}}$. Analysis by Dufrenoy:

$\dddot{\mathrm{Si}}$ 52·37, $\bar{\mathrm{Al}}$ 24·02, $\dot{\mathrm{Ca}}$ 11·85, $\dot{\mathrm{Mg}}$ 1·40 $\dot{\mathrm{K}}$ 5·52, $\dot{\mathrm{Na}}$ 3·96=98·55.

B.B. fuses to a white enamel. Not attacked by the acids.

From Couzeran. Occurs in mica slate at Barèges, Dept. of the Haute Pyrenees, in slender crystals. Kobell and Haidinger suggest that it may be labradorite.

HYPOSCLERITE, *Breithaupt.*

Triclinic. Prism oblique to the *right*, as in anorthite. P : M= (see figure of anorthite) 87°, T : T′=119°; P : T=114° 30′; a vertical plane between M and T, on a corresponding plane between T′ and the opposite M=59°; P : $\breve{a}$=127°. Cleavage parallel with P and M.

H.=6·5. G.=2·609—2·612, Breithaupt; 2·66, Hermann. Greenish-gray, with a weak greasy lustre, inclining to vitreous. Translucent.

Composition.—$3\dot{R}\dddot{Si}+\dddot{\bar{Al}}^2\dddot{Si}^3$. Analysis by Hermann, (J. f. pr. Chem. xlvi, 396):

$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dddot{\bar{Mn}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	$\dot{Ce}$, $\dot{La}$
56·43	21·70	0·75	0·39	4·83	3·39	5·79	2·65	2·00, ign. 1·87=99·80.

No water in a matrass. B.B. in the forceps fuses with difficulty on the edges to a white enamel.

From Arendal, in crystals one-fourth to one-half an inch in length.

This species is peculiar among the feldspars in having the ratio of the oxygen in the protoxyds and peroxyds as 1 : 2.

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; 3·342, Pays de Vaud. Lustre pearly, inclining to vitreous upon the faces of cleavage; also resinous in some specimens, particularly the massive. Streak white. Color white, passing into greenish-white, mountain-green or ash-gray. Fracture uneven, splintery. Subtranslucent. Extremely tough.

Composition.—$\dot{R}^3\dddot{Si}+2\dddot{\bar{Al}}\dddot{Si}$? Analyses: 1, Klaproth, (Beit. iv, 278); 2, Saussure, (J. d. Mines, xix, 205); 3, 4, Boulanger, (Ann. d. Mines, [3], viii, 159):

	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dddot{\bar{Mn}}$	$\dot{Ca}$	$\dot{Na}$	$\dot{K}$	$\dot{Mg}$
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 upon by acids.

Saussurite occurs in primitive regions, 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.

LATROBITE, *Brooke*, Ann. Phil. 2d ser. v, 383. Diploite, *Breit.*

Triclinic; P : M=91° 9′, P : T=98° 30′, M : T=93° 30′ (fig. 103, pl. 2); angles obtained from cleavage planes. Cleavage parallel to P, M, and T. Occurs also massive.

H.=5·5—6·5. G.=2·72, Gmelin; 2·8, Brooke. Lustre vitreous; of P dull; M and T unequally shining. Color a pale rose-red, or a pink, resembling lepidolite. Subtranslucent—opaque.

Composition.—$\dot{R}^3\dddot{Si}+4\dddot{\bar{Al}}\dddot{Si}$. Analyses by C. Gmelin, (Pogg. iii, 68):

	$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\bar{\dddot{\mathrm{Mn}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	$\dot{\bar{\mathrm{H}}}$
1.	44·65	36·81	3·16	0·63	8·28	6·58	2·04=102·16.
2.	41·78	32·83	5·77		9·79	6·58	2·04=98·78.

B.B. in the platinum forceps fuses on the edges, with some intumescence, to a white enamel. With borax, it affords a pale amethyst-red globule in the oxydating flame, and colorless in the reducing. With salt of phosphorus it melts to a clear glass, containing a skeleton of silica.

Found on Amitok island, near the coast of Labrador, where it is associated with feldspar, mica, and calcareous spar. It was found by the Rev. C. I. Latrobe.

This species may be identical with anorthite.

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, $\bar{\dddot{\mathrm{Al}}}$ 16·394, $\bar{\dddot{\mathrm{Fe}}}$ 0·862, $\dot{\mathrm{K}}$ 16·506, $\dot{\mathrm{Na}}$ and $\dot{\mathrm{Li}}$ *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.

PETALITE.

Massive, with cleavage in one direction perfect; in two others imperfect, making an angle together of 106°; also between the perfect and one imperfect, an angle of 142° nearly; Haüy makes the angle 137° 10′; Mohs gives 95°, and Brooke 100°, for a rhombic prism; and Leonhard 84° for an oblique rhombic or rhomboidal prism. The system of crystallization is probably monoclinic. Structure sometimes columnar, occasionally impalpable, usually strongly coherent.

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. Streak white. Color white or gray, with occasionally a reddish or greenish tinge. Translucent. Fracture imperfectly conchoidal.

Composition.—$(\dot{\mathrm{Li}}, \dot{\mathrm{Na}})^3\dddot{\mathrm{Si}}^4+4\bar{\dddot{\mathrm{Al}}}\dddot{\mathrm{Si}}^4$=Silica 77·9, alumina 17·4, lithia 2·7, soda 2·0.

Analyses: 1, Arfvedson, (Schw. J. xxii, 93); 2, Gmelin, (Gilb. Ann. lxii, 399); 3, 4, R. Hagen, (Pogg. xlviii, 361):

	$\dddot{\mathrm{Si}}$	$\bar{\dddot{\mathrm{Al}}}$	$\dot{\mathrm{Li}}$	$\dot{\mathrm{Na}}$	
1. Utö,	79·212	17·225	5·761	——	=102·198, Arfvedson.
2. “	74·17	17·41	5·16		$\dot{\mathrm{Ca}}$ 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, “

Gently heated, it emits a blue phosphorescent light. B.B. on charcoal becomes glassy, subtransparent, and white, and melts only on the edges; gives the reaction of lithia, (p. 163). With borax, it forms a clear, colorless glass. Not acted on by acids.

Petalite occurs near Stockholm, at the iron mine of Utö, accompanying lepidolite, tourmaline, spodumene, and quartz: also at Bolton, Mass., where it is associated in a lime quarry with scapolite, sphene, and pyroxene.

Lithia was first discovered in this mineral by Arfvedson. The name *petalite* is derived from *πεταλον, a leaf.*

SPODUMENE, *d'Andrada.* Triphane, *H.*

Massive, and probably trimetric; yielding by cleavage rhombic prisms of 93°, (Brooke).

H.=6·5—7. G.=3·15—3·2; 3·17, Haidinger; 3·188, Thomson, specimen from Dublin Bay. Lustre pearly. Cross fracture vitreous. Color grayish-green, passing into greenish-white, and grayish-white; streak uncolored. Translucent—subtranslucent. Fracture uneven.

Composition.—$(\dot{\mathrm{Na}}, \dot{\mathrm{Li}})^3\dddot{\mathrm{Si}}^4+4\bar{\mathrm{Al}}\dddot{\mathrm{Si}}^3$ (Berzelius)=Silica 69·0, alumina 25·6, lithia 5·4. Nearer the analyses, $(\dot{\mathrm{Na}}, \dot{\mathrm{Li}})^3\dddot{\mathrm{Si}}^2+4\bar{\mathrm{Al}}\dddot{\mathrm{Si}}^2$, Kobell=Silica 65·0, alumina 28·9, lithia 6·1.

Analyses: 1, Arfvedson, (Schw. J. xxi, 58); 2, Stromeyer, (Unters. i, 426); 3, Regnault, (Ann. d. Mines, [3], 1839, 380); 4, R. Hagen, (Pogg. xlviii, 361); 5, Thomson. (Min. i, 302):

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\bar{\mathrm{Fe}}$	$\dot{\mathrm{Li}}$
1. Utö,	66·40	25·30	1·45	8·85, ign. 0·45=102·45, Arfvedson.
2. "	63·288	28·776	0·794	5·626, ign. 0·775=99·463, Stromeyer.
3. "	65·30	25·34	2·83	6·76=100·23, Hagen.
4. "	66·136	27·024	0·321	3·836, $\dot{\mathrm{Na}}$ 2·683=100, Hagen.
5. Killiney,	63·812	28·508	——	5·604, $\dot{\mathrm{Fe}}$ 0·828, $\dot{\mathrm{Ca}}$ 0·728, $\dot{\mathrm{H}}$ 0·36=99·84, Thom.

In a specimen from Mexico, Hagen found $\dddot{\mathrm{Si}}$ 65·247, $\bar{\mathrm{Al}}$, $\bar{\mathrm{Fe}}$ 27·556; and in another from Tyrol, $\dddot{\mathrm{Si}}$ 66·027, $\bar{\mathrm{Al}}$ 26·451. Hagen shows that part of the alkali is soda.

B.B. loses translucency and color, intumesces and fuses to a glassy globule; gives the reaction of lithia, (p. 163).

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, imbeded 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, and Stirling, 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.

The name spodumene is derived from *σποδός*, *ashes*, and was given the mineral because it assumes an appearance like ashes before the blowpipe.

Killinite, (Thomson, Min. i, 330), has the appearance of spodumene, and is associated with it at Killiney Bay. H.=4. G.=2·65. Lustre vitreous, weak. Color greenish-gray, or yellowish. *Composition.*—According to Lehunt and Blythe:

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{H}}$
1.	49·08	30·60	6·72	2·27	0·68	1·08	——	10.00=100·43, L.
2.	47·93	31·04	6·06	2·33	0·72	0·46	1·25	10·00=99·80, Bl.

B.B. fuses to a white enamel.

CASTOR. Kastor, *Breit.*, *Plattner*, Ann. d. Ch. u. Pharm. lxix, 443.

Monoclinic. Cleavage distinct in two directions, inclined to one another 128½°. Massive with the lustre and transparency of quartz.

H.=6—6·5. G.=2·392. Fracture conchoidal.

Composition.—$\dot{\mathrm{Li}}\dddot{\mathrm{Si}}^3+2\bar{\mathrm{Al}}\dddot{\mathrm{Si}}^3$=Silica 78·0, alumina 19·3, lithia 2·7=100. Analysis by Plattner:

$\dddot{\mathrm{Si}}$ 78·012, $\bar{\mathrm{Al}}$ 18·856, $\bar{\mathrm{Fe}}$ 0·613, $\dot{\mathrm{Li}}$ and *trace* of $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$ 2·760=100·241.

B.B. in the outer flame fuses with difficulty to a transparent colorless globule, giving a carmine tint to the flame. Easily dissolves with borax to a glass which is colorless when cold. With salt of phosphorus, bead becomes opaline on cooling. Not attacked by acids.

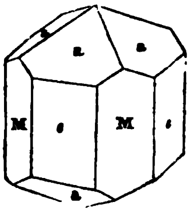
From Elba, forming druses in granite. The composition is very near that of Petalite.

ZYGADITE, Breithaupt, Ann. d. Ph. u. Chem. lxix, 429. Near castor. Plattner in a qualitative analysis found silica, alumina, and lithia, without water. Form a broad rhombic prism, only seen in twins, and like albite. G.=2·511. Lustre like glass. Color red and yellowish-white. Feebly transparent.

SCAPOLITE. Meionite. Dipyre, *P.* Paranthine. Wernerite, *H.* Ekebergite. Nuttallite, *Brooke.* Tetraklasit, *Haus.* Schmelzstein, Skapolith, Spreustein, *Wern.*

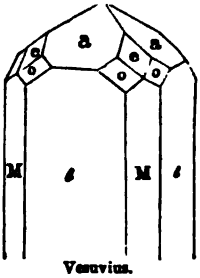
Dimetric. M : *e*=135°, *e* : a=121° 20′—121° 50′, a : a=136° 20′—136° 38′; over *e*=62° 40′—63° 40′. Cleavage parallel with M and *e* rather distinct, but interrupted. Also massive, granular, or with a faint fibrous appearance; sometimes columnar.

1



Gouverneur, N. Y.

2



Vesuvius.

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.

Composition.—Under the species Scapolite, three or four different chemical compounds are included, which may be distinct species, although no essential differences in crystallization have yet been pointed out. These are,—

1. *Meionite.*—$\dot{C}a^3\dddot{S}i+2\dddot{\overline{A}}l\dddot{S}i$=Silica 42·5, alumina 31·6, lime 25·9. Occurs in geodes of transparent crystals usually in limestone blocks on Monte Somma. G.=2·8—2·65. B.B. fuses with intumescence to a colorless glass. A clear glass with soda. With acids gelatinizes according to Kobell, but less perfectly after heating. a : a=136° 22′ and 62° 56′.

2. *Scapolite.*—(Ekebergite, Paranthine, Bergmannite, Nuttallite, Porcelain Spar)=$(\dot{C}a, \dot{N}a)^3\dddot{S}i^2+2\dddot{\overline{A}}l\dddot{S}i$=Silica 49·7, alumina 27·6, lime 22·7. Occurs in square prisms, large or small, and also massive. Translucent to nearly opaque. G.=2·62—2·8. *Paranthine* included compact varieties of white and pale blue colors. Nuttallite differs from Wernerite in presenting a tinge of blue with the gray, and a feeble chatoyant reflection of light. *Ekebergite* is a massive scapolite, having a slightly fibrous appearance, not uncommon. The massive scapolite of Bolton has been called ekebergite, although the crystals common there are ordinary scapolite. *Porcelain spar* occurs in prisms resembling scapolite, massive with a subvitreous or sub-pearly lustre. G.=2·65—2·68. Color white or yellowish-white. B.B. fuse in a strong heat with much intumescence to a clear or white glass. With soda the ekebergite of Pargas forms with difficulty an iron-green glass. In acids soluble without gelatinizing.

3, 4, *Wernerite.*—This variety has rather darker shades of color than the so-called scapolite, and contains but little or no alkalies. Wernerite of Ersby has the specific gravity 2·77. Rammelsberg deduces the formula (from analysis 17) $\dot{C}a^3\dddot{S}i+3\dddot{\overline{A}}l\dddot{S}i$=Sil[illegible] 43·7, alumina 36·4, lime 19·9. Wolff's analysis of a Pargas variety corresponds more nearly to $\dot{C}a^3\dddot{S}i+2\bar{A}l\dddot{S}i$=Silica 46·58, alumina 34·52, lime 18·90=100. G.=2·712. B.B. the Pargas wernerite forms easily with soda a clear glass.

Among these different compounds the Ersby wernerite is essentially identical in formula with anorthite and lepidomelane; and the Pargas wernerite, with nepheline.

Analyses: 1, L. Gmelin, (Schw. J. xxv, 36, xxxv, 348); 2, Stromeyer, (Unters. 378); 3, Wolff, (De Comp. Foss. Ekeberg. &c., Berolini, 1843, Ramm. 2d Supp. 133); 4, Hartwall, (Jahresb. iv, 155); 5, 6, 7, Wolff; 8, C. T. Jackson, (Bost. Jour. Nat. Hist. Jan. 1844); 9, Thomson, (Min. i, 273); 10, 11, Wolff; 12, Ekeberg, (Afh. i Fys. ii, 153); 13, Berg, (Jahresb. xxv, 356); 14, 15, 16, Hartwall and Hedberg, (Jahresb. iv, 155); 17, Nordenskiöld, (Schw. Jour. xxxi, 417); 18, Wolff; 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, Thomson, (Ann. Lyc. N. H. New York, iii, 83); 23, L. Stadtmuller, (Am. J. Sci., viii, 394):

I. *Meionite.*

	$\dddot{S}i$	$\bar{A}l$	$\bar{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	
1. Somma,	43·80	32·85	——	20·64	——	——	——	, $\dot{F}e$ 1·07, $\dot{N}a$ and $\dot{L}i$ 2·57=100·93, Gmelin.
2. "	40·53	32·73	——	24·24	——		1·81,	$\dot{F}e$ 0·18=99·50, Str.
3. "	42·07	31·71	——	22·43	——	0·45	0·31,	ign. 0·31=97·29. W.

II. *Scapolite—Ekebergite.* G. of No. 5, 2·623; of 6, 2·733; of 7, 2·718; of 8, 2·7133; of 10, 2·735; of 11, 2·712; of 13, 2·34.

	$\dddot{S}i$	$\bar{A}l$	$\bar{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	
4. Pargas,	49·42	25·41	1·40	15.59	0·68	6·05	——	, ign. 1·45=100, H.
5. Wermland,	49·68	27·02	0·21	12·71	0·85	7·59	0·87,	ign. 0·77=99·90, W.
6. Finland,	48·15	25·38	1·48	16·68	0·84	4·91	0·12,	ign. 0·85=98·45, W.
7. Bolton,	48·79	28·16	0·32	15·02	1·29	4·52	0·54,	ign. 0·74=99·36, W.
8. " *pink*,	45·94	28·84	——	14·63	0·21	5·43	0·64,	$\dot{L}i$ 1·58, $\dot{C}e$ and $\dot{L}a$ 2·0, $\dot{H}$ 0·5=99·77, J.
9. "	46·30	26·48	——	18·62	——	——	——	, $\dot{N}a$ and $\dot{L}i$ 3·64, $\dot{H}$ 5·04=100·09, Thom.
10. Hesselkulla,	49·26	26·40	0·54	14·44	——	6·14	0·65,	ign. 0·69=98·12, W.
11. Arendal,	50·91	25·81	0·75	13·34	0·58	7·09	0·85,	ign. 0·41=99·74, W.
12. Hesselkulla,	46·00	28·75	0·75	13·50	——	5·25	——	, ign. 2·25=96·50, E.
13. Drothems,	46·35	26·84	0·32	17·00	0·54	4·71	0·82,	ign. 1·60, undecom. 0·99=98·17, Berg.

III. *Wernerite,* (or so called by the analysts). G. of 18, 2·712.

	$\dddot{S}i$	$\bar{A}l$	$\bar{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	
14. Ersby,	48·77	31·05	——	15·94	——	3·25	——	, $\dot{H}$ 0·61=99·63, H.&H.
15. "	52·11	27·60	0·55[a]	13·53	——	3·86	——	, $\dot{H}$ 0·73=98·38 "
16. Petteby,	51·34	32·27	1·91[a]	9·33	——	5·12	——	, $\dot{H}$ 1·00=100·97 "
17. Ersby,	48·83	35·43	——	13·96	——	——	——	, $\dot{H}$ 1·03, Nord.
18. Pargas,	45·10	32·76	——	17·84	——	0·76	0·68,	ign. 1·04=98·18, W.

[a] With $\dot{M}g$.

IV. *Porcelain Spar—Nuttallite.*

	$\dddot{S}i$	$\bar{A}l$	$\bar{F}e$	$\dot{C}a$	$\dot{M}g$	$\dot{N}a$	$\dot{K}$	
19. *Porc. spar.*	49·30	27·90	——	14·42	——	5·46	——	, $\dot{H}$ 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	——	4·58	1·23,	Cl 0·92, $\dot{H}$ 1·2=99·2, Schafhäutl.
22. *Nuttallite,*	37·81	25·10	——	18·34	——			$\dot{K}$ 7·81, $\dot{F}e$ 7·89, $\dot{H}$ 1·50=97·95, T.
23. "	45·79	30·11	1·86	17·41	——			$\dot{N}a$ *trace*, $\dot{K}$ 3·49, $\dot{M}n$ *trace*, $\dot{H}$ 1·63=100·28, Stadtmuller.

The recent analysis of *Nuttallite* by Mr. Stadtmuller, under the direction of Silliman, Jr., shows that it is identical with common scapolite. The angles are also the same.

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.

Porcelain spar occurs in granular limestone at Obernzell in Bavaria.

Good crystals occur at Gouverneur, N. Y., in granular limestone, with apatite, sphene, and augite; at Two-Ponds in Orange Co., N. Y., a reddish-white crystallized scapolite with pyroxene, sphene, and zircon; one crystal has been observed ten inches long and five in diameter; in Warwick of the same county, milk-white crystals occur near Amity, with pyroxene, sphene, and graphite; also five miles south of Warwick, and also two miles north of Edenville, near Greenwood Furnace, are other good localities; in Essex county, perfect crystals and massive forms nearly fibrous, of white and greenish-white colors, are abundant near Kirbys graphite mine, four miles northwest of Alexandria, in Ticonderoga, associated with pyroxene. In Lewis Co., N. Y., the variety Nuttallite occurs in fine crystals of white, bluish, and dark gray colors, presenting the play of light usual with this variety; the edges of the crystals are often rounded. Bolton and Boxborough, Mass., afford good scapolite, both the common and the variety nuttallite, often in crystals sometimes of large size; also Chelmsford, Littleton, Chester, and Carlisle. At Parsonsfield and Raymond, near Dr. Swett's house, good crystals are obtained along with yellow garnet and adularia. At Franklin and Newton, N. J., and three miles west of Attleboro', crystallized scapolite occurs in limestone.

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.

The *Terenite* of Emmons appears to be an altered scapolite.

BARSOWITE, *G. Rose*, Pogg. xlviii, 567, 1839.

Massive of a coarse 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.—$(\dot{\mathrm{Ca}}, \dot{\mathrm{Mg}})^3\overline{\mathrm{Si}}^2 + 3\overline{\overline{\mathrm{Al}}}\,\overline{\mathrm{Si}}$=Silica 49·08, alumina 32·76, lime 18·16. Analyses by Varrentrapp, (Pogg. xlviii, 568):

	$\overline{\mathrm{Si}}$	$\overline{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$
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, accompanying blue corundum, greenish-black spinel, and white mica. Resembles scapolite in external characters and composition, but differs in its action with acids and the blowpipe.

BYTOWNITE, *Thomson*, Min. i, 372.—The Bytownite of Thomson gives the same formula as Barsowite, excepting the replacement of part of the lime by soda. It occurs massive with a granular texture, vitreous lustre, and translucent in fragments a quarter of an inch thick: color by transmitted light a smoky blue; by reflected light dark bluish green. Fracture splintery. H.=6. G.=2·801. Analyses by Thomson:

	$\overline{\mathrm{Si}}$	$\overline{\overline{\mathrm{Al}}}$	$\overline{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	Moisture
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.

Occurs in large boulders, near Bytown, Canada West, and looks more like a rock than a simple mineral.

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. Streak white—grayish-white. Color different shades of grayish green to liver-brown; none bright. Faintly subtranslucent—opaque. Fracture uneven—splintery.

Composition.—$3\dot{\text{R}}^3\dddot{\text{Si}}+\dddot{\bar{\text{R}}}^3\dddot{\text{Si}}$, Ramm. Analyses: 1, Fuchs, (Schw. xv, 377); 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):

	$\dddot{\text{Si}}$	$\dddot{\bar{\text{Al}}}$	$\dddot{\bar{\text{Fe}}}$	$\dot{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	
1. Fassa,	29·64	24·80	6·56		35·30	—,	$\dot{\text{H}}$ 3·30=99·60, Fuchs.
2. "	29·13	25·05	—	4·35	37·38	—,	$\dot{\text{H}}$ 4·54=100·45, Thomson.
3. "	31·0	21·4	—	4·4	37·4	3·4,	$\dot{\text{H}}$ 2·0=99·6, Kobell.
4. "	31·60	19·80	5·97		38·11	2·20,	$\dot{\text{H}}$ 1·58, $\dot{\text{Na}}$ 0·33=99·54, Damour.
5. "	30·47	17·79	7·30	—	36·97	2·99,	$\dot{\text{H}}$ 3·62=99·14, Kühn.
6. "	29·52	19·00	—	7·25	36·55	1·41,	$\dot{\text{H}}$ 5·55=99·28, "
7. "	29·78	22·02	3·22	1·73	37·90	3·88,	$\dot{\text{H}}$ and loss 1·28, $\dot{\text{Mn}}$ 0·19=100, Ramm.

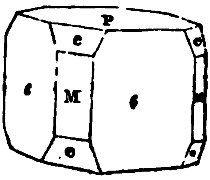
Rammelsberg has cleared up the discrepancies in the analyses, by discovering that the mineral contains both *peroxyd* and *protoxyd* of iron.

B.B. thin splinters fuse with difficulty to a gray glass. With borax fuses slowly to a vitreous globule colored by iron. Gelatinizes in muriatic acid.

Gehlenite is found mostly at Mount Monzoni, in the Fassa Valley, in isolated or aggregated crystals, invested by calcareous spar.

Gehlenite was named by Fuchs in honor of his colleague, Gehlen.

HUMBOLDTILITE, *Monticelli and Covelli.* Sarcolite, *Thomson.* Somervillite, *Brooke.* Mellilite, *Carpi.* Zurlite, *Ramondini.*



Dimetric; e : e (over M)=65° 50′, P : e=147° 15′, e : e (over terminal edge)=134° 48′. Cleavage basal distinct.

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.—$2\dot{\text{R}}^3\dddot{\text{Si}}+\dddot{\bar{\text{R}}}\dddot{\text{Si}}$. Analyses: 1, Kobell, (Schw. J. lxiv, 293); 2, 3, 4, Damour, (Ann. Ch. Phys. [3], x, 59); 5, Kobell, (Kast. Arch. iv, 313):

	$\dddot{\text{Si}}$	$\dddot{\bar{\text{Al}}}$	$\dddot{\bar{\text{Fe}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	
1. *Humb.*, Somma,	43·96	11·20	—	31·96	6·10	4·28	0·38,	$\dot{\text{Fe}}$ 2·32=100·20, Kobell.
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,	$\dot{\text{H}}$ 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* of yellow and brownish colors is found at Capo di Bove near Rome, with nepheline. *Somervillite*, which Descloizeaux has shown to have the crystallization of this species, is found at Vesuvius in dull yellow crystals. The name *Zurlite* was given to crystals of this species by Ramondini.

SARCOLITE. The sarcolite of Thomson has been referred to this place; the form is near that figured, excepting that the basal edges are removed. Brooke made the angle between P and a plane on the angle, 115° 16′, and Descloiseaux also finds the angles different from those of Humboldtilite, and sustains the separation of the two minerals. The form resembles a cubo-octahedron, and the species has been arranged with analcime.

Scacchi obtained in an analysis "non molto rigorosa," (Quadri Crystallografici, Naples, 1842, p. 66):

$\dddot{\text{Si}}$ 42·11, $\dddot{\bar{\text{Al}}}$ 24·50, $\dot{\text{Ca}}$ 32·43, $\dot{\text{Na}}$ 2·93=101·97,

leading to the formula $(\dot{\text{Ca}}, \dot{\text{Na}})^3\,\dddot{\text{Si}}+\dddot{\bar{\text{Al}}}\dddot{\text{Si}}$, according to which it is an idocrase or garnet containing soda. It comes from Vesuvius and is extremely brittle. It is the *analcime carnea* of Monticelli.

DIPYRE, *Haüy*. Schmelzstein, *W.*

In 4 and 8-sided prisms, 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($\dot{\text{C}}$a, $\dot{\text{N}}$a) $\dddot{\text{Si}}$+3$\bar{\text{Al}}\dddot{\text{Si}}$, Delesse. Analysis by Delesse, (Compt. Rend. xviii, 994, 1844):

$\dddot{\text{Si}}$ 55·5, $\bar{\text{Al}}$ 24·8, $\dot{\text{C}}$a 9·0, $\dot{\text{N}}$a 9·4, $\dot{\text{K}}$ 0·7.

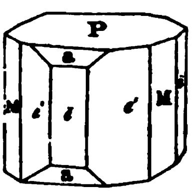
Vauquelin obtained,

$\dddot{\text{Si}}$ 60, $\bar{\text{Al}}$ 24, $\dot{\text{C}}$a 10, $\dot{\text{H}}$ 2=96.

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 Mauléon in the Lower Pyrenees, with talc or chlorite, in an unctuous argillite. Dipyre has been referred to scapolite. Kobell some time since placed it under labradorite, which it more resembles in composition, though apparently distinct from that species.

IOLITE. Dichroite. Peliom. Steinheilite. Cordierite, *H.* Sapphire d'eau. Hard Fahlunite.



Trimetric. In stout prisms of 6 and 12 sides; M : M=119° 10′, M : $\bar{e}$=149° 35′, M : $\check{e}$=120° 25′. Cleavage parallel to P and $\check{e}$, indistinct, often transversely divided or foliated parallel with P; also massive, compact.

H.=7—7·5. G.=2·5969, Greenland, Stromeyer; 2·65—2·6643, Haddam, Thomson; Ostgothland 2·64, and 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.—($\dot{\text{M}}$g, $\dot{\text{F}}$e)$^3\dddot{\text{Si}}^2$+3($\bar{\text{Al}}$, $\bar{\text{Fe}}$) $\dddot{\text{Si}}$, Berz.=Silica 50·25, alumina 31·98, magnesia 9·68, protoxyd of iron 8·19. This formula is essentially the same with that of Barsowite and Bytownite.

Analyses: 1, 2, 3, 4, Stromeyer, (Unters. 329, 431); 5, Bonsdorff, (Schw. J. xxxiv, 369); 6, 7, 8, Schütz, (Pogg. liv, 565); 9, Scheerer, (Pogg. lxviii, 319, mean of two analyses); 10, Thomson, (Min. i, 276); 11, 12, 13, Jackson, (this work last ed. 406, and Geol. Rep. New Hampshire, 184):

	$\dddot{\text{Si}}$	$\bar{\text{Al}}$	$\dot{\text{M}}$g	$\dot{\text{M}}$n	$\dot{\text{F}}$e	$\dot{\text{H}}$
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. Orrijerfvi,	48·54	31·87	11·31	0·70	5·69	1·69=99·65, Stromeyer.
4. Fahlun,	50·25	32·42	10·85	——	4·01	1·66, $\bar{\text{Mn}}$ 0·68=99·87, Strom.
5. Orrijerfvi,	49·95	32·88	10·45	0·03	5·00	1·75=100·06, Bonsdorff.
6. Orrijerfvi,	48·9	30·9	11·2	0·3	6·3	ign. 1·9, undec. 1·6=101·1, S.
7. Ostgothland,	48·6	30·5	8·2	0·1	10·7	ign, 1·5, undec. 0·2=100·8, S.
8. Südermanland,	49·7	32·0	9·5	0·1	6·0	$\dot{\text{C}}$a 0·6, ign. 2·1, und. 0·6=100·6, S.
9. Krageroe,	50·44	32·95	12·76	——	——	$\dot{\text{H}}$ 1·02, $\bar{\text{Fe}}$ 1·07, $\dot{\text{C}}$a 1·12=99·36, S.
10. Haddam, Ct.	49·62	28·72	8·64	1·51	11·58	——, $\dot{\text{C}}$a 0·20=100·30, Thom.
11. Haddam, Ct.	48·35	32·50	10·00	0·10	6·00	3·10=100·05, Jackson.
12. Unity, Me.	48·15	32·50	10·14	0·28	7·92	0·50=99·49, Jackson.
13. Richmond, N.H.	48·	35·	10·	1·	6·	——=100, Jackson.

The above formula is sustained by Scheerer's recent analysis (No. 9) of a transparent variety.

B.B. fuses slowly on charcoal 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 crystallizations. 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 Orrijerfvi, 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 jewellers.

At Haddam, Conn., it is associated with garnet and anthophyllite in gneiss; also 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; it is abundant in large massive individuals. At Brimfield, Mass., on the road leading to Warren, near Sam. Patrick's, it is associated with adularia, in gneiss; occurs also in beautiful specimens at Richmond, N. H., in talcose rock, along with anthophyllite.

It is occasionally employed as an ornamental stone, and when cut exhibits different colors in different directions.

The name *iolite* is derived from ιον, *violet*, and λιθος, *stone*, in allusion to its color. From its property of exhibiting different colors in different directions, it has been named *dichroite*, from δις, *double*, and χροα, color.

This mineral gradually undergoes a change on exposure, becoming hydrated at first, and then farther changing its constitution through the removal of some ingredients by infiltrating waters; and at the same time the structure becomes transversely foliated or micaceous.

The minerals Pinite, Fahlunite, Bonsdorffite, Esmarkite, Chlorophyllite, Gigantolite, (see page 293), are iolite in the different states of alteration thus induced.

WICHTYNE, *Laurent*. Wichtisite, *Hausmann*.

Massive; cleavage parallel to the sides of a prism, which is nearly rectangular, according to Laurent. Scratches glass. G.=3·03. Color black. Lustre dull. Fracture angular or flat conchoidal.

Composition.—$\dot{R}^3\dddot{Si}^3+\bar{\ddot{R}}\dddot{Si}^2$. Analysis by Laurent, (Ann. Ch. Phys. lix, 109):

$\dddot{Si}$ 56·3, $\bar{\dddot{Al}}$ 13·3, $\bar{\dddot{Fe}}$ 4·0, $\dot{Fe}$ 13·0, $\dot{Ca}$ 6·0, $\dot{Mg}$ 3·0, $\dot{Na}$ 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*.

Trimetric or monoclinic. In indistinct 6-sided prisms, long thin and irregular, 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.—$3\dot{R}^3\dddot{Si}^2+2\bar{\dddot{Al}}\dddot{Si}^2$. Analysis by Schnedermann, (J. f. pr. Chem. xxxiv, 238):

$\dddot{Si}$ 56·49, $\bar{\dddot{Al}}$ 12·23, $\dot{Fe}$ 10·91, $\dot{Mn}$ 0·50, $\dot{Mg}$ 7·97, $\dot{Ca}$ 2·25, $\dot{Na}$ with *trace* $\dot{K}$ 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.

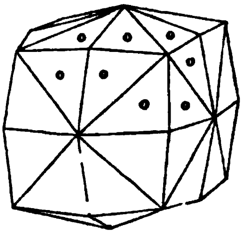
Occurs at the island of Syra, one of the Cyclades, in mica slate, along with garnet, hornblende, and mica. The name alludes to its bluish color.

GARNET FAMILY.

The Garnet Family includes the species Garnet, Idocrase, Epidote, and Allanite. Garnet and Idocrase (in part) have the same formula, and the compound therefore is dimorphous, one of the forms being monometric and the other dimetric. Allanite appears also to have the same composition, with sometimes the addition of an atom or so of water. Epidote ($\dot{R}^3\bar{S}i+2\bar{\bar{R}}\bar{S}i$) has the same crystallization as orthite. The crystals of the monoclinic species are usually long and slender, but sometimes broad tabular. The colors are often bright, but very various, from white through bright green and red colors to black.

The formula of garnet is essentially identical with that of hexagonal mica, and this last species adds therefore another form to the compound $\dot{R}^3\bar{S}i+\bar{\bar{R}}\bar{S}i$.

GARNET. Melanite. Pyrope. Grossularite. Topazolite. Almandine. Aplome. Essonite. Cinnamon stone. Greenlandite. Pyrenaite. Colophonite. Allochroite. Granat. Ouvarovite or Uwarowite, *Hess.* Rothoffit. Pirop. Kolophonit. Kaneelstein. Romanzovit, *Nordenskiöld.* Braunsteinkiesel, *W.* Grenat, *H.* Carbunculus. Polyadelphite, *Thom.*



Monometric: common form, the dodecahedron and trapezohedron, figs. 7 and 16, pl. 1; also 11, 18, 27, and several of these in combination; also the annexed figure, which is similar to fig. 25, a hexoctahedron. Cleavage dodecahedral, sometimes distinct. Also massive; granular, coarse or fine, and sometimes friable. Lamellar—laminæ thick and bent.

H.=6·5—7·5. G.=3·5—4·3. Lustre vitreous—resinous. Streak white. Color red, brown, yellow, white, green, black; none bright, except red and green colors. Transparent—subtranslucent. Fracture subconchoidal, uneven.

Garnet is a compound of three or four silicates—silicates of alumina, lime, iron, and manganese. It has been divided into six sub-species.

I. Consisting of silicates of alumina and lime and called *alumina-lime garnet*, including cinnamon stone or essonite.

II. Containing alumina and magnesia and called *alumina-magnesia garnet.*

III. Consisting of silicates of alumina and iron—*alumina-iron garnet*—including almandine or precious ganet, 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—*a lime-chrome garnet.*

But these compounds are seldom distinct and they pass into one another by imperceptible shades, as the following analyses show. The characters of the varieties are mentioned in connection with the following analyses:

Composition.—$\dot{R}^3\bar{S}i+\bar{\bar{R}}\bar{S}i$. 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, T. Wachtmeister, (loc. cit.); 11, Hisinger, (Schw. xxi, 258); 12, 13, Kobell, (ib. lxiv, 283); 14, 15, 16, Karsten, (loc. cit.); 17, 18, 19, T. Wachtmeister, (loc. cit.); 20, Klaproth, (Beit. ii, 22, v, 131); 21, W. Wachtmeister, (Jahresb. xxv, 364); 22, Bahr, (Jahresb. xxv, 364);—

23, H. Seybert, (Am. J. Sci. vi, 155, 1823); 24, d'Ohsson, (Schw. J. xxx, 346); 25, Hisinger, (Jahresb. ii, 101); 26, Seybert, (Am. J. Sci. v, 118, where iron is made protoxyd); 27, Karsten, (loc. cit.); 28, 29, Bredberg, (K. V. Ac. H. 1822, i, 63); 30, Bucholz, (Scheerer's N. J. iv, 172); 31—36, Wachtmeister, (loc. cit.); 37, Thomson, (Ann. Lyc. N. York, 1829, iii, 9); 38, Vauquelin, (Jour. de Phys. An. viii, L. 94); 39, Klaproth, (Beit. v, 168, where the iron is made *protoxyd*); 40, Karsten, (loc. cit.); 41, Ebelmen, (Ann. des Mines, [4], vii, 19); 42, W. Fisher, (Am. J. Sci. [2], ix, 84); 43, Komonen, (Verh. min. Ges. St. Petersb. 1842, p. 55); 44, Erdmann, (Jahresb. xxiii, 291):

I. *Lime-Garnet.*—$\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{S}}\mathrm{i}+\bar{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}$=Silica 40·81, alumina 22·40, lime 37·28. Color greenish pale clear red and reddish-orange, cinnamon color. G.=3·55—3·73. B.B. fuses to a glass or enamel slightly greenish: in powder, soluble in concentrated muriatic acid. *Cinnamon stone*, *essonite*, *grossular*, *wiluite*, *erlanite*, *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.

	$\dddot{\mathrm{S}}\mathrm{i}$	$\bar{\mathrm{A}}\mathrm{l}$	$\bar{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{n}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{C}}\mathrm{a}$
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, $\dot{\mathrm{K}}$ 0·59, ign. 0·33=98·17, Gmelin.
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. and loss 1 98, N.

II. *Magnesia-Garnet.*—$(\dot{\mathrm{M}}\mathrm{g},\ \dot{\mathrm{F}}\mathrm{e})^3\dddot{\mathrm{S}}\mathrm{i}+\bar{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}$. 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.

10. Arendal,	42·45	22·47	—	9·29	6·27	13·43	6·53=100·44, Wacht.

III. *Iron-Garnet*, ($\dot{\mathrm{F}}\mathrm{e}^3\dddot{\mathrm{S}}\mathrm{i}+\bar{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}$),—*Common Garnet*, *Precious Garnet*, *Almandine.*—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.

	$\dddot{\mathrm{S}}\mathrm{i}$	$\bar{\mathrm{A}}\mathrm{l}$	$\bar{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{n}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{C}}\mathrm{a}$
11. Fahlun, *Almand.*	39·66	19·66	—	39·68	1·80	—	—=100·80, Hisinger.
12. Zillerthal, *bn.*	39·12	21·08	6·00	27·28	0·80	—	5·76=100·04, Kobell.
13. Hungary, *prec.*	40·56	20·61	5·00	32·70	1·47	—	—=100·34, Kobell.
14. Zillerthal, "	39·62	19·30	—	34·05	0·85	2·00	3·28=99·10, Karsten.
15. Ohlapian,	37·15	18·08	—	31·30	0·30	10·15	0·36=97·34, Karsten.
16. Greenland,	39·85	20·60	—	24·85	0·46	9·93	3·51=99·20, Karsten.
17. Engsö, *dull red,*	40·60	19·95	—	33·93	6·69	—	—=101·17, Wacht.
18. N. York, "	42·51	19·15	—	33·57	5·49	—	1·07=101·79, Wacht.
19. Norway,	52·11	18·04	—	23·54	1·74	—	5·78=101·20, Wacht.
20. Oriental,	35·75	27·25	—	32·33	0·25	—	—=95·58, Klaproth.
21. Garpenberg,	39·42	20·28	—	24·82	7·51	3·69	2·63=98·35, Wacht.
22. Brena, Westm.	37·16	19·30	—	37·65	3·19	2·03	0·90=100·23, Bahr.

IV. *Manganese-Garnet.*—$\dot{\mathrm{M}}\mathrm{n}^3\dddot{\mathrm{S}}\mathrm{i}+\bar{\mathrm{A}}\mathrm{l}\dddot{\mathrm{S}}\mathrm{i}$. Brownish-red. B.B. gives the reaction of manganese. G.=3·7—4·2. This variety has been called *spessartine*.

	$\dddot{\mathrm{S}}\mathrm{i}$	$\bar{\mathrm{A}}\mathrm{l}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{n}$
23. Haddam, Ct.	35·83	18·06	14·93	30·96=99·78, Seyb. G.=4·128.
24. Broddbo,	39·00	14·30	15·44	27·90, $\ddot{\mathrm{S}}\mathrm{n}$ 1=97·64, d'Ohsson.

V. *Iron-Lime Garnet—Melanite, Pyreneite.*—$\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{S}}\mathrm{i}+\bar{\mathrm{F}}\mathrm{e}\dddot{\mathrm{S}}\mathrm{i}$. Dark red, brownish-black, black; either dull or shining. Sometimes with a resinous lustre, then called *colophonite*. *Melanite* has a velvet black color. *Pyreneite* is black or grayish-black, with often a submetallic lustre. G. of these varieties 3·65—4·0. *Aplome* has the faces striated parallel to the shorter diagonal, and is brown or orange-brown, with G.=3·44.

	$\dddot{\mathrm{S}}\mathrm{i}$	$\bar{\mathrm{A}}\mathrm{l}$	$\bar{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{n}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{C}}\mathrm{a}$
25. Westmanland,	37·55	—	31·35	—	4·70	—	26·74=100·34, Hising.
26. Willsboro', *coloph.*	38·00	6·00	28·06	—	—	—	29·00=101·06, Seybert. G.=3·896.
27. Schwarzenberg, *gn.*	36·85	4·05	25·35	—	0·95	—	32·32=99·52, Karsten.
28. Sala,	36·62	7·58	22·18	—	—	1·95	31·80=100·08, Bred.
29. "	36·78	2·78	25·83	—	—	12·44	21·79=99·57, Bred.
30. Thuringia, *brown,*	34·00	2·00	27·84	—	3·15	—	30·75, $\dot{\mathrm{H}}$, $\dot{\mathrm{C}}\mathrm{u}$ 4·25=101·94, B.
31. Langbanshytta, *yw.*	35·10	—	29·10	—	7·08	—	26·91, $\dot{\mathrm{K}}$ 0·98, Wacht.
32. Altenau, *Aplome,*	35·64	—	30·00	—	3·02	—	29·21, $\dot{\mathrm{K}}$ 2·35, Wacht.
33. Hesselkulla, *bn.*	37·99	2·71	28·53	—	1·62	—	30·74=100·59, Wacht.
34. " *gn.*	38·13	7·32	19·42	—	3·30	—	31·65=99·82, Wacht.
35. Arendal, *bnh-bk.*	40·20	6·95	20·50	—	4·00	—	29·48=101·13, Wacht.
36. Vesuvius, *bn.*	39·93	13·45	10·95	3·35	1·40	—	31·66=100·94, Wacht.
37. Franklin, N. J. *gn.*	33·72	7·97	17·64	—	16·70	—	22·88=98·92, Thomson.
38. Frascati, *black,*	34·0	6·4	25·5	—	—	—	33·0=98·9, Vauq.
39. " *black,*	35·50	6·00	26·00	—	—	—	32·50, $\bar{\mathrm{M}}\mathrm{n}$ 0·4=100·4, K.
40. " *black,*	34·60	4·55	28·15	—	—	0·65	31·80=99·75, Karsten.
31. Beaujeu, *black,*	36·45	2·06	29·48	—	0·28	0·06	30·76, ign. 0·96=100·05, Ebelmen.
42. Franconia, N. H.	38·85	—	28·15	—	—	—	32·00=99·00, Fisher.

VI. *Lime-Chrome Garnet—Ouvarovite*=$\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{S}}\mathrm{i}+(\bar{\mathrm{C}}\mathrm{r},\bar{\mathrm{A}}\mathrm{l})\dddot{\mathrm{S}}\mathrm{i}$. Color emerald green. G.=3·4184. H.=7·5. B.B. alone infusible; a clear chrome-green glass with borax.

	$\dddot{\mathrm{S}}\mathrm{i}$	$\bar{\mathrm{A}}\mathrm{l}$	$\bar{\mathrm{F}}\mathrm{e}$	$\bar{\mathrm{C}}\mathrm{r}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dot{\mathrm{C}}\mathrm{a}$
43. Bisserak,	37·11	5·88	—	22·54	2·44	1·10	30·34, $\dot{\mathrm{H}}$ 1·01=100·42, K.
44. "	36·93	5·68	1·96	21·84	—	1·54	31·63, $\dot{\mathrm{C}}\mathrm{u}$ *trace*=99·58, E.

Polyadelphite of Thomson 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 in crystals of less size, in mica slate, in the island of Mull, in Perth and Inverness, Shetland; of green color at Swartzenberg in Saxony. The magnesia-alumina garnet occurs at Arendal with calc spar. *Melanite* is found in the Vesuvian lavas, and also near Rome. *Grossularite* occurs near the Wilui River in Siberia. *Cinnamon stone* is met with in masses of considerable size in the primitive rocks of Ceylon, and at Malsjö in Wermland. *Romanzovite*, a similar variety, comes from Kimito, Finland. *Aplome* occurs on the banks of the river Lena in Siberia, and at Swartzenberg in Saxony. *Ouvarovite* occurs in emerald-green dodecahedrons, at Bisserak in Russia, with chromic iron.

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, some an inch and a half in diameter, in chlorite; at Unity, on the estate of J. Neal, associated with actinolite and magnetic iron, and at Lisbon, near Mink Pond, in mica slate with staurotide. In Massachusetts, at Carlisle, geodes of transparent cinnamon-brown crystals, similar to figure 18, plate 1, 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 occurs 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, from half an inch to an inch in diameter, in mica slate, at Monroe; at Haddam, large brittle trapezohedrons of manganesian garnet, often two inches through, with chrysoberyl; at Lyme, blackish-brown crystals of large size, (fig. 18, pl. 1), in limestone. In New York, in mica slate, in Dover, Duchess Co., small; at Rogers's Rock, crystallized as well as 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, seven miles from Wilmington. Also at Knife rapids on the Mississippi. Colophonite forms a large vein in gneiss at Willsborough, 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.

Garnet, *brown tourmaline*, *idocrase*, and *staurotide* have often much resemblance in color and lustre, and sometimes even in form. When in regular crystals garnet is readily distinguished by its monometric shapes. But frequently the dodecahedrons are lengthened, as in figure 11, page 78, so as to resemble six-sided prisms with rhombohedral terminations, like tourmaline; or distorted in another direction, as in figure 12, so as to look like a square prism of idocrase or zircon. In each case the determination of the angles will show that the basal edges are equal to the lateral; and without a goniometer the identity of the terminal and lateral planes will be seen in their similarity in lustre and striæ or markings. In another mode of distortion, represented in figure 14, page 78, the garnet looks like an octahedron of spinel, and the distortion in figure 13 may approach some staurotides. *Spinel*, *zircon*, *staurotide*, and *corundum* are infusible before the blowpipe, as well as insoluble in acids. Idocrase is more fusible than garnet and has less specific gravity. The color of the red garnet when transparent, is much more sombre than that of red spinel or sapphire, and when set in jewelry it is readily distinguished by its peculiar tint.

Rutile may also have the color and lustre of garnet, and its semitransparency; but its higher specific gravity at once distinguishes it, as well as its infusibility.

PYROPE. Bohemian Garnet.

Monometric; cubic? Generally in rounded grains. Cleavage none.

H.=7·5. G.=3·69—3·8. Lustre vitreous. Color blood-red. Transparent—translucent. Fracture conchoidal.

Composition.—$R\bar{S}i+3\bar{R}\bar{S}i$? 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); 4, Connel, (Edinb. Phil. J. xxxix, 209):

	$\dddot{\mathrm{Si}}$	$\overline{\mathrm{Al}}$	$\overline{\mathrm{Fe}}$	$\overline{\mathrm{Mn}}$	$\breve{\mathrm{Cr}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$
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[a]	5·60	6·72, $\dot{\mathrm{F}}$e 11·48, $\dot{\mathrm{M}}$n 3·68, W.
3. Stiefelberg,	42·08	20·00	1·51	0·32	3·01	10·20	1·99, " 9·10=98·21, Kob.
4. *Elie Pyrope*,	42·80	28·65	9·81	——	——	10·67	4·78, $\dot{\mathrm{M}}$n 0·25=96·46, Con.

[a] With oxyd of chrome.

According to Apjohn, pyrope contains at least 3 per cent. of yttria.

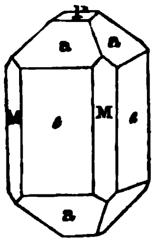
Fuses with some difficulty before the blowpipe to a black glass, and with borax yields an emerald-green globule.

From the mountains on the south side of Bohemia, imbedded in trap tufa and wacke; and also at Zöblitz in Saxony, and at Elie, Scotland in trap. A fine blood-red garnet from Greene's creek, Delaware Co., Penn., has been called pyrope, but it has not been analyzed; and no characters have been observed that satisfy us that it belongs to this species.

IDOCRASE, *H.* Vesuvian. Egeran. Gökumite. Loboit, Frugardit, Idokras. Heteromerite, *Hermann.* Protheite, *Ure.* Wiluite. Cyprine. Xanthite, *Mather.*

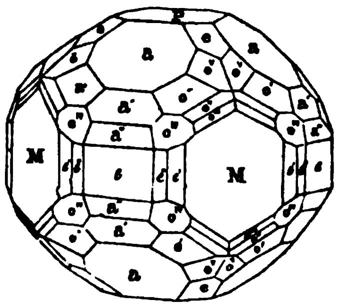
Dimetric. Usual in modified square prisms:

1



Amity, N. Y.

2



Vesuvius.

P: a=142° 53′, a : a (over e)=74° 14′, (or 73° 35′—74° 25′), 74° 21′, Auerbach, a Ural crystal, M : e=135°, M : e′=153° 26′, M : e″ =161° 34′, e : a′=146° 33′, e : a″=161° 43′, a : e=154° 44½′, o^{v} : o^{v}=146° 25′, P : e=151° 56′. Cleavage lateral not very distinct, basal still less so. Imperfect crystallizations: columnar structure rare—particles straight and divergent, or irregular; occasionally granular.

H.=6·5. G.=3·349—4·0. Lustre vitreous; often inclining to resinous. Streak white. 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. Subtransparent—faintly subtranslucent. Fracture subconchoidal—uneven.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+\overline{\mathrm{R}}\dddot{\mathrm{Si}}$. Some analyses require $3\dot{\mathrm{R}}^3\dddot{\mathrm{S}}+2\overline{\mathrm{R}}\dddot{\mathrm{Si}}$, which=(if $\dot{\mathrm{R}}=\dot{\mathrm{Ca}}$ and $\dot{\mathrm{Fe}}$ in the ratio, 5 : 1) Silica 38·58, alumina 17·16, lime 35·24, protoxyd of iron 9·02 =100. Analyses: 1, Klaproth, (Beit. ii, 27); 2, 3, 4, 5, Magnus, (Pogg. xxi, 50); 6, 7, 8, 9, Karsten, (Karsten's Archiv f. Min. iv, 391); 10, 11, Varrentrapp, (Pogg. xlvi, 343); 12, Ivanov, (Pogg. xlvi, 341); 13, 14, Kobell, (Kast. Arch. vii, 399); 15, Nordenskiöld, (Schw. J. xxxi, 436); 16, Thomson, (Min. i, 148); 17, Richardson, (ib. 262); 18, 19, 20, Hermann, (J. f. prakt. Ch. xliv, 193):

	$\dddot{\mathrm{Si}}$	$\overline{\mathrm{Al}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$
1. Vesuvius, *brown*,	35·50	22·25	——	33·00	——, $\overline{\mathrm{Mn}}$ 0·25, $\overline{\mathrm{Fe}}$ 7·50=98·50, K.
2. "	37·36	23·53	3·99	29·68	——, $\dot{\mathrm{Mg}}$ and $\dot{\mathrm{Mn}}$ 5·21=99·77, M.
3. Slatoust, Ural,	37·18	18·11	4·67	35·79	0·77, $\dot{\mathrm{Mn}}$ 1·49=98·01, Magnus.
4. Cziklowa, *green*,	38·52	20·06	3·42	32·41	2·99, $\dot{\mathrm{Mn}}$ 0·02=97·42, "
5. Christiansand,	37·66	17·69	6·49	31·90	4·54, $\dot{\mathrm{Mn}}$ 0·50=98·77, "
6. Vesuvius, G.=3·420,	37·50	18·50	6·25	33·71	3·10, $\dot{\mathrm{Mn}}$ 0·10=99·16, Karsten.
7. Piedmont, *gn.* G.=3·399,	39·25	18·10	4·30	33·85	2·70, $\dot{\mathrm{Mn}}$ 0·75=98·95, "
8. Sasser Valley, *brown*,	38·40	18·05	3·10	36·72	1·50, $\dot{\mathrm{Mn}}$ 0·65, $\dot{\mathrm{Na}}$ 0·9=99·32, K.
9. *Egeran*,	39·70	18·95	2·90	34·88	——, $\dot{\mathrm{Mn}}$ 0·96, $\dot{\mathrm{Na}}$ 2·10=99·49, K.
10. Slatoust, Ural,	37·55	17·88	6·34	35·56	2·62=99·95, Varrentrapp.
11. "	37·84	17·99	6·45	35·18	2·81=100·27, "
12. "	37·08	14·16	16·02	30·88	1·86=100, Ivanoff.
13. Ala,	34·85	20·71	5·40	35·61	——=96·57, Kobell.
14. Monzoni,	37·65	15·42	6·42	38·24	——=97·72, "
15. *Frugardite*,	38·53	17·40	3·90	27·70	10·60, $\dot{\mathrm{Mn}}$ 0·33=98·46, Nord.
16. *Xanthite*,	35·09	17·48	——	33·08	2·00, $\overline{\mathrm{Fe}}$ 6·37, $\dot{\mathrm{Mn}}$ 2·80, $\dot{\mathrm{H}}$ 1·68 =98·43, T.
17. *Cyprine*, G.=3·228,	38·80	20·40	8·35	32·00	——=99·55, Richardson.
18. Achmatowsk, G.=3·4,	37·62	13·25	0·60	36·43	3·79, $\dot{\mathrm{Mn}}$ 0·5, $\overline{\mathrm{Fe}}$ 7·12, $\ddot{\mathrm{C}}$ 0·7= 100·01, Hermann.
19. Slatoust, G.=3·42,	38·19	14·34	0·61	32·69	6·20, $\dot{\mathrm{Mn}}$ 2·1, $\overline{\mathrm{Fe}}$ 5·26=99·39, H.
20. " G.=3·35,	39·20	16·56	0·80	34·78	4·00, $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$ 2·0, $\overline{\mathrm{Fe}}$ 1·20, $\ddot{\mathrm{C}}$ 1·50 =99·49, Hermann.

Hermann makes the iron mostly peroxyd, and changes the formula accordingly. He deduces for the oxygen ratio in $\dot{\mathrm{R}}$, $\overline{\mathrm{R}}$, $\dddot{\mathrm{Si}}$, 9 : 6 : 14. But his last analysis (No. 20) gives more nearly the ratio 9 : 6 : 15, and this yields the formula $3\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+2\overline{\mathrm{R}}\dddot{\mathrm{Si}}$. Another of his analyses affords the proportion 8·77 : 6 : 14·48, which he interprets 9 : 6 : 14; yet it is nearer 9 : 6 : 15. The proportion 9 : 6 : 14 corresponds to $27\dot{\mathrm{R}}$, $6\overline{\mathrm{R}}$, $14\dddot{\mathrm{Si}}$, which cannot be arranged into a probable formula.

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.

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.

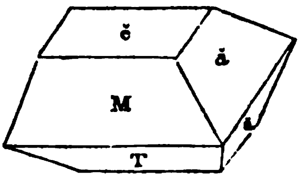
The Vesuvian idocrase has a hair-brown or olive-green color, and is associated with ice-spar, garnet, mica, and nepheline. The finest specimens occur at Ala, in the Val-di-Brozzo, in Piedmont; they are usually transparent, of brilliant lustre, and have green or brown colors; rarely perfectly black. Egg, near Christiana, in Norway, the Ural, Wilui river, near Lake Baikal, Cziklowa in the Bannat, and Monzoni in the Fassa valley, are other localities. Crystals of a sulphur yellow-color have been found at the latter place. From Frugard, Finnland, comes the *frugardite;* and 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.

Phippsburg and Rumford, just below the falls in Maine, afford fine crystals and massive idocrase, associated with yellow garnet, pyroxene, &c., in limestone; also Parsonsfield, Me., with the same minerals, abundant; also at Poland, and Sandford, Me. It has been collected at Worcester, Mass., in a quartz rock, with garnet, but the locality is exhausted. A yellowish-brown idocrase occurs in crystals at Newtown, N. J., associated with corundum and spinel. Half a mile south of Amity, N. Y., grayish and yellowish-brown crystals, sometimes an inch in diameter, occur 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. Minute crystals occur in limestone with sphene on the banks of Vrooman's lake, in Antwerp, near Oxbow.

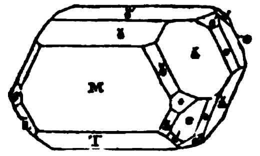
The name *idocrase* is derived from *ειδω, to see*, and *κρασις, mixture*, because the crystalline forms have much resemblance to those of some other species.

EPIDOTE, *H.* Zoisite. Pistacite. Thallite. Withamite. Akanticon. Scorza. Delphinite. Arendalite. Bucklandite, *Levy*. Piemontischer Braunstein, *W.* Eisenepidot. Manganepidot. Thulite. Puschkinite, *Wagner*. Achmatit, *Hermann*.

1

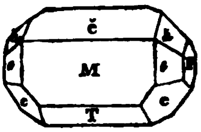


2



Monoclinic. M : T=114° 25′. M : ĕ(r)=116° 12′, T : ĕ(r)=120° 22′, ă(*n*) : ă(*n*)=109° 17′, ĕ(*r*) : ă(*n*)=125° 21′. M : ă(*n*)=104° 48′, M : a(*d*)=126° 56′, M : e(*z*)=103° 42′ and 76° 18′, T : e(*z*)=124° 57′. Cleavage perfect parallel to M, less so to T. Compound crystals: composition parallel to T; also parallel to ĕ. Imperfect crystallizations: structure columnar, divergent, or parallel; also granular, particles of various sizes, sometimes impalpable.

3



H.=6—7. G.=3·25—3·5. Lustre vitreous, inclining to pearly or resinous upon M, both as face of crystallization and cleavage. Color bright or deep green, brown or gray, sometimes red, white, black; green colors usually somewhat 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. Pistacite or epidote proper,—*lime-and-iron-epidote.*—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.=3·48;—the latter black; G.=3·51.

2. Zoisite, *lime-epidote.*—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.

4. *Cerium-epidote*, containing cerium.—*Withamite* occurs in bright red crystals, which are pale straw-yellow in one direction across the prism. *Thulite* has a rose or peach-blossom red color. The following species, allanite or orthite, has been considered a true cerium-epidote.

Composition.—$\dot{R}^3\dddot{Si}+2\bar{R}\dddot{Si}$ for many varieties. Gerhardt observes that the oxygen of the peroxyds and protoxyds together equals that of the silica, and that on this principle the anomalies in the constitution of some varieties will conform to the same type.

Analyses: 1, Thomson, (Min. i, 271); 2, Bucholz, (Gehl. J. i, 200); 3, Geffken, (Epid. Anal. Jenæ, 1824); 4, Thomson, (Min. i, 271); 5, Besnard, (J. f. pr. Chem. v, 212); 6, Geffkin; 7, Rammelsberg, (3d Supp. p. 43, and Pogg. lxviii, 509); 8, Kühn, (Ann. d. Ch. u. Pharm. lix, 373); 9, Hermann, (J. f. pr. Chem. xliii); 10, Gmelin, (Pogg. xlix, 539); 11, 12, Beudant, (Ann. d. M. [2], v, 313); 13, Geffken (as above); 14, Vauquelin, (Haüy's T. 2d ed. ii, 570); 15, Rammelsberg, (2d Supp. 48); 16—19, Kühn, (Ann. d. Ch.

u. Pharm. lix); 20—23, Hermann, (loc. cit.); 24, Osersky, (Bull. Soc. Nat. Moscow, 1841, 112); 25, Hartwall, (K. V. Ac. H. 1828, 171); 26, Sobrero, (Arsb. 1840, 218); 27, Geffken, (loc. cit.):

I. *Zoisite, or Lime-epidote.*

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$
1.	Carinthia,	39·30	29·49	——	6·48	22·96, $\dot{\bar{\mathrm{H}}}$ 1·36=99·58, Thomson.
2.	Fichtelgebirge,	40·25	30·25	4·50	——	22·50, $\dot{\bar{\mathrm{H}}}$ 2·00=99·50, Bucholz.
3.	"	40·08	29·83	——	4·24	18·85, $\dot{\mathrm{Mn}}$ 7·55=100·50, Geffken.
4.	Williamsburgh,	40·21	25·59	——	7·68	23·28, $\dot{\bar{\mathrm{H}}}$ 1·71=98·46, Thomson.
5.	Grossarl,	40·00	26·46	6·33	——	20·66, $\dot{\mathrm{Mg}}$ 3·6, $\dot{\mathrm{K}}$ 1·5=98·55., B.
6.	Falltigel,	40·74	28·94	5·19	——	20·52, $\dot{\mathrm{Mn}}$ 1·78, $\dot{\mathrm{Mg}}$ 4·75=101·92, Geff.
7.	Rothlaue,	44·56	23·72	8·33	——	24·71=101·32, Ramm.; G. 3·387.
8.	Zwiesel, Bav.	40·62	29·18	6·19	——	22·67, $\dot{\mathrm{Mg}}$ 0·73, ign. 0·42=99·81 K.
9.	Falltigel, *gray*,	40·95	30·34	——	4·96	21·56, $\dot{\bar{\mathrm{H}}}$ 0·56, $\ddot{\mathrm{C}}$ 1·13=99·50, H.
10.	*Thulite*,	42·81	31·14	2·29	——	18·73, $\dot{\mathrm{Mg}}$ 1·64, $\dot{\mathrm{Na}}$ 1·89, $\dot{\bar{\mathrm{H}}}$ 0·64=99·13, G.

II. *Pistacite or Lime-and-iron-epidote.* For No. 20, G.=3·39; 21, G.=3·38; 22, G.=3·48.

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$
11.	I. St. Jean,	41·0	28·9	13·9	——	13·6, $\dot{\mathrm{Mg}}$ 0·6=100, Beudant.
12.	"	40·9	28·9	14·0	——	16·2=100, Beudant.
13.	Arendal,	36·14	22·24	14·29	——	22·86, $\dot{\mathrm{Mg}}$ 2·38, $\dot{\mathrm{Mn}}$ 2·12=100·03, G.
14.	"	37·0	21·0	24·0	——	15·0, $\dddot{\bar{\mathrm{Mn}}}$ 1·5=98·5, Vauquelin.
15.	"	37·98	20·78	17·24	——	23·74, $\dot{\mathrm{Mg}}$ 1·11=100·85, Ramm.
16.	"	36·68	21·72	16·72	——	23·07, $\dot{\mathrm{Mg}}$ 0·53=98·72, Kühn,
17.	Geier, Erzgeb.	40·57	14·47	13·44	——	30·00, $\dot{\mathrm{Mg}}$ 2·76=101·24, "
18.	Dauphiny,	39·85	21·61	16·61	——	22·15, $\dot{\mathrm{Mg}}$ 0·3=100·52, "
19.	Penig, Sax.	38·64	21·98	17·42	——	21·95, $\dot{\mathrm{Mg}}$ 0·27=100·26, "
20.	Achmatowsk,	37·38	18·25	12·31	2·20	24·72, $\dot{\mathrm{Mg}}$ 0·89, $\dot{\mathrm{Na}}$ 0·91, $\dot{\bar{\mathrm{H}}}$ 0·59, $\ddot{\mathrm{C}}$ 1·61=98·86, Hermann.
21.	B. d'Oisans,	37·60	18·57	13·37	5·55	21·19, $\dot{\mathrm{Mg}}$ 1·40, $\dot{\bar{\mathrm{H}}}$ 0·46, $\ddot{\mathrm{C}}$ 1·22=99·36, H.
22.	*Bucklandite*,	36·97	21·84	10·19	9·19	21·14, $\dot{\bar{\mathrm{H}}}$ 0·68, $\ddot{\mathrm{C}}$ 0·32=100·33, Herm.
23.	*Puschkinite*,	37·47	18·64	14·15	2·56	22·06, $\dot{\mathrm{Na}}$, $\dot{\mathrm{Li}}$ (*tr.*), 2·28, $\dot{\bar{\mathrm{H}}}$ 0·65, $\ddot{\mathrm{C}}$ 0·79, $\dddot{\mathrm{B}}$ *trace*=98·60, Hermann.
24.	"	33·88	18·85	16·34	——	16·00, $\dddot{\bar{\mathrm{Mn}}}$ 9·26, $\dot{\mathrm{Mg}}$ 6·1, $\dot{\mathrm{Na}}$ 1·67, $\dot{\mathrm{Li}}$ 0·46=98·56, Osersky.

III. *Manganesian Epidote.*

		$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$
25.	St. Marcel,	38·47	17·65	6·60	——	21·65, $\dddot{\bar{\mathrm{Mn}}}$ 14·08, $\dot{\mathrm{Mg}}$ 1·82=100·27, Hart.
26.	"	37·86	16·30	——	7·41	13·42, $\dddot{\bar{\mathrm{Mn}}}$ 18·96, $\dot{\mathrm{Mn}}$ 4·82, $\ddot{\mathrm{Sn}}$, $\dot{\mathrm{Cu}}$ 0·4=99·17, Sobrero.
27.	"	36·87	11·76	10·33	——	22·78, $\dddot{\bar{\mathrm{Mn}}}$ 18·25=99·99, Geffken.

B.B. alone, zoisite swells, and the extreme edges fuse to a transparent yellowish glass, while the swollen part remains mostly a vitreous slag; a transparent glass with borax. Epidote 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. 14 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 Salzburg, Bourg d'Oisans, and numerous other places.

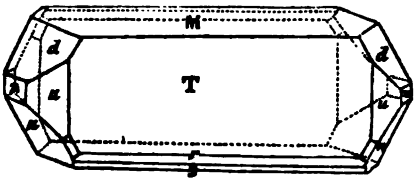
Bucklandite is from Achmatowsk, Arendal, and Lake Laach. *Puschkinite* is from west of the Urals, north of Katherinenburg. Zoisite accompanies kyanite, hornblende, and titanium, in the Sau Alpe and the Bacher mountain in Styria, in the Tyrol, &c. The manganesian variety occurs at St. Marcel, in the valley of Aosta, in Piedmont.

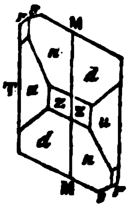
At Franconia, N. H., both crystallized and granular epidote are abundant, the latter containing magnetic iron. Large crystals of unusual beauty are obtained at Haddam, Conn. Epidote occurs also in crystals at the gneiss quarries of Hadlyme and Chester; in limestone at Newbury, Mass.; in greenstone near 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. *Zoisite* 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 W. Bradford and W. Goshen, Chester Co.; also in Kennet township and East Marlboro.

ALLANITE. Cerine, *Hisinger*, (1811). Orthite, *Berz.*, (1815). Bagrationite, *Kokscharov.* Tscheffkinite. Uralorthite, *Hermann.* Xanthorthit, *Hermann.*

Monoclinic, and isomorphous with epidote. M : T (of right rhomboidal prism of uralorthite) = 114° 55′ and 65° 05′; M : *d* =





127° 40′; M : *r* = 116° 20′; M : *n* = 105° 1′: T : *r* = 128° 45′; T : *z* = 125° 25½′; T : *u* = 144° 53½′; *d* : *z* = 156° 28′; *n* : *n* = 108° 30½′; *n* : *r* = 125° 45′, Kokscharov. Scheerer found M : T in orthite = 113°—116°; M : *r* = 116°; T : *r* = 130° 48′; and Rose found in cerine, M : T = 116°: M : *r* = 116°; T : *r* = 128°; T : *l* = 154°; M : *l* = 90°. Compound crystals like those of epidote. Cleavage in traces, parallel with M. 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 Fjeld; 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 is yellowish; G. = 2·78—2·9 (anal. 19 and 21). 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.—Probably $\dot{R}^3\ddot{Si}+\overline{R}\ddot{Si}$. Rammelsberg writes for the orthite of the Ural, $\dot{R}^3\ddot{Si}+\overline{R}\ddot{Si}+\frac{1}{3}\dot{H}$; for that of Hitteroe $\dot{R}^3\ddot{Si}+\overline{R}\ddot{Si}+\dot{H}$. Scheerer deduced from his analyses of allanite $3\dot{R}^3\ddot{Si}+2\overline{R}\ddot{Si}$, which is the formula of some idocrase, (p. 350).

Analyses: 1, Thomson, (Roy. Soc. Edinb. vi, 371); 2, Stromeyer, (Pogg. xxxii, 288); 3, Wollaston, (Lieb. u. Pogg. Handw. i, 265); 4, 5, 6, 7, Scheerer, (Pogg. li, 407, 465); 8, Beck, (Min. of N. Y. p. 441); 9, Hisinger, (Afh. i Fys. iv, 327); 10, Scheerer, (loc. cit.); 11, 12, Berzelius, (Hisingers' Min. Schwed.); 13, 14, Berlin, (Jarhesb. xvii, 221); 15, 16, 17, 18, Scheerer, (Pogg. li, lvi, 479); 19, 20, 21, Bahr and Berlin, (Œfvers. Af. K. V. 1845, 86); 22, Hermann, (J. f. pr. Ch. xliii, 105); 23, Ulex and Choubine:

I. *Allanite*, (Anhydrous). 1, from Alluk; 2, Iglorsoit; 3, Mysore; 4, 5, Jotun Fjeld 6, 7, Snarum; 8, Orange Co. N. Y.

	$\dddot{\text{Si}}$	$\not{\dddot{\text{A}}}\text{l}$	$\dot{\text{F}}\text{e}$	$\dot{\text{C}}\text{e}$	$\dot{\text{C}}\text{a}$	$\dot{\text{M}}\text{g}$
1.	35·4	4·1	22·8	31·5	9·2	——, ign. 4·0=107, Thomson.
2.	33·02	15·23	15·10	21·60	11·08	——, $\dot{\text{M}}\text{n}$ 0·40, $\dot{\text{H}}$ 3·0=99·43, Stromeyer.
3.	34·0	9·0	——	19·8	——	——, $\not{\dddot{\text{F}}}\text{e}$ 32·0=94·8. Wollaston.
4.	34·69	15·58	14·42	19·65[a]	11·90	1·09, $\dot{\text{M}}\text{n}$ 1·55, $\dot{\text{H}}$ 0·52=99·40, Scheerer.
5.	35·15	16·23	15·55	13·34	12·02	0·78, $\dot{\text{L}}\text{a}$ 5·80, $\dot{\text{M}}\text{n}$ 0·98, $\dot{\text{H}}$ 0·5=100·35, Sch.
6.	35·75	15·49	15·19	19·96[a]	11·25	0·77=98·41, Scheerer.
7.	34·00	16·40	15·51	13·73	11·75	0·56, $\dot{\text{L}}\text{a}$ 7·80=99·75, Scheerer.
8.	30·50	11·25	22·27	24·90	9·87	——=98·79, Beck.

II. *Cerine*, (Anhydrous). No. 9, from Bastnäs; 10, from Riddarhyttan.

9.	30·17	11·31	20·72	28·19	9·12	——, $\dot{\text{C}}\text{u}$ 0·87=100·38, Hisinger.
10.	32·06	6·47	——	28·80	8·08	1·16, $\not{\dddot{\text{F}}}\text{e}$ 25·26, $\dot{\text{L}}\text{a}$ 2·45, $\dot{\text{H}}$ 0·6=99·90, Sch.

III. *Orthite*, (Hydrous). 11, from Finbo; 12, Fahlun; 13, 14, Ytterby; 15, Fille Fjeld; 16, 17, 18, Hitteroe; 19, Erikberg, (*Xanthorthite*); 20, Thiergarten; 21, Kullberg, (*Xanthorthite*).

G. of 16 and 17, 3·5; of 18, 3·373; of 19, 2·78; of 20, 3·41; of 21, 2·88.

11.	36·25	14·00	11·42	17·39	4·87	——, $\dot{\text{Y}}$ 3·80, $\dot{\text{M}}\text{n}$ 1·36, $\dot{\text{H}}$ 8·70=97·79, Berz.
12.	32·00	14·80	12·44	19·44	7·84	——, " 3·44, $\dot{\text{M}}\text{n}$ 3·40, $\dot{\text{H}}$ 5·36=98·72, "
13.	36·24	8·18	9·06	4·98	5·48	0·61, " 29·81, $\dot{\text{H}}$ 4·59, $\dot{\text{K}}$, $\dot{\text{N}}\text{a}$ 0·61=99·96, B.
14.	33·60	12·58	13·48	4·56	9·59	1·60, " 20·83, $\dot{\text{H}}$ 3·34, $\dot{\text{K}}$, $\dot{\text{N}}\text{a}$ 0·62=100, B.
15.	34·93	14·26	14·90	21·43[a]	10·42	0·86, " 1·91, $\dot{\text{H}}$ 0·52, $\dot{\text{M}}\text{n}$ 0·35=100·08, Sch.
16.	32·77	14·32	14·76	17·70	11·18	0·50, " 0·85, $\dot{\text{L}}\text{a}$ 2·31, $\dot{\text{M}}\text{n}$ 1·12, $\dot{\text{K}}$ 0·76, $\dot{\text{H}}$ 2·51 =98·28, S.
17.	32·70	14·09	15·31[b]	20·28	11·07	——[c] " 0·81, $\dot{\text{H}}$ 2·56=96·82, S.
18.	33·81	13·04	15·65[b]	20·50	9·42	0·38, " 1·45, $\dot{\text{K}}$ 0·67, $\dot{\text{H}}$ 3·38=98·39, Scheer.
19.	32·93	15·54	4·21	20·01[a]	6·76	2·15, $\dot{\text{M}}\text{n}$ 0·39, $\dot{\text{Y}}$ 0·59, $\dot{\text{H}}$ and some $\ddot{\text{C}}$ 17·55 =100·13, B.
20.	33·05	15·29	16·64	20·55[a]	10·18	1·58[b], $\dot{\text{Y}}$ 1·18, ign. 1·24=99·71, B.
21.	27·59	16·14	16·01	11·75[a]	2·28	4·94, $\dot{\text{M}}\text{n}$ 1·55, $\dot{\text{Y}}$ 2·12, $\dot{\text{H}}$ 11·46, $\ddot{\text{C}}$ 6·71=100·55, Bahr.

[a] Including oxyd of Lanthanum and Didymium. [b] Containing also $\dot{\text{M}}\text{n}$. [c] Undetermined.

IV. *Uralorthite*, or *Tscheffkinite*, (Tschewkinite). From the Ilmen Mts.

22.	35·49	18·21	13·03[d]	10·85	9·25	2·06, $\not{\dddot{\text{M}}}\text{n}$ 2·37, $\dot{\text{L}}\text{a}$ 6·54, $\dot{\text{H}}$ 2=99·80, Herm.
23.	34·47	14·36	7·67	14·79.	10·20	1·08, $\dot{\text{F}}\text{e}$ 8·24, $\dot{\text{L}}\text{a}$ 7·66, $\dot{\text{H}}$ 1·56=100·03, U and C.

[d] Including $\dot{\text{F}}\text{e}$.

Rammelsberg has examined the orthite of Hitteroe, with special reference to its proportion of iron oxyds, (Pogg. lxxvi, 96); and corrects analysis 18 as follows: $\dddot{\text{Si}}$ 33·81, $\not{\dddot{\text{A}}}\text{l}$ 13·04, $\not{\dddot{\text{F}}}\text{e}$ 8·16, $\dot{\text{F}}\text{e}$ 8·30, $\dot{\text{C}}\text{e}$ 20·50 Y 1·45, $\dot{\text{C}}\text{a}$ 9·42, $\dot{\text{M}}\text{g}$ 0·38, $\dot{\text{K}}$ 0·67, $\dot{\text{H}}$ 3·38=99·11, which gives, excluding the water, the formula above. The water amounts to 1 $\dot{\text{H}}$, with this formula. The same composition is derived from Hermann's analysis, No. 22.

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. 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 in length at Finbo near Fahlun, and at Ytterby in Sweden; at Skeppsholm near Stockholm, in black vitreous masses disseminated through gneiss; also at Hitteroe and Fille Fjeld in Norway, at Miask in the Ural. 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, Allanite has been found 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. A massive pitch-black mineral from Monroe, Orange Co., N. Y., (Anal. 8), has been referred to this species; a similar variety is found at East Bradford, Chester Co., Pa.; G.=3·5.

MICA FAMILY.

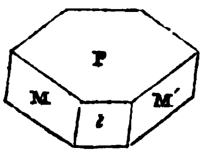
Under the term Mica, various aluminous compounds are included, which are alike in having an eminently easy cleavage in one direction. The species are distinguished often with great difficulty by external characters, and at times not at all, even when crystallized, except by means of chemical analysis or polarized light.*

The oblique micas contain, in general, potash or lithia, and little magnesia. The trimetric and hexagonal micas contain magnesia and often little alkali.

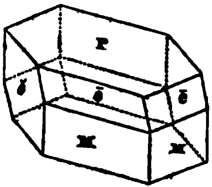
MUSCOVITE, *D.* Oblique Mica. Biaxial Mica. Potash Mica. Glimmer, *in part.* Muscovy Glass. Verre de Moscovie.

Monoclinic; M : M=120°, P : M=98° 40′, Phillips; in figure 3, according to Marignac, M : M=120° 40′, P : M=94° 50′, M : ĕ =119° 40′, P : ĕ=98° 30′ (approximately), M : ĕ′=150°; crystals

1

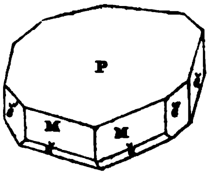


2



Miask, Siberia.

3



Val. Binnen, Valais.

supposed from St. Gothard, M : M=121°, P : M=95° 30′, Marignac; from Middletown, Ct., M : M=121°, P : M=95° to 98°, D.; in figure 2, according to Levy, M : M=120°, P on the axis 100°, P : ĕ′=121° 7′. Cleavage basal, eminent; occasionally a transverse cleavage in one direction tolerably perfect. 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

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* See Appendix for remarks on the mode of observing the optical distinctions of micas.

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 55°—75°.

Composition.—Analyses: 1, 2, H. Rose, (Schw. Jour. xxix, 282, and Gilb. Ann. lxxi, 13, and Pogg. i, 757); 3, Svanberg, (K. V. Ac. H. 1839, 155); 4, 5, 6, Rose, (loc. cit.); 7, Klaproth, (Beit. v, 64); 8, Svanberg, (loc. cit.); 9, Schafhäutl, (Ann. d Ch. u. Pharm. xliv, 40); 10, J. D. Darrack, in the laboratory of J. C. Booth, (private communication from Prof. B.):

	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dddot{\bar{Mn}}$	$\dot{Mg}$	$\dot{K}$	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=99·40, Svanberg.
4. Fahlun,	46·22	34·52	6·04	2·11		8·22	1·09, $\dot{H}$ 0·98, 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, $\dot{Ca}$ 0·13=100·88, R.
7. Siberia.	48·00	34·25	4·50	0·50		8·75	—, ign. 1·25=97·25, Klap.
8. Abborforss,	39·45	9·27	35·78	—	3·29	5·06	—, F 0·29, $\dot{Ca}$ 0·31, $\dot{Fe}$ 1·45, $\dot{Mn}$ 2·57=99·59. Svanberg.
9. *Fuchsite*,	47·95	34·45	1·80	—	0·72	10·75	—, F 0·35, $\dddot{\bar{Cr}}$ 3·95, $\dot{Na}$ 0·37, $\dot{Ca}$ 0·42=100·76, Schaf.
10. Unionville,	46·75	39·20	*trace*	—	1·02	6·56	—, $\dot{Ca}$ 0·39, $\dot{H}$ 4·90=98·82, D.

In analyses 1 to 7, the oxygen of the peroxyds and silica has closely the ratio 3 : 4; or for the protoxyds, peroxyds and silica 1 : 12 : 16, affording $3\dot{R}$, $12\dddot{\bar{Al}}$, $16\dddot{Si}$.

H. Rose suggested the formula $\dot{K}\dddot{Si}+4\dddot{\bar{Al}}\dddot{Si}$, corresponding to the ratio 1 : 12 : 15, or a ratio of 4 to 5 between the oxygen of the alumina and silica. But the analyses alluded to, afford quite uniformly the ratio 3 : 4, instead of 4 : 5.

The Abborforss mica (No. 8) also has closely the same ratio 3 : 4; or for the whole 2 : 9 : 12, giving the formula $\dot{R}^2\dddot{Si}+3\dddot{\bar{R}}\dddot{Si}$.

Analysis No. 9 has nearly the ratio 3 : 4 for the peroxyds and silica, and the whole ratio 1 : 9 : 12 (or more nearly 1⅓ : 9 : 12.) The formula, as Rammelsberg states, may be $\dot{R}\dddot{Si}+3\dddot{\bar{Al}}\dddot{Si}$.

Analysis No. 10 has the oxygen ratio 1·61 : 18·32 : 24·29 (and for the water 4·35). This gives 3 : 4 for the peroxyds and silica, and very nearly 1 : 12 : 16 : 3 for the whole ratio. The mica is a granular variety.

In recapitulation, the analyses afford, excluding the water, the following ratios for the oxygen of the protoxyds, peroxyds, and silica:

Nos. 1 to 7,	¼ : 3 : 4.	No. 9,	⅓ : 3 : 4.
No. 8,	⅔ : 3 : 4.	No. 10,	¼ : 3 : 4.

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.*

In the Pennsbury (Penn.) mica, the cleavage direction is not the line of either diagonal, but makes an angle of 30° with the shorter, so that the plates formed by it are often nearly rectangular, two of the edges being cleavage edges and two primary edges of the crystal.

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.

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 with beryl, and at Mendon and Brimfield; at Chester, Hampden 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; a silvery mica 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 rhombs with a cleavage in the direction of the shorter diagonal. In Pennsylvania, in fine hexagonal crystals of a dark brown color at Pennsbury near Pennsville, Chester Co.; at the Unionville Corundum locality, of a whitish color; and also at another locality one and a half miles distant; 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 Delaware, Newcastle Co., at Dixon's quarry, associated with apatite; on the Wilmington road near the woodlands. 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.

The biaxial character of many of these micas has been particularly examined by the author, in connection with B. Silliman, Jr. (See Appendix).

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, $\dddot{\bar{\mathrm{Al}}}$ 23·67, $\dddot{\bar{\mathrm{Fe}}}$ 7·31, $\dot{\mathrm{K}}$ 15·29, $\dot{\mathrm{Ca}}$ 6·18, $\dot{\mathrm{Li}}$ 0·06=101·89,

affording the oxygen ratio 1 : 3 : 6, and the formula $\dot{\mathrm{R}}\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}$, corresponding to some Lithia micas.

An *oblique mica* from Vesuvius of a blackish-green color, and another from Zillerthal, have been found to have the composition of magnesia mica or biotite, giving the formula $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}$; P : M=98° 40′; M : M=120° 46′. Analysis of the former, by Chodnew, (Pogg. lxi, 381, mean of two analyses); and by Varrentrapp, of the latter, (ib.):

1. $\dddot{\mathrm{Si}}$ 40·91, $\dddot{\bar{\mathrm{Al}}}$ 17·79, $\dddot{\bar{\mathrm{Fe}}}$ 11·02, $\dot{\mathrm{Mg}}$ 19·04, $\dot{\mathrm{K}}$ 9·96, $\dot{\mathrm{Ca}}$ 0·3=99·02, Chodnew.
2. 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.

Another mica from Chamouni, (probably biaxial, but not fully ascertained,) afforded Delesse, (Ann. Ch. Phys. [3], xxv),

$\dddot{\mathrm{Si}}$ 41·22, $\dddot{\bar{\mathrm{Al}}}$ 13·92, $\dddot{\bar{\mathrm{Fe}}}$ 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, and the formula $3\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+5\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}$. G.=3·127.

As there are more than one "potash mica," "oblique mica," or "common mica," a distinctive name for the above species has become necessary. The designation MUSCOVITE, on this account adopted, is already so far connected with the mineral, as to be sufficiently familiar and unobjectionable.

MARGARODITE, *Schafhäutl*. Schistose Talc of Zillerthal.

Foliated like common mica; sometimes in small plates or scales aggregated into wedge shapes, or forming a scaly mass. Refraction biaxial; angle between the axes of polarization, nearly as in Muscovite.

H.=2·5—3. G.=2·872, Schafhäutl; 2·79—2·81, Brewer; 2·817, Delesse; 2·831, Rammelsberg. Lustre pearly. Color silvery-white. Translucent to nearly opaque. Laminæ more or less elastic.

Composition.—$\dot{\mathrm{R}}\dddot{\mathrm{Si}}+2\dddot{\bar{\mathrm{R}}}\dddot{\mathrm{Si}}$, (with ½$\dot{\mathrm{H}}$ to 1½$\dot{\mathrm{H}}$). Analyses: 1, Schafhäutl; 2, Delesse, (Ann. d. Mines, [4], xvi, 202, 1849); 3, 4, Brewer, (Private communication); 5, Rammelsberg, (4th Supp. 75):

	$\dddot{Si}$	$\bar{\bar{Al}}$	$\bar{\bar{Fe}}$	$\bar{\bar{Mn}}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$	$\dot{H}$
1. Zillerthal,	47·05	34·90	1·50	—	1·95	4·07	7·96	1·45=98·88, Schafhäutl.
2. St. Etienne,	46·23	33·08	3·48	*trace*	2·10	1·45	8·87	4·12, F *trace*=99·33, D.
3. Monroe, Ct.,	49·96	32·85	*trace*	—	1·08	2·89	7·91	4·46[a], Cl 0·14=99·29, B.
4. " "	49·97	32·60	—	—	1·41	*undetermined*		4·46[a], Brewer.
5. Loc. doubtful,	47·84	32·36	3·06	—	1·28	1·55	10·25	2·43, $\dot{Ca}$ 0·29=99·06, R.

[a] A mean of 4 determinations.

Delesse's analysis gives for the oxygen of the protoxyds, peroxyds, and silica 2·65 : 16·46 : 24·02=1 : 6 : 9, corresponding to the above formula. Rammelsberg deduces for his mica, 2·71 : 16·03 : 24·86=1 : 6 : 9, or the same as afforded by the preceding. No. 1 affords 3·17 : 16·35 : 24·45=1⅛ : 6 : 9; and 3, 4, afford 2·63 : 15·35 : 25·96=1 : 6 : 10. Notwithstanding the small variations from the first ratio in the last three, there is reason to believe that all pertain to the same species. The oxygen ratio for the peroxyds and silica in this species is 2 : 3, while it is 3 : 4 in muscovite.

From Zillerthal; St. Etienne in the Vosges in graphic granite; and from Monroe, Connecticut, associated with topaz and fluor at the topaz vein.

PHLOGOPITE, *Breit.* Rhombic Mica. Magnesia Mica, in part.

Trimetric. In rhombic or hexagonal prisms, with refraction biaxial; M : M=120°—121° 15′. Color yellow or copper red; also white or colorless, and different shades of brown. Cleavage like common mica. Biaxial; angle between the axes 5° to 20°.

Composition.—$3\dot{R}^3\dddot{Si}+2\bar{\bar{R}}\dddot{Si}$, which is the formula of idocrase, and perhaps also of some allanite. Mean of three analyses by Meitzendorff, (Pogg. lviii, 157); 2, Svanberg, (K. V. Ac. H. 1839):

	$\dddot{Si}$	$\bar{\bar{Al}}$	$\bar{\bar{Fe}}$	$\dot{Fe}$	$\dot{Mg}$	$\bar{\bar{Mn}}$	$\dot{K}$	F
1. N. Y.,	41·30	15·35	1·77	—	28·79	—	9·70	3·30, $\dot{Na}$, some $\dot{Li}$ 0·65, ign. 0·28=101·14, M.
2. Sala,	42·65	12·86	—	7·11	25·39	1·06	6·08	0·62, Mg 0·36, Al 0·1, $\dot{H}$ 3·17 =99·16, Sv.

The mica of No. 2 has not been shown to be biaxial; yet, as it agrees in atomic proportions with the *Phlogopite*, it appears to belong here. The ratio between the oxygen of the alumina and silica in this species is 1 : 2½, or the whole ratio 3 : 2 : 5.

B.B. like common mica, fusing to a white enamel, and giving the reaction usually of fluorine.

Svanberg's mica was from Sala, Sweden. A mica with the color given for phlogopite occurs at Natural Bridge, Jefferson Co., N. Y. It is yellowish brown, somewhat copper-like, and nearly yellow in thin laminæ. The angle between the axes of polarization is about 16°, according to measurements by the author in connection with B. Silliman, Jr. Henderson has been cited by mistake as the locality of a mica of this kind.

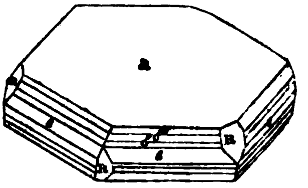
There are other similar micas having a still smaller angle between the axes, which in thin laminæ show a single series of ellipses, slightly differing from circles; but in thicker pieces exhibit the two sets partly complete. A variety from Edwards, N. Y., is transparent to opaque white and somewhat pearly, with a soapy feel to the powder; and the angle between the axes is 13° to 14°. Very similar in optical characters are the following:—a brown copper mica from Pope's Mills, St. Lawrence Co., N. Y., and a transparent glassy mica from the same locality, both occurring in long and large hexagonal prisms, often tapering at the extremities, as if modified by accuminating planes, and having (the latter) for the optical angle 7°; a light coppery mica from Franklin, N. J., occurring in large plates. A brown mica on Vrooman's lake, N. Y., near Rossie, belongs to this species; but the particular variety is not yet ascertained.

Dufrénoy describes hexagonal micas from Clayette, (Dept. of Saône-et-Loire), and from the Dept. of Finisterre, and also Lake Baikal, which are trimetric, resembling closely the Pope's Mills crystals, with the angle M : M 120° nearly, and P on the plane on the basal edges 95°.

Brewster mentions his having found the angle 14° between the optical axes of a mica he examined.

BIOTITE, *Hausmann.* Hexagonal Mica. Uniaxial Mica. Magnesia Mica. Rubellan, *Breit.* Meroxen, *Breit.* Glimmer, (in part).

Rhombohedral. Usual in tabular prisms, sometimes with the sides affording planes of a rhombohedron, and rarely other replacements. In large crystals from Greenwood Furnace, N. Y., R : R =71° to 72°, R : a (cleavage plane) 113°—114°, D.; Kobell gives the angle for the species and this variety 71° 3′ 46″. In the annexed figure, R : R=62° 46′, R : a=99° 40′, (or 99° 45′ by calculation), a on *o* 102° 28′, on *o′* 98° 23′, on *o″* 95° 37′, Marignac. Cleavage basal, highly eminent. Also common in foliated masses. Refraction unaxial.



Vesuvius.

H.=2·5—3. G.=2·8—3·1. Lustre pearly; often submetallic on the terminal faces of the prism; splendent—shining. Colors various, like 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.—$\dot{R}^3\dddot{Si}+(\overline{Al}, \overline{Fe})\dddot{Si}$, which is essentially the formula of 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, Shafhäutl, (Ann. d. Ch. u. Pharm. xlvi, 325):

		$\dddot{Si}$	$\dddot{\overline{Al}}$	$\dddot{\overline{Fe}}$	$\dot{Mg}$	$\dot{K}$
1.	Siberia,	42·50	11·50	22.00	9·00	10·00, $\overline{Mn}$ 2·0, ign. 1·00=98, Klaproth.
2.	"	40·00	12·67	19·03	15·70	5·61, HF 2·10, $\overline{Mn}$ 0·63, $\ddot{Ti}$ and $\overline{Fe}$ 1·63=97·37, Rose.
3.	"	42·12	12·83	10·38	16·15	8·58, $\dot{Fe}$ 9·36, $\dot{H}$ 1·07=100·49, Kobell.
4.	Monroe, N. Y.	40·00	16·16	7·50	21·54	10·83, HF 0·53, $\ddot{Ti}$ 0·2, $\dot{H}$ 3·0=99·76, K.
5.	Greenland,	41·00	16·88	4·50	18·86	8·76, HF *trace*, $\dot{Fe}$ 5·05, $\dot{H}$ 4·30=99·35, K.
6.	Pargas,	42·58	21·68	10·39	10·27	8·45, F 0·51, $\dot{Mn}$ 0·75, $\dot{H}$ 3·35, $\dot{Ca}$ 0·26, Ca 0·56=99·80, Svanberg.
7.	Rosendal,	44·41	16·86	——	11·26	4·05, F 0·41, $\dot{Fe}$ 20·71, $\dot{Mn}$ 0·46, $\dot{H}$ 1·13, $\dot{Ca}$ 0·90, Ca, 0·43=101·60, Svanberg.
8.	Bodenmais,	40·86	15·13	13·00	22·00	8·83, $\dot{H}$ 0·44=100·26, Kob.; G. 2·7.
9.	Vesuvius,	39·75	15·99	8·29	24·49	8·78, $\dot{Ca}$ 0·87, ign. 0·75, undc. 0·1=98·62, B.
10.	L. Baikal,	42·01	16·05	4·93	25·97	7·55, HF 0·68=97·19, Rose.
11.	*Chrome, M.*	47·68	15·15	5·72	11·58	7·27, $\overline{Mn}$ 1·16, $\overline{Cr}$ 5·91, $\dot{Na}$ 1·17, $\dot{H}$ 2·86, F *trace* =98·50, Schafhäutl.

The hexagonal or 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 ½ : 1 : 2, and the chrome mica (No. 11), nearly ¼ : 1 : 2.

B.B. fuses with difficulty to a grayish or blackish glass. With the fluxes an iron glass.

In brilliant crystals from Vesuvius (*Meroxene*); also from Pargas and other localities mentioned above.

In tabular and rhombohedral forms near Greenwood Furnace, Orange Co., N. Y., of a greenish black color, six or seven inches across, (analysis 4); as they are seen in cabinets, they often appear to be acute oblique prisms, and also tetrahedral pyramids as well as tables with lateral rhombohedral planes. Also silvery white and opaque, (or transparent only in very thin laminæ), at Easton, Pa. The former was identified with hexagonal mica by Kobell, and both have been examined optically by the author. A mica from near Germantown, Pa., in black crystals is referred here. All the localities of this species have not been distinguished from those of oblique micas. One of the uniaxial micas examined by Biot is cited from Topsham, Maine.

LEPIDOLITE. Lithia Mica. Lithion-glimmer. In part, Zinnwaldite, *Haid.*

Monoclinic? Occurs in oblique hexagonal prisms of 119° and 122° nearly; also in coarsely granular masses consisting of foliated scales. Cleavage basal, highly eminent.

H.=2·5—4. G.=2·85—3. Lustre pearly or metallic pearly. Color rose-red, violet gray. Translucent. Two axes of refraction.

Composition.—$\text{RF}+\bar{\text{R}}^2\bar{\text{Si}}^3$, Zinnwald, from Lohmeyer's analysis; Kobell deduced for that of Chursdorf, $\text{KF}^3+2\text{Li F}+4\bar{\text{Al}}\ \bar{\text{Si}}^2$, from Gmelin's analysis; Rose considers the iron in all cases peroxyd, and deduces $\text{RF}+(\bar{\text{Al}}, \bar{\text{Mn}})\bar{\text{Si}}^3$=Silica 49·81, alumina 27·71, potassium 9·06 (potash 10·91), lithium 1·55 (lithia 3·48), sodium 1·78 (soda 2·12), fluorine 10·09 =100. See farther, Appendix.

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—13, Turner, (loc. cit.); 14, 15, Regnault, (Ann. d. Mines, [3], xiii, 151); 16, 17, Rosales, (Pogg. lxviii, 154); 18, Stein, (J. f. pr. Chem. xxviii, 295):

	$\bar{\text{Si}}$	$\bar{\text{Al}}$	$\bar{\text{Fe}}$	$\bar{\text{Mn}}$	$\dot{\text{Mn}}$	$\dot{\text{K}}$	$\dot{\text{Li}}$	HF
1.	54·50	38·25	0·75		—	4·00	—	—, $\dot{\text{H}}$ and loss 2·50=100, Klap.
2.	49·06	33·61	—	1·40	—	4·19	3·59	3·44, $\dot{\text{Mg}}$ 0·41, $\ddot{\text{P}}$ 0·11, $\dot{\text{H}}$, loss 4·18, G.
3.	49·08	34·01	—	1·08	—	4·19	3·58	3·50 (with $\ddot{\text{P}}$), $\dot{\text{Mg}}$ 0·41, $\dot{\text{H}}$, loss 3·15, K.
4.	52·25	28·35	—	—	3·66	6·90	4·79	5·07, $\dot{\text{H}}$ *trace*=101·03, Gmelin.
5.	46·23	14·14	17·97	—	4·57	4·90	4·21	8·53, $\dot{\text{H}}$ 0·83=101·39, "
6.	44·28	24·53	—	—	1·66	9·47	4·09	5·14, $\dot{\text{Fe}}$ 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, $\dot{\text{Na}}$ 1·41, Cl 0·21, ign. 0·22=98·38, Lohmeyer.
9.	40·19	22·79	—	—	2·02	7·49	3·06	3·99, $\dot{\text{Fe}}$ 19·78=99·25, Turner.
10.	50·91	28·17	—	—	1·08	9·50	5·67	4·11=99·44, Turner.
11.	50·35	28·30	—	—	1·23	9·04	5·49	5·20=99·61, Turner.
12.	50·82	21·33	—	—	*trace*	9·86	4·05	4·81, $\dot{\text{Fe}}$ 9·08=99·95, Turner.
13.	40·06	22·90	27·06	—	1·79	4·30	2·00	2·71=100·82, Turner.
14.	52·40	26·80	—	—	1·50	9·14	4·82	4·40=99·09, Regnault.
15.	49·78	19·88	13·22	—	—	8·79	4·15	4·25=100·07, Regnault.
16.	48·92	19·08	—	5·59	—	10·96	2·77	F 10·44, Cl 1·31, $\dot{\text{Ca}}$ 0·14, $\dot{\text{Na}}$ 2·23, R.
17.	46·62	21·05	—	4·12	—	*und.*	*und.*	F 10·01, Cl 1·01, $\dot{\text{Ca}}$ 0·12, rest *und.* R.
18.	47·01	20·35	14·34	—	1·53	9·62	4·33	F 1·48, Cl 0·40, ign 1·58=100·54, S.

1, 2, 3, from Rozena; 4, Chursdorf; 5—8, Zinnwald; 9, Altenberg; 10, 11, Utö; 12, 13, Cornwall; 14, Rozena; 16, 17, Juschakowa in the Ural; 18, 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.*

Chursdorf, Rozena, Zinnwald, Altenberg, and Cornwall, are some of the foreign localities. In the United States, a rose mica is obtained at the albite vein in Chesterfield, Mass., and at Goshen in the same State. The granular variety occurs at Paris, Maine, with red tourmalines, and often traversed by them; also near Middletown, Conn. The Goshen mineral is of difficult fusibility and slight lithia reaction, and may not be of this species.

MARGARITE. Perlglimmer, *L.*

Monoclinic. Cleavage basal, eminent. Usually in intersecting or aggregated laminæ.

H.=3·5—4·5. G.=3·032. Lustre of base pearly, laterally vitreous. · Color grayish, reddish-white, yellowish. Translucent—subtranslucent. Laminæ rather brittle, or slightly elastic.

Composition.—$\dot{\text{R}}^3, \bar{\text{Al}}^{12}, \bar{\text{Si}}^8$=Silica 34·47, alumina 57·55, lime 7·98. Analyses: 1, Dumenil; 2, Göttingen Laboratory, (according to Hausmann):

1. $\bar{\text{Si}}$ 37·00 $\bar{\text{Al}}$ 40·50 $\bar{\text{Fe}}$ 4·50 $\dot{\text{Ca}}$ 8·96 $\dot{\text{Na}}$ 1·24 $\dot{\text{H}}$ 1·00=93·20.
2. 33·50 58·00 $\dot{\text{Fe}}$ 0·42 7·50 $\dot{\text{Mn}}$ 0·03 $\dot{\text{Mg}}$ 0·05=99·50.

B.B. intumesces and fuses with difficulty. Soluble in acids.

From Sterzing in the Tyrol, in chlorite. *Diphanite* (p. 292) is Margarite, according to Breithaupt.

EMERYLITE, *J. Lawrence Smith.* Corundellite and Clingmanite, *Silliman, Jr.*

Foliated like mica; folia easily separable. Either in coarse plates or in masses consisting of aggregated spangles.

H.=3·5—4·5. G.—2·995, Silliman, Jr. Color white. Translucent, or nearly opaque. Folia brittle or slightly flexible.

Composition.—$\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+3\,\dddot{\bar{\mathrm{A}}}\mathrm{l}^2\dddot{\mathrm{Si}}[+3\,\dot{\mathrm{H}}]$=Silica 30·58, alumina 50·99, lime 13·96, water 4·47. Analyses: 1, J. Lawrence Smith, (Am. J. Sci. [3], vii, 285); 2, 3, 4, Wm. J. Craw, in the Yale Laboratory, (Silliman, Am. J. Sci. [2], viii, 379); 5, 6, ibid, (private communication); 7, C. Hartshorne, in Lab. J. C. Booth, (private communication from J. C. Booth); 8, Silliman, Jr. (private communication):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$	
1. Asia Minor,	30·	50·	13·	—	—	—	—	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$, $\dot{\mathrm{Mn}}$, $\dot{\mathrm{K}}$ 3, $\dddot{\bar{\mathrm{Z}}}\mathrm{r}$ 4=100, S.
2. Village Green,	32·31	49·24	10·66	0·30	2·21	(loss)	5·27=100, Craw.	
3. "	31·06	51·50	9·24	0·28	2·97	"	5·27=100, Craw.	
4. "	31·26	51·60	10·15	0·50	1·22	"	4·27=100, Craw.	
5. "	30·18	51·40	10·87	0·92	2·23	0·54	4·52=100, Craw.	
6. Unionville,	29·99	50·57	11·31	0·62	1·62	0·85	5·14=100, Craw.	
7. "	32·15	54·28	11·36	0·05	*undetermined*		0·50,	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$ *trace*, Hartshorne.
8. North Carolina,	29·17	48·40	9·87	1·24	6·15	—	3·99,	HF 2·03=100·80, Silliman.

From the mean of the results we deduce the oxygen ratio 1 : 6 : 4.

Commonly yields water in a matrass, with sometimes a trace of fluorine. B.B. exfoliates and emits a bright light and finally fuses on the edges.

Detected by Dr. Smith with the corundum of Asia Minor. Also found with corundum at Village Green, Delaware Co., Pa.; at Unionville, Chester Co., Pa., (Corundellite); at the corundum locality in Buncombe Co., North Carolina, (Clingmanite).

EUPHYLLITE, *Silliman, Jr.*

Structure as in common mica, but laminæ not as easily separable. Biaxial; angle between the optical axes 71½°, Silliman, Jr.

H.=3·5—4·5. G.=2·963—3·008. 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.—Analyses: 1, 2, H. Erni, in the Yale Laboratory, (private communication); 3, 4, T. Garrett, in J. C. Booth's Laboratory, Philad., (private communication):

	$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{A}}}\mathrm{l}$	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{H}}$
1. Unionville,	43·69	44·69	—	3·98	0·75	0·98	0·82	5·60=100·41, Erni.
2. "	43·45	44·98	—	4·34	0·69	*undetermined*		4·97, Erni.
3. "	45·93	48·23	0·60	3·53	2·44	—	*trace*	—=100·73, Garrett.
4. " (dif. loc.)	45·33	46·47		2·36	*trace*	—	*undet.*	—, Garrett.

These correspond very nearly to the ratio 1 : 12 : 12, or 1 $\dot{\mathrm{R}}$, 4 $\dddot{\bar{\mathrm{R}}}$, 4 $\dddot{\mathrm{Si}}$, which seems to give no probable formula. The ratio approaches even more nearly 1 : 11 : 12, or 1 : 12 : 13, the former of which gives the formula $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+11\,\dddot{\bar{\mathrm{R}}}\,\dddot{\mathrm{Si}}$, or including the water found by Mr. Erni, the same with 3 $\dot{\mathrm{H}}$. 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 mica, leaves a very smooth, hard looking surface. Also in the same vicinity in aggregated laminæ, or scales.

LEPIDOMELANE, *Soltmann*, Pogg. 1, 664.

Hexagonal. In small six-sided tables, or an aggregate of minute scales. Cleavage basal, perfect.

H.=3. G.=3·000. 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.—$(\dot{Fe}, \dot{K})^3\dddot{Si}+3(\overline{\dddot{Al}}, \overline{\dddot{Fe}})\dddot{Si}$. Analysis by Soltmann:

$\dddot{Si}$ 37·40, $\overline{\dddot{Al}}$ 11·60, $\overline{\dddot{Fe}}$ 27·66, $\dot{Fe}$ 12·43, $\dot{Mg}$ and $\dot{Ca}$ 0·26, $\dot{K}$ 9·20, $\dot{H}$ 0·60=99·49.

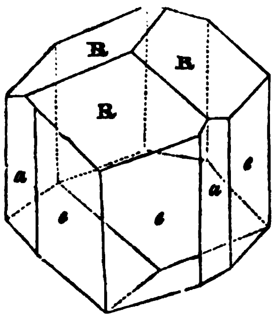
B.B. at a red heat, becomes pinchbeck-brown, and resembles magnetic pyrites; then fuses to a black opaque magnetic enamel. With borax forms a bottle-green glass.

Occurs at Persberg in Wermland. It was named, in allusion to its structure and color, from λεπις, *a scale*, and μελας, *black*. The *Siderischer Felsglimmer* or *Rabenglimmer* of Breithaupt is probably identical with this species, (Soltmann).

TOURMALINE, *W.* Schörl. Rubellite. Indicolite. Aphrizite. Aphrite, *W.* Turmalin. Tourmaline Apyre, *H.*

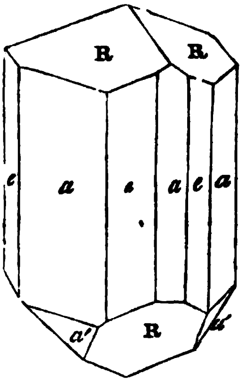
Rhombohedral; R : R=133° 26′ (132°—134°, Breit.) R : e=156° 43′, R : *a*′=141° 40½′, e : e=155° 9′, R : *e*=113° 17′; *e* : *a*=150°, *e* : *e*=120. Crystals often hemihedrally modified, or having dissimilar extremities, as in the annexed figures, and also page 136. Cleavage parallel with R and *e*, difficult. Sometimes massive compact; also columnar, coarse or fine, parallel or divergent.

1



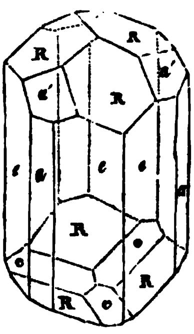
Monroe, Conn.

2



Haddam, Conn.

3



Gouverneur, N. Y., Newark, N. J.

H.=7—7·5. G.=3—3·3; 3·021, red from Paris, Me., Shepard. Lustre vitreous. Color black, brown, blue, green, red, and rarely white; some specimens red internally, and green externally; and others red at one extremity, and green, blue, or black, at the other; Exhibits dichroism; some varieties red in the direction of the axis, and bluish across it; others liver-brown in one direction and reddish-brown in the other. Streak uncolored. Transparent—

opaque; less transparent across the prism than in the line of the axis. Fracture subconchoidal—uneven. Brittle. Pyroelectric, (p. 135).

Composition.—Formula not determined. The mineral contains boracic acid with silica and different bases. Analysis: 1, 2, 3, Gmelin, (Schw. J. xxxi, 299, xxxviii, 514, Pogg. ix, 172); 4, Gruner, (Gilb. Ann. lxv, 209, 328); 5, Arfvedson, (Schw. J. xxii, 111); 6, 7, 8, Gmelin, (loc. cit.); 9, 10, Klaproth, (Beit. v, 144); 11, Du Menil, (Kastn. Arch. xi, 485); 12—15, Gmelin, (loc. cit.); 16, Bucholz, (Schw. J. iii, 25):

	$\dddot{Si}$	$\dddot{B}$	$\overline{\dddot{Al}}$	$\overline{\dddot{Fe}}$	$\overline{\dddot{Mn}}$	$\dot{Mg}$	$\dot{Ca}$	$\dot{K}$	$\dot{Na}$	
1. *Red*,	42·13	5·74	36·43	—	6·32	—	1·20	2·41	—,	$\dot{Li}$ 2·04, ign. 1.81=97·58, G.
2. *Red*,	39·37	4·18	44·00	—	5·02	—	—	1·29	—,	" 2·52, ign. 1·58=97·96, G.
3. *Gn.*,	39·16	4·59	40·00	5·96^a	2·14	—	—	—	—,	" $\dot{K}$ 3·59, ign. 1·58=97·02, G.
4. *Gn.*,	41·	9·	32·	5·	1·	3·	—	—	—,	" 5=96, Gruner.
5. *Blue*,	40·30	1·10	40·50	4·85	1·50	—	—	—	—,	" 4·30, ign. 3·60=96·15, A.
6. *Bk*,	35·20	4·11	35·50	17·86^a	0·43	0·70	0·55	—	2·09	=96·44, Gmelin.
7. *Gn.*,	38·80	3·88	39·61	7·43^a	2·88	—	—	—	4·95,	ign. 0·78=98·33, Gmelin.
8. *Bk.*,	33·05	1·89	38·23	—	—	—	0·86		3·17	$\dot{Fe}$ 23·86, ign. 0·45=101·51, G.
9. *Bk.*,	36·75	—	34·50	21·00^a	*trace*	0·25	6·00	—	—	=98·50, Klaproth.
10. *Bk.*,	36·50	—	31·00	23·50^a	*trace*	1·25	5·50	—	—	=97·75, Klaproth.
11. *Bk.*,	38·25	2·64	32·64	21·45	0·45	1·50	—	—	2·70	=99·63, Du Menil.
12. *Bk.*,	37·65	3·83	33·46	9·38^a	—	10·98	0·25		2·53	ign. 0·03=98·11, Gmelin.
13. *Bk.*,	35·48	4·02	34·75	17·44^a	1·89	4·68	*trace*	0·48	1·75	=100·49, Gmelin.
14. *Bk.*,	38·79	3·63	37·19	5·81^a	*trace*	5·86	—	0·22	3·13,	ign. 1·86=96·48, Gmelin.
15. *Bn.*,	37·81	4·18	31·61	7·77^a	1·11	5·99	0·98	1·20	—,	ign. 0·24=90·89, Gmelin.
16. *Bk.*,	36·50	—	33·75	—	*trace*	6·08	0·25	1·66	—,	$\dot{Fe}$ 8·00, $\dot{H}$ 1·50=87·74, B.

^{a} Fe^{3}O^4.

1, from Rozena; 2, Perm; 3, Brazil; 4, Greenland; 5, Utoe; 6, Bovey; 7, Chesterfield, Mass.; 8, 9, Eibenstock; 10, Spessart; 11, Sonnenberg; 12, Käringbricka; 13, Rabenstein; 14, Greenland; 15, 16, St. Gothard.

Recently Hermann has examined some Russian tourmalines and obtained a large percentage of boracic acid, amounting to 11·78 per cent. in one specimen, besides 1 to 2½ per cent. of carbonic acid, (J. f. pr. Chem. xxxv, 232); but his results are not deemed perfectly satisfactory. See Appendix.

B.B. the action is various. In general, they intumesce more or less, some fusing readily, particularly those which contain lime, others assuming a slaggy appearance, without melting, while others, especially the red variety, are not acted on at all.

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, and the red 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.

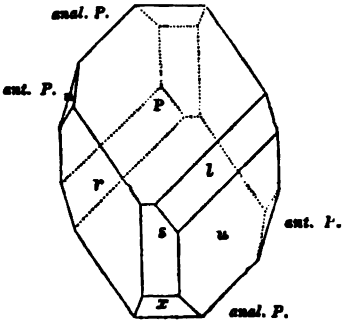
Large black tourmalines occur in Greenland, at Hörlberg, near Bodenmais, in Bavaria; at Käringbricka in Sweden; near Bovey in Devonshire. Small brilliant crystals in decomposed feldspar, at Andreasberg in the Hartz, are the variety *Aphrizite*. Rubellite occurs near Ekatherinenburg in Siberia; pale yellowish brown crystals are found in talc, at Windisch Kappell, in Carinthia; white specimens (*Achroite*) come from St. Gothard, Siberia and Elba. Rubellites of gigantic size occur in the Altai Mts., Siberia.

In the United States, magnificent red and green tourmalines have been found at Paris, Maine; some of the transparent crystals exceed an inch in diameter, and have a ruby-red color within, surrounded by green; or are red at one extremity and green at the other. Blue and pink varieties commonly imbedded in lepidolite, are still to be obtained at this place. Red and green tourmalines occur at Chesterfield, Mass., in a narrow vein of granite traversing gneiss along with albite, uranite, and pyrochlore. The crystals are commonly small and curved, nearly opaque, and exceedingly frangible. Green crystals often contain distinct prisms of red color, especially when they occur in smoky quartz. Blue tourmalines also occur at this locality. At Goshen, Mass., similar varieties occur, and the blue tourmaline is met with in greater perfection. Norwich, New Braintree, and Carlisle, Mass., afford good black tourmalines; also Alstead, Grafton, Acworth, and Saddleback Mt., N. H., and Streaked Mountain, Me; Brattleboro', Vt.; large brownish-black tourmalines are abundant in steatite at Orford, N. H. Green and black tourmalines are found with beryl and feldspar at Albany, Me. Perfect crystals of a dark brown color occur in mica-slate near Lane's Mine, Monroe, Conn. They are sometimes two inches in length and breadth. Haddam, Conn., affords interesting black crystals in mica slate with anthophyllite, in granite with iolite, and at the gneiss quarries. Near Gouverneur, N. Y., light and dark brown tourmalines, often in highly modified crystals, occur with apatite and scapolite in granular limestone; also at Canton; also in simple prisms in the same rock near Port Henry, Essex Co.; also at Schroon, with chondrodite and scapolite. Black crystals are obtained at the chrysoberyl locality near Saratoga, N. Y.; also at Alexandria, Jefferson Co. At Kingsbridge, N. Y., brown, yellowish or reddish-brown crystals occur in dolomite. Gray or bluish-gray and green varieties in three-sided prisms occur near Edenville. Short black crystals are found in the same vicinity, and at Rocky Hill, sometimes five inches in diameter. A mile southwest of Amity, yellow and cinnamon colored crystals occur with spinel in calc spar; also near the same village a clove-brown variety associated with hornblende and rutile in granular limestone. Franklin and Newton, N. J., also afford interesting black and brown tourmalines in limestone, associated with spinel. Good crystals occur in Pennsylvania at Newlin, Chester Co.; at London Grove and near Unionville, of a light yellow color in limestone, and rarely *white;* at Parksburg; Aston; at Chester, fine black; Leiperville, 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, of light brown to yellow and sometimes transparent crystals. Near New Hope on the Delaware, large black crystals occur, in which the prismatic faces are very short and sometimes almost obsolete. Occurs also in Cheowee valley, South Carolina; Habersham Co., Georgia.

AXINITE, *Karsten.* Thummerstein. Thumite. Yanolite.

Triclinic. Usual in thin oblique crystals with sharp edges. *P* : *r*=135° 10′; *P* : *u*=134° 40′; *u* : *r*=115° 30′; *r* : *s*=143° 20′; *u* : *s*=152° 5′; *P* : *l*=151° 5′. Cleavage indistinct and interrupted. 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; different colors, as cinnamon-brown, violet-blue, olive-green, seen in different directions. Streak uncolored. Transparent to subtranslucent. Fracture conchoidal. Brittle. Pyroelectric.



Composition.—$\dot{R}^3(\dddot{Si}, \dddot{B})^2+2\,\bar{\bar{R}}(\dddot{Si}, \dddot{B})$, Ramm. Analyses: 1, Klaproth, (Beit. ii, 118, v, 25); 2, Vauquelin, (J. d. Mines, xxiii, 6); 3, Hisinger, (Min. Schwed., 170); 4, Wiegmann, (Schw. J. xxxii, 462); 5—9, Rammelsberg, (Pogg. l, 368):

	$\dddot{Si}$	$\dddot{B}$	$\bar{\bar{Al}}$	$\bar{\bar{Fe}}$	$\bar{\bar{Mn}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	
1. Dauphiny,	50·50	——	16·00	9·50	5·25	17·00	——	0·25	=98·50, Klaproth.
2. "	44	——	18	14	4	19	——	——	=99, Vauquelin.
3. Wermland,	41·50	——	18·56	7·36	10·00	25·84	——	——	ign. 0·30=98·56, His.
4. Treseburg,	45·00	2·00	19·00	12·25	9·00	12·50	0·25	——	=100, Wiegmann.
5. Dauphiny,	43·68	5·61	15·63	9·45	3·05	20·67	1·70	0·64	=100·43, Ramm.
6. "	43·46	*und.*	16·30	10·25	2·74	19·90	1·55	*und.*	, Ramm.
7. "	*und.*	*und.*	17·17	9·31	2·94	20·00	1·94	0·11	, Ramm.
8. Treseburg,	43·74	——	15·66	11·94	1·37	18·90	1·77	——	$\dddot{B}$, $\dot{K}$ and loss 6·621, R.
9. Ural,	43·72	——	16·92	10·21	1·16	19·97	2·21	——	$\dddot{B}$, $\dot{K}$ and loss 5·810, 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 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.

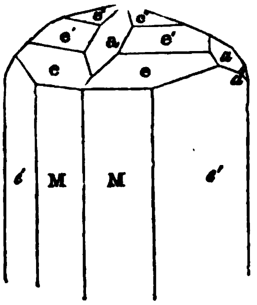
Axinite occurs in implanted glassy clove-brown crystals, at St. Cristophe near Bourg d'Oisans in Dauphiny, along with albite, prehnite, and quartz; at the silver mines of Kongsberg, in smaller crystals; with hornblende or magnetic iron ore in Normark in Sweden, and in rather complex crystals, of a dark 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*. Axinite has been found by Jackson 'at Phipsburg, Maine, associated 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.

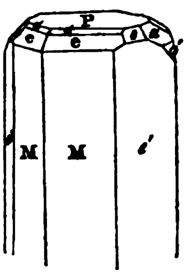
TOPAZ. Fluosilicate of Alumina, *Thom.* Physalite, Pyrophysalite, *Hisinger.* Schorlite. Schorlartiger Beril, *W.* Stangenstein. Alumine Fluatée Siliceuse, *H.*

Trimetric. M : M=124° 19′; M : e'=164° 24½′, e' : e'=86° 52′

1



2



Schneckenstein.

and 93° 8′, M : e=135° 27½′, (135° 59′, Levy), e : e=141° 7′, M : e′ =124° 7′, M : e″=116° 56′, e″ : e″=155° 37′. 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.

Composition.—2 $\bar{A}l\,F^3+5\,\dddot{\bar{A}l}\,\dddot{Si}$=Silica 35·27, alumina 54·92, fluorine 17·14, Forchhammer. Rammelsberg suggests that the fluorine replaces oxygen, and writes for topaz the simple formula, $\dddot{\bar{A}l}^3\,\dddot{Si}^2$, one-seventh of the oxygen being replaced by fluorine. This formula written out in full, and substituting O (oxygen), for the dots, that it may correspond with F (fluorine), becomes

$$6\,[3\,Al^2\,O^3+2\,Si\,O^3]+[3\,Al^2\,F^3+2\,Si\,F^3].$$

This view of the constitution is sustained by the near isomorphism of topaz with *andalusite*, (Am. J. Sci. [2], ix, 407), which last has the formula $\dddot{\bar{A}l}^3\,\dddot{Si}^2$.

Analyses: 1, Klaproth, (Beit. iv, 160); 2—4, Berzelius, (Schweig J. xvi, 423, Afhand. iv, 236); 5—7, Forchhammer, (J. f. pr. Ch. xxix, 195, xxx, 400):

	$\dddot{Si}$	$\dddot{\bar{A}l}$	HF	
1. Auerbach, Saxony,	35·	59·	5·=99, Klaproth.	
2. " "	34·24	57·45	7·75	(14·99)[a]= 99·44 (106·68), Berzelius.
3. Brazil, yellow,	34·01	58·38	7·79	(15·06)[a]=100·18 (107·45), "
4. Finbo, *pyrophysalite*,	34·36	57·74	7·77	(15·02)[a]= 99·87 (107·12), "
5. Brazil,	*undet.*	54·88		17·33, Forchhammer.
6. Monroe, Ct.,	35·39	55·96		17·35=108·70, Forchhammer.
7. Finbo, *pyrophysalite*,	35·66	55·16		17·79=108·61, "

[a] Corrected for later atomic weights.

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. Pyroelectric, (p. 137).

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 φυσάω, to blow. Minute crystals of 3 or 4 kinds, and 2 or 3 kinds of fluids have been detected by Sir David Brewster in crystals of topaz.

Topaz occurs in granite, with tourmaline, mica, and beryl, occasionally apatite, fluor spar, and tin; also in talcose rock, as in Brazil, with euclase, &c. 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 are brought from the Uralian and Altai mountains, Siberia, and from Kamschatka, where they occur of green and blue colors. In Brazil they are found of a deep yellow color, either in veins or nests in lithomarge, or in loose crystals or pebbles. Magnificent sky-blue crystals have been obtained in Cairngorum, Aberdeenshire; Jameson mentions a crystal from this locality, which weighed nineteen ounces. The tin mines of Schlackenwald, Zinnwald, and Ehrenfriedersdorf in Bohemia, afford smaller crystals. In the Mourne mountains small limpid crystals occur with beryl, albite, and mica, in drusy cavities in granite. Physalite occurs in crystals of great size, at Finbo, Sweden, in a granite quarry, and at Broddbo in a boulder. One crystal from this locality, at Stockholm, weighs eighty pounds.

Topaz occurs in the United States at Trumbull and 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, but are deficient in lustre, and nearly opaque. They are associated with magnetic pyrites, mica, and chlorophane; also rarely with wolfram and tungstate of lime.

Topaz is employed in jewelry, either of its natural yellow color or altered by heat. The variety 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.

PYCNITE.

Monoclinic, Forchhammer; trimetric, Hausmann. Massive. Structure compact columnar. Cleavage oblique transverse, according to Forchhammer; transverse like topaz, Hausmann, who denies that the oblique divisions are a result of cleavage.

H.=7·5. G.=3·49—3·54. Lustre vitreous. Color straw-yellow, or white with a shade of yellow or red. Translucent.

Composition.—According to Rammelsberg, $\bar{\text{A}}\text{l}\ \ddot{\bar{\text{S}}}\text{i}$, with one-seventh of the oxygen replaced by fluorine, and affording the detailed formula

$$6[Al^3O^3+Si\,O^3]+[Al^2F^3+Si\,F^3].$$

Analyses: 1, Berzelius, (Schw. J. xvi); 2, Bucholz, (Schw. J. i, 385); 3, Forchhammer, (J. f. pr. Ch. xxix, xxx):

		$\ddot{\bar{\text{S}}}\text{i}$	$\bar{\text{A}}\text{l}$	HF	(HF corrected)[a]
1.	Altenberg,	38·43	51·00	8·84	(17·09)=98·27 (106·52), Berzelius.
2.	"	35·0	48·0		16·5, $\dot{\text{C}}\text{a}$ 0·5=101·0, Bucholz.
3.	"	39·04	51·25		18·48=108·77, Forchhammer.

[a] Corrected for later atomic weight.

Forchhammer deduced for the species the formula 2 $Al^2F^3+\bar{\text{A}}\text{l}^4\ \ddot{\bar{\text{S}}}\text{i}^3$.

B.B. acts like topaz.

From the tin mines of Altenburg in Saxony, Schlackenwald and Zinnwald in Bohemia, associated with quartz and lithia mica.

HAUYNE FAMILY.

The species of the Haüyne Family are monometric in crystallization, and contain chlorine or sulphuric acid, along with silica. They are Sodalite, Haüyne, Lapis Lazuli, Nosean, Skolopsite, and Ittnerite.

SODALITE.

Monometric. In dodecahedrons; also figures 4 and 5, plate 1. Cleavage dodecahedral, more or less distinct, Also massive.

H.=5·5—6. G. 2·29, Vesuvius; 2·289, Ural; 2·37, Greenland. Lustre vitreous. Color brown, gray, green, and sometimes blue. Transparent—translucent. Fracture conchoidal—uneven.

Composition,—$\dot{\text{Na}}^3\,\dddot{\text{Si}}+3\bar{\ddot{\text{Al}}}\,\dddot{\text{Si}}+\text{Na Cl}$=Silica 37·60, alumina 31·37, soda 19·09, sodium 4·74, chlorine 7·20=100; or silica 37·60, alumina 31·37, soda 25·47, muriatic acid 7·41=101·83.

Analyses: 1, Ekeberg, (Thomson's Ann. Phil. i, 104); 2, Thomson, (Trans. Royal. Soc. Edinb. i, 390); 3, D. Borkowsky, (J. de Phys. lxxxiii, 428); 4. Arfvedson, (Jahresb. ii, 97); 5, Hofmann, (Pogg. xlvii, 377); 6, 7, Whitney, (Pogg. lxx, 431):

	$\dddot{\text{Si}}$	$\bar{\ddot{\text{Al}}}$	$\dot{\text{Na}}$	HCl	$\bar{\ddot{\text{Fe}}}$
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, $\dot{\text{Ca}}$ 2·70, ign. 2·10=98·30, T.
3. Vesuvius,	44·87	23·75	27·50ᵃ	3·76	0·12=100, Borkowsky.
4. "	33·75	35·50	26·23	5·30	——=100·78, Arfvedson.
5. Ilmen Mountains, *Cancrinite*, G. Rose,	38·40	32·04	24·47	7·30	—, $\dot{\text{Ca}}$ 0·32=102·53, Hofmann.
6. Litchfield, Me.,	37·30	32·88ᵃ	23·86,	Cl 6·97, $\dot{\text{K}}$ 0·59=101·60, Whitney.	
4. " "	37·63	30·93	25·48.	$\bar{\ddot{\text{Fe}}}$ 1·08, rest undetermined, Whitney.	

ᵃ With $\bar{\ddot{\text{Fe}}}$.

The sodalite from Greenland fuses with difficulty before the blowpipe. The sodalite of Vesuvius forms a colorless glassy globule. Gelatinizes with nitric acid.

Sodalite is met with in 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, Urals, of a blue color in granite with elæolite and feldspar. A blue variety occurs at Litchfield, Me., massive, with distinct cleavage, associated with elæolite, zircon, and cancrinite.

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.—Analyses: 1, Klaproth, (Beit. i, 189); 2, Gmelin, (Schw. J. xiv, 329); 3, Varrentrapp, (Pogg. xlix, 515):

	$\dddot{\text{Si}}$	$\dddot{\text{S}}$	$\bar{\ddot{\text{Al}}}$	$\bar{\ddot{\text{Fe}}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$
1.	46·0	4·0	14·5	3·0	17·5	——	2·0 $\ddot{\text{C}}$ 10·0=97·0, Klaproth.
2.	49·	2·	11·	4·	16·	8·	— $\dot{\text{Mg}}$ 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. Magnificent slabs are contained in some of the Italian cathedrals. It is also employed in the manufacture of mosaics; and when powdered constitutes the rich and durable paint called *Ultramarine*. An artificial ultramarine used in painting porcelain at Meissner contains, according to Varrentrapp,

$\dddot{\text{Si}}$ 45·604, $\dddot{\text{S}}$ 3·830, $\bar{\ddot{\text{Al}}}$ 23·304, $\dot{\text{Ca}}$ 0·021, $\dot{\text{Na}}$ 21·476, $\dot{\text{K}}$ 1·752, S 1·685, Fe 1·068, Cl *trace*=98·735.

This artificial ultramarine equals the native in brilliancy of color and permanency, and is now extensively used in the arts.

HAÜYNE. Auina, *Monticelli.* Berzeline, *Necker.* Marialite, *Ryllo.*

Monometric. In dodecahedrons. Cleavage sometimes distinct. Common in crystalline grains.

H.=5—5·5. G.=2·4—2·5. Lustre vitreous. Color bright blue, occasionally asparagus-green. Transparent. Fracture flat-conchoidal—uneven.

Composition.—$\dot{Na}^3\dddot{Si}+3\bar{\dddot{Al}}\dddot{Si}+2\dot{Ca}\dddot{S}$ (Whitney, Haüyne of Mt. Albano)=Silica 32·46, alumina 27·09, lime 9·88, soda 16·49, sulphuric acid 14·08. Analyses: 1, Gmelin, (Schw. J. xiv, 325, xv, 1); 2, Varrentrapp, (Pogg. xlix, 515); 3—5, J. D. Whitney, (Pogg. lxx, 481):

	$\dddot{Si}$	$\dddot{S}$	$\bar{\dddot{Al}}$	$\dot{Ca}$	$\dot{K}$	$\dot{Na}$
1. Marino,	35·48	12·39	18·87	12·00	15·45	—, $\bar{\dddot{Fe}}$ 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=100·76, Whitney.
4. "	34·83	12·13	28·51	7·23	—	18·57, $\bar{\dddot{Fe}}$ 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

$$\dot{Na}^3\dddot{Si}+3\bar{\dddot{Al}}\dddot{Si}+\dot{Na}\dddot{S},\ 2(\dot{Na}^3\dddot{Si}+3\bar{\dddot{Al}}\dddot{Si}+2\dot{Ca}\dddot{S}),$$

corresponding to a compound of 1 Nosean and 2 of the Albano Haüyne.

B.B. Haüyne decrepitates and fuses slowly to an opaque white mass. With borax effervesces and forms a glass which is yellow on cooling. Gelatinises with muriatic acid.

Haüyne occurs in the Vesuvian lavas; also in the vicinity of Rome, in basalt at Niedermendig, near Andernach on the Rhine, and in peperino at Albano and Marino.

NOSEAN. Nosin. Spinellane. Haüyne, *in part.*

Monometric, like Haüyne. Often granular massive.

H.=5·5. G.=2·25—2·3. Color grayish, bluish, brownish; sometimes black. Translucent to nearly opaque.

Composition.—$\dot{Na}^3\dddot{Si}+3\bar{\dddot{Al}}\dddot{Si}+\dot{Na}\dddot{S}$ (Whitney) =Silica 36·65, sulphuric acid 7·94, alumina 30·59, soda 24·82=100. Analyses: 1, Klaproth, (Beit. vi, 371); 2, 3, Bergmann, (Bullet. des Sci. 1828, iii, 406); 4, Varrentrapp, (Pogg. xlix, 515); 5, 6, J. D. Whitney, (Pogg. lxx, 481):

	$\dddot{Si}$	$\dddot{S}$	$\bar{\dddot{A}}$	$\dot{Ca}$	$\dot{Na}$
1. Lake Laach,	43·0	—	29·5	1·5	19·0, $\bar{\dddot{Fe}}$ 2·0, S 1·0, $\dot{H}$ 2·5=98·5, Klaproth.
2. "	38·50	8·16	29·25	1·14	16·56, $\dot{Fe}$ 1·50, $\bar{\dddot{Mn}}$ 1·00, HS 3·00=99·11, B.
3. "	37·00	11·56	27·50	8·14	12·24, $\dot{Fe}$ 1·15, $\bar{\dddot{Mn}}$ 0·50, HS 1·50=99·59, B.
4. "	35·99	9·17	32·57	1·12	17·84, Fe 0·04, Cl 0·65, $\dot{H}$ 1·85=99·22, Var.
5. "	36·52	7·66	29·54	1·09	23·12, $\bar{\dddot{Fe}}$ 0·44, Cl 0·61, ign. 1·37=100·34, W.
6. "	36·53	7·13	29·42	1·62	22·97, $\bar{\dddot{Fe}}$ 0·44 Cl 0·61, ign. 1·37=100·09, "

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 granular.

H.=5. G.=2·53. Color grayish-white, pale reddish gray. Translucent in thin splinters. Rather brittle. Fracture splintery.

Composition.—$3(\dot{\mathrm{Ca}}, \dot{\mathrm{Na}}, \dot{\mathrm{Mg}})^3\dddot{\mathrm{Si}}^2+3\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}+\dot{\mathrm{Na}}\dddot{\mathrm{S}}$. Analysis by Kobell, (loc. cit.):

$\dddot{\mathrm{Si}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}, \dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dddot{\mathrm{S}}$	
41·18	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.

This species is near Nosean.

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 $(\dot{\mathrm{Na}}, \dot{\mathrm{Ca}})^3\,\dddot{\mathrm{Si}}+3\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}+6\dot{\mathrm{H}}$, with some NaCl, and $\dot{\mathrm{Ca}}\dddot{\mathrm{S}}$. Analyses by Gmelin, (Schw. J. xxxvi, 74); and J. D. Whitney, (Pogg. lxx, 442):

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{S}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$
1.	34·02	2·86	28·40	7·27	12·15	1·56, $\dddot{\bar{\mathrm{Fe}}}$ 0·62, HCl 0·75, $\dot{\mathrm{H}}$ and HS 10·76=98·39, G.
2.	35 69	4·62	29·14	5·64	12·57	1·20, Cl 1·25, $\dot{\mathrm{H}}$ (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.

Found in the dolerite of the Kaiserstuhl near Freiberg; at Sasbach in basaltic dolerite; and at Endingen in phonolitic dolerite, with hornblende, pyrites, titanic iron, and apatite.

IV. COMBINATION OF ALUMINA WITH MAGNESIA.

SPINEL, *W.* Ceylanite. Pleonaste. Spinelle Ruby. Balas Ruby. Almandine Ruby. Rubicelle. Candite, *Bournon.* Zeilanit, *W.* Alumine Magnesiée or Spinelle, *H.* Automolite. Gahnite. Dysluite. Hercinite. Kreittonite. Chlorospinel. Sapphirine.

Monometric. In octahedrons and related forms, figs. 3, 7, 9, pl. 1, 3+9, 17, 21, and 3+9+17, besides other forms. Cleavage octahedral, though obtained with difficulty. Compound crystals, fig. 128, pl. 2; composition parallel with a face of the octahedron.

H.=8. G.=3·5—4·9; 3·523, Haid.; a red transparent variety; 3·575, a black variety, Ceylanite; 3·91—3·95, Hercinite; 4·1—4·6, Automolite; 4·55, Dysluite; 3·591—3·594, Chlorospinel; 4·49, Kreittonite. Lustre vitreous; splendent—nearly dull. Streak white. Color red of various shades, passing into blue, green, yellow, brown, and black; occasionally almost white. Transparent—nearly opaque. Fracture conchoidal.

Composition.—(Ṁg, Ḟe, Ċa, Żn, Ṁn) A̶l. Pure spinel, sometimes Ṁg A̶l=Magnesia 28·68, alumina 71·32; 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, Vauquelin, (Scheer. J. d. Chem. ii, 27); 2, 3, Abich, (Pogg. xxiii, 305); 4, Berzelius, (Gehl. N. J. d. Chem. vi, 304); 5, 6, Thomson, (Min. i, 214); 7, Laugier, (Mem. Mus. xii, 183); 8, Descotils, (J. d. M. v, 421); 9, C. Gmelin, (Jahresb. iv, 156); 10—13, Abich, (loc. cit.); 14, Abich, (K. V. Ac. H. 1842, 6); 15, Scheerer, (Pogg. lxv, 294); 16, 17, H. Rose, (Pogg. l, 652); 18, Ekeberg, (Gehlen's N. J. v, 418); 19, 20, Abich, (loc. cit.); 21, Thomson, (Min. i, 221); 22, Kobell, (J. f. pr. Ch. xliv, 99); 23, Zippe, (Ann. d. Ch. u. Pharm. lv, 357); 23, Stromeyer, (Untersuch. i, 391); 24, Zippe:

I. *Containing Magnesia, Lime or Iron.*

	A̶l	Ṁg	Ċa	Ḟe	
1. Ceylon, *red*,	86·00	8·50	——	——	C̈r 5·25=99·75, Vauq.
2. " "	69·01	26·21	——	0·71	C̈r 1·10, S⃛i 2·02=99·05, Ab.
3. Aker, *blue*,	68·94	25·72	——	3·49	S⃛i 2·25=100·47, Abich.
4. " "	72·25	14·63	——	4·26	" 5·43=96·62, B. and H.
5. Franklin, N. J., *green*,	73·31	13·63	7·42	——	" 5·62=99·98, Thomson.
6. Amity, N. Y.	61·79	17·87	10·56	——	ĊaC̈ 2·80, Ḣ 0·98=99·60, T.
7. Ceylon, *Ceylanite*,	65·0	13·0	2·0	——	F̶e 16·5, S⃛i 2·0=98·5, Laug.
8. " "	68·	12·	——	——	" 16·0, " 2=98, Descotils.
9. " "	57·20	18·24	——	20·51	S⃛i 3·15=99·11, Gmelin.
10. Ural, *Pleonaste*,	65·27	17·58	——	13·97	" 2·50=99·32, Abich.
11. Monzoni, "	66·89	23·61	——	8·07	" 1·23=99·80, Abich.
12. Vesuvius, "	67·46	25·94	——	5·06	" 2·38=100·84, Abich.
13. Iserwiese, "	59·66	17·70	——	19·29	" 1·79=99·17, Abich.
14. Vesuvius,	62·84	24·87	——	3·87	F̶e 6·15, S⃛i 1·33=99·56, A.
15. Arendal,	55·17	17·65	——	18·33	S⃛i 5·09, Ṁn 2·71=98·95, S.
16. Ural, *Chlorospinel*,	64·13	26·77	0·27	——	F̶e 8·70, Ċu 0·27=100·14, R.
17. " "	57·34	27·49	——	——	" 14·77, " 0·62=100·22, R.

II. *Containing Oxyd of Zinc.*

18. Fahlun, *Automolite*, 60·00 ——, Ṁn *trace*, Żn 24·25, S⃛i 4·75, F̶e 9·25=98·25, E.
19. " " 55·14 5·25, " *trace*, " 30·02, " 3·84, " 5·85=100·10, A.
20. North America, 57·09 2·22, " *trace*, " 34·80, " 1·22, Ḟe 4·55=99·38, A.
21. Sterling, N. J. *Dysluite*, 30·49 ——, " 7·60, " 16·80, " 2·97, Ḣ 0·40, F̶e 41·93=100·19, Thomson.
22. Bodenmais, *Kreittonite*, 44·66 8·05, Ċa 1·30, " 24·00, F̶e 16·68, insol. 10=99·64, Kobell.

III. *Sapphirine, Hercinite.*

23. Greenland, *Sapphirine*, 63·106 16·85, Ċa 0·38, Ḟe 3·92, Ṁn 0·53, ign. 0·49, S⃛i 14·5=99·78, Str.
24. Bohemia, *Hercinite*, 61·17 2·92, Ḟe 35·67=99·76, Zippe.

Automolite (or gahnite) is a zinc-spinel=ŻnA̶l; color dark-green or black. *Hercinite* is an iron spinel=ḞeA̶l. *Ceylanite* (or pleonaste) is an iron and magnesia spinel=(Ṁg, Ḟe)A̶l. *Dysluite* is a zinc, manganese, and iron spinel; color yellowish-brown or grayish-brown; (Żn, Ṁn) (A̶l, F̶e). *Sapphirine* is referred to spinel by Kobell; color pale blue; G.=3·428; translucent. See description farther, page 320. *Chlorospinel* (G. Rose) is a grass-green spinel from Slatoust; Ṁg(A̶l,F̶e). For the Kreittonite, a black spinel, Kobell writes the formula ŻnA̶l+ḞeF̶e, or (Żn, Ḟe) (A̶l, F̶e), and corrects the analysis as regards the iron as follows:

A̶l 49·73, F̶e 8·70, Żn 26·72, Ḟe 8·04, Ṁg 3·41, Ṁn 1·45=98·05.

B.B. alone infusible; the red varieties change to brown, and even black and opaque, as the temperature increases, and on cooling become first green, and then nearly colorless, and at last resume their red color. Fuses with difficulty with borax, but somewhat more readily with salt of phosphorus. The black varieties yield a deep green globule, owing to the large amount of iron they contain. The zinc varieties afford with soda oxyd of zinc.

The specimens of this species have been denominated, according to their colors, as follows: the name *pleonaste* has been applied to the black varieties; *spinelle ruby* to the scarlet; *balas ruby* to the rose red; *rubicelle* to the yellow or orange-red; and *almandine ruby* to the violet colored. The *oriental ruby* belongs to the species 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, Siam, and other eastern countries, it occurs, of beautiful colors, in rolled pebbles in the channels of rivers. The pleonaste variety is found at Candy, in Ceylon, and hence was called *Candite*, by Bournon. At Aker, in Sudermannland, Sweden, it is found of a pale-blue and pearl-gray color, in primitive limestone. Small black crystals of splendent lustre occur at Vesuvius, in the ancient scoria of Mount Somma, associated with mica and idocrase; also imbedded in compact gehlenite, at Monzoni, in the Fassathal.

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 found sixteen 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. They occur of various shades of green, black, brown, and less commonly red, along with chondrodite, and other minerals. A mile southwest of Amity, on J. Layton's farm, is one of the most remarkable localities; 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. 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; Bryan, red, brown, green, and black colors, along with chondrodite. At Sterling, Sparta, 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 pink and reddish-brown in Gouverneur, two miles north 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 spinel occurs in Burgess, Canada.

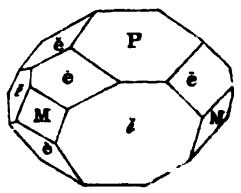
The *automolite* occurs in talcose slate near Fahlun and elsewhere in Sweden. The *dysluite* is from Sterling, N. J., along with franklinite and troostite. *Kreittonite* is from Bodenmais; and *chlorospinel* from Slatoust.

The fine colored spinels, when of large size, are highly esteemed as gems.

NOTE. The minerals *franklinite*, *magnetic iron*, and *chromic iron* belong to the spinel series, each being composed of equal parts of protoxyds and peroxyds.

Franklinite=$(\dot{\mathrm{Zn}}, \dot{\mathrm{Fe}}), (\bar{\mathrm{Mn}}, \bar{\mathrm{Fe}})$.
Magnetic iron=$\dot{\mathrm{Fe}}\ \bar{\mathrm{Fe}}$.
Chromic iron=$(\dot{\mathrm{Fe}}, \dot{\mathrm{Mg}})\ (\bar{\mathrm{Cr}}, \bar{\mathrm{Al}})$.
These species are described under Iron.

TURNERITE, *Levy*, Ann. of Phil. xviii, 241.



Monoclinic. M : M=96° 10′, P : M=99° 40′; M : $\bar{e}$=138° 5′, M : $\breve{e}$=131° 55′. 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.

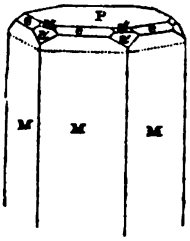
Accompanies quartz, albite, feldspar, crichtonite, and anatase, at Mount Sorel in Dauphiné. It was distinguished by Levy, and named in honor of Mr. Turner, in whose collection it was first found.

V. COMPOUNDS OF GLUCINA.

BERYL. Emerald. Aquamarine. Smaragd. Emeraude, *H.* Davidsonite, *Richardson.*

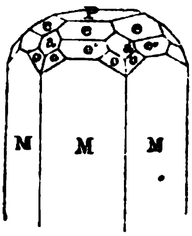
Hexagonal. Figure 125, pl. 2, and the annexed. M : e=119°

1



Haddam, Ct.

2



Siberia.

53′, P : e=150° 6′, M : e″=139° 1′, P : e″=130° 59′. Cleavage basal; lateral, indistinct. Occasionally coarse columnar and large granular.

H.=7·5—8. G.=2·732, Haidinger, emerald; 2·678, apple-green. Lustre vitreous; sometimes resinous. Streak white. Color pale green, emerald-green, passing into light-blue, impure yellow, and white. Transparent—subtranslucent. Fracture conchoidal, uneven. Brittle.

Composition.—$\dot{\mathrm{B}}\mathrm{e}^3\overline{\mathrm{Si}}^2+\not{\mathrm{A}}\mathrm{l}\overline{\mathrm{Si}}^2$=Silica 67·41, alumina 18·75, glucina 13·84=100. Analyses: 1, Klaproth, (Beit. i, 9); 2, Du Menil, (Schw. J. xxxix, 487); 2, Berzelius, (Schw. J. xvi, 265, 277); 4, 5, C. Gmelin, (Pogg. l, 180); 6, Klaproth, (Beit. iii, 215); 7, 8, Moberg, (Acta Soc. Sci. Fenn. ii, 71); 9, Schlieper, (Ramm. 2d Supp. 24):

	$\overline{\mathrm{Si}}$	$\not{\mathrm{A}}\mathrm{l}$	$\not{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{B}}\mathrm{e}$
1. Siberia, *Beryl,*	66·45	16·75	0·60	15·50=99·30, Klaproth.
2. " "	67·00	16·50	1·00	14·50, $\dot{\mathrm{C}}\mathrm{a}$ 0·50=99·50, Du Menil.
3. Broddbo, "	68·35	17·60	0·72	13·13, $\overline{\mathrm{T}}\mathrm{a}$ 0·72=100·52, Berzelius.
4. " "	69·70	16·83	0·24	13·39=100·16, Gmelin.
5. Limoges, "	67·54	17·68	—	13·51=98·68, "
6. *Emerald,*	68·50	15·75	1·00	12·50 $\not{\mathrm{C}}\mathrm{r}$ 0·30, $\dot{\mathrm{C}}\mathrm{a}$ 0·25=98·30, Klaproth.
7. " Finland,	67·359	16·465	1·497	12·747, $\overline{\mathrm{T}}\mathrm{a}$ 0·280=98·348, Moberg.
8. " "	66·615	16·514	3·026	12·749, $\overline{\mathrm{T}}\mathrm{a}$ 0·102=99·006, "
9. " S. Amer.	69·51	14·49	—	15·41, $\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{C}}\mathrm{a}$ 1·64=101·05, Schlieper.

The old atomic weight of glucina, 962, gives the formula $\not{\mathrm{B}}\mathrm{e}\overline{\mathrm{Si}}^4+2\not{\mathrm{A}}\mathrm{l}\overline{\mathrm{Si}}^2$; and 474·24 gives $(\frac{1}{2}\not{\mathrm{B}}\mathrm{e}+\frac{1}{2}\not{\mathrm{A}}\mathrm{l})\overline{\mathrm{Si}}^2$, or $(\not{\mathrm{B}}\mathrm{e}, \not{\mathrm{A}}\mathrm{l})\overline{\mathrm{Si}}^2$.

B.B. alone unchanged or becomes clouded; at a high temperature the edges are rounded, and ultimately a vesiccular 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. They were first united in one species by Wallerius. The finest emeralds are found in a vein of dolomite, which traverses a hornblende rock at Muso, near Santa Fé de Bogota, in Grenada. A perfect hexagonal crystal from this locality, two inches long and about an inch in diameter, is in the cabinet of the Duke of Devonshire. It weighs 8 oz. 18 dwts., and though containing numerous flaws, and therefore but partially fit for jewelry, has been valued at 150 guineas. 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 larger, occur in Siberia. One specimen in the Royal collection measures 14¾ inches long and 12 broad, and weighs 16⅝ pounds troy; another is 7 inches long and 4 broad, and weighs 6 pounds troy. Mount Zalóra, 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.

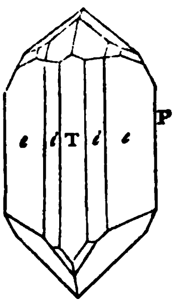
Pliny speaks of the finest beryls as those "qui viriditatem puri maris imitantur,"—*green like the sea*,—and crystals of clear shades of sky-blue, or mountain-green, are hence termed *aquamarine*. This variety is found in Siberia, Hindostan, and Brazil. In Siberia they occur in the granite district of Nertschinsk, and in the Uralian and Altai ranges of Siberia. They have been obtained exceeding a foot in length; they are commonly very deeply 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 18¾ pounds. The specimen is perfectly transparent, and without a flaw; its color is a fine pale bottle-green. 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; Bodenmais and Rabenstein in Bavaria, tin mines of Schlackenwald, and elsewhere.

Beryls of gigantic dimensions have been found in the United States, at Acworth, N. H., and Royalston, Mass. One hexagonal prism from the former locality weighed 240 pounds, and measured four feet in length, with the lateral faces 5½ inches across; its color was bluish-green, except a foot at one extremity, which was dull green and yellow. Other crystals have a honey or wax-yellow color. At Royalston, one crystal has been obtained exceeding a foot in length. The smaller prisms are often limpid, and a variety of a yellowish color forms a gem resembling chrysolite; the colors are mostly aquamarine, grass-green, and yellowish-green. The 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. 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.; in interesting crystals, with modified terminations, (fig. 1), 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 fig. 1; 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, (fig. 30, p. 81). Crystals, sometimes ten or twelve inches in length, and an inch and a half in diameter, occur with black tourmalines at Leiperville and Chester, Pennsylvania, Delaware Co.; also less interesting at Mineral Hill.

The emerald is supposed to derive its color from the presence of a minute quantity of oxyd of chrome, and beryl from oxyd of iron. This species affords some of the most splendid ornaments to the cabinet of the mineralogist. The emerald is among the richest of gems.

The *Goshenite* of Shepard, (Shepard's Min. 2d ed., 143), is beryl from Goshen, Mass. It was previously described by Shepard as phenacite.

EUCLASE, *H.* Euklas, *W.*



Monoclinic. M : T=108° 53′; *e* : *e* (over T)=114° 50′; T : *e*=147° 25′, Levy. Cleavage highly perfect parallel to P; less distinct parallel with M and T.

H.=7·5. G.=2·907, Lowry; 3·098, Haidinger. Lustre vitreous. Color pale mountain-green, passing into blue and white; streak uncolored. Transparent; occasionally subtransparent. Fracture conchoidal. Very brittle and fragile.

Composition.—$2\dot{\text{B}}\text{e}^{2}\dddot{\text{S}}\text{i}+\bar{\text{A}}\text{l}^{2}\dddot{\text{S}}\text{i}$=Silica 43·68, alumina 32·40, glucina 23·92=100. Analysis by Berzelius, (Schw. J. xxvii, 73):

$\dddot{\text{S}}\text{i}$ 43·22, $\bar{\text{A}}\text{l}$ 30·56, $\bar{\text{F}}\text{e}$ 2·22, $\dot{\text{B}}\text{e}$ 21·78, $\ddot{\text{S}}\text{n}$ 0·70=98·48.

B.B. strongly heated intumesces and becomes white, throws out points, and melts to a white enamel, if the temperature is still farther increased. Dissolves with borax with effervescence to a clear glass. A silica skeleton with salt of phosphorus. Becomes electric by friction, and when once excited, retains this property for several hours.

Euclase was first brought from Peru; but the specimens were probably from Brazil, where it has since been obtained in the mining district of Villa Rica. It occurs in chlorite slate resting on sandstone. Scacchi suggests a relation between this species and epidote.

Euclase generally possesses an agreeable and uniform color, and will receive a high polish; but it is useless as an ornamental stone, on account of its brittleness. This property led Haüy to give it the name it bears, from *εὖ*, *easily*, and *κλάω*, *to break*.

PHENACITE. Phenakit, *Nordenskiöld*, K. V. Ac. H. 1833, p. 160, and Pogg. xxxi, 57.

Rhombohedral. R : R=115° 25′, Nordenskiöld, figs. 109, 111, and 119, pl. 2; also the three combined; also in six-sided prisms terminated by hexagonal pyramids, more or less modified; P : e=147° 43½′. Crystals often compound in the direction of the axis. Cleavage rhombohedral.

H.=8. G.=2·969. Lustre vitreous. Colorless; also, bright wine-yellow, inclining to red. Transparent—opaque. Fracture similar to that of quartz.

Composition.—$\dot{\text{B}}\text{e}^{2}\dddot{\text{S}}\text{i}$=Silica 54·90, glucina 45·10=100. Analyses: 1, Hartwall, (Pogg. xxxi, 57); 2, Bischof, (Pogg. xxxiv, 525):

1. Ural, $\dddot{\text{S}}\text{i}$ 55·14 $\dot{\text{B}}\text{e}$ 44·47 $\bar{\text{A}}\text{l}$ and $\dot{\text{M}}\text{g}$ *trace*=99·61, Hartwall.
2. Framont, 54·400 45·567 $\dot{\text{C}}\text{a}$ and $\dot{\text{M}}\text{g}$ 0·096=100·063, Bischof.

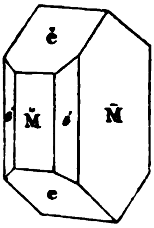
B.B. alone remains unaltered; with borax fuses with extreme slowness, unless pulverized, to a transparent glass. With soda affords a white enamel; adding more, intumesces and becomes infusible. Not blue with cobalt solution.

Occurs with emerald in mica slate, in Perm, 85 wersts from Katherinenburg, in the Ilmen mountains, Urals, with topaz and green feldspar; also in highly modified crystals, accompanied by quartz, in the brown iron ore of Framont. It was named from *φέναξ*, *a deceiver*, in allusion to its having been mistaken for quartz.

CHRYSOBERYL. Cymophane, *H.* Krisoberil, *W.* Alexandrite.

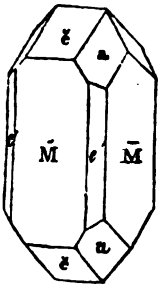
Trimetric. $\breve{M} : \breve{e} = 120° \; 7'$, $\breve{e} : \breve{e}$ (adjacent planes)$=119° \; 46'$,

1



Greenfield, N. Y.

2

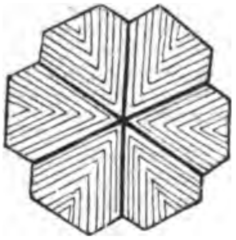


Siberia.

3

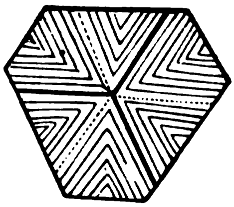
Haddam.

4



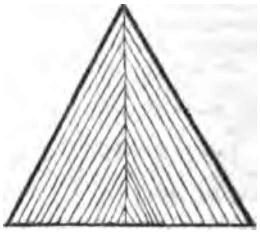
Greenfield, N. Y.

5



Greenfield, N. Y.

6



Greenfield, N. Y.

$\breve{M} : e' \; 125° \; 20'$, a : a$=139° \; 53'$ and $85° \; 50'$, a : $\breve{e}=132° \; 55'$. Cleavage parallel to $\breve{M}$; less distinct parallel to $\bar{M}$. Compound crystals: figs. 3, 4, 5, 6.

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.—$\dot{B}e\ddot{\bar{A}}l$=Alumina 80·25, glucina 19·75=100. $\dot{B}e\ddot{\bar{A}}l^3$, with glucina 474·24, as adopted in Berzelius's late tables. Analyses: 1, Bergemann, (de Chrysob. Diss. Götting. 1826); 2, Thomson, (Min. i, 400); 3, 4, 5, Awdejew, (Pogg. lvi, 118); 6, 7, 8, Damour, (Ann. Ch. Phys. [3], vii, 173); 9, Seybert, (Am. J. Sci. viii, 105, and Trans. Am. Phil. Soc. Philad. ii, 116):

	$\ddot{\bar{A}}l$	$\dot{B}e$	$\dot{F}e$
1.	71·010	16·005	3·472, $\ddot{T}i$ 2·820, $\dddot{S}i$ 5·130, ign. 0·522=98·959, Berg.
2. Brazil,	76·752	17·791	4·494, ign. 0·480=99·517, Thomson.
3. "	78·10	17·94	4·47=100·51, Awdejew; G. 3·7337.
4. "	78·71	18·06	3·47=100·24, "
5. Ural,	78·92	18·02	3·12, $\ddot{\bar{C}}r$ 0·36, $\dot{C}u$ and $\dot{P}b$ 0·29=100·71, Awdejew.
6. Haddam, Ct.,	76·02	18·41	—, $\ddot{\bar{F}}e$ 4·51, quartz 0·49=99·43, Damour.
7. "	74·34	19·03	—, " 3·53, " 2·91=99·81, "
[illegible] "	75·43	17·93	—, " 4·06, " 0·96=98·38, "
"	73·6	15·8	3·4, $\ddot{T}i$ 1·0, $\dddot{S}i$ 4·0, ign. 0·4=98·2, Seybert.

B.B. alone unaltered; with soda, the surface is merely rendered dull. With borax, or salt of phosphorus, fuses with great difficulty.

Chrysoberyl occurs in Brazil, and also Ceylon, in rolled pebbles, in the alluvial deposits of rivers; also in the Ural 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 and to bear the same relation to common chrysoberyl that the emerald does to beryl. At Haddam, Ct., it occurs in granite traversing gneiss, and is associated with tourmaline, garnet, beryl, automolite, and columbite. It is found also in the same rock at Greenfield, near Saratoga, N. Y., accompanied by tourmaline, garnet, and apatite, and interesting figures of crystals have been given by Beck, in his Report on the Mineralogy of New-York, (p. 376), from which the last three of the above are copied.

When transparent and free from flaws, and of sufficient size, chrysoberyl is cut with facets, and forms a beautiful yellowish-green gem. If opalescent, it is usually cut *en cabochon*.

Chrysoberyl was so named from *χρυσος, golden, βηρυλλος, beryl.* This name was employed by the ancients for a different mineral, which possibly was chrysoprase. The name *Cymophane*, from *κῦμα, wave, φαινω, to appear,* alludes to a peculiar opalescence it sometimes exhibits.

LEUCOPHANE, *Esmark*, Berz. Jahresbericht, xx and xxi. Leucofanite.

Triclinic? Cleavage imperfect in three directions. Usually massive and columnar.

H.=3·5—3·75. G.=2·974. Lustre vitreous on a cleavage surface. Powder white. Color pale dirty green to deep wine-yellow. Thin fragments transparent and colorless. Powder phosphorescent. Electric when heated.

Composition.—$\mathrm{NaF}+\dot{\mathrm{C}}\mathrm{a}^{3}\dddot{\mathrm{Si}}^{2}+\dot{\mathrm{B}}\mathrm{e}^{3}\dddot{\mathrm{Si}}$=Silica 45·59, lime 28·11, glucina 12·48, sodium 7·66, fluorine 6·16. Analysis by Erdmann, (K. V. Ac. H. f. 1840):

$\dddot{\mathrm{Si}}$ 47·82, $\dot{\mathrm{C}}\mathrm{a}$ 25·00, $\dot{\mathrm{B}}\mathrm{e}$ 11·51, $\dot{\mathrm{M}}\mathrm{n}$ 1·01, Na 7·59, K 0·26, F 6·17=99·86.

B.B. fuses to a clear violet glass, which becomes clouded on cooling. With borax it 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 *φαινω, to appear.*

HELVIN, *W.* Tetrahedral Garnet.

Monometric, tetrahedral, figs. 30 and 32, pl. 1. 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.—$3(\dot{\mathrm{M}}\mathrm{n}, \dot{\mathrm{B}}\mathrm{e}, \dot{\mathrm{F}}\mathrm{e})^{2}\dddot{\mathrm{Si}}+\dot{\mathrm{M}}\mathrm{n}\acute{\mathrm{M}}\mathrm{n}$; or, with the old atomic weight of glucina, $(\bar{\mathrm{B}}\mathrm{e}, \bar{\mathrm{F}}\mathrm{e})^{2}\dddot{\mathrm{Si}}^{3}+3\dot{\mathrm{M}}\mathrm{n}^{2}\dddot{\mathrm{Si}}+3\mathrm{MnS}$=Silica 35·63, glucina 9·90, peroxyd of iron 10·06, protoxyd of manganese 27·53, sulphuret of manganese 16·88.

Analyses by Gmelin, (Pogg. iii, 53):

$\dddot{\mathrm{Si}}$ 33·26, $\dot{\mathrm{B}}\mathrm{e}$ and some $\bar{\mathrm{A}}\mathrm{l}$ 12·03, $\dot{\mathrm{M}}\mathrm{n}$ 31·82, $\acute{\mathrm{M}}\mathrm{n}$ 14·00, $\dot{\mathrm{F}}\mathrm{e}$ 5·56, ign. 1·16=97·82.

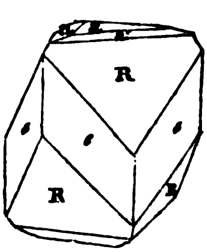
" 35·27, " 8·026, " 1·45, " 29·34, " 14·00, " 7·99, " 1·16=97·27.

B.B. on charcoal fuses with intumescence in the reducing flame, to a yellow opaque globule. With borax gives the reaction of manganese.

Occurs in gneiss at Schwarzenberg in Saxony, associated with garnet, quartz, fluor, and calc spar; at Breitenbrunn, Saxony; also at Hortebulle, near Modum, in Norway. It was named by Werner in allusion to its yellow color, from ἥλιος, *the sun.*

VI. SILICATES OF ZIRCONIA, OF YTTRIA, AND OF OXYDS OF CERIUM AND THORIUM.*

EUDIALYTE, *Stromeyer.* Eudyalite, *improper orthography.*



Rhombohedral; R : R=73° 40′, and 106° 20′, Levy; 73° 30′, and 106° 30′, Miller; R : *e*=143° 10′, R : a=112° 33′, R : a′=143° 44′, a : *e* =90°. Miller obtained for another crystal having three additional planes, e, *a*′, and *a*, a : a′=148° 38′, a : R=112° 18′, a : e=129° 22′, a : *a*′=101° 35′, a : *a*=90°, *a*′ : *a*′=126° 25′. Cleavage parallel with a, very perfect. Occurs 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.—$2\dot{R}^3\bar{Si}^2+\bar{Zr}\bar{Si}^3$, Ramm. Analyses: 1, Pfaff, (Schw. J. xxix, 1); 2, 3, Stromeyer, (Gilb. Ann. lxiii, 379); 4, Rammelsberg, (Pogg. lxiii, 142):

	$\bar{Si}$	$\bar{Zr}$	$\bar{Fe}$	$\bar{Mn}$	$\dot{Ca}$	$\dot{Na}$	
1.	54·10	11·58	7·86	2·93	10·80	11·40,	HCl 0·30, $\dot{H}$ 1·66, $\dot{Cu}$ 0·92=101·55, Pfaff.
2.	53·33	11·10	6·75	2·06	9·78	13·82,	HCl 1·03, $\dot{H}$ 1·80=99·68, Stromeyer.
3.	52·48	10·90	6·86	2·57	10·14	13·92,	HCl 1·03, $\dot{H}$ 1·80=99·71, "

Rammelsberg makes the iron and manganese protoxyd, and thus gives

	$\bar{Si}$	$\bar{Zr}$	$\dot{Fe}$	$\dot{Mn}$	$\dot{Ca}$	$\dot{Na}$	
3, bis.	52·43	10·89	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,	$\dot{K}$ 0·65, Cl 1·19, ign. 0·37=100·52, R.

Pfaff supposed his silica to include a new earth, which he called *tantaline.*

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.

The only known locality is at Kangerdluarsuk, in West Greenland, where it is either associated with hornblende and sodalite, or imbedded in compact white feldspar. The crystals are usually small, but sometimes occur an inch or more in length. The name alludes to its easy solubility in acids, from εὖ, *easily,* and διαλύω, *to dissolve.*

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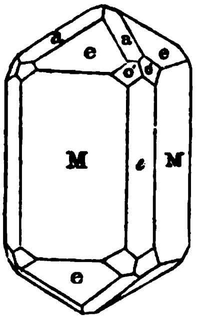
[*] The silicates of oxyd of cerium, yttrium, and zirconium, are related chemically to the silicates of alumina and other bases already described, and one prominent species, allanite, (including orthite), has been inserted on page 354, near epidote, which it resembles in crystallization. The other species are retained together, and are here described. A further study of them may bring out other cases of intimate affiliation with preceding species, which will require a distribution accordingly.

ZIRCON, *W.* Hyacinth. Jargon. Zirconite. Silicate of Zirconia.

Dimetric. M : *e*=135°, M : e=132° 10′, e : e=123° 19′, M : e′ 159° 47′, o′ : o′=132° 43′, 147° 3′, a : *e*=122° 39′, a : e=151° 39′.

1



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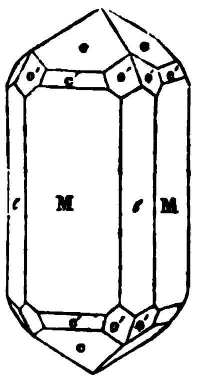

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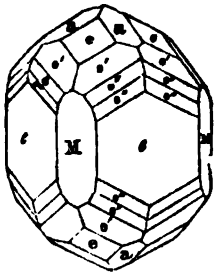


Cleavage lateral; also less distinct parallel to e. Also in irregular forms and grains.

H.=7·5. G.=4·5—4·75; 4·505, Haidinger; 4·681, Thomson; 4·721, Lowry. Lustre more or less perfectly adamantine. Color red, brown, yellow, gray, white. Streak uncolored. Transparent —subtranslucent. Fracture conchoidal, and brilliant.

Composition.—$\bar{Z}r\dddot{S}i$=Silica 33·61, zirconia 66·39=100. Analyses: 1, Klaproth, (Beit. iii, 266); 2, Berzelius, (K. V. Ac. H. 1824); 3, Vanuxem, (J. Acad. Sc. Philad. iii, 59); 4, W. Gibbs, (Pogg. lxxi, 559); 5, Henneberg, (J. f. pr. Chem. xxxviii, 508):

	$\dddot{S}i$	$\bar{Z}r$	$\bar{F}e$	
1. Fredericksvärn,	33·	65·	1·	=99, Klaproth.
2. Expailly,	33·49	67·16	—	=100·64, Berzelius.
3. N. Carolina; G.=4·458,	32·08	67·07	—	=99·15, Vanuxem.
4. Litchfield, Me. G.=4·7,	35·26	63·33	0·79	undecomp. 0·39=99·74, Gibbs.
5. G.=4·615—4·71,	33·85	64·81	1·55	$\dot{C}a$ 0·88=101·09, Henneberg.

Not acted on by the acids, excepting 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 those individuals which present bright colors, considerable transparency, and smooth and shining surfaces. *Zirconite* presents grayish or brownish tints, and is 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, occasionally in volcanic tufa in Auvergne, and at Vesuvius. Splendid specimens occur in Greenland, and in the zircon-syenite of Fredericksvärn in Norway; in the Ilmen mountains, Ural; in the iron mines of Arendal, and at many places in Europe; occurs also in Scotland, at Scalpay in Harris, and in the granite of Criffel in Kirkcudbrightshire.

In Buncombe Co., N. C., on the road from the Saluda Gap to Ashville, upon the first elevation after passing Green river, crystals of zircon are found loose in the soil, and sometimes attached to feldspar and quartz; also in the sands of the gold washings of McDowall Co., N. C., the crystals terminating in eight-sided pyramids, (o′) and small planes e at summit. In New York, zircon occurs of a cinnamon-red color at Hall's mine in Moriah, Essex Co., in a vein of quartz running through the ore; near the outlet of Two Ponds, Orange Co., it is associated with scapolite, pyroxene, and sphene, in crystals sometimes an inch in length; on Deer Hill, a mile southeast of Canterbury, in the same Co., crystals are abundant; they have a deep brownish-red or black color, and occasionally are an inch and a half in length; chocolate-brown crystals are obtained in Warwick, at the southern base of Mount Eve, in limestone and scapolite; near Amity, and also in Monroe and Cornwall, are several localities of zircons, presenting white, reddish-brown, clove-brown, and black colors; at Diana in Lewis Co., in large brown crystals sometimes two inches 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 an inch and a half long, and half an inch wide, and they sometimes contain, according to Beck, a nucleus of carbonate of lime. Crystals are found also at Rossie; also at Johnsburg, in Warren Co. In New Jersey at Franklin, and in gneiss at Trenton; at Middlebury, Vt.; at Litchfield, Me.; in talcose slate at Easton, Pa.

Hyacinth occurs of sufficient dimensions to be valuable as a gem.

It is very doubtful whether the modern hyacinth is one of the number of 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, *Breithaupt*, New Phil. Jour. iv, 186, 1827–8.

Trimetric; M : M=96° and 84°. Common form, a rhombic prism with the lateral edges slightly truncated, and the basal edges deeply replaced; e : e=128° 14′, and 133° 42′. Cleavage parallel with ĕ, (shorter diagonal), scarcely perceptible.

H.=6—6·5. G.=4·32—4·4. Lustre vitreous. Color clove-brown, sometimes with smoky-gray spots. Streak lighter than the color, grayish or white. Very brittle.

B.B. infusible, but the color becomes paler. With borax melts with difficulty to a transparent glass. Insoluble in nitric acid.

This mineral occurs in Norway, and it is supposed in the zircon-syenite of Fredericksvärn. The specimens examined were part of the collection of Chev. Heyer of Dresden; they are about an inch in length. It resembles zircon, but differs in crystallization.

This species was named by Breithaupt after the goddess Ostra.

MALACONE—Malakon, *Scheerer*, Pogg. lxii, 436. Hydro-silicate of Zirconia, *Damour*, Ann. Ph. Chem. 3d Ser., xxiv, 87; *Descloizeaux*, ib. p. 94.

Dimetric, and near zircon. Crystals square octahedrons, with basal angles replaced; pyramidal edge (e : e) 124° 40′, Descloizeaux, 124° 57′, Scheerer.

H.=6·5. G.=3·9—4·047. Lustre vitreous, subresinous. Color brown, internally bluish-white; powder reddish-brown, or uncolored.

Composition.—$2\bar{Z}r\dddot{S}i+\dot{H}$. Analyses: 1, Scheerer, (loc. cit.); 2, 3, Damour, (loc. cit.):

	$\dddot{S}i$	$\bar{Z}r$	$\bar{F}e$	$\dot{Y}$	$\dot{C}a$	$\dot{M}g$	$\dot{H}$
1. Hitteroe,	31·31	63·40	0·41	0·34	0·39	0·11	3·03=98·99, Scheerer.
2. Chanteloube,	31·23	61·70	2·91	—	*trace*	—	3·29, $\bar{M}n$ *trace*=99·13, Damour.
3. "	30·87	61·17	3·67	—	0·08	—	3·09, $\bar{M}n$ 0·14=99·02, "

In a matrass yields water. B.B. infusible. Dissolves in borax slowly, and not in salt of phosphorus. In fine powder attacked by boiling concentrated sulphuric acid.

From Hitteroe, Norway; also from near Chanteloube, (Haute Vienne), along with a tantaliferous mineral, occurring in thin plates rarely over 3 to 4 millimeters thick, and occasionally with crystals on their surface. It appears to differ in its angles from zircon, yet farther examination may prove that it is only that species slightly altered by the absorption of water.

THORITE, *Berzelius*, K. V. Ac. H. 1829.

Massive and compact. Not scratched by the knife.

G.=4·63—4·8. Lustre of the surface of fresh fracture, vitreous; of exposed surface, resinous and dull. Color black, sometimes inclining to brown. Streak dark brown. Fracture conchoidal. Easily frangible.

Composition.—Essentially $\dot{Th}^3\dddot{Si}+3\dot{H}$=Silica 16·8, thoria 73·4, water 9·8. Analysis by Berzelius, (loc. cit.):

$\dddot{Si}$	$\dot{Th}$	$\dot{Ca}$	$\bar{Fe}$	$\bar{Mn}$	$\bar{Al}$	$\bar{U}$	$\dot{P}$	$\ddot{Zn}$	$\dot{K}$	$\dot{Na}$	$\dot{Mg}$	$\dot{H}$
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.

B.B. gives out water and becomes pale brownish-red, but does not fuse. Calcined in a tube, gives slight indications of fluoric acid. With soda on platinum foil, becomes green; on charcoal, forms a yellowish-brown slag. Fuses easily with borax to a glass colored by iron. Gelatinizes with muriatic acid.

Found in syenite by M. Esmark at Lövö, near Brevig, in Norway. It is stated to resemble Gadolinite in external characters. 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, rare. Massive; structure granular. H.=5·5. G.=4·912, Haidinger. Lustre dull adamantine or resinous. Streak grayish-white. Color between clove-brown and cherry-red, passing into gray. Slightly subtranslucent. Fracture splintery.

Composition.—$(\dot{Ce}, \dot{La})^2\dddot{Si}+3\dot{H}$=Silica 19·64, protoxyd of cerium 68·88, water 11·48. Analyses: 1. Klaproth, (Beit. iv, 140); 2, Hisinger, (Afhand. i Fys. iii, 287); 3, Vauquelin, (Ann. du Mus. d'hist. Nat. v, 405); 4, Hermann, (J. f. pr. Chem. xxx, 193):

		$\dddot{Si}$	$\dot{Ce}$	$\bar{Fe}$	$\dot{Ca}$	$\dot{H}$
1.	Bastnäs,	34·50	50·75	3·50	1·25	5·00=95·00, Klaproth.
2.	"	18·00	68·59	2·00	1·25	9·60=99·44, Hisinger.
3.	"	17·	67·	2·	2·	12·=100, Vauquelin.
4.	"	16·06	26·55	3·53	3·56	9·10, $\bar{Al}$ 1·68, $\bar{Mn}$ 0·27, Cu *trace*, $\bar{La}$ 33·38, $\ddot{C}$ 4·62=98·75, Hermann.

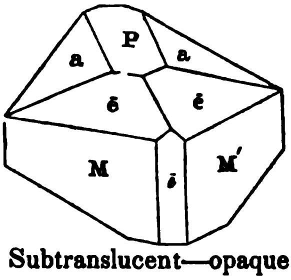
Hermann's specimen was probably impure from mixture with carbonate of lime.

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 Bastnaes, near Riddarhyttan, in Westmanland, 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 from mixture with quartz. He deduced for it the formula $\dot{Ce}^3\dddot{Si}^2+3\dot{H}$=Silica 32·83, protoxyd of cerium 57·58, water 9·59.

GADOLINITE. Gadolinit, *W.* Ytterbyte.



Monoclinic; P : M=95° 22′; P : a=149° 49′; M : M=115°; M : ē=152° 57′; ē : ē=119° 48′, Levy. Cleavage very indistinct. Also 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, 11, 12, Berlin, (Dissert. Gadol. Upsal. 1834, and Ofvers. af K. V. Ac. 1845, 86):

		$\dddot{Si}$	$\dot{Y}$	$\dot{C}e$	$\dot{F}e$
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.	Kararfvet,	29·18	47·30	——	—— $\dddot{\bar{C}}e$ 3·40, $\dddot{\bar{F}}e$ 8·00, $\dot{B}e$ 2·00, $\dddot{\bar{M}}n$ 1·30, $\dot{C}a$ 3·15, $\dot{H}$ 5·20=99·53, Berzelius.
4.	"	24·65	45·20	——	—— $\dddot{\bar{C}}e$ 4·60, $\dddot{\bar{F}}e$ 14·55, $\dot{B}e$ 11·05, $\dot{H}$ 0·50=100·55, Richardson.
5.	Hitteroe,	25·78	45·67	1·81	11·68, $\dot{C}a$ 0·34, $\dddot{\bar{L}}a$ 4·75, $\dddot{\bar{F}}e$ 1·28, $\dot{B}e$ 9·57=100·71, Scheerer.
6.	"	25·59	44·96	——	12·13, $\dot{C}a$ 0·23, $\dot{B}e$ 10·18, $\dddot{\bar{L}}a$ 6·33=99·42, Scheerer.
7.	Ytterby,	25·62	50·00	7·90	14·44, $\dot{C}a$ 1·30, $\dot{M}g$ 0·54, $\dddot{\bar{A}}l$ 0·48, $\dot{K}$ 0·19, $\dot{N}a$ 0·18=100·63, Berlin.
8.	"	25·26	45·53	6·08	20·28, $\dot{C}a$ 0·50, $\dot{M}g$ 0·11, $\dddot{\bar{A}}l$ 0·28, $\dot{K}$ 0·21, $\dot{N}a$ 0·20=98·45, Berlin.
9.	"	24·65	49·60	——	15·03, $\dddot{\bar{C}}e$ and $\dddot{\bar{L}}a$ 7·64, $\dot{B}e$ 2·13, $\dot{C}a$ 0·46, $\dot{M}g$, $\dot{M}n$ *trace*=99·51, Berlin.
10.	"	24·65	51·38	——	14·69, $\dddot{\bar{C}}e$ and $\dddot{\bar{L}}a$ 7·99, $\dot{B}e$ *trace*, $\dot{C}a$, $\dot{M}n$, $\dot{M}g$ 1·29=100, Berlin.
11.	"	24·86	48·32	——	14·80, $\dddot{\bar{C}}e$ and $\dddot{\bar{L}}a$ 7·41, $\dot{B}e$ 4·50, $\dot{C}a$ 0·67, $\dot{M}n$, $\dot{M}g$ 0·67=100·23, Berlin.
12.	"	24·85	51·46	——	13·01, $\dddot{\bar{C}}e$ and $\dddot{\bar{L}}a$ 5·24, $\dot{B}e$ 4·80, $\dot{C}a$ 0·50, $\dot{M}n$, $\dot{M}g$ 1·11=100·97, Berlin.

Of Berlin's analyses, the first two were of the glassy gadolinite; the others, excepting the last, did not present the glow of light on heating.

Decrepitates in the blowpipe flame, 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. Forms 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 Kararfvet and Finbo, near Fahlun, in Sweden; also at Ytterby, near Stockholm. At each locality it occurs indistinctly crystallized, and in rounded masses, which are often encircled with a yellow crust and imbedded in coarse-grained granite. At Kararfvet crystals have been obtained four inches long. It has also been met with at Disko in Greenland, and imbedded in granite in Ceylon. It occurs also at Finbo and Broddbo, and at Hitteroe in the southern part of Norway.

This mineral was first noticed by Capt. Arhenius, at Ytterby, and analyzed by M. Gadolin, who, in 1794, discovered in it a new earth, which was afterwards named *yttria*, from its locality, Ytterby.

The *titaniferous cerine* of Laugier, (Ann. Ch. Phys. xxvii, 313), resembles gadolinite and allanite. H.=6·5—7. *Composition.*—Oxyd of cerium 36·5, oxyd of iron 19·8, lime 8, alumina 6, water 11, oxyd of manganese 1·2, silica 19, titanic acid 8; the excess above 100 of the sum of these quantities, resulted from a change of the protoxyd of cerium to a peroxyd, during the analysis. It swells up when heated, and is attacked both by acids and alkalies.

From the Coromandel coast.

MOSANDRITE. *Erdmann*, Jahresb. xxi, 178.

Flat prisms. Also massive 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 reddish-brown. Streak-powder grayish-brown. Thin splinters translucent, bright red by transmitted light.

Composition.—Erdmann detected silica, titanic acid, oxyds of cerium and lanthanum, together with some oxyd of manganese, lime, a little magnesia and potash and water.

B.B. yields water, becomes brownish-yellow, and fuses easily to a brownish-green pearl. With borax an amethystine glass, which becomes yellowish or almost colorless in the reducing flame. A manganese reaction with soda.

Occurs with albite and violet fluor at Brevig, Norway.

BODENITE, *Breithaupt*, Pogg. Ann. lxii, 273; *Kersten*, ibid. lxiii, 135; *Kerndt*, J. f. pr. Chem. xliii, 219.

In long prismatic crystals, apparently rhombic prisms; M : M=110°—112°.

H.=6—6·5. G.=3·523. Color brown, reddish-brown to nearly black. Streak grayish-white. Lustre somewhat greasy, inclining to vitreous. Subtranslucent. Fracture flat conchoidal to uneven.

Composition.—$\overline{\text{Al}}\,\overline{\text{Si}}+\dot{\text{R}}^3\overline{\text{Si}}^2$. Analysis by Kerndt, (loc. cit.):

$\overline{\text{Si}}$	$\overline{\text{Al}}$	$\overline{\text{Fe}}$	$\dot{\text{Y}}$	$\dot{\text{Ce}}$	$\dot{\text{La}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{Mn}}$	$\dot{\text{K}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$
26·12	10·34	12·05	17·43	10·46	7·57	6·32	2·34	1·62	1·21	0·84	3·82=100.

In a matrass yields water, having an acid reaction. 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. Reaction of iron with borax, which is more distinct on adding tin. Reaction of manganese with soda.

From Boden, near Marienberg, in the Saxon Erzgebirge, with oligoclase.

MUROMONTITE, *Kerndt*, J. f. pr. Ch. xliii, 228.

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. Streak-powder grayish-white. Lustre vitreous or slightly greasy. In thin splinters subtranslucent. Fracture flat conchoidal to uneven.

Composition.—Analysis by Kerndt, (loc. cit.):

$\overline{\text{Si}}$	$\overline{\text{Al}}$	$\dot{\text{Be}}$	$\dot{\text{Y}}$	$\dot{\text{Ce}}$	$\dot{\text{La}}$	$\dot{\text{Fe}}$	$\dot{\text{Mg}}$	$\dot{\text{Mn}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	$\dot{\text{K}}$	$\dot{\text{H}}$ and loss.
31·09	2·24	5·52	37·14	5·54	3·54	11·23	0·42	0·91	0·71	0·65	0·17	0·85=100.

B.B. like Bodenite.

From Mauersberg, near Marienberg, in the Saxon Erzgebirge.

VI. METALS AND METALLIC ORES.

I. TIN, TITANIUM, COLUMBIUM, TUNGSTEN, MOLYBDENUM.

Tin has been reported as occurring native. The common ore consists of tin combined with oxygen, ($\ddot{\mathrm{Sn}}$). Tin is also occasionally found as a sulphuret; also in some ores of columbium; and in traces in a few ores of titanium and uranium.

Titanium is also said to occur native. It is found in the state of an acid, $\ddot{\mathrm{Ti}}$, (in rutile, brookite, and anatase); also the same acid in combination with lime, alumina, yttria, ceria, zirconia, oxyds of iron, and other bases, and is sometimes associated with silica in composition. As an oxyd ($\dddot{\overline{\mathrm{Ti}}}$) it is isomorphous with peroxyd of iron, ($\dddot{\overline{\mathrm{Fe}}}$), and the two occur together in various proportions, under a common form, in titanic iron.

Columbium, (or Tantalum), *Tungsten*, and *Molybdenum*, are other metals of the same group; but these exist in nature only in combination. With oxygen, we have tungstic and molybdic ochre; with bases, columbates of lime, yttria, oxyds of cerium, and iron; tungstates of lime, iron, lead; molybdate of lead; with sulphur, sulphuret of molybdenum. An instance of the isomorphism of tungsten and columbium is afforded (as first shown by H. Rose) in columbium and wolfram. The metals *Niobium* and *Pelopium* are usually associated with Columbium, and are related to it in character.

The metal *Columbium* (Tantalum) in the pure state is brittle, of a black color, and infusible. *Tungsten*, or Wolframium, is a gray metal resembling iron. Its specific gravity is high, it being 17·5; and it is almost infusible. It is reduced from its ores with great difficulty. *Molybdenum* is a white brittle metal, and is nearly infusible. G.=8·615. It tarnishes on exposure.

NATIVE TIN.

In small grayish-white metallic grains along with the Siberian gold.

Composition.—Tin with some lead. *Hermann*, J. f. pr. Ch. xxxiii, 300.

Tin crystallizes in cubes, according to Frankenheim, in right square prisms from galvanic deposition, according to Miller, and in hexagonal prisms in the Cornwall furnaces, according to Breithaupt.

CASSITERITE, *Beud.* Tin Ore. Oxyd of Tin. Peroxyd of Tin, *Thom.* Tin Stone. Wood Tin. Stream Tin. Zinnerz, Zinnstein, *W.* Etain Oxydé, *H.*

Dimetric. Secondary forms: M : e=133° 38′, e : e=121° 35′, *e* : a=124°, e : a=150° 47′, a : a (over terminal edge)=132° 53′, a : a (over summit)=112° 1′, o : o=159° 6′ and 118° 16′, *e*′ : *e*′= 112° 37′ and 157° 23′. Cleavage hardly distinct parallel with M and *e*. Compound crystals, fig. 3, parallel to the plane a; also fig. 12, pl. 4. Often in reniform shapes, structure fibrous divergent; also massive, granular or impalpable.

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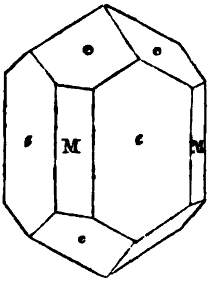

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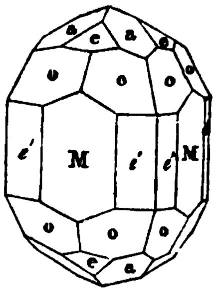

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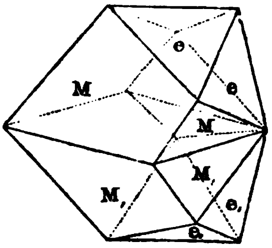


H.=6—7. G.=6·3—7·1; 6·96, crystallized variety; 6·514, thin columnar variety. Lustre adamantine, and crystals usually splendent. Color brown or black; sometimes red, gray, white, or yellow. Streak grayish, brownish. Nearly transparent—opaque. Fracture subconchoidal, uneven. Brittle.

Composition.—$\ddot{\mathrm{S}}\mathrm{n}$=Tin 79, oxygen 21. Berzelius, (Afhand. iv, 164), found in a Finbo specimen:

$\ddot{\mathrm{S}}\mathrm{n}$ 93·6 Ta 2·4, $\mathrm{\bar{F}e}$ 1·4, $\mathrm{\bar{M}n}$ 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 the finest and most 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. It also occurs 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 more abundantly on the estate of Mr. Eastman, in the town of Jackson, N. H., where it was discovered by Dr. C. T. Jackson. It has also been observed sparingly in some of the gold mines of Virginia, by Prof. Rogers, imbedded in a talco-micaceous slate.

The Cornwall mines have been worked from a very remote antiquity. The purest grain tin is obtained from the stream ore, which often yields 70 per cent.

The annual production of tin in different countries is as follows:—

Great Britain,	100,000 cwt.
Banca and Malacca,	90,000 "
Saxony,	3,500 "
Austria,	380 "
Sweden,	750 "

Iron coated with tin constitutes the ordinary tin ware. Mixed with mercury, it is used for the metallic covering of mirrors. With lead it forms pewter.

STANNITE, *Breithaupt.*

Amorphous, compact.

H.=6·5. G.=3·545. Lustre nearly dull. Color pale yellowish-white. Translucent on the thinnest edges. Fracture conchoidal.

Composition.—Contains, according to Plattner, (Pogg. lxix, 435), Silica, alumina, and 36·5 per cent. of oxyd of tin. B.B. infusible.

From Cornwall. May be only a mechanical mixture.

TIN PYRITES. Stannine, *Beud.* Sulphuret of Tin, *P.* Bell Metal Ore. Zinnkies, *W.* Etain Sulfuré, *H.*

Monometric. In cubes, but rare. Commonly massive, granular, and disseminated.

H.=4. G.=4·3—4·51; 4·506, Zinnwald. Lustre metallic. Streak black. Color steel-gray when pure; often yellowish from the presence of copper pyrites. Opaque. Fracture uneven. Brittle.

Composition.—$2(\overline{\mathrm{Cu}}, \mathrm{Fe}, \mathrm{Zn})\mathrm{S}+\mathrm{SnS}^2$. Analyses: 1, Klaproth, (Beit. v, 228); 2, Kudernatsch, (Pogg. xxxix, 146); 3, Johnston, (Rep. Geol. Cornwall, &c., 1839); 4, Rammelsberg, (2d Supp., 179):

	S	Sn	Cu	Fe	Zn
1. Cornwall,	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, Kudern.
3. "	29·929	31·618	23·549	4·791	10·118=100, Johnston.
4. Zinnwald,	29·89	28·94	26·31	6·80	6·98, Pb 0·41=99·28, 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 Wheal 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 at Carn Brea; 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.*

NATIVE TITANIUM.

Monometric. In cubes of a copper red color.

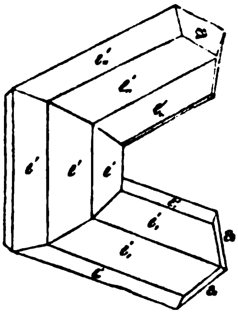
Composition.—Pure titanium. Gives the reaction of titanium.

Said to be found native in the mines of Merthyr Tydrill, Cornwall. The crystals supposed to be pure titanium found in the scoria of the furnaces of Cornwall, where they have resulted from the heat in the reduction of ore, have been recently shown by Wöhler to consist of cyanuret and nitruret of titanium=$10\mathrm{Ti}+1\mathrm{Cy}+3\mathrm{N}$.

RUTILE. Nigrine. Gallicinite. Sagenite, *Saussure*. Crispite. Titane Oxydé, *H.* Titanic Acid, *Thom.* Eisentitan, *Hausm.*

Dimetric; fig. 51, pl. 1, with the planes forming a four-sided pyramid at each extremity of the crystals. Also the annexed figures:

1



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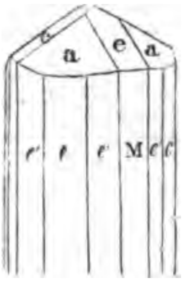

M : *e*=135°, M : *e'*=161° 34', *e* : *e'*=150° 26', a : a=122° 55', a : e =151° 28', e : e=135° 5', M : e=122° 52'. Cleavage lateral, distinct; diagonal, less so. M, *e* and *e'*, usually vertically striated. Crystals often acicular; often in singly and doubly geniculated crystals; fig. 1. Also massive, compact.

H.=6—6·5. G.=4·18—4·25; 4·249, Ohlapian, Nigrine. 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, $\ddot{\mathrm{Ti}}$=Titanium 61·14, oxygen 38·86. 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):

1. St. Yrieix, *rdh. subtrp.* G.=4·209, $\ddot{\mathrm{Ti}}$ 97·60, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 1·55=99·15, Damour.
2. Freiberg, *nigrine*, G.=4·242, $\ddot{\mathrm{Ti}}$ 96·75, $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ and mag. iron 2·40=99·15, Kersten.

The magnetic iron in the last 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, in masses of quartz or feldspar, and often occurs in acicular crystals penetrating quartz. It has also been met with in specular iron.

Brazil affords acicular crystallizations in limpid quartz. At Yrieix, in France, and in Castile, geniculated crystals are obtained, often of large size. At Ohlapian in Transylvania, *Nigrine* occurs in pebbles. Large crystals are found in Crianlarich in Perthshire; a massive variety at Arendal; also at Karingsbricka in Sweden, giving a chrome-green glass with the fluxes in the outer flame;—it contains a small percentage of chrome, and is the *titane oxydé chromifère* of Haüy.

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 Shelburn, in fine crystals in mica slate; at Leyden, with scapolite; at Conway, with zoisite. In Vermont, at 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, in magnificent specimens of acicular crystals in quartz, but only as 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 limestone 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 8-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.

The oxyd of titanium is employed 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*.

BROOKITE, *Levy*, Ann. Phil. 2d ser. ix, 140. Jurinite, *Soret*. Arkansite, *Shephard*, Am. J. Sci. 2d ser. ii, 250, and iv, 279.

Trimetric. M : M=100° 30′, e : e=135° 46′ and 101° 37′; M : ē =140°, M : e=134, P : e=132° 38′, *a*′ : *a*′=123° 36′, P : ō= 147° 30′, *a*″ : *a*″=102° 24′, Levy; M : M=100° 30′, e : e=135°,

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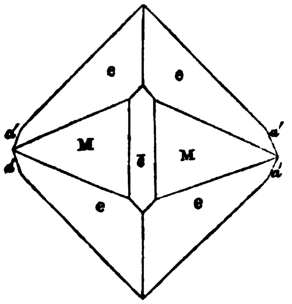

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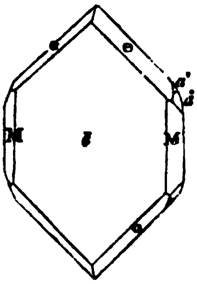


Hermann. For the Arkansas variety (fig. 1) M : M=101°, e : e=135° 15′, M : e=133° 45′, Shepard; M : M=100°, e : e=135° 45′, M : e= 133° 35′, *a*′ : *a*′=124°, Teschemacher; M : M=100° 19′, e : e= 135° 51′ and 101° 19′, Breithaupt. Cleavage parallel to M, indistinct; more so parallel to P.

H.=5·5—6. G.=4·12—4·17, Brookite; 4·052—4·085, Arkansite, Whitney, 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.

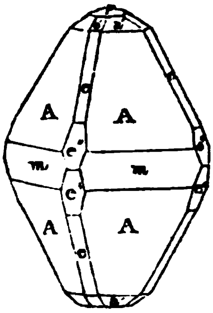
Composition.—Pure titanic acid, (Ti), like anatase. The Ural brookite, which gives a low specific gravity, contains, according to Hermann, (J. f. pr. Chem. xlvi, 404),

Ti 94·09, Fe 4·50, Al *trace*, ign. 1·40=100·00.

Rammelsberg obtained 94·23 per cent. of titanic acid from the arkansite, and a corresponding low specific gravity, while Whitney found little impurity and a higher specific gravity.

Brookite was first found in Dauphiny. Occurs also at St. Gothard, with albite and quartz; in the Urals, district of Slatoust; on Snowdon and near Tremaddoc, Wales; and in thick black crystals (arkansite) at Magnet Cove, Ozark Mts., Arkansas, along with elæolite and schorlomite. This species has also been reported from the gold washings of North Carolina. Breithaupt infers, (Pogg. lxxviii, 143), that brookite and arkansite are distinct in form and other characters, and that titanic acid is consequently tetramorphous. But we see no good reason for such a conclusion.

ANATASE. Octahedrite, *J.* Oisanite. Titane Anatase, *H.*



Dimetric; commonly octahedral, or tabular; A : A (over a terminal edge)=97° 55′, A : A (over a basal edge)=136° 30′, A : e=138° 58′, A : m=158° 15′, A : p=111° 45′, a′ : m=116° 33′, P : e=119° 26′, e″ : e″=158° 42′, Descloizeaux. Cleavage parallel to A and *p*, perfect.

H.=5·5—6. G.=3·85—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, and before the blowpipe exhibits the phenomena of that substance. 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], x, 417), Ti 98·35, $\mathrm{\bar{F}e}$ 1·11, Zn 0·20=99·67.

Anatase occurs most abundantly at Bourg d'Oisans in Dauphiny, accompanying feldspar, axinite, and crichtonite. It is also found in mica slate in the Grisons, in Bavaria, Norway, and the Urals. In Brazil it occurs imbedded in quartz, and in detached crystals of so splendent a lustre, 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.

MOLYBDENITE. Sulphuret of Molybdena. *P.* Molybdänglanz, *L.* Wasserblei, *W.* Molybdène Sulfuré, *H.*

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. Streak similar to color, slightly inclined to green. Color pure lead-gray. Opaque. Laminæ highly flexible, not elastic. Sectile, and almost malleable. Leaves a gray trace on paper, a greenish on porcelain.

Composition.—Mo S^2=Sulphur 40·2, molybdenum 59·8. Analyses: 1, Brandes, (Schw. J. xxix, 325); 2, Seybert, (Am. J. Sci. iv, 1822, 320):

1. Altenberg,		Mo 59·6	S 40·4=100, Brandes.
2. Chester, Pa.	G.=4·444,	59·42	39·68=99·10, Seybert.

Does not fuse before the blowpipe, but sulphureous fumes are emitted, which are deposited on the charcoal. Dissolves in nitric acid, excepting a gray residue. Deflagrates with nitre.

Molybdenite generally occurs imbedded in, or disseminated through, granite, gneiss, zircon-syenite, and other crystalline rocks. At Numedal in Sweden, and Arendal in Norway, and Greenland, it has been observed in hexagonal prisms. The secondary form is exceedingly rare. Altenberg in Saxony, and Schlackenwald and Zinnwald in Bohemia, 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 Corybuy on Loch Creran.

In Connecticut at Haddam, and the adjoining towns on the Connecticut river, it occurs in gneiss in crystals and large plates; at Saybrook it is associated with stilbite. 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 in mica slate, where it is abundant; at Landaff, 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.

This mineral is readily distinguished from plumbago by its lustre and streak, and also by its behavior before the blowpipe and with acids.

MOLYBDIC OCHRE. Molybdena Ochre. Molybdänocher, *Karsten*.

An earthy yellow powder or incrustation.

Composition.—$\dddot{Mo}$=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.

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. Dr. C. T. Jackson has detected a small portion of oxyd of uranium in the yellow oxyd of molybdenum from Westmoreland.

TUNGSTIC OCHRE, *B. Silliman*, Am. J. Sci. iv, 52. Tungsten ochre, *Nicol*. Wolfram-ochre, *Haus*. Scheelsaure, *Naumann*.

Pulverulent. Earthy. Color bright yellow, or yellowish-green.

Composition.—$\dddot{W}$=Oxygen 20·16, tungsten 79·84. It is pure tungstic acid. B.B. on charcoal becomes black in the inner flame, but infusible. Forms a clear glass in the outer flame with borax; with more of the mineral becomes 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, Conn., filling small cavities in other ores of tungsten, or coating them, and has resulted from their decomposition.

II. TITANATES, COLUMBATES, TUNGSTATES, MOLYBDATES.

PEROVSKITE, *G. Rose*, Pogg. xlviii, 558.

Monometric; usual in cubes, more or less modified and hemihedral. 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.

position.—$\dot{Ca}\ddot{Ti}$=Titanic acid 58·87, lime 41·13=100. Analyses: 1, Jacobson, lxii, 596); 2, Brooks, (ib.):

	Ti	Ċa	Ṁg	
1.	58·96	39·20	*trace*	Ḟe and *trace* of Ṁn 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.

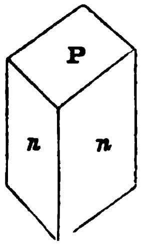
Perovskite occurs in crystals or druses of crystals, the largest individuals of which yet seen are not over three lines in length. One crystal figured by Descloizeaux had seven planes on each edge and ten on each angle, or 164 faces in all, (Ann. Ch. Phys. xiii, 1845). It is associated with finely crystallized chlorite, and magnetic iron in chlorite slate, at Achmatovsk, near Slatoust in the Ural. It is named in honor of von Perovski of St. Petersburg.

SPHENE. Titanite. Braun-Menakerz, Gelb Menakerz, Menachine Ore, *Wern.* Titane Silico-calcaire, *H.* Lederite, *Shepard.* Greenovite, *Duf.* Spinthère. Pictite, *Saus.*

Monoclinic. M : M=76° 2′, Rose; 76° 13′, Descloizeaux; *n* : *n* =136° 6′, R., (136° 48′, D.), P : *y* (adjacent planes)=60° 24′, *r* : *r*= 113° 30′, R., (114° 24′, D.), *t* : *t*=110° 54′, R., (111°, D.), *l* : *l*= 133° 48′, (133° 56′, D.), *s* : *s*=67° 46′. Cleavage sometimes distinct parallel with *r*; still less so parallel with *l* and P, and not easily obtained. Also massive, compact, and sometimes lamellar.

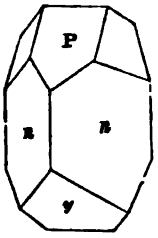
H.=5—5·5. G.=3·4—3·56. Lustre adamantine—resinous. Streak white. Color brown, gray, yellow, green, and black. Transparent—opaque. Brittle.

1



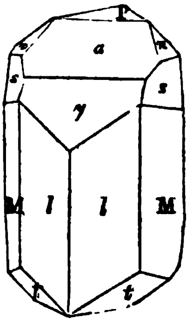
Norway,—Roger's Rock, Lake George.

2



Gouverneur, N. Y.

5



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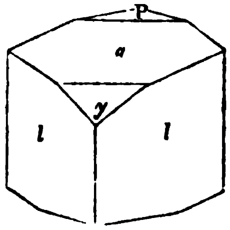
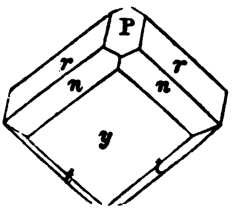


Amity, N. Y.

4



Lederite.

Composition.—$\dot{C}a^2\ \ddot{S}i^2\ \ddot{T}i^3$=Silica 34·19, titanic acid 44·73, lime 21·08=100; or better $\dot{C}a^3\ \ddot{S}i^2\ \ddot{T}i^3$=Silica 31·08, titanic acid 40·60, lime 28·37=100.

Analyses: 1, Klaproth, (Beit. i, 245); 2, Fuchs, (Ann. d. Ch. u. Pharm. xlvi, 319); 3, 4, 5, H. Rose, (Pogg. lxii, 253); 6, Marignac, (Ann. Ch. Phys. [3], xiv, 47); 7, 8, Delesse, (Ann. d. Mines, [4], vi, 325):

	$\dddot{Si}$	$\ddot{Ti}$	$\dot{Ca}$	
1. Passau, *brown sphene,*	35·	33·	33·	=101, Klaproth.
2. Schwarzenstein. *yw. sph.,*	32·52	43·21	24·18	=99·91, Fuchs; G. 3·44.
3. Zillerthal, *ywh. green,*	32·29	41·58	26·61,	$\dot{Fe}$ 0·96=101·44, Rose; G. 3·535.
4. Arendal, *brown,*	31·20	40·92	22·25,	$\dot{Fe}$ 5·06=99·43, Rose.
5. Passau, "	30·63	42·56	25·00,	$\dot{Fe}$ 3·93=102·12, Rose.
6. Piedmont, *Greenovite,*	32·26	38·57	27·65,	$\dot{Fe}$ 0·76, $\dot{Mn}$ 0·76=100, Marignac.
7. " "	29·8	43·0	23·6	$\dot{Mn}$ 2·9=99·3, Delesse.
8. " "	30·4	42·0	24·3	$\dot{Mn}$ 3·6=100·3, "

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.

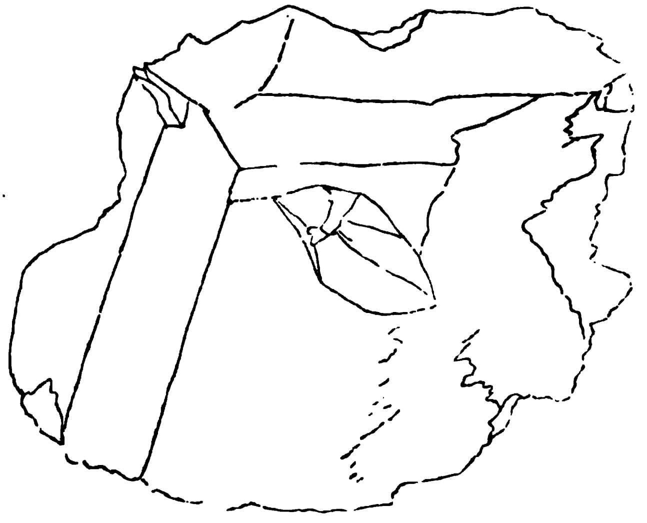
This species was formerly divided into *titanite* and *sphene;* the former included the brown or black variety, the latter the lighter colored and translucent.

Sphene occurs in imbedded crystals, in gneiss, granite, mica slate, and granular limestone; also in syenite, and beds of iron ore.

Titanite occurs with pyroxene, in beds of iron ore, at Arendal in Norway, in granite in Greenland. Sphene in complicated compound crystals of a pale green color and transparent, occurs 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.

Greenovite is from St. Marcel in Piedmont; its crystallization was shown to be identical with that of sphene by Descloizeaux.

Occurs in Canada, at Grenville and Elmsley. 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 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; the crystals of sphene are sometimes nearly three inches square, and one of them is here represented from a figure by William S. Vaux; at Rossie, St. Law-



rence Co., in pale-red and brown crystals with apatite, pargasite, and feldspar; at Gouverneur, in black crystals in granite; 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 σφήν, *a wedge*.

Ligurite, (from a talcose rock in the Appenines), according to Dufrénoy, has the angles and characters of sphene.

KEILHAUITE, *Erdmann*, K. V. Ac. H. 1844. Yttrotitanite, *Scheerer*, Pogg. lxiii, 459.

Massive with one perfect cleavage.

H.=6·5. G.=3·69. Brownish-black. In splinters brownish-red and translucent. Streak-powder grayish-brown. Lustre vitreous to resinous.

Composition.—$3\dot{C}a^3\dddot{Si}+\overline{R}\dddot{Si}+\dot{Y}\ddot{Ti}^3$. Analyses by A. Erdmann, (loc. cit.):

	$\dddot{Si}$	$\ddot{Ti}$	$\overline{Fe}$	$\overline{Al}$	$\overline{Mn}$	$\overline{Ce}$	$\dot{C}a$	$\dot{Y}$
1.	30·00	29·01	6·35	6·09	0·67	0·32	18·92	9·62=100·98.
2.	29·45	28·14	6·48	5·90	0·86	0·63	18·68	9·74=99·88.

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.

Said to resemble garnet in appearance, but has a higher specific gravity.

Occurs about one and a half miles from Arendal, Norway, in a feldspathic rock.

ŒRSTEDITE, *Forchhammer*.

Dimetric. Common form, a square prism with the angles and edges replaced; a : a=123° 16½′, which is nearly the angle of zircon.

H.=5·5. G.=3·629. Lustre splendent, adamantine. Color reddish-brown. Opaque or subtranslucent.

Composition.—Analysis by Forchhammer, (Pogg. xxxv, 630):

$\dddot{Si}$ 19·708, $\dot{C}a$ 2·612, $\dot{M}g$ 2·047, $\dot{F}e$ 1·136, $\ddot{Ti}$ and $\ddot{Zr}$ 68·965, $\dot{H}$ 5·532=100.

In a matrass yields water. B.B. infusible. Dissolves with difficulty in borax or salt of phosphorus to a colorless glass, and according to Berzelius yields a trace of tin with the latter, and the reaction of titanium. Not dissolved with soda.

Occurs in brilliant highly modified crystals at Arendal, Norway, and is commonly found upon crystals of pyroxene. This species was named in honor of Œrsted.

WARWICKITE, *Shepard*, Am. J. Sci. xxxiv, 313, and xxxvi, 85. Enceladite, *T. S. Hunt*.

Monoclinic. M : M=93°—94°, Beck. Rhombic prisms, usually with the obtuse lateral edges truncated, and the acute beveled; the summits generally rounded. Cleavage parallel with the longer diagonal very perfect. Cleavage surfaces finely striated vertically and exhibiting distinct oblique cross cleavages.

H.=3—4. G.=3—3·29, Shepard; 3·188, Hunt. Lustre metallic pearly on the cleavage surface; of other surfaces, vitreous or subvitreous: often nearly dull. Color dark hair-brown to iron-gray, and often with a copper-red tinge on the face of perfect cleavage. Decomposing crystals are nearly iron-black, with a faint tinge of purple. Streak bluish-black. Fracture uneven. Brittle.

Composition.—$(\not{\mathrm{A}}\mathrm{l}, \not{\mathrm{T}}\mathrm{i}, \not{\mathrm{F}}\mathrm{e})^2\dddot{\mathrm{S}}\mathrm{i}+\dot{\mathrm{M}}\mathrm{g}^3\dot{\mathrm{H}}^2$=Silica 17·8, oxyd of titanium, oxyd of iron, and alumina 51·2, magnesia 22·9, lime 1·3, water 6·7. Analysis by T. S. Hunt, (Am. J. Sci. [2], ii, 35):

1. A.	$\ddot{\mathrm{T}}\mathrm{i}$ 28·2	$\dddot{\mathrm{S}}\mathrm{i}$ 18·5	$\not{\mathrm{A}}\mathrm{l}$ 13·84	$\dot{\mathrm{F}}\mathrm{e}$ 10·59	$\dot{\mathrm{M}}\mathrm{g}$ 22·2	$\dot{\mathrm{C}}\mathrm{a}$ 1·3	$\dot{\mathrm{H}}$ 7·35.
B.	$\not{\mathrm{T}}\mathrm{i}$ 25·16	18·5	13·84	$\not{\mathrm{F}}\mathrm{e}$ 13·0	22·2	1·3	7·35.

In A, the titanium is reckoned as titanic acid, and in B, as titanic oxyd. The latter, the one adopted by Mr. Hunt, affords the above formula. Prof. Shepard obtained, (loc. cit.), Titanium 64·71, iron 7·14, yttrium 0·80, fluorine 27·33, aluminium *trace*=99·98.

In a matrass, yields water. B.B. infusible alone, but becomes lighter colored. With borax it gives a clear bead colored by iron. With salt of phosphorus affords a bead orange when hot, and purplish-gray and opaque on cooling.

Occurs in granular limestone two and a half miles southwest of Edenville, N. Y., associated with spinel, chondrodite, serpentine, &c. The crystals are usually small and slender; but occasionally they are met with two inches or more in length, and a third of an inch in diameter. Resembles a little Mosandrite.

SCHORLOMITE, *Shepard*, Am. J. Sci. 2d Ser. ii, 251.

Hexagonal. In hexagonal prisms with lateral edges truncated by narrow and brilliant planes. Cleavage indistinct.

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.—$2\dot{\mathrm{R}}^3\dddot{\mathrm{S}}\mathrm{i}^2+3\dot{\mathrm{R}}^2\ddot{\mathrm{T}}\mathrm{i}$=Silica 28·61, titanic acid 19·13, lime 52·26, Rammelsberg. Analyses: 1, 2, Crossley, (Whitney, in Jour. Bost. Nat. Hist. Soc. 1849, vi, 46); 3, 4, Rammelsberg, (Pogg. Ann. lxxvii, 123, 1849):

1.	$\dddot{\mathrm{S}}\mathrm{i}$ 25·66	$\ddot{\mathrm{T}}\mathrm{i}$ 22·10	$\dot{\mathrm{C}}\mathrm{a}$ 29·78	$\not{\mathrm{F}}\mathrm{e}$ 21·58=99·12, Crossley.
2.	27·89[a]	20·43	30·05	21·90=100·27, Crossley.
3.	26·09	17·36	31·12	$\dot{\mathrm{F}}\mathrm{e}$ 22·83, $\dot{\mathrm{M}}\mathrm{g}$ 1·55=98·95, Rammelsberg.
4.	27·85[a]	15·32	32·01	23·75, $\dot{\mathrm{M}}\mathrm{g}$ 1·52=100·45, Rammelsb.

[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 minute crystals and small masses with elæolite and brookite in the Ozark Mts. Magnet cove, Arkansas.

Mr. Crossley informs the author that in his analysis the iron was partly protoxyd.

WÖHLERITE, *Scheerer*, Pogg. lix, 327, 1843.

In tabular crystals and prisms: form undetermined. Cleavage distinct in one direction. Also granular.

H.=5·5. G.=3·41. Lustre vitreous, inclining to resinous. Color light-yellow, wine-, honey-, and resin-yellow, brownish, grayish; streak-powder yellowish-white. Transparent—subtranslucent. Fracture more or less conchoidal—splintery.

Composition.—$\ddot{\mathrm{Z}}\mathrm{r}^3\dddot{\mathrm{T}}\mathrm{a}+5(\dot{\mathrm{N}}\mathrm{a}\dddot{\mathrm{S}}\mathrm{i}+\dot{\mathrm{C}}\mathrm{a}^3\dddot{\mathrm{S}}\mathrm{i})$, Scheerer,=Silica 30·22, tantalic acid 13·66, zirconia 17·91, lime 27·97, soda 10·24=100: but Scheerer has since ascertained that the tantalic acid was *niobic*. He obtained in his analysis,

$\dddot{\mathrm{Si}}$ 30·62, $\dddot{\mathrm{Ta}}$ 14·47, $\bar{\mathrm{Zr}}$ 15·17, $\dddot{\bar{\mathrm{Fe}}}$ 2·12, $\dot{\mathrm{Mn}}$ 1·55, $\dot{\mathrm{Ca}}$ 26·19, $\dot{\mathrm{Mg}}$ 0·40, $\dot{\mathrm{Na}}$ 7·78, $\dot{\mathrm{H}}$ 0·24=98·54,

with perhaps traces of cerium.

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 the island of Langesund-Fjords, near Brevig, in Norway.

EUKOLITE, *Scheerer*, Jahresb. xxv, 375, and Pogg. Ann. lxxii, 561.

In reniform masses. Color brown. Resembles wöhlerite.

Composition.—Analysis by Scheerer, (loc. cit.):

$\dddot{\mathrm{Si}}$ 47·85, met. acids and some $\bar{\mathrm{Zr}}$ 14·05, $\dddot{\bar{\mathrm{Fe}}}$ 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=100·87.

Scheerer considers it a wöhlerite, in which the zirconia is replaced by peroxyd of iron. From Rödkindholm near Fredericksvärn, Norway; also near Brevig.

ÆSCHYNITE, *Berzelius*, Jahresb. ix, 195.

Trimetric. M : M=129°, Descloizeaux; 127° 19′, Rose; terminal pyramid 74°, D.; 73° 44′, R.; another 137° 30′, D., 137° 33′, R. Crystals usually striated.

H.=5—6. G.=4·9—5·14. Lustre resinous—submetallic, nearly dull. Color nearly black, inclining to brownish-yellow when translucent. Streak gray, almost black. Subtranslucent—opaque. Fracture small subconchoidal.

Composition.—Analyses: 1, Hartwall, (Pogg. xvii, 483, Jahresb. ix, 195); 2, 3, Hermann, (J. f. pr. Chem. xxxi, 89, and xxxviii, 116):

1.	$\ddot{\mathrm{Ti}}$ 56·0	$\bar{\mathrm{Zr}}$ 20·0	$\bar{\mathrm{Ce}}$ 15·0	$\dot{\mathrm{Ca}}$ 3·8	$\dddot{\bar{\mathrm{Fe}}}$ 2·6	$\ddot{\mathrm{Sn}}$ 0·5=97·9, Hartwall.
2.	11·94	17·52	2·48	2·40	$\dot{\mathrm{Fe}}$ 17·65	$\dddot{\mathrm{Ta}}$ 33·39, $\dot{\mathrm{Y}}$ 9·35, $\dot{\bar{\mathrm{La}}}$ 4·76, $\dot{\mathrm{H}}$ 1·56 =101·05, Hermann.
3.	10·56	† 17·58	15·59	—	4·32	$\dddot{\mathrm{Ni}}$ 35·05, " 4·62, $\dot{\bar{\mathrm{La}}}$ 11·13, $\dot{\mathrm{H}}$ and trace of F 1·66=100·51, Herm.

Hermann concludes that the mineral contains niobic acid in place of tantalic, and perhaps the new earth noria in place of zirconia. He found in his first analysis (No. 2) traces of magnesia, manganese, tungstic acid, and fluorine. He deduced from his first analysis the formula:

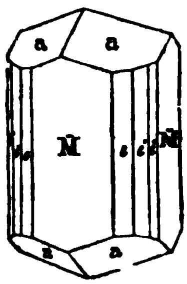
$$2\bar{\mathrm{Zr}}^3\ddot{\mathrm{Ti}}^2+3\dot{\mathrm{R}}^6\dddot{\mathrm{Ta}}.$$

But until the exact nature of the constituents is understood, this can be considered only an approximation.

In a matrass yields water, and in an open tube traces of fluoric acid. B.B. on charcoal, swells and becomes yellow, but does not fuse, though forming a black slag on the edges. With borax it readily forms a dark-yellow glass; with salt of phosphorus it yields a transparent colorless bead, which with more of the salt appears yellow and clouded. Affords some tin.

This mineral was brought by Menge from Miask in the Ural, where it occurs imbedded in feldspar and associated with mica and zircon. The name *Æschynite* is derived from *αἰσχύνη*, *shame*, and was given this mineral 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.

POLYMIGNITE, *Berzelius*, K. V. Ac. H. 1824, p. 338.



Trimetric. a : a=136° 28′, and 116° 22′, $\bar{\mathrm{M}} : e = 144° 53'$. Cleavage in traces parallel to $\bar{\mathrm{M}}$ and $\breve{\mathrm{M}}$. 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, $\bar{\mathrm{Zr}}$ 14·14, $\bar{\mathrm{Fe}}$ 12·20, $\dot{\mathrm{Ca}}$ 4·20, $\bar{\mathrm{Mn}}$ 2·70, $\bar{\mathrm{Ce}}$ 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.

MENGITE, *G. Rose.* Ilmenite, *Brooke*, Phil. Mag. x, 1831.

Trimetric. Occurs in short prisms often terminated by four-sided pyramids. M : M=136° 20′; pyramidal angles 150° 32′ and 101° 10′. 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, 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.

AZORITE. *J. E. Teschemacher*, Am. J. Sci. 2d Ser. 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′. Cleavage none. 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 recent reëxamination of the species by Mr. Hayes corroborates his first announcement that the mineral contains neither cerium nor phosphoric acid.

The angle 123° 15′ is near that of *zircon*, p. 379, and *œrstedite*, p. 393.

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 Perovski of St. Petersburg, at Alabaschka, near Mursinsk, where it occurs in drusy feldspar cavities, containing also tables of lithia mica, crystals of albite, and a single crystal of 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 (niobate) of zirconia, colored apparently by oxyds of iron, uranium, and manganese.

B.B. in the forceps on the first impulse of 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 color 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 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.

PYROCHLORE. Brewst. Jour. vi, 358. Microlite, *Shepard.*

Monometric. In octahedrons; also figs. 9 and 17, plate 1. Octahedral cleavage sometimes distinct, especially in the smaller crystals.

H.=5—5·25. G.=3·802, (Pyrochlore from Brevig), Berzelius; 4·32, (from Miask), Rose; 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, Wöhler, (Pogg. xlviii, 83); 3, Miask, Hermann, (J. f. pr. Chem. xxxi, 94); 4, 5, Fredericksvärn, A. A. Hayes, (Am. J. Sci., xlvi, 164):

POLYMIGNITE, *Berr*

Trimetric. a : a=136° ?
=144° 53′. Cleavage in
M̆. Crystals generally s'
ated longitudinally.
H.=6·5. G.=4·7'
lic, but brilliant.
brown. Opaque..
presenting like
metallic.

F 3·23, Ti S̈n, M̈g ?=102·
S̈n, M̈g, N̈a *trace*=97·?
2·00, K̈, N̈a, Li 3·7?
T̈i 2·28, Ḧ 0·50=
Pb, Sn 1·20, ig-
, ign. 0·80=
ıcid.

26

ıoxy
ə0, oxyd o.

Composition.—
Ti 46·30,
with a trace
B.B. alor
bead beo
to a gla
Occ
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ıh, Ċe)^3 Ta.

ə the view that tantalic acid contains 2 ɩ

$$2\dot{\mathrm{C}}\mathrm{a}^4\,\mathrm{Ta}^3+\mathrm{NaF},$$

. Gebirge. Ural, Berlin, 1842). Hermann has the formula

$$2\dot{\mathrm{R}}^3\,\mathrm{Ta}+\ddot{\mathrm{R}}(\mathrm{Ta},\mathrm{Ti})+(\mathrm{K},\mathrm{Na},\mathrm{Li})\mathrm{F}.$$

Hayes's analysis (No. 5) gives nearly (including Ṅa under Ċa), $\dot{\mathrm{C}}\mathrm{a}^2\mathrm{Ta}^2+3\dot{\mathrm{C}}\mathrm{a}\mathrm{Ti}$, or adopting Ta, it becomes Ċa(Ta, Ti).

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.

Pyrochlore was so named by Berzelius, in allusion to its becoming yellowish-green under the blowpipe, from πυρ, *fire*, and χλωρος, *green.*

MICROLITE, Shepard, (Amer. J. Sci. xxvii, 361, xxxii, 338). The microlite resembles pyrochlore closely, and has been referred to this species by J. E. Teschemacher, (Am. J. Sci. xliii, 33). It occurs in small octahedral crystals, translucent to opaque, and of light yellow and brown shades of color, associated with albite, green and red tourmaline, uranite and columbite, at the Chesterfield vein, Massachusetts. The octahedrons occur often with truncated edges, (fig. 9, pl. 1), and also with the angles replaced by four planes inclined on the octahedral faces, as in fig. 17, pl. 1. H.=5·5. G.=4·75—5, Shepard; 5·405, Hayes. Analyses according to Shepard, (Am. J. Sci. xxxii, 338), and Hayes, (Am. J. Sci. xlvi, 158):

Ta 75·70, Ċa 14·84, $\dddot{\mathrm{W}}$, Ẏ, U̇ 7·42 Ḣ 2·04=100, Shepard.

Ta 79·60, Ċa 10·87, F̶e 0·99, oxyd of U and Mn 2·21, Pb 1·60, Sn 0·70=95·97, H.

The oxygen of the lime and columbic acid, has the ratio 1 : 2 in Shepard's analysis, corresponding to $\dot{\mathrm{C}}\mathrm{a}^2\mathrm{Ta}^2$, or ĊaTa; and the ratio 1 : 3 in that by Hayes, corresponding to ĊaTa, or $\dot{\mathrm{C}}\mathrm{a}^2\mathrm{Ta}^3$. But as there are other bases present as well as lime, the true constitution of the species, Hayes states, is not probably represented correctly by either of these formulas.

Hayes gives the following blowpipe characters, (Am. J. Sci. xliii, 33):—In the outer flame fuses on the edges to an enamel, which in the reducing flame darkens and becomes finally of a clove color; the outer flame restores again the former color. With borax on a platinum wire, fuses with slight effervescence; and the outer flame gives a glass which is reddish-brown while hot, but becomes pale yellow as it cools; the globule in the reducing flame remains clear, and when cold is of a pale green color; on flaming

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* In this case the atomic weight of tantalum is 1531·15.

a white enamel is prodr
reducing flame gives th
of phosphorus a reddis
in the reducing flame

(in part). Tantale Oxidé, *H.* Niobite, *Haid.* ud. Torrelite, *Thom.*

$\breve{M} : e=129^\circ\ 40'$, $\bar{M} : \bar{e}=157^\circ\ 29'$, 79° 20′; $\breve{e} : \breve{e}=43^\circ\ 48'$ and 136° 160° 34′, P : ĕ=119° 40′, P : a= : $e=143^\circ\ 58'$, P : $\breve{o}'=136^\circ\ 36'$, $\breve{e}=133^\circ\ 24'$, P : $\breve{o}''=119^\circ\ 13'$,

etric,
e′

Lustre e.
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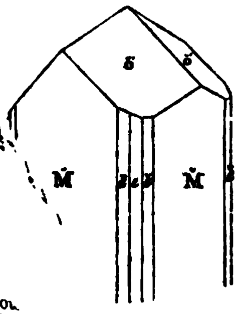
brownish-black; in th
or yellowish-brown. St
translucent—opaque. Frac.
choidal.

8



Conn.

Composition.—$(\dot{Y}, \dot{C}e)^3\,Ta$. Analysis by H. Ac. H. 1828, 167):

Ta 47·75, $\dot{Y}$ 41·91, $\dot{C}e$ 4·68, Zr 3·02, Sn 1·00,

B.B. infusible but loses color; with borax it fuses with which is yellow while hot, with some interspersed white spo. With soda it is decomposed without solution, leaving a reddish slag. tin.

Discovered by Gisècké, near Cape Farewell, in Greenland, dissemin. and named in honor of Robert Ferguson, of Raith.

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50′.

YTTRO-COLUMBITE. Yttrotantalite. Tantale Oxidé Yttrifère, H.

There are three varieties of this species; the *black*, the *yellow*, re and the *brown* or *dark* yttro-columbite.

The *black* exhibits indistinct traces of crystallization in four- or six-sided irregular prisms and plates. H.=5·5. G.=5·395. Lustre submetallic. Color iron-black. Streak gray. Opaque.

The *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.

The *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.—$\dot{R}^3(Ta, \dddot{W}, \ddot{U})$. Analyses: 1—4, Berzelius, (Afhandl. iv, 268, 272, and Schw. J. xvi, 451):

	Ta	$\dddot{W}$	$\ddot{U}$	$\dot{Y}$	$\dot{C}a$	$\dot{F}e$
1. *yellow*, $\dot{Y}^3(Ta, \ddot{U})$,	60·12	1·04	6·62	29·78	0·50	1·16=99·28.
2. " "	59·50	1·25	3·23	29·90	3·29	2·72=99·89.
3. *black*, $(\dot{Y}, \dot{C}a, \dot{F}e)^3(Ta, \dddot{W})$,	57·00	8·25	0·50	20·25	6·25	3·50=95·75.
4. *brown*, $(\dot{Y}, \dot{C}a)^3\,Ta$,	51·82	2·59	1·11	38·52	3·26	0·55=97·85.

Ta Th,Ce Ċa Ẏ Ṁn Ḟe Ḣ
1. 67·38 13·15 10·98 0·81 0·15 1·29 1·16, Ṅa 3·93, F 3·23, Ti Sn, Ṁg !=102·074, W.
2. 67·02 5·16 9·88 —— 1·69 1·38 7·06 Ü 4·60, Ti, Sn, Ṁg, Ṅa *trace*=97·80, W.
3. 62·25 —— 13·54, Ẏ, Ṁn 0·7, Ḟe 5·68, Ce 3·32, La 2·00, K̇, Ṅa, L̇i 3·72, F !, Ẅ *trace*, Zr 5·57, Ti 2·23, Ḣ 0·50=99·51, Hermann.
4. 53·10, Ti 20·20, Ċa 19·45, Ḟe 2·35, Oxyds of U, Mn, Pb, Sn 1·20, ign. 0·80=97·10, H.
5. 59·00,[a] Ti 18·33, Ċa 16·78, Ḟe and Ü, &c 0·70, Ṅa 5·68, ign. 0·80=101·19, Hayes.

[a] With some lime and titanic acid.

Wöhler by later experiments, (Ann. Ch. u. Pharm. lxi, 264), confirms the presence of thoria, not found by Hermann. He finds in the Fredericksvärn crystals, 62·75 titanic acid, (instead of columbic), and 12·85 of lime, with protoxyd of manganese 2·75, oxyd of iron 2·16, oxyd of uranium 6·18, oxyd of cerium 6·80, oxyd of tin 0·61, water 4·20. The formula deduced from analyses 1 and 2 is

$$(\dot{\mathrm{Ca}},\ \mathrm{Th},\ \dot{\mathrm{Ce}})^2\ \mathrm{Ta}.$$

G. Rose has written it (adoping the view that tantalic acid contains 2 of oxygen)[*]

$$2\dot{\mathrm{Ca}}^4\ \mathrm{Ta}^3+\mathrm{NaF},$$

(Syst. Uebers. Min. Gebirgs. Ural, Berlin, 1842). Hermann has the formula

$$2\dot{\mathrm{R}}^3\ \mathrm{Ta}+\bar{\mathrm{R}}(\mathrm{Ta},\ \mathrm{Ti})+(\mathrm{K},\ \mathrm{Na},\ \mathrm{Li})\mathrm{F}.$$

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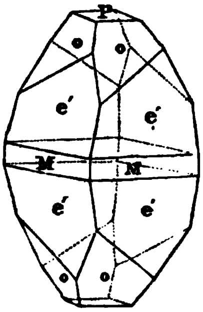
a white enamel is produced. With a particle of oxyd of iron, the borax globule in the reducing flame gives the characteristic reactions of ferruginous titanic acid. With salt of phosphorus a reddish yellow glass in the outer flame, which becomes green on cooling; in the reducing flame a clear green glass.

FERGUSONITE, *Haidinger*, Edinb. Trans. x, 274.



Dimetric, hemihedral. o : o=100° 28′ and 128° 27′, e′ : e′=88° 6′ and 159° 2′, M : e′= 169° 31′. Cleavage basal 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, or yellowish-brown. Streak pale brown. Subtranslucent—opaque. Fracture imperfect conchoidal.

Composition.—$(\dot{Y}, \dot{C}e)^3 \mathrm{Ta}$. Analysis by Hartwall, (K. V. Ac. H. 1828, 167):

Ta 47·75, $\dot{Y}$ 41·91, $\dot{C}e$ 4·68, $\bar{\bar{Z}}r$ 3·02, $\ddot{S}n$ 1·00, $\bar{U}$ 0·95, $\bar{F}e$ 0·34=99·65.

B.B. infusible but loses color; with borax it fuses with difficulty, and forms a glass, which is yellow while hot, with some interspersed white spots of undissolved matter. With soda it is decomposed without solution, leaving a reddish slag; affords globules of tin.

Discovered by Gisècké, near Cape Farewell, in Greenland, disseminated in quartz, and named in honor of Robert Ferguson, of Raith.

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1. *yellow*, $\dot{Y}^3(\mathrm{Ta}, \bar{U})$,	60·12	1·04	6·62	29·78	0·50	1·16=99·23.
2. " "	59·50	1·25	3·28	29·90	3·29	2·72=99·89.
3. *black*, $(\dot{Y}, \dot{C}a, \dot{F}e)^3(\mathrm{Ta}, \dddot{W})$,	57·00	8·25	0·50	20·25	6·25	3·50=95·75.
4. *brown*, $(\dot{Y}, \dot{C}a)^3 \mathrm{Ta}$,	51·82	2·59	1·11	38·52	3·26	0·55=97·85.

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-columbite occur in Sweden at Ytterby, in red feldspar, and at Broddbo and Finbo, near Fahlun, imbedded in quartz and albite, and associated with garnet, mica, and the pyrophysalite variety of topaz. We are indebted to Berzelius for the discovery and description of them.

EUXENITE, *Scheerer*, Pogg. l, 149, and lxxii, 561.

Trimetric. Angle of prism according to Scheerer, near 140°, culminant edge about 136°. Also massive, without any traces of cleavage.

H.=6·5. G.=4·6—4·76. Lustre metallic, vitreous. Streak-powder reddish-brown. Color brownish-black; in thin splinters has a reddish brown translucence, lighter than the streak. 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,	3·14	2·91
Protox. iron,	—	2·60
Lime,	2·47	—
Magnesia,	0·29	—
Water,	3·97	4·04

Scheerer's first analysis made the metallic acids the columbic and titanic; but he has since ascertained, that the mineral contains niobic and pelopic acids in place of columbic. 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 it becomes yellow or brownish-yellow, and the color is the same after cooling; and by flaming, it forms a yellowish enamel. The color is but little changed in the reduction flame. With salt of phosphorus it 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. It was named by Scheerer from ευξενος, *a stranger*, in allusion to the rarity of its occurrence. In its crystallization it approaches columbite.

POLYCRASE, (Polykras, *Scheerer*, Pogg. lxii, 480), is described with nearly the characters of euxenite. Its form is trimetric; M : M about 140°, and culminant edge 136°, Scheerer; the crystals are thin linear, ½ to 1½ inches long, and without cleavage.

H.=5·5. G.=5·10. Lustre bright. Black, and in fine splinters, brownish, streak grayish-brown. Fracture conchoidal.

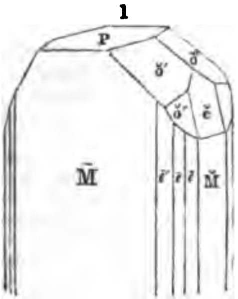
Composition.—Near Polymignite, but containing in addition, pelopic acid, niobic acid, protoxyd of uranium, and but little lime and no manganese. B.B. decrepitates, glows and becomes brown, but infusible. Yields with borax a glass which is yellow in the outer flame and brown in the inner. With soda on 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. The name is from πολυς, *many*, and κρασις, *mixture*.

COLUMBITE, *Hatchett.* Tantalite, (in part). Tantale Oxidé, *H.* Niobite, *Haid.* Baierine, *Beud.* Torrelite, *Thom.*

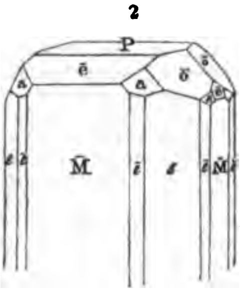
Trimetric. $\bar{\mathrm{M}} : e = 140° 20'$, $\breve{\mathrm{M}} : e = 129° 40'$, $\bar{\mathrm{M}} : \bar{e} = 157° 29'$, $\breve{\mathrm{M}} : \breve{e} = 158° 6'$, $e : e = 100° 40'$ and $79° 20'$; $\breve{e} : \breve{e} = 43° 48'$ and $136° 12'$; $\bar{e} : \bar{e} = 134° 58'$, $45° 2'$; $\mathrm{P} : \bar{e} = 160° 34'$, $\mathrm{P} : \breve{e} = 119° 40'$, $\mathrm{P} : \mathrm{a} = 126° 2'$, a : a (over $\breve{o}'$)$=102° 58'$, $\mathrm{a} : e = 143° 58'$. $\mathrm{P} : \breve{o}' = 136° 36'$, $\breve{o}' : \breve{o}' = 150° 17'$, $\mathrm{a} : \breve{o}' = 156° 20\frac{1}{2}'$, $\breve{o}' : \breve{e} = 133° 24'$, $\mathrm{P} : \breve{o}'' = 119° 13'$,

1



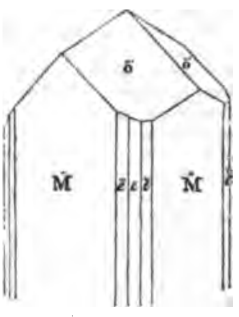
Bohemia.

2



Middletown, Conn.

3



Haddam, Conn.

$\breve{o}'' : \breve{o}''$ (over $\bar{e}$)$=160° 29'$, $\bar{e} : \breve{o}'' = 170° 14\frac{1}{2}'$. Brooke found with the common goniometer, from a specimen supposed from Bodenmais, $\breve{\mathrm{M}} : \breve{e} = 156° 30'$, $\breve{\mathrm{M}} : \bar{e} = 114° 30'$, $\mathrm{P} : \bar{e} = 120°$, $\mathrm{P} : \breve{o}' = 136° 30'$. Dr. Torrey found the angle $\breve{\mathrm{M}} : \breve{e}$, of a crystal (fig. 3) from Haddam, (Ann. New York Lyc. i, 89), to equal 157°, and $\breve{\mathrm{M}} : e = 129° 50'$. Cleavage parallel with $\bar{\mathrm{M}}$ and $\breve{\mathrm{M}}$ rather distinct, the former the more so; parallel with P indistinct. Occurs also massive.

H.=5—6. G.=5·4—6·4; 5·469—5·708, Connecticut; 5·7—6·39, Bavarian. Lustre submetallic; brownish-black; a little shining. Streak dark red to black. Color iron-black, brownish-black, grayish-black. Opaque. Fracture subconchoidal, uneven. Brittle.

Composition.—Essentially protox. of iron and of manganese with columbic, niobic, or pelopic acid$=(\dot{\mathrm{F}}\mathrm{e}, \dot{\mathrm{M}}\mathrm{n})^3(\mathrm{Ta}, \tilde{\mathrm{N}}\mathrm{i}, \dot{\mathrm{P}}\mathrm{e})^2$. Analyses: 1, Wollaston; 2, Schlieper, (Pogg. lxiii, 317); 3, 4, 5, 6, H. Rose, (ib.); 7, Awdejew, (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):

		G	Met. acids.	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{M}}\mathrm{n}$	$\ddot{\mathrm{S}}\mathrm{n}$	$\dot{\mathrm{C}}\mathrm{u}$
1.	Connecticut,	——	80·	15·	5·	——	——=100, Wollaston.
2.	Middletown,	5·469—5·495	78·83	16·66	4·17	0·29	0·07, $\dot{\mathrm{C}}\mathrm{a}$ 0·45, $\tilde{\mathrm{N}}\mathrm{i}$ 0·22=101·28, S.
3.	"	5·708	09·62	16·37	4·44	0·47	0·06, $\dot{\mathrm{C}}\mathrm{a}$ *trace*=100·96, Rose.
4.	Bodenmais,	6·39	81·07	14·30	3·85	0·45	0·13, " " =99·80, 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, Awd.
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, $\dot{\mathrm{Y}}$ 0·2 $\dot{\mathrm{M}}\mathrm{g}$ 2·44, $\dot{\mathrm{U}}$ 0·50=100, Herm.		
10.	" "	5·461	78·60	12·76	4·48, $\dot{\mathrm{C}}\mathrm{a}$ 0·75, $\dot{\mathrm{M}}\mathrm{g}$ 3·01, $\ddot{\mathrm{U}}$ 0·56, $\dot{\mathrm{C}}\mathrm{u}$ *trace*=		
11.	Limoges,	5·6—5·727	78·44	14·96	6·52=99·92, Damour. [100·17, Bromeis.		
12.	"	" "	78·90	14·50	7·15=100·55. Damour.		
13.	Middletown,	5·8	78·22	14·06	5·68, $\dot{\mathrm{M}}\mathrm{g}$ 0·49, $\ddot{\mathrm{S}}\mathrm{n}$ 0·4, $\bar{\mathrm{W}}$ 0·26=99·06, H.		

The yttria and uranium of the Ilmen columbite, Hermann attributes to a mixture with samarskite. The Ṁn in the above analysis of Bromeis includes also yttria.

H. Rose has discovered that in this species the columbic acid is more or less replaced by niobic and pelopic acids. The Ilmen specimens, according to him, contain mostly niobic acid along with traces of pelopic and tungstic acids; and this is also true of the Connecticut columbite. The Bodenmais mineral includes more pelopic acid, and hence its higher specific gravity. Specimens of the highest specific gravity at Bodenmais, give a black powder, and others of less gravity a dark reddish brown. The Limoges specimens (analyses 11, 12) resemble those of Bavaria, in containing principally pelopic acid; and Damour has proposed to adopt for this variety the name *Baierine*, while the niobic variety has been called *Niobite*.

Wollaston's analysis was made on four grains of the original specimen in the British Museum, sent out from Connecticut by Gov. Winthrop to Sir Hans Sloane.

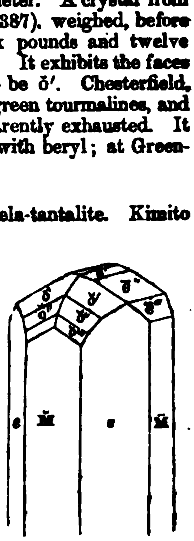
B.B. alone, on charcoal, infusible. With borax, in powder, fusion takes place slowly but perfectly, forming a blackish-green glass.

Columbite of Bodenmais, in Bavaria, and also of Rabenstein, near Zwiesel, in Bohemia, 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 Gov. Winthrop to Sir Hans Sloane, then President of the Royal Society, which was labeled as found at Neatneague. D. 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, associated with chrysoberyl, beryl, and automolite. Finer crystals come from a feldspar quarry near Middletown, along with albite. The above figure, 2, represents one of these crystals three quarters of an inch long; its faces are sufficiently brilliant for the use of the reflecting goniometer. A crystal from this locality, described by Professor Johnston, (Amer. J. Sci, xxx, 387). weighed, before it was broken, fourteen pounds. The part figured weighed six pounds and twelve ounces avoirdupois, and was about six inches in length and breadth. It exhibits the faces M̄, M̆, ĕ, ĕ′, ĕ, ē, and another imperfect plane, which appears to be ŏ′. 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.

FERRO-TANTALITE. Tantalite. Columbate of Iron. Tamela-tantalite. Kimito Tantalite.



Trimetric. M̆ : e=122° 54′, M̄ : ē′′′=152° 58′, ē′ : ē′=167° 38′, ŏ′ : ŏ′ (adjacent)=126°, ŏ′ : ŏ′ (over ē′)=112° 30′, ŏ′ : ŏ′ (planes at opposite extremities of the crystals)=91° 42′, ŏ′′ : ŏ′′ (adjacent)=91° 59′, ŏ′′′ : ŏ′′′=73° 37′. Also massive.

H.=5—6. G.=7·1—7·963. Lustre nearly pure metallic. Color iron black. Streak reddish-brown. Opaque. Brittle.

Composition.—The same elements as the preceding=(Ḟe, Ṁn)(T̈a, N̈i, P̈e). 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.):

	Ta	Ḟe	Ṁn	S̈n	Ċu	Ċa
1. Kimito,	83·2	7·2	7·4	0·6	—	—=98·4, Berzelius.
2. "	85·67	12·93	1·61	0·80	—	0·56, S̈i 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	1·31	0 07=101·98, 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. Berzelius found

	Ta	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\ddot{\mathrm{Sn}}$	$\dot{\mathrm{Ca}}$
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, $\ddot{\mathrm{W}}$ 6·19=100·59.
3. "	66·35	11·07	6·60	8·40	1·50, " 6·12=100·19.

Ferro-tantalite is confined mostly to albitic granite, and is usually associated with beryl. It occurs in Finland, both at Tamela and Kimito. In the Kimito tantalite, part of the iron is replaced by manganese. Near Harkasaari, ferro-tantalite is associated with rose quartz and gigantolite, in albitic granite. At Katiala it is associated with lithia mica, black tourmaline, and colorless beryl.

SAMARSKITE, *H. Rose.* Uranotantal, *G. Rose.* Yttroilmenite, *Herm.*

Trimetric: angle of prism 135° to 136°, which is near *ĕ* : *ĕ* of columbite. Usually in flattened grains.

H.=5·5. G.=5·614—5·68, Uranotantalite; 5·398—5·45, Yttroilmenite. Lustre of surface of fracture shining and submetallic. Color velvet black. Streak dark reddish-brown. Opaque.

Composition.—Analyses: 1, 2, 3, Perez, under the direction of Rose, (Pogg. lxxi, 157):

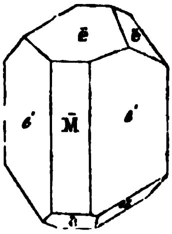
Met. acids.	$\ddot{\mathrm{U}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Y}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$ and $\dot{\mathrm{Mn}}$
56·38	14·16	15·43	9·15	0·80	0·92=96 84.
56·00	16·70	15·90	11·04	0·75	1·02=101·41.
55·91	16·77	15·94	8·36	0·75	1·88=99·61.

Hermann's ilmenic acid is shown by Rose to be a mixture of niobic and tungstic acids. Hermann gives as his result, ilmenic acid 57·813, titanic acid 5·901, $\dot{\mathrm{Ce}}$ and $\dot{\mathrm{La}}$ 2·278, $\dot{\mathrm{Y}}$ 18·302, $\ddot{\mathrm{U}}$ 1·869, $\dot{\mathrm{Fe}}$ 13·613, $\dot{\mathrm{Mn}}$ 0·310, $\dot{\mathrm{Ca}}$ 0·500=100·581. Hermann's name *yttroilmenite* alludes to the supposed new metal *ilmenium*, alledged to exist in this species.

Heated lightly in a glass tube, it decrepitates, disengages a little moisture, and burns 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.

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.

WOLFRAM, *M.* Tungstate of Iron. Tungstate of Iron and Manganese. Scheelate of Iron and Manganese. Scheelin Ferruginé, *H.*



Trimetric, and nearly of the form of columbite. *e'* : *e'*=101° 5', ē : ē (over the apex)=125° 20', ĕ : ĕ (over the apex)=99° 12', G. Rose; e' : e'=101° 45', Kerndt. Cleavage perfect parallel with the shorter diagonal; imperfect parallel to the longer. Compound crystals, composition parallel to M̄ and ĕ; also irregular lamellar; coarse divergent columnar; massive granular—particles strongly coherent.

H.=5—5·5. G.=7·1—7·55. Lustre submetallic. Streak dark reddish-brown. Color dark grayish or brownish-black. Opaque. Sometimes weak magnetic.

Composition.—$(\dot{F}e, \dot{M}n)\dddot{W}$; either $2\dot{F}e\dddot{W}+3\dot{M}n\dddot{W}$, or $4\dot{F}e\dddot{W}+\dot{M}n\dddot{W}$.

Analyses: 1, 2, Schaffgotsch, (Pogg. lii, 475); 3, Ebelmen, mean of 2 analyses, (Ann. Ch. Phys. [3], viii, 505): 4, Kussin, (Ramm. 3d Supp. 127); 5—10, Kerndt, (J. f. pr. Chem. xlii, 81): 11, 12, Schaffgotsch, (loc. cit.); 13, Ebelmen, mean of 5 analyses, (loc. cit.); 14, Rammelsberg, (2d Supp. 175); 15, 16, 17, 18, Kerndt:

I. Formula, $2\dot{F}e\dddot{W}+3\dot{M}n\dddot{W}$.

	G	$\dddot{W}$	$\dot{F}e$	$\dot{M}n$
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, $\dot{C}a$ 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	75·62	9·55	14·35=100·02, "
7. Lane's Mine,	7·411—7·486	75·47	9·53	14·26=99·26 "
8. "	7·208—7·269	75·76	9·74	14·50=100·00, "
9. Schlackenwald,	7·482—7·535	74·68	9·56	14·30=99·54, "
10. Altenberg,	7·198—7·189	75·44	9·64	14·90=99·98, "

II. Formula, $4\dot{F}e\dddot{W}+\dot{M}n\dddot{W}$.

11. Ehrenfriedersdorf,		76·10	19·16	4·74=100, Schaffgotsch.
12. Chanteloup,	7·437	76·00	18·33	5·67=100, "
13. Limoges,		76·20	19·19	4·48, $\dot{M}g$ 0·80=100·67, Ebelmen.
14. Harzgerode,	7·143	75·56	20·17	3·54=99·27, Rammelsberg.
15. "	7·23	75·90	19·25	4·80=99·95, Kerndt.
16. Monte Video,	7·5—7·513	76·02	19·20	4·75=99·98, "
17. Nertschinsk,	7·5	75·64	19·55	4·81=100·00, "
18. Chanteloup,	7·48—7·51	75·83	19·32	4·84=99·99, "

Schaffgotsch makes the tungstic acid, $\ddot{W}$; and Margueritte considers the tungsten in the state of W^2O^5, or $\ddot{W}+\dddot{W}$, and the iron and manganese as peroxyd. Rammelsberg adopts the formula above given.

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, Zinnwald, Ehrenfriedersdorf, and Nertschinsk; also at Limoges, in France, 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; also reported from near Mine La Motte, Missouri. Pseudomorphs, of the form of tungstate of lime, are often observed at Lane's mine. It has also been met with in small quantities in Trumbull, Conn., at the topaz vein; also massive 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).

A mineral from Schlackenwald, occurring with fluor spar and apatite, in fine needles of a brownish red color, and G.=6·45, afforded Rammelsberg on analysis, (Ramm. 3d Supp. 127):

$\dddot{W}$ 67·05, $\dot{F}e$ 6·72, $\dot{M}n$ 19·73, $\dot{C}a$ 3·02, $\not{\dddot{A}}l$ 1·01, $\dddot{S}i$ 0·08, $\not{\dddot{P}}$ and F 0·61, ign. 0·78=100.

Rammelsberg observes that it may be a partially altered wolfram, or perhaps has the formula $\not{R}^3\dddot{W}^2$.

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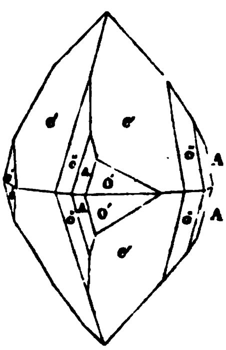
* Erroneously printed H. Rose, on page 384.

SCHEELITE, *Leonh.* Tungstate of Lime. Tungsten. Scheelin calcaire, *H.* Schwerstein, *W.*

Dimetric; hemihedral; A : A=100° 40′ and 129° 2′, Levy; e′ : e′=108° 12′, and 112° 2′. A : e′=140° 20′, e′ : o′=151° 33′. Cleavage octahedral, though interrupted; in traces parallel to A. Compound crystals, composition parallel to planes truncating the basal edges. Imperfect crystallizations, reniform with columnar structure; also massive granular.



Schlackenwald.

H.=4·5—5. G.=6—6·076, the latter, white crystalline from Schlackenwald, Haidinger. Lustre vitreous, inclining to adamantine. Streak white. Color white, inclining to yellow and brown; sometimes almost orange-yellow. Subtransparent—translucent. Fracture uneven. Brittle.

Composition.—$\dot{\mathrm{Ca}}\dddot{\mathrm{W}}$=Lime 19·36, tungstic acid 80·64.

Analyses: 1, Scheele, (K. V. Ac. Handl. f. 1781); 2, 3, Klaproth, (Beit. iii, 44); 4, Berzelius, (Afh. i Fis. iv, 305); 5, 6, Brandes and Bucholz, (Schweig. xx, 285); 7, Choubine, (Ann. des. M. Russ. 1841, 317); 8, Rammelsberg, (Pogg. lxxvii, 245); 9, Bowen, (Am. J. Sci. v, 118):

	$\dot{\mathrm{Ca}}$	$\dddot{\mathrm{W}}$	$\bar{\mathrm{S}}\mathrm{i}$	$\overline{\mathrm{Fe}}$
1. Bitsberg, Sweden,	31·00	65·00	4·00	——=100, Scheele in 1781.
2. Schlackenwald,	17·60	77·75	3·00	——=98·35, Klaproth.
3. Cornwall,	18·70	75·25	1·50	1·25, $\overline{\mathrm{Mn}}$ 0·75=97·45, Klaproth.
4. Westmanland, Sweden,	19·40	80·417	——	——=99·817, Berzelius.
5. Schlackenwald,	19·06	78·00	2·00	——=99·06, B. and B.
6. Zinnwald,	16·60	76·50	2·94	1·50, $\dot{\mathrm{Ca}}$ 1·1=98·54, B. and B.
7. Katherinenburg,	18·88	78·41		$\dot{\mathrm{Mg}}$ 0·65=97·94, Choubine; G. 6·071.
8. Neudorf,	21·56	78·64	——	——=100·20, Ramm.; G. 6·08.
9. Monroe, Ct.	19·36	76·05	2·54	1·03, $\overline{\mathrm{Mn}}$ 0·31=99·29, Bowen.

Domeyko has analyzed a green scheelite from the Province of Coquimbo in Chili, and found it to contain, (Ann. d. M. [4], iii, 15):

$\dddot{\mathrm{W}}$ 75·75, $\dot{\mathrm{Ca}}$ 18·05, $\dot{\mathrm{Cu}}$ 3·30, $\bar{\mathrm{S}}\mathrm{i}$ 0·75=97·85.

The loss, according to Rammelsberg, is without doubt tungstic acid.

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 acids 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 Caldbeckfell, 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; and Coquimbo, Chili.

In the United States it is found crystallized and massive, at Monroe and Huntington, Conn., at Lane's mine, where it is associated with wolfram, pyrites, rutile, and native bismuth, in quartz.

Tungstate of lime has not been employed in the arts. It affords tungstic acid, which is a beautiful yellow pigment, but becomes green on exposure.

SCHEELETINE, *Beud.* Tungstate of Lead. Stolzit, *Haid.* Scheelbleierz. Scheelsaures Blei. Scheelbleispath. Bleischeelat.

Dimetric. In modified square octahedrons or prisms. A : A = 99° 44′, and 131° 25′; another octahedron has the angles 92° 46′ and 154° 36′. Crystals often indistinctly aggregated. Cleavage basal, imperfect.

H.=2·75—3. G.=7·904—8·13. Lustre resinous, subadamantine. Color green, gray, brown, and red. Streak uncolored. Faintly translucent.

Composition.—$\dot{\mathrm{Pb}}\dddot{\mathrm{W}}$=Tungstic acid 52, oxyd of lead 48.

Kerndt obtained as the mean of two analyses of specimens from Zinnwald, (J. f. pr. Ch. xlii, 116):

$\dddot{\mathrm{W}}$ 51·736, $\dot{\mathrm{Pb}}$ 45·993, $\dot{\mathrm{Ca}}$ 1·395, $\dot{\mathrm{Fe}}$ and $\dot{\mathrm{Mn}}$ 0·471.

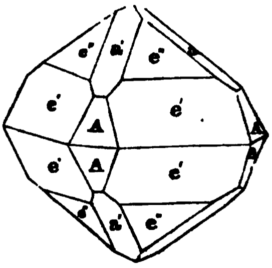
B.B. melts and gives off vapors of lead, leaving a dark colored submetallic crystalline globule, having a pale-gray streak. Soluble in nitric acid with a yellow precipitate.

Scheeletine occurs at Zinnwald in Bohemia, associated with quartz and mica; also at Bleiberg in Carinthia, accompanying molybdate of lead.

WULFENITE, *Haid.* Molybdate of Lead. Gelb-bleierz, *Wern.* Yellow Lead Ore. Bleigelb, *Haus.* Bleimolybdat.

Dimetric. In modified square tables and square octahedrons; A : A (over a terminal edge)=99° 40′; A : A (over a basal edge)=131° 35′; fig. 54, pl. 1; also the annexed figure, e′ : e′ (over basal edge)=115° 7′, A : a′=150° 46′, e′ : e″=168° 49′, e″ : e″ (over a′)=118° 26′, e″ : e″ (over e′)=92° 43′. Cleavage octahedral, very smooth. Also granularly massive, coarse or fine, firmly coherent.

H.=2·75—3. G.=6·3—6·9. Lustre resinous or adamantine. Streak white. Color wax-yellow, passing into orange-yellow; also siskin and olive-green, yellowish-gray, grayish-white. Subtransparent—subtranslucent. Fracture subconchoidal. Brittle.



Bleiberg.

Composition.—$\dot{\mathrm{Pb}}\dddot{\mathrm{Mo}}$=Molybdic acid 39·19, oxyd of lead 60·81. Analyses: 1, Hatchett, (Phil. Trans. 1796, p. 233); 2, Göbel, (Schw. J. xxxvii, 71); 3, Melling, (Rammelsberg, 1st Supp. 59); 4, 5, J. Brown, (Proc. Phil. Soc. Glasgow, April, 1847):

1.	Carinthia,	$\dot{\mathrm{Pb}}$ 58·40	$\dddot{\mathrm{Mo}}$ 37·00, $\dddot{\bar{\mathrm{Fe}}}$ 3·08, $\dddot{\mathrm{Si}}$ 0·28=98·76, Hatchett.
2.	"	59·0	40·5=99·5, Göbel.
3.	"	61·903	40·293=102·196, Melling.
4.	"	60·35	39·30=99·65, Brown.
5.	"	60·23	39·19=99·42, "

A red variety contains a few per cent. 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 Schwarzenbach, Bleiberg, and Windish-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 at the Perkiomen mine near Philadelphia.

A molybdate of lead from Pamplona, S. A., afforded Boussingault, (Ann. Ch. Phys. xlv, 325):

$\dot{\mathrm{P}}\mathrm{b}$ 78·8, $\dddot{\mathrm{M}}\mathrm{o}$ 10·0, $\ddot{\mathrm{C}}$ 2·9, HCl 1·3, $\overset{\cdots}{\overline{\mathrm{P}}}$ 1·3, $\dddot{\mathrm{C}}\mathrm{r}$ 1·2, $\ddot{\overline{\mathrm{F}}}\mathrm{e}$ 1·7, $\ddot{\overline{\mathrm{A}}}\mathrm{l}$ 2·2, quartz 3·7=98·1.

He considers it a basic salt with the formula $\dot{\mathrm{P}}\mathrm{b}^3\dddot{\mathrm{M}}\mathrm{o}$.

Domeyko gives an analysis of an ore from Chili, (Ann. d. Mines, [4], iii, 15), which afforded him

$\dot{\mathrm{P}}\mathrm{b}$ 4·30, $\dddot{\mathrm{M}}\mathrm{o}$ 42·2, $\dot{\mathrm{C}}\mathrm{a}$ 6·3, $\ddot{\overline{\mathrm{F}}}\mathrm{e}$ 8·5=100,

in which lime appears to replace part of the lead.

III. URANIUM.

Uranium does not exist native. It occurs in combination with oxygen; also with sulphuric, phosphoric, and carbonic acids, combined in most of these compounds with lime or oxyd of copper. It is also contained in some ores of columbium, as yttro-columbite, (p. 399), pyrochlore, (p. 297), samarskite, (p. 403), and euxenite, (p. 400).

URANOCHRE. Uranblüthe. Uraconise, *Beud.*

Earthy and pulverulent. Color sulphur-yellow, citron-yellow to brownish or reddish-yellow. Opaque.

Composition.—Probably $\ddot{\overline{\mathrm{U}}}$ with water and sometimes 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.

It accompanies pitchblende in Cornwall and in Bohemia. At the Callington tin mine, Cornwall, it has been observed in masses of considerable size, which were quite free from carbonic acid. It is found sparingly with columbite and uranite at the feldspar quarry near Middletown, Ct.

PITCHBLENDE. Protoxyd of Uranium. Pecherz, *W.* Pechuran, *Haus.* Gummierz, Pittinerz, *Breit.* Uranpecherz. Urane Oxydulé, *H.*

Monometric. In octahedrons, and the same with the faces of the cube, Scheerer. Usually massive and botryoidal; also in grains; structure sometimes columnar or curved lamellar.

H.=5·5. G.=6·468—7·1. Lustre submetallic or dull. Color grayish, brownish, or velvet-black, red. Streak black, a little shining. Opaque. Fracture conchoidal, uneven.

Composition.—$\dot{\mathrm{U}}\dddot{\bar{\mathrm{U}}}$! 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, (J. f. pr. Chem. xxix, 333):

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. $\dot{\mathrm{U}}\dddot{\bar{\mathrm{U}}}$ 79·15 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, $\dddot{\mathrm{S}}$ 0·60, $\dot{\mathrm{H}}$ 1·85=100·89, Ebelmen.
5. 76·6, 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*, $\dddot{\bar{\mathrm{P}}}$ 2·30, HF *trace*=99·36, K.

The specimens for these analyses were from Joachimsthal, excepting Nos. 2 and 6, and the last is the so-called *Gummierz*. No. 5 is the crystallized variety. The composition of this species is not fully ascertained, neither is it quite certain that the crystallized specimens are identical with the amorphous. Vanadium and also selenium occur in the ore from Johanngeorgenstadt.

B.B. alone infusible, but in the forceps colors exterior flame green. With borax it 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. 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 Tol Carne mines near Redruth, in Cornwall; also near Adrianople, Turkey.

It is employed in porcelain painting, affording an orange-color in the enamelling fire, and a black color in that in which the porcelain is baked.

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—4·2. Color hyacinth-red; contains nearly 15 per cent. of water.

CORACITE, Le Conte, (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):

$\dddot{\bar{\mathrm{U}}}$ 59·30, $\dot{\mathrm{Pb}}$ 5·36, $\dot{\mathrm{Ca}}$ 14·44, $\ddot{\mathrm{C}}$ 7·47, $\dddot{\bar{\mathrm{Fe}}}$ 2·24, $\dddot{\bar{\mathrm{Al}}}$ 0 90, $\dot{\mathrm{H}}$ 4·64, $\dddot{\mathrm{Si}}$ 4·35, $\dot{\mathrm{Mg}}$, $\dot{\mathrm{Mn}}$ *trace*=98·70.

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. The 7·47 $\ddot{\mathrm{C}}$ would take up 9·55 of the lime, making 17·02 per cent. of carbonate of lime—an amount that would promote much the solubility of the mineral in acids. Excluding the carbonate of lime, 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.

The mineral evidently contains the carbonate of lime as impurity.

JOHANNITE. Sulphate of the Protoxyd of Uranium. Uranvitriol.

Monoclinic. Crystals flattened and from one to three lines in length, arranged in concentric druses or reniform masses.

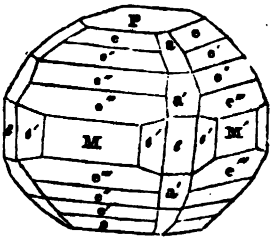
H.=2—2·5. G.=3·19. Lustre vitreous. Color beautiful emerald-green, sometimes passing into apple-green. Streak paler. Transparent—translucent; sometimes opaque. Taste bitter, rather than astringent.

Composition.—According to John's researches a hydrous sulphate of the protoxyd of uranium.

Soluble in water. Solution precipitated chestnut-brown by prussiate of potash, yellowish-green by alkalies, and in brown flocks by an infusion of nutgalls.

This mineral was discovered by John, near Joachimsthal in Bohemia, after whom it is named.

URANITE. Uran Mica. Uranglimmer. Uranoxyd, *Haus.* Urane Oxydé, *H.* Uranphyllit.



Dimetric. Forms similar to figs. 52 and 53, pl. 1; also the annexed figure; P : e=145° 32′, P : e′=140° 40′, P : e″=137° 10′, P : e‴=111° 50′; P : a′=134°, Phillips. Cleavage basal, highly perfect; traces of *e*. Surface P smooth, M rough.

Lustre of P pearly, of other faces adamantine. Transparent — subtranslucent. Fracture not observable. Sectile. Laminæ brittle and not flexible.

VAR. 1. URANITE. Lime-Uranite. Kalk-Uranit.

H.=2—2·5. G.=3·05—3·19. Color citron to sulphur-yellow.

Composition.—$\dot{\text{C}}\text{a}^{2}\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}+\bar{\text{U}}^{4}\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}+16\dot{\text{H}}$=Phosphoric acid 15·52, oxyd of uranium 62·63, lime 6·19, water 15·66=100. Analysis by Berzelius (Jahresb. xxii, 212):

$\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$	$\bar{\text{U}}$	$\dot{\text{C}}\text{a}$	$\dot{\text{M}}\text{g}$ and $\dot{\text{M}}\text{n}$	$\dot{\text{B}}\text{a}$	$\ddot{\text{S}}\text{n}$	$\dot{\text{H}}$
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 ores.

Occurs in the Siebengebirge in the hornstone of a trachytic range; at Johanngeorgenstadt; at Lake Onega, Wolf Island, Russia; also near Limoges. 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 Acworth, N. H., where it was detected by J. E. Teschemacher; the colors are straw-yellow and light green.

VAR. 2. CHALCOLITE. Copper-Uranite, Kupfer-Uranit.

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.—$\dot{\text{C}}\text{u}^{2}\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}+\bar{\text{U}}^{4}\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}+16\dot{\text{H}}$, or same as above, with copper in place of lime=Phosphoric acid 15·15, oxyd of uranium 61·14, oxyd of copper 8·42, water 15·29=100. Analyses: 1, Berzelius, (loc. cit.): 2, Werther, (J. f. pr. Ch. xliii, 334):

$\overset{\cdot\cdot\cdot\cdot\cdot}{\text{P}}$	$\bar{\text{U}}$	$\dot{\text{C}}\text{u}$	$\dot{\text{H}}$
15·57	61·39	8·44	15·05=100·45, Berzelius.
14·34	59·03	8·27	15·39, $\bar{\text{S}}\text{i}$ 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 Tincroft and Wheal Buller, near Redruth in Cornwall. Found also at Johanngeorgenstadt, and elsewhere in Saxony; in Bohemia at Joachimstahl and Zinnwald; at St. Symphorien near Autun in veins in granite.

Composition.—ÜŰ; Analyses: 1, Klaproth, (P 826); 3, Rammelsberg, (Pogg. lix, 35); 4, Ebe' Scheerer, (Pogg. lxxii, 561); 6, Kersten, (J. f. r

1. Ü 86·5 ḞeF̈e 2·5 PbS 6·0 S̈i 5·0=10
2. 84·52 Ḟe 8·24 4·20 2·02, Ċ
3. ÜŰ 79·15 Fe 3·03 Pb 6·20 As 1·13
4. " 75·94 Ḟe 3·10 4·22 Ṁn
5. 76·6, Pb, met. acids, and S̈i
6. Ű 72·00, M̈n 0·05, Ċa 6·00, S̈

The specimens for these analy the last is the so-called *Gumm* of this species is not fully as specimens are identical with ore from Johanngeorgenst

B.B. alone infusible, b melts to a dark yellow dissolved, but yields th nitric acid, evolving r tractable by the m

Pitchblende acc enberg, and Schr banya in Hung Redruth, in C

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336. Carbonate of Uranium a

cleavage apparent in one direction. cture vitreous. Color beautiful apple-

ȮH=Oxyd of uranium 36·3, lime 7·1, carbonic acid 11·1, L. Smith, (loc. cit.):

0, Ċa 8·0, C̈ 10·2, Ḣ 45·2.

s much water, and becomes yellowish-gray. At redness it blackens, and on cooling returns to an orange-red color. At a higher heat it black- mains so on cooling. With borax it gives a yellow glass in the outer flame, green glass in the inner. Tested for vanadic acid, but none found. Dissolves readily nitric acids with violent effervescence, and affords a yellow solution. Occurs with Medjidite on pitchblende. Dr. Smith states that both the lime and uranium of this salt are derived from the pitchblende.

IV. TELLURIUM, BISMUTH, ANTIMONY, ARSENIC.

The metals Tellurium, Bismuth, Antimony, Arsenic, occur native. *Tellurium* is besides found in combination with gold, silver, lead, and bismuth; and also as an ochreous oxyd.

Antimony exists commonly in combination with sulphur, or sulphur and lead; also with sulphur and bismuth; with copper, cobalt, nickel, silver. Occasionally it occurs as an acid, and sometimes in combination with lime or lead, forming antimonates.

Arsenic forms arseniurets with iron, cobalt, nickel, copper, silver, manganese or antimony; also with sulphur, (realgar, orpiment); it exists also as an acid, and in this state is united with lime, or oxyd of lead, copper, nickel, cobalt, or iron.

Bismuth is found combined with sulphur, tellurium, antimony, nickel, and silver, and also with gold; also as an oxyd with silica and carbonic acid.

The metals in this section are isomorphous.

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$2BiTe^2+Bi($

$3BiTe+BiS^3$.

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g in Saxony, at Joachimstahl in Bohemia, and with Beresof in Siberia.

in Cornwall, afforded Macgregor, Oxyd of bis- iron 2·1, alumina 7·5, silica 6·7, water 3 6.

ieselwismuth. Arsenikwismuth. Silicate Thom.

ary forms, figs. 30, 34, and mperfect; usually in minute nellar, or granular. esinous or adamantine. straw-yellow. Streak —opaque. Fracture

TELLURIUM. Gediegen Sylvan, *W.* Gediege Auro-ferrifère, *H.*

Frankenheim. Analysis and Ḧ 1·01=98·6. to a dark-yellow ining it yellow- button, at first h. With salt nes colorless

Hexagonal or rhombohedral, with R : R=86 regular six-sided prisms, with the terminal edges re 122° 24′, W. Phillips. Cleavage, lateral perfect, basa Also massive and granular.

H.—2—2·5. G.=5·7—6·3. Lustre metallic. Color and str 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.

Nicol.

Native tellurium occurs at the mine of Maria Loretto, near Zalathna, in Transylvania, where it occurs 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.

TELLURIC OCHRE. Tellurite, *Nicol.* Tellurige Saure, *Petz.*

In small spherical masses; structure radiated. Color yellowish or grayish-white. Also as an earthy coating.

Composition.—Probably $\ddot{Te}$, or tellurous acid.

Occurs with native tellurium at Facebay and Zalathna in Siebenburg.

BISMUTH. Gediegen Wismuth, *W.* Bisemutum, *Agricola.* Plumbum Cinereum. Tectum Argenti. Antimonium Femininum.

Rhombohedral, G. Rose; R : R=87° 40′, or so near a right angle that the crystals appear like cubes. Cleavage parallel to a plane on the lateral angles, and also basal. Also in reticulated and arborescent shapes; foliated and granular.

H.=2—2·5. G.=9·737. 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 may be malleated.

MEDJIDITE, *J. L. Smith*, Am. J. Sci. 2d ser. v, 336. Sulphate of Uranium and Lime.

Massive, with an imperfectly crystalline structure.

H.=2·5. Lustre vitreous in the fracture. Color dark amber. Transparent.

Composition.—$\ddot{\bar{U}}\dddot{S}+\dot{C}a\dddot{S}+15\dot{H}$, 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 in some places with crystals of sulphate of lime. 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.

LIEBIGITE, *J. L. Smith*, Am. J. Sci. 2d ser. v, 336. Carbonate of Uranium and Lime.

In mammillary concretions, cleavage apparent in one direction.

H.=2—2·5. Lustre of fracture vitreous. Color beautiful apple-green. Transparent.

Composition.—$\ddot{\bar{U}}\ddot{C}+\dot{C}a\ddot{C}+20\dot{H}$=Oxyd of uranium 36·3, lime 7·1, carbonic acid 11·1, water 45·5. Analysis by J. L. Smith, (loc. cit.):

$\ddot{\bar{U}}$ 38·0, $\dot{C}a$ 8·0, $\ddot{C}$ 10·2, $\dot{H}$ 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.

Occurs with Medjidite on pitchblende. Dr. Smith states that both the lime and uranium of this salt are derived from the pitchblende.

IV. TELLURIUM, BISMUTH, ANTIMONY, ARSENIC.

The metals Tellurium, Bismuth, Antimony, Arsenic, occur native. *Tellurium* is besides found in combination with gold, silver, lead, and bismuth; and also as an ochreous oxyd.

Antimony exists commonly in combination with sulphur, or sulphur and lead; also with sulphur and bismuth; with copper, cobalt, nickel, silver. Occasionally it occurs as an acid, and sometimes in combination with lime or lead, forming antimonates.

Arsenic forms arseniurets with iron, cobalt, nickel, copper, silver, manganese or antimony; also with sulphur, (realgar, orpiment); it exists also as an acid, and in this state is united with lime, or oxyd of lead, copper, nickel, cobalt, or iron.

Bismuth is found combined with sulphur, tellurium, antimony, nickel, and silver, and also with gold; also as an oxyd with silica and carbonic acid.

The metals in this section are isomorphous.

List of Species.

Native Tellurium.		White Antimony,	SbO^3.
Telluric Ochre.		Romeine,	$\dot{\text{Ca}}^4\ddot{\text{Sb}}^2$.
Native Bismuth,		Stiblite,	$\text{SbO}^4+\dot{\text{H}}$.
Bismuthine,	BiS^3.	Cervantite,	SbO^4.
Bismuth Ochre,	BiO^3.	Red Antimony,	$\text{SbO}^3+2\text{SbS}^3$.
Bismuth Blende,	$\overline{\text{Bi}}^2\overline{\text{Si}}^3$.	Antimony Glance,	SbS^3.
Bismutite,	(?) $\overline{\text{Bi}}^4\ddot{\text{C}}^3\dot{\text{H}}^4$.	Berthierite,	SbS^3 and FeS.
Aciculite,	$3(\text{Ɵu}, \text{Pb})\text{S}+\text{BiS}^3$.	Arsenic'l Antimony,	SbAs^3.
Cupreous Bismuth,	(?)$\text{ƟuS}+\text{BiS}$.	Native Arsenic.	
Tetradymite,	$2\text{BiTe}^3+\text{Bi}(\text{S}, \text{Se})^3$	Arsenous Acid,	AsO^3.
Bornite,	$3\text{BiTe}+\text{BiS}^3$.	Realgar,	AsS^2.
Native Antimony.		Orpiment,	AsS^3.

TELLURIUM. Gediegen Sylvan, *W.* Gediegen Tellur, *Haus.* and *L.* Tellure Natif Auro-ferrifère, *H.*

Hexagonal or rhombohedral, with R : R=86° 57′, G. Rose. In regular six-sided prisms, with the terminal edges replaced; P : e=122° 24′, W. Phillips. Cleavage, lateral perfect, basal imperfect. Also massive and granular.

H.—2—2·5. G.=5·7—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, where it occurs 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.

TELLURIC OCHRE. Tellurite, *Nicol.* Tellurige Saure, *Petz.*

In small spherical masses; structure radiated. Color yellowish or grayish-white. Also as an earthy coating.

Composition.—Probably $\ddot{\text{Te}}$, or tellurous acid.

Occurs with native tellurium at Facebay and Zalathna in Siebenburg.

BISMUTH. Gediegen Wismuth, *W.* Bisemutum, *Agricola.* Plumbum Cinereum. Tectum Argenti. Antimonium Femininum.

Rhombohedral, G. Rose; R : R=87° 40′, or so near a right angle that the crystals appear like cubes. Cleavage parallel to a plane on the lateral angles, and also basal. Also in reticulated and arborescent shapes; foliated and granular.

H.=2—2·5. G.=9·737. 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 may be malleated.

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 arborescent delineations in brown jasper. At Wheal 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 with wolfram, tungstate of lime, galena, blende, &c., in quartz; also at Brewer's mine, Chesterfield district, South Carolina.

BISMUTHINE, *Beud.* Sulphuret of Bismuth. Wismuthglanz. Bismuth Sulfuré, *H.*

Trimetric. In acicular crystals, prismatic, of 91° 30′. Cleavage parallel to the lateral axes, to one of them perfect; to P imperfect. Also massive, with a foliated or fibrous structure.

H.=2—2·5. G.=6·549. Lustre metallic. Streak and color lead gray to tin-white, with a yellowish or iridescent tarnish. Opaque. Sectile.

Composition.—BiS^3=Sulphur 18·49, bismuth 81·51; isomorphous with Antimony glance. Analyses: 1, H. Rose, (Gilb. Ann. lxxii, 192); 2, Wehrle, (Baumg. Zeits. x, 385); 3, Warrington, (Phil. Mag. ix, 29); 4, Scheerer, (Pogg. lxv, 299); 5, Hubert:

	S	Bi
1. Riddarhyttan,	18·72	80·98=99·70, Rose.
2. Retzbanya,	18·28	80·96=99·24, Wehrle.
3. Cornwall,	20·00	72·49, Fe 3·70, Cu 3·81=100, Warrington.
4. Gjellebäk,	19·12	79·77, " 0·15, " 0·14=99·18, Scheerer; G. 6·403.
5. Orawitza,	19·47	74·55, " 0·40, " 3·13, Au 1·23, Pb 2·27=100·35, Hubert.

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, in brilliant tin-white crystals; at Botellack, near Land's End, of a yellowish-white color; at Johanngeorgenstadt, Altenberg and Schneeberg in Saxony, both massive and acicular in limestone; with cerium ore at Bastnaes in Sweden.

It is said to have been observed at Haddam, Conn., associated with chrysoberyl, beryl, garnet, and columbite.

Unlike native bismuth, this ore does not effervesce in cold nitric acid. By this test, these two species may be distinguished, when other characters fail. It is more fusible than galena, and less volatile than gray antimony.

The angle 91½° was obtained from artificial crystals by Brooke.

BISMUTH OCHRE. Oxyd of Bismuth. Wismuthocre, *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.—Bi=Oxygen 10·14, bismuth 89·86, 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.

B.B. on charcoal, it is easily reduced to the metallic state, and subsequently the greater part may be dissipated.

It occurs pulverulent at Schneeberg in Saxony, at Joachimstahl in Bohemia, and with native gold and an ore of bismuth at Beresof in Siberia.

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.

BISMUTH BLENDE. Eulytine, *Breit.* Kieselwismuth. Arsenikwismuth. Silicate of Bismuth, *Thom.*

Monometric: hemihedral. Secondary forms, figs. 30, 34, and 35, pl. 1. Cleavage dodecahedral, very imperfect; usually in minute crystals; also globular, and columnar, lamellar, or granular.

H.=4·5. G.=5·912—6·006. Lustre resinous or adamantine. Color dark hair-brown, yellowish-gray, and straw-yellow. Streak yellowish-gray or uncolored. Subtransparent—opaque. Fracture uneven. Rather brittle.

Composition.—$\dddot{\overline{\rm Bi}}{}^2\dddot{\rm Si}{}^3$, with some phosphate and fluorid of iron, Frankenheim. Analysis by Kersten, (Pogg. xxvii, 81):

$\dddot{\overline{\rm Bi}}$ 69·38, $\dddot{\rm Si}$ 22·23, $\overline{\rm P}$ 3·31, $\overline{\rm Fe}$ 2·40, $\overline{\rm Mn}$ 0·30, HF and $\dot{\rm H}$ 1·01=98·6.

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.

BISMUTITE, *Breit.*, Pogg. liii, 627. Wismuthoxyd Kohlensaures. Bismuthite, *Nicol.* Wismuthspath. Carbonate of Bismuth.

In implanted acicular crystallizations, (pseudomorphous); also incrusting, or massive.

H.=4—4·5; 3·5 specimens that have lost their lustre. G.=6·86—6·909, Breit.; 7·670, from S. C., 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, $3(\dddot{\overline{\rm Bi}}\,\ddot{\rm C}+\dot{\rm H})+\dddot{\overline{\rm Bi}}\,\dot{\rm H}\,(=\dddot{\overline{\rm Bi}}{}^4\,\ddot{\rm C}{}^3\,\dot{\rm H}{}^4)$=Oxyd of bismuth 90·28, carbonic acid 6·29, water 3 43=100. Analysis, (Pogg. lxxvi, 564, 1849):

$\dddot{\overline{\rm Bi}}$ 90·00, $\ddot{\rm C}$ 6·56, $\dot{\rm H}$ 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 Voigland, with brown iron ire, 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.

ACICULITE, *Nicol.* Acicular Bismuth. Needle Ore, *J.* Plumbo-cupriferous Sulphuret of Bismuth. Nadelerz. Bismuth Sulfuré Plumbo-Cuprifère, *H.*

Trimetric; in imbedded long acicular crystals, longitudinally striated. Also massive.

H.=2—2·5. G.=6·125, John. Lustre metallic. Color blackish lead-gray, with a pale copper-red tarnish. Opaque. Fracture uneven.

Composition.—$(3\overline{\mathrm{C}}\mathrm{uS}+\mathrm{BiS}^3)+2(3\mathrm{PbS}+\mathrm{BiS}^3)=3(\overline{\mathrm{C}}\mathrm{u}, \mathrm{Pb})\mathrm{S}+\mathrm{BiS}^3$, or analogous to Bournonite, with which it is isomorphous.

Analyses: 1, John, (Gehl. J. [2], v, 227—analysis imperfect); 2, 3, Frick, (Pogg. xxxi, 529); 4, Chapman, (Phil. Mag. [3], xxxi, 541):

	S	Bi	Pb	Cu
1. Beresof,	11·58	43·20	24·32	12·10, Ni 1·58. Te 1·32=94·10, John.
2. "	16·05	34·62	35·69	11·79=90·15, Frick.
3. "	16·61	36·45	36·05	10·59=99·70, "
4. "	18·78	27·93	40·10	12·53=99·64, Chapman.

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.

CUPREOUS BISMUTH. Kupferwismutherz, *Klap.*

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.—$\overline{\mathrm{C}}\mathrm{uS}+\mathrm{BiS}$? 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 supposed the loss in his analysis to be oxygen.

From cobalt mines near Wittichen in Furstenberg; and in six-sided prisms at Wheal Buller in Cornwall.

TETRADYMITE. Telluric Bismuth. Tellurwismuth.

Rhombohedral. R : R=66° 40′. Usually in compound crystals; composition often parallel with e. Also massive, foliated or granular.

H.=2. G.=7·514; 6·1, Chapman. Lustre metallic. Color pale steel-gray. Not very sectile. Laminæ elastic. Soils paper.

Composition.—$2\mathrm{BiTe}^3+\mathrm{Bi}(\mathrm{S}, \mathrm{Se})^3$=Tellurium 59·6, sulphur 4·5, bismuth 35·9; or if tellurium and sulphur may be considered isomorphous (as seems not probable) BiR^3.

Analyses: 1, Wehrle, (Schw. J. lix. 482); 2, Berzelius, (K. V. Ac. H. 1823, 183); 3, 4, C. Fisher, Jr., (Am. J. Sci. [2], vii, 282); 5, Wehrle, (Baumg. Zeit. ix, 144):

1. Schubkau,	Te 34·6	S 4·8	Se *trace*	Bi 60·0=99·4, Werhle.
2. "	36·05	4·32	—	58·30, gangue 0·75=99·42, Berzelius.
3. Virginia,	35·77	—	6·81	51·65, Fe 1·25, $\ddot{\text{S}}$i 3·86=99·34, Fisher.
4. "	37·96	—	7·23	54·81=100, Fisher.
5. Deutsch-Pilsen,	29·74	2·33	—	61·15, Ag 2·07=95·29, Werhle.

The Virginia ore differs in containing selenium in place of sulphur. The Deutsch-Pilsen ore (called also *molybdänsilber*, or *molybdic silver*) is somewhat peculiar. The color is light steel-gray, and it has one perfect cleavage with another at right angles less perfect. G.=8—8·44. The analysis is imperfect, yet is supposed to point to the formula $Bi(S, Te)^3$, or $4BiTe^3+BiS^3$=Tellurium 31·8, sulphur 2·0, bismuth 66·2.

B.B. fuses instantly, tinging the flame blue, and covers 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 Virginia ore.

Occurs at Schubkau near Schemnitz; at Retzbanya; at Tellemark in Norway; at Bastnaes, Sweden; at Deutsch-Pilsen in Hungary. In the United States at the White Hall gold mine, Spotsylvania Co., Virginia, associated with native gold.

BORNITE.

Near Tetradymite. Occurs in thin laminæ, slightly flexible, and very tender. Lustre like polished steel.

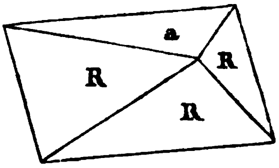
Composition.—$BiS^3+3BiTe$, Damour; perhaps $Bi^2(S, Se, Te)^3$, the Te and S being in equal atomic proportions. Analyses by Damour, (Ann. Ch. Phys. [3], xiii, 372):

1.	Te 15·93	S 3·15	Se 1·48	Bi 79·15=99·71.
2.	15·68	S and Se 4·58		78·40=98·66.

B.B. fuses easily on charcoal, surrounds itself with a white areola, and finally disappears in the coal. Dissolves and gives no color to a bead of salt of phosphorus, but tin brings out at once a black color. In an open tube, fumes of sulphur, and then of white oxyd of tellurium, and a reddish sublimate of selenium on the tube.

From San José in Brazil, in marble.

ANTIMONY. Gediegen Antimon. Spiesglas, *W.* Antimoine Natif, *H.*



Rhombohedral. R : R=117° 15′. Another rhombohedron has the angle R : R=87° 35′, Rose. Cleavage highly perfect and producing a surface of splendent lustre parallel to a; also distinct parallel with R. Seldom in crystals: generally massive, structure lamellar; sometimes botryoidal or reniform with a granular texture.

H.=3—3·5. G.=6·72, Klaproth; 6·646, a Swedish variety. 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.

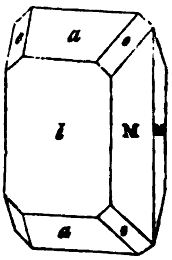
B.B. soon melts to a globule, which continues to burn though the heat be removed; a continuation of the heat causes it to evaporate in white fumes, which are deposited around the globule. Under the microscope, yellowish-white octahedrons, probably of antimonous acid, are seen to be first formed, and 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 Sahla 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.

Antimony is variously employed in the arts, and for pharmaceutical preparations. One part of antimony is alloyed with four to sixteen parts of lead in the formation of type metal. It is a constituent of brittania ware. With tin, it forms the metal on which music is engraved.

WHITE ANTIMONY. Valentinite, *Haid.* Oxyd of Antimony. Antimony Bloom. Weisspiessglanzerz, *W.*, *Hof.* Spiesglanzweiss. Antimonblüthe, *L.* Antimonoxyd. Exitèle, *Beud.* Antimoine Oxidé, *H.*



Trimetric; M : M=136° 58′. Often in rectangular plates, with the lateral edges beveled and in acicular rhombic prisms; M : ĕ=111° 31′, *a* : ĕ=144° 44′, *a* : *a* (adjacent planes)=70° 32′. Cleavage lateral, highly perfect, easily obtained. Compound crystals, composition parallel with ĕ; this union of thin plates produces the common forms, formerly supposed to be single forms. Also massive, structure lamellar, columnar, and granular.

H.=2·5—3. G.=5·566, crystals from Bräunsdorf. Lustre adamantine, ĕ 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.

The tabular crystallizations of this species occur in small quantities at Przibram in Bohemia, in veins traversing primitive rocks; and the prismatic have been observed at Bräunsdorf, near Freiberg in Saxony, Malaczka in Hungary, Allemont in Dauphiny, and elsewhere in Europe. Also near Algiers, in nodules, having a radiated fibrous structure and white pearly appearance. It is usually associated with ores of antimony, and also those of lead, together with blende and calcareous spar.

Antimonophyllite contains oxyd of antimony, and occurs in thin inequiangular six-sided prisms. Locality unknown.

ROMEINE, *Damour*, Ann. des Mines, xx, 3d series, 247. Romeit.

Dimetric. In octahedrons; basal angle, according to Dufrénoy, 110° 50′—111° 20′; angle over the summit 68° 10′—69°. Occurs in groups of minute crystals. Scratches glass. Color hyacinth or honey-yellow.

Composition.—$\dot{C}a^4\dddot{S}b^3$, with $\dot{C}a$ in part replaced by $\dot{M}n$ and $\dot{F}e$. Analysis by Damour, (loc. cit.):

Antimonous acid 79·31, $\dot{C}a$ 16·67, $\dot{F}e$ 1·20, $\dot{M}n$ 2·16, $\dddot{S}i$ 0·64=99·98.

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 in honor of Romé de l'Isle.

STIBLITE, *Blum.* Antimonial Ochre. Antimonocher. Spiessglanzocher, *Haus.* Stibiconise, *Beud.*

Massive, or somewhat porous. Transparent.

H.=5·5. G.=5·28. Lustre greasy. Color yellowish. Streak yellowish and shining.

Composition.—$SbO^4+\dot{H}$=Oxygen 18·82, antimony 75·89, water 5·29. Analysis by Blum and Delffs, (J. f. pr. Chem. xl, 318): Sb 75·83, As *trace*, O 19·54, $\dot{H}$ 4·63.

From Losacio in Spain, Felsobanya and Kremnitz in Hungary, Goldkronach in Bavaria, and also Zacualpan in Mexico; also Padstow, England.

CERVANTITE.—M. Dufrénoy obtained for an ochre from Cervantes in Galicia, Spain, Sb 67·50, O 16·85, $\dot{C}a\,\ddot{C}$ 11·45, $\bar{F}e$ 1·50, insol. 2·70=99·80. A crust on antimony ores from Chazelles in Auvergne, was found to have the same constitution.

It is hence anhydrous, and has the formula SbO^4. The carbonate of lime was an impurity. Color isabella-yellow. G.=4·084; lustre greasy but bright. Easily soluble in muriatic acid. B.B. infusible; but on charcoal is reduced and affords antimonial vapors. (Tr. de Min. 1845, ii, 654).

RED ANTIMONY. Rothspiesglaserz, *W.* Rothspeissglanzerz, *Haus.* Antimonblende, *L.* Antimoine Hydro-Sulfuré. Antimoine Oxydé Sulfuré, *H.* Pyrantimonite, *Br.*

Monoclinic? M : T=101° 19′. Cleavage parallel to the lateral axes. Usually in tufts of capillary crystals, consisting of elongated, slender, six-sided prisms.

H.=1—1·5. G.—4·45—4·6. Lustre adamantine. Streak brownish-red. Color cherry-red. Feebly translucent. Sectile.

Composition.—SbO^3+2SbS^3=Oxyd of antimony 30·14, sulphuret of antimony 69·86 =100. Analyses by H. Rose, (Pogg. iii, 453):

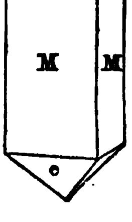
1.	Antimony 74·45,	oxygen 5·29,	sulphur *undetermined.*
2.	" 75·66,	" 4·27,	" "
3.	" *undet.*	" *undet.*	" 20·49.

B.B. fuses readily on charcoal, and at last is entirely volatilized. In nitric acid it becomes covered with a white coating.

Occurs in veins in quartz, accompanying gray and white antimony, at Malazka near Pösing 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.

ANTIMONY GLANCE. Sulphuret of Antimony, *P.* Gray Antimony. Grauspiessglaserz, *W.* Grauspiessglanzerz, *Haus.* Antimonglanz. Antimoine Sulfuré, *H.* Stibium, Στιμμι. Πλατυόφθαλμον. Leo Ruber. Plumbum Nigrum, *Vetr.* Lupus Metallorum. *Alchem.*



Trimetric; M : M=90° 45′. Secondary form, M : e =145° 29′, e : e=109° 16′, and 108° 10′. Lateral planes deeply striated longitudinally. Cleavage highly perfect, parallel with the shorter diagonal. Often columnar, coarse or fine; also granular—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.—SbS^3=Sulphur 27·12, antimony 72·89. Analyses: 1, Bergman, (Chem. Opus. ii, 167); J. Davy, (Phil. Trans. 1812, 196); 2, Thomson, (Min. i, 86); 3, Brandes, (Trommsdorf's N. J. iii, 252):

Antimony,	74	74·06	73·77	73·5
Sulphur,	26=100, Berg.	25·94=100, D.	26·28=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 sulphureous 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 Presburg 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, eyelashes, and edges of the lids; and as this last application was intended to increase the apparent size of the eye, 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*. From this we may infer that the metal antimony was occasionally seen by the ancients, though not recognized by them as distinct from lead. (Moore's An. Min., p. 52).

BERTHIERITE, *Poggendorf.* Haidingerite of *Berthier.*

In elongated prisms or massive; a longitudinal cleavage rather distinct. 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.—SbS^3 and FeS in different proportions. Analyses: 1, 2, 3, Berthier, (Ann. Ch. Phys. xxxv, 51); 4, 5, Rammelsberg, (Pogg. xl, 153):

	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, Rammelsberg.

No. 1=$3FeS+2SbS^3$=Sulphur 29·91, antimony 53·28, iron 16·81=100.

No. 2=$3FeS+4SbS^3$=Sulphur 28·78, antimony 61·42, iron 9·70=100.

Nos. 3, 4, 5=$FeS+SbS^3$=Sulphur 29·19, antimony 58·51, iron 12·30=100.

B.B. fuses readily, gives out fumes of antimony, and forms a black magnetic slag. Dissolves readily in muriatic acid, giving out sulphuretted hydrogen.

It occurs at Chazelles and Martouret in Auvergne, associated with quartz, calcareous spar, and iron pyrites; at Anglar in La Creuse; also at Bräunsdorf in Saxony, and at Tintagel and Padstow in Cornwall. It yields antimony, but of inferior quality.

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.—$SbAs^2$=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.

ARSENIC. Gediegen Arsenik, *W.* Arsenicum. *Αρρενικον, Αρσενικον.*

Rhombohedral. R : R=85° 4′, G. Rose; 85° 26′, Breit. Cleavage imperfect parallel with a; also reticulated, reniform, and stalactitic. Structure columnar or granular.

H.=3·5. G.=5·67—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 red silver ore, realgar, blende, and other metallic minerals.

The silver mines of Freiberg, Annaberg, and Schneeberg, afford this metal in considerable quantities. It occurs also at Joachimstahl in Bohemia, at Andreasberg in the Hartz, at Kapnik in Transylvania, at Orawitza in the Bannat, at Kongsberg in Norway, at Zimeoff in Siberia, in large masses, and at 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 in the same State.

Arsenic is a virulent poison. It is employed in several pharmaceutical preparations. It is also used in giving a milky tint to glass, and in various metallurgical operations.

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.

ARSENOUS ACID. Arsenite, *Haid.* Arsenious Acid. White Arsenic. Arsenikblüthe. Arsenic oxidé, *H.*

Monometric; fig. 4, pl. 1. Occurs usually in minute capillary crystals, stellarly aggregated, 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.—$\bar{A}s$=Oxygen 24·24, arsenic 75·76.

B.B. completely volatilized in white fumes. In the inner flame blackens, and gives off an alliaceous odor. Slightly soluble in hot water.

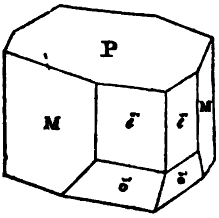
Found accompanying ores of silver, lead, and arsenic, at Andreasberg in the Hartz, and probably formed by the decomposition of other species. Occurs also at Joachimsthal in Bohemia, at Kapnik in Hungary, and in the old mines of Biber in Hanau.

It differs from pharmacolite, which it much resembles, in being soluble.

REALGAR. Red Orpiment or Ruby Sulphur, *J.* Red Sulphuret of Arsenic. Rothes Rauschgelb, *W.* Arsenic Sulfuré Rouge, *H.* Arsenicum Sandaraca, *Linn.* Σανδαρακη, *Theoph.* *Discor.* Sandaraca, *Plin.* *Vitr.*

Monoclinic. M : M=74° 30′, ĕ′ : ĕ′=113° 20′, P : ĕ (plane truncating the edge between ĕ′ and ĕ′)=113° 16′. Cleavage parallel to P and the clinodiagonal rather perfect; parallel to M and the orthodiagonal in traces. Also granular, coarse or fine; compact.

H.=1·5—2. G.=3·642, Breith.; 3·384, Brisson. Lustre resinous. Color aurora-red or orange-yellow. Streak varying from orange-yellow to aurora-red. Transparent—translucent. Fracture conchoidal, uneven. Sectile; yields to the nail.



Composition.—As S^2=Sulphur 29·97, arsenic 70·03=100.

B.B. fuses readily, burns with a blue flame, and is dissipated in fumes of an alliaceous odor, with some sulphurous acid.

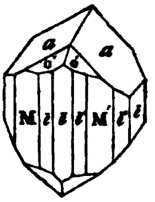
Fine crystallizations of this species have been observed with ores of silver and lead, at Felsobanya in Upper Hungary, at Kapnik and Nagyag in Transylvania, at Joachimsthal in Bohemia, at Schneeberg in Saxony, at Andreasberg in the Hartz. At Tajowa in Hungary, it occurs in beds of clay, and at St. Gothard in Switzerland, imbedded in dolomite, near Julamerk in Koordistan. It has also been observed 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 has long been used as a pigment.

ORPIMENT. Yellow Sulphuret of Arsenic. Gelbes Rauschgelb, *W.* Rauschgelb, *Haus.* Operment. Auripigment, *L.* Arsenic Sulfuré Jaune, *H.* Resigallum. Auripigmentum, *Vitr.* Αρρενικόν, *Dioscor.* Αρρενῖκον, *Theoph.* Arsenicum, *Plin.*

Trimetric; M : M=100° 40′, ĕ′ : ĕ′=117° 49′, M : ĕ=129° 40′, *a* : *a*=83° 37′, ĕ : *a*=138° 12′. Cleavage parallel with ē highly perfect; parallel with ĕ in traces; ĕ longitudinally striated. Also massive foliated or columnar, sometimes reniform.

H.=1·5—2. G.=3·48, Haidinger; 3·4, Breithaupt. Lustre pearly upon the faces of perfect cleavage; elesewhere 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 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 nitric, muriatic, and sulphuric acids.

Orpiment in small crystals is imbedded in clay, at Tajowa, near Neusohl in Lower Hungary. It usually occurs 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. 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 is used as a pigment, but is mostly prepared artificially for this purpose.

V. CHROMIUM.

The metal chromium is not found native. It occurs as chromic acid in combination with oxyd of lead, and as an oxyd with iron. The oxyd is associated with silica and alumina in some clayey compounds, possibly mere mechanical mixtures. The coloring ingredient of the emerald, and of alexandrite, a variety of chrysoberyl, is an oxyd of chromium.

SHEPARDITE, *Haidinger*. Schreibersite, *Shepard*, Am. J. Sci., 2d Ser. ii, 383.

In small deeply striated prisms, too irregular for measurement. Cleavage in traces parallel with the sides of the prism.

H.=4·0. Color brownish-black; streak the same. Lustre submetallic. Opaque. Brittle.

Composition.—Probably a sesquisulphuret of chromium, according to Shepard. B.B. emits sulphurous fumes, and forms without ebullition a black glass, which is magnetic. With borax, fuses to a globule, deep yellow while hot, but paler on cooling, and often showing a tinge of green. With tin forms a glass colored by chrome. The iron present is attributed to a mixture with magnetic pyrites.

Occurs in small grains not larger than a grain of rice, in the Bishopville (South Carolina) meteoric stone, where it was detected by Prof. Shepard.

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):

	$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Cr}}}$	$\dddot{\overline{\mathrm{Fe}}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dddot{\overline{\mathrm{Mn}}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
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, Kersten.
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.

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.

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):

	$\dddot{\text{Si}}$	$\dddot{\overline{\text{Cr}}}$	$\dddot{\overline{\text{Al}}}$	$\dddot{\overline{\text{Fe}}}$	$\dot{\text{H}}$	
1. Creuzat, Fr.	64·0	10·5	23·0	—	——	$\dot{\text{Ca}}$ and $\dot{\text{Mg}}$ 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, $\dot{\text{K}}$ 3·44, $\dot{\text{Na}}$ 0·46=100, Wolff.	

The formula $(\dddot{\overline{\text{Al}}}, \dddot{\overline{\text{Cr}}}, \dddot{\overline{\text{Fe}}})\dddot{\text{Si}}^2$ corresponds nearly to the composition. Wolff's analysis, (No. 4), gives $(\dddot{\overline{\text{Al}}}, \dddot{\overline{\text{Cr}}})^3\dddot{\text{Si}}^4+4\dot{\text{H}}$, which is the constitution of a kaolin. It is probably not a true chemical compound.

Chrome ochre occurs at the localities here 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 $(\dddot{\overline{\text{Al}}}, \dddot{\overline{\text{Cr}}})^3\dddot{\text{Si}}^2+9\dot{\text{H}}$. Analysis by Kersten, (Pogg. xlvii, 485):

$\dddot{\text{Si}}$ 27·50, $\dddot{\overline{\text{Al}}}$ 45·01, $\dddot{\overline{\text{Cr}}}$ 3·61, $\dot{\text{Ca}}$ 0·30, $\dot{\text{Mg}}$ 0·20, $\dot{\text{H}}$ 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.

VI. IRON.

Iron occurs native or alloyed with nickel in meteoric iron. Its most abundant ores are the oxyds and sulphurets. Combined with carbonic acid (spathic iron) it is also of common occurrence. It is found united with various acids, with arsenic, and rarely with antimonial compounds. It is isomorphous with manganese, aluminium, calcium, magnesium, zinc, and chromium, and hence the corresponding oxyds of these metals replace one another: consequently hydrous silicates of magnesia pass into hydrous silicates of protoxyd of iron, as seen in serpentine and allied compounds; while the anhydrous have the same relations as seen in chrysolite, hornblende, and augite. Again, silicates of alumina graduate into silicates of peroxyd of iron. The carbonates of lime, magnesia, manganese, zinc and iron are similar in crystallization and structure, besides often shading into one another by a mutual substitution of bases.

Iron, nickel, and cobalt are also isomorphous, and the sulphurets and arseniurets of these metals are closely related crystallographically with those of iron. Peroxyd of iron ($\dddot{\overline{\text{Fe}}}$) and peroxyd of titanium ($\dddot{\overline{\text{Ti}}}$) are likewise isomorphous, and unite in indefinite proportions under a common crystalline form; so that specular and titanic iron crystallize alike.

The ores of iron are widely disseminated. The oxyds are the ordinary coloring ingredients of rocks, tinging them red, yellow, dull green, brown, and black.

1. *Native.*

IRON. Gediegen Eisen, *W.* and *L.* Fer Natif, *H.* Mars, *Alchem.*

Monometric. Cleavage octahedral.

H.=4·5. G.=7·3—7·8; 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.

Meteoric iron usually contains nickel, and small quantities of other metals. Dr. C. T. Jackson first pointed out the existence of chlorine as a constituent in some meteoric iron. (See Am. Jour. Sci. vol. xxxiv, p. 335).

The following analyses of meteoric iron are by Berzelius, (K. V. Ac. H. 1834, pp. 137, 163, and 171):

	Blanskö.	Siberia.		Elbogen.
Iron,	93·816	88·042		88·231
Nickel,	5·053	10·732		8·517
Cobalt,	0·347	0·455		0·762
Manganese,	——	0·132	Sulphur and mang.	*trace*
Tin and copper,	0·460	0·066		——
Sulphur,	0·324	*trace*		——
Phosphorus,	*trace*	——	Metal. Phosphurets,	2.211
Magnesium,	——	0·050		0·279
Carbon,	——	0·043		——
Insoluble part,	——=100.	0·480=100.		——=100.

The *first* specimen fell near Blanskö, on the 25th November, 1833. The metallic iron constituted only ·1715 part of it. The *second* was discovered by Pallas on a mountain, between Kresnojarsk and Abekansk, in Siberia. It contained imbedded olivine. The *third* is supposed to have fallen near the close of the fourteenth century; it is preservd at Vienna.

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 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. Mr. Silliman has remarked 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.

2. *Combined with Sulphur, Arsenic, or Phosphorus.*

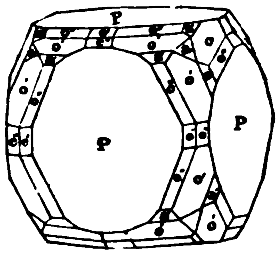
List of Species.

PYRITES,—Monometric,	FeS^2.
MARCASITE,—Trimetric, 106° 2′,	FeS^2.
LEUCOPYRITE,—Trimetric, 122° 26′,	Fe As.
MISPICKEL,—Trimetric, 111° 53′,	$FeAs + FeS^2$.
MAGNETIC PYRITES,—Hexagonal,	Fe^7S^8.
SCHREIBERSITE,—A phosphuret of Iron and Nickel.	

PYRITES. Cubic Pyrites. Mundic. Marcasite. Bisulphuret of Iron, *Thomson.* Schwefelkies, *W.* Eisenkies, *L.* Fer Sulfuré, *H.* πυρίτης.

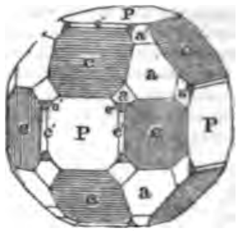
Monometric. Common form, the cube, often with striated faces; also figs. 2, 3, 4, 14, 15, 16, 42, 43, 44, 45, 46, 47, 48, pl. 1; also the annexed figures. P : a=125° 15′ 51¾″, P : a′=144° 44′ 8¼″,

1



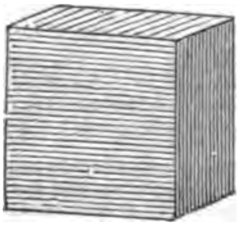
Peru.

2



Rossie.

3



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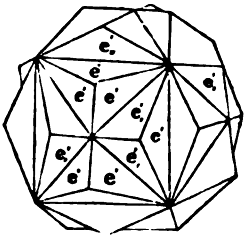


Schoharie.

P : e″=146° 18′ 36″, P : e′=153° 26′ 6″, P : o′=143° 18′ 3″, P : o″ =150° 47′ 39″. Cleavage cubic and octahedral, more or less distinct. Planes P and e′ often striated. Compound crystals: composition parallel to e′; this composition sometimes parallel to each of the edges, when the form in fig. 4 is produced. Also radiated subfibrous, and massive. Often reniform or globular with a crystalline surface.

=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.—FeS^2=Iron 46·7, sulphur 53·3. BB. 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 obtained,

S 53·37, Fe 44·47, Cu 2·39.

This variety tarnishes readily, assuming the bluish tarnish of steel.

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, graywacke slate, 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., polished crystals variously modified occur at the lead mine in green shale; at Schoharie, 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 lake, in modified octahedrons, (fig. 3, pl. 1); in limestone at Shoreham, Vt., crystals are abundant; at Lane's mine, Monroe, Conn., in small octahedral crystals; 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 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; near French Creek, in polished yellow octahedrons. 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, (sawmills), 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 greater part of the sulphate of iron and sulphuric acid of commerce, and also a considerable portion of the sulphur and alum. It is also of importance in the smelting of ores, particularly those of silver.

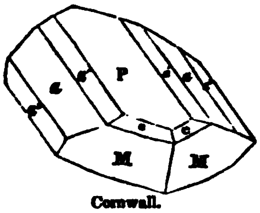
Pyrites sometimes contains mechanically mingled, a minute quantity (perhaps one five thousandth part) of gold, and is then termed *auriferous pyrites*. It occurs abundantly in the gold mines of Beresof in Siberia, and in Brazil, in detached disintegrating crystals of a dark-brown color.

The name *pyrites* is derived from the Greek, πυρίτης, 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.

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 of the *Germans*. Fer Sulphuré Aciculaire Radié, Fer Sulfuré Blanc, *H.* Weisskupfererz and Kyrosite, *Breit.*

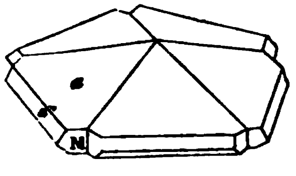
Trimetric. M : M=106° 2′, P : *a′*=130° 1′. Cleavage parallel with M, rather perfect. Planes *a* and *a″* longitudinally striated. Compound crystals, composition parallel with M; sometimes consisting of five individuals, united by the acute lateral angle: also others with composition parallel to *a*. Also globular, reniform, and other imitative shapes—structure straight columnar; often massive, columnar or granular.

1



Cornwall.

2



Warwick, N. Y.

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.

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	53·35, Mn 0·70, $\bar{S}i$ 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, imbedded in granite, and is associated 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, and particularly at Cummington, Mass., where it is associated with cummingtonite and garnet. It occurs also 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.

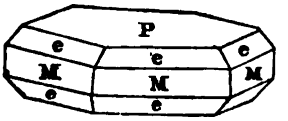
LONCHIDITE, *Breit.* and *Plattn.* Pogg. Ann. lxxvii, 135.—This mineral appears to be a variety of marcasite. Breithaupt gives for it the angles 104° 24′ for M : M, and 100°

36′ for the brachydiagonal prism. H.=6½. G.=4·925—5. Color tin-white, sometimes greenish or grayish; streak black. Analysis by Plattner:

S 49·61, As 4·40, Fe 44·28, Co 0·35, Cu 0·75, Pb 0·20=99·54,

equivalent to 25 of marcasite (FeS^2) and 1 of FeAs. From Freiberg, Schneeberg, and Cornwall.

MAGNETIC PYRITES. Pyrrhotine, *Breit.* Magnetkies, *W.* Fer Sulfuré ferrifère. Fer sulfuré magnetique, *H.*



Hexagonal. Form similar to fig. 125, pl. 2; also the annexed figure. P : e=134° 52′, M : e=135° 08′, M : *e*=150°. Cleavage basal, perfect; lateral less so. Commonly massive and amorphous; structure granular.

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 attractable by the magnet, and subject to speedy tarnish.

Composition.—$5FeS+Fe^2S^3[=Fe^7S^8]$=Sulphur 39·51, iron 60·49, 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	40·48	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 FeS=Sulphur 36·4, iron 63·6, considering the species isomorphous with greenockite (Cd S).

In a specimen from Klefva, in Alsheda in Smaoland, (G.=4·674). Berzelius found (Jahresb. xxi, 182),

S 38·089, Fe 57·643, Ni 3·044, Co 0·094, Mn 0·223, Cu 0·447, Gangue 0·460.

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 globule is magnetic, and yellowish and crystalline within. The mass which is obtained 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. 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 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.

It is mined for its sulphur, and for the fabrication of sulphuric acid and sulphate of iron.

Its inferior hardness is sufficient to distinguish it from common pyrites.

LEUCOPYRITE, *Shepard.* Glanzarsenikkies. Arsenikeisen, Arsenikalkies. Arsenosiderit. Lölingite, *Haid.*

Trimetric; M : M=122° 26′. Secondary form similar to the figure of Liroconite, (see under Copper); a : a (adjacent planes)=51° 20′. Occurs also massive.

H.=5—5·5. G.=7·228, specimen from Silesia; 7·337, a crystal from Bedford Co., Penn. Lustre metallic. Color between silver-white and steel-gray. Streak grayish-black. Fracture uneven. Brittle.

Composition.—FeAs=Arsenic 72·82, iron 27·18—or (Fe, Ni, Co) As. Analyses: 1, Hoffmann, (Pogg. xv, 485); 2, Meyer, (Pogg. l, 154); 3, 4, Scheerer, (Pogg. xlix, 536, and l, 153); 5, Hoffmann:

	As	S	Fe	Ni	Co	
1. Reich'stein,	65·99	1·94	28·06	——	——	, serpentine 2·17=98·16, Hoffmann.
2. "	63·142	1·681	30·243	——	——	" 3·550=98·566, Meyer.
3. Fossum,	70·09	1·38	27·39	——	——	=98·81, Scheerer.
4. "	70·22	1·28	28·14	——	——	=99·64, Scheerer.
5. Schladming,	60·41	5·20	18·49	13·37	5·10	=97·57, Hoffmann.

B.B. affords sulphuret of arsenic, and afterwards metallic arsenic sublimes; on charcoal yields arsenical fumes and a magnetic globule is left.

It 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.

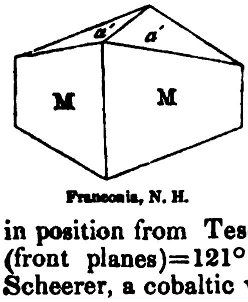
A crystal, weighing two or three ounces, has been found in Bedford Co., Penn., but it is not known under what circumstances. In Randolph Co., N. C., a mass was found weighing nearly two pounds.

The name leucopyrite is derived from λευκος, *white*, and *pyrites*.

MISPICKEL. Marcasite. Arsenikkies. Fer Arsenical, *H.* Danaite. Plinian, *Breit.*

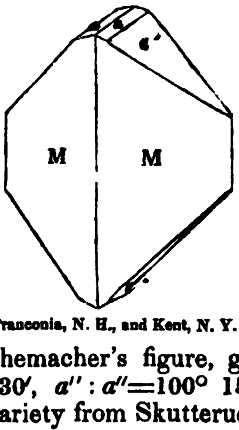
Trimetric; M : M=111° 53′, *a′* : *a′*=145° 26′, *a″* : *a″* (over a‴)=99° 52′, and adjacent, 80° 8′; according to Teschemacher, a crystal of the cobaltic variety, (Danaite), figure 3, which is altered in position from Teschemacher's figure, gives M : M=112°, a : a (front planes)=121° 30′, *a″* : *a″*=100° 15′; and according to Scheerer, a cobaltic variety from Skutterud in Norway, has M : M 111° 40′—112° 2′, and a : a=121° 30′. Cleavage parallel to M

1



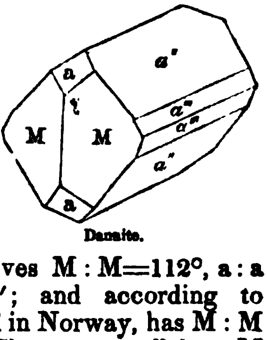
Franconia, N. H.

2



Franconia, N. H., and Kent, N. Y.

3



Danaite.

rather distinct. Compound crystals, composition parallel with M. Also columnar—straight and divergent, or irregular; compact granular, or impalpable.

H.=5·5—6. G.=6·127. Lustre metallic. Color silver-white, inclining to steel-gray. Streak dark grayish-black. Fracture uneven. Brittle.

Composition.—$FeAs+FeS^2$=Arsenic 46·01, sulphur 19·64, iron 34·35; or (Fe, Co) As +(Fe, Co)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, 5, Scheerer, (Pogg. lxii, 546); 6, Wöhler, (Pogg. xliii, 591); 7, Hayes, (Am. J. Sci. xxiv, 386):

	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. "	46·01	18·06	26·97	8·38=99·42, Scheerer.
6. "	47·45	17·48	30·91	4·75=100·59, Wöhler.
7. *Danaite*,	41·44	17·84	32·94	6·45=98·67, Hayes.

Mispickel, nickel glance, and cobaltine, the latter two monometric, have analogous chemical formulas; and so also the new species *glaucodot*, which is a cobaltic mineral agreeing with mispickel in crystalline form.

B.B. on charcoal, copious arsenical fumes are driven off, and a globule is obtained of nearly pure sulphuret of iron, which acts on the needle like magnetic pyrites. Gives fire with steel, emitting at the same time an alliaceous odor. Dissolves in nitric acid, with the exception of a whitish residue.

The localities of mispickel are principally in crystalline rocks, and its usual mineral associates are ores of silver, lead, and tin, iron and copper pyrites, and blende. It occurs also in serpentine.

It is 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. Wheal Mawdlin, and Unanimity, in Cornwall, are other localities.

It is 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. Analysis by Plattner, (Pogg. lxix, 430), afforded,

As 45·46, S 20·07, Fe 34·46.

It is 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+3Fe As=Arsenic 56·7, sulphur 8·0, iron 35·2.

Jordan made out 3As, 2S, 6Fe, which requires arsenic 52·9, sulphur 7·5, iron 39·6.

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.

3. *Combined with Oxygen.*

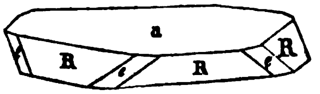
List of Species.

Specular Iron,—Rhombohedral, 86° 10′,	$\dddot{\bar{\mathrm{F}}}\mathrm{e}$.
Ilmenite,—Rhombohedral, 85° 59′,	($\dddot{\bar{\mathrm{F}}}\mathrm{e}$, $\ddot{\mathrm{T}}\mathrm{i}$).
Magnetite,—Monometric and isomorphous with spinel,	$\dot{\mathrm{F}}\mathrm{e}\,\dddot{\bar{\mathrm{F}}}\mathrm{e}$.
Franklinite, " " "	($\dot{\mathrm{F}}\mathrm{e}$ $\dot{\mathrm{Z}}\mathrm{n}$, $\dot{\mathrm{M}}\mathrm{n}$) ($\dddot{\bar{\mathrm{F}}}\mathrm{e}$, $\dddot{\bar{\mathrm{M}}}\mathrm{n}$).
Chromic Iron, " " "	$\dot{\mathrm{F}}\mathrm{e}$ ($\dddot{\bar{\mathrm{C}}}\mathrm{r}$, $\dddot{\bar{\mathrm{A}}}\mathrm{l}$).
Limonite,	$\dddot{\bar{\mathrm{F}}}\mathrm{e}^2\,\dot{\mathrm{H}}^3$.
Göthite,—Trimetric,	$\dddot{\bar{\mathrm{F}}}\mathrm{e}\,\dot{\mathrm{H}}$.

SPECULAR IRON. 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.*

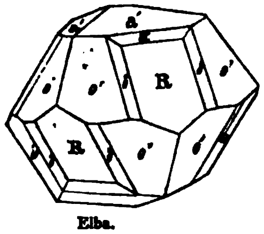
Rhombohedral. R : R=86° 10′; R : *e*=136° 55′, *o*′ : *o*′=128° 5′, R : *o*′=153° 3′, a′ : a′=143° 8′, R : a′=143° 55′, R : a=122° 30′. Cleavage parallel to a and R; often indistinct. Compound crystals: composition parallel to R; also parallel to a, the truncating plane of the vertical angle. Also columnar—globular, reniform, botryoidal, and stalactitic shapes; also lamellar—laminæ joined parallel to a, and variously bent—thick or thin; also granular—friable or compact.

1



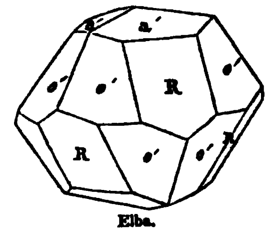
Vesuvius.

2



Elba.

3



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—massive varieties sometimes earthy. Color dark steel-gray or iron-black; impure varieties red and unmetallic. Streak cherry-red or reddish-brown. Opaque, except when in very thin laminæ, which are faintly translucent, and of a blood-red tinge. Fracture subconchoidal, uneven. Sometimes slightly attractable by the magnet; volcanic varieties occasionally exhibit polarity.

Composition.—$\overline{\mathrm{F}}$e=Iron 70, oxygen 30.

B.B. infusible alone, with borax it forms a green or yellow glass. Dissolves in heated muriatic acid.

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.

Specular iron occurs in crystalline rocks; also among the ejected lavas of Vesuvius. Argillaceous ores form beds in secondary rocks.

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 a and a′ 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 crystallised plates grouped in the form of rosettes, and accompanying crystals of feldspar. Near Limoges, France, it occurs in large crystals. Fine crystallizations are the result of volcanic action at Etna and Vesuvius, and particularly in Fossa Kankarone, on Monte Somma, where it forms crystalline incrustations on the ejected lavas. Arendal in Norway, Langbanshyttan in Sweden, Framont in Lorraine, Dauphiny, and Switzerland, also afford splendid specimens of specular iron. 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 Brasil it is associated with quartz, and thus forms a rock called *itaberite*.

Specular iron, 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. It 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. Red hematite is found at Ticonderoga, upon Lake George. The two iron mountains of Missouri are situated about fourteen miles from the La Motte lead mines, and ninety miles south of St. Louis. They are conical hills, consisting of iron ore, "in masses of all sizes, from a pigeon's egg to a middle size church." The ore is both massive and the micaceous variety, with vast quantities of the red ochreous iron, about the one called the Pilot Knob. Lenticular argillaceous ore is abundant in Oneida, Herkimer, Maddison, and Wayne Cos., N. Y., constituting one or two beds, ten to twenty inches thick, in a compact sandstone.

This ore affords a considerable portion of the iron manufactured in different countries. These 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. Specular iron is readily distinguished from magnetic iron ore, by its reddish streak.

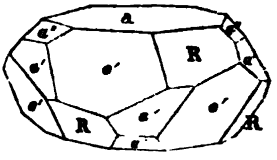
Hematite, a word in use among the ancients, was applied to this species on account of the red color of the powder, from αἱμα, *blood*. The term *specular* alludes to the brilliant lustre it often presents.

Martite, *Breit.*—Octahedral crystals of this species, believed to be pseudomorphous, after magnetic iron. They come from Brazil, G.=4·82; from Peru, G.=3·86; Puy de Dome, G.=4·65; also from Framont. Also abundant in Vermont at Plymouth.

A variety of Specular iron, having an octahedral form due to a combination of rhombohedrons, according to Scacchi, occurs at Vesuvius.

Turgite, *Hermann.*—A reddish-brown mineral from the Turginsk copper mines in the Ural. G.=3·54—3·74. Contains $\overline{\rm F}{\rm e}$ 94·15, $\dot{\rm H}$ 5·85, and is probably essentially the red oxyd of iron.

ILMENITE, *Kupffer.* Titanate of Iron. Crichtonite, *Bournon.* Titaniferous Iron. Iserine. Menakan, Menaccanite, Kibdelophan, Basanomelan, *Kobell.* Titaneisen. Hystatite. Trappisches Eisenerz, *Breit.* Washingtonite, *Shepard.* Mohsite, *Levy.*



Rhombohedral. R : R=85° 59′. Cleavage parallel with the terminal plane a—but properly planes of composition. Crystals usually tabular. Often in thin plates or laminæ, angular masses or grains.

H.=5—6. G.=4·5—5. Lustre submetallic. Streak metallic. Color iron-black. 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 acid 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—4·785, Breit. Occurs in crystals; usually massive, or in thin plates or laminæ.

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.=4·805, Breit.; R : R=85° 43′.

Mennaccanite.—Occurs massive with traces of cleavage. 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=61° 29′. 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; a the brightest face, R the least so. H.=5·75. G.=4·968, from Westerly; 5·016, from Litchfield.

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. H.=5. G.=4·62—5·89. Lustre metallic. Color iron-black. Streak black. Fracture conchoidal. Strongly magnetic.

The *titaniferous iron* of Aschaffenburg.—Occurs massive and in plates, with imperfect cleavage in one direction. H.=6. G.=4·78. Color iron-black.

The crystals with octahedral and cubic forms are referred by some to a distinct species under the name *Iserine*, and by others considered pseudomorphs. They probably have the same relation to the rhombohedral ilmenite that the octahedrons of specular iron have to the common varieties of that species. Either both or neither are pseudomorphs, and on this point more light is required.

Composition.—T̶i and F̶e in various, and probably, indefinite proportions, *H. Rose.* Rose has shown that the T̈i (titanic acid) and Ḟe (protoxyd of iron) found in analyses, arise from an oxydation of the titanic oxyd (T̶i) of the mineral, at the expense of the F̶e, which takes place during the investigation. Berzelius confirms 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.); 15, Plantamour, (J. f. pr. Chem. xxiv, 302); 16—18, Kobell, (loc. cit.); 19, Rammelsberg, (Pogg. liii, 129); 20, ib. (3d Supp. 122):

		T̈i	F̶e	Ḟe
1.	Kibdelophan, Gastein,	59·00	4·25	36·00, Ṁn 1·65=100, Kobell.
2.	*Crichtonite*, St. Christophe,	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, " 2·39, " 0·60, Ċa 0·25, C̶r 0·38, S⃛i 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.	*Titanic iron*, Egersund,	43·73	42·70	13·57=100, Rose.
7.	*Menaccanite*, "	43·24	28·66	27·91=99·81, Kobell.
8.	" "	42·57	23·21	29·27, Ċa 0·50, Ṁg 1·22, C̶r 0·38, S⃛i 1·65=98·75, Mosander.
9.	" "	41·08	25·93	29·04, Ċa 0·49, Ṁg 1·94, Ẏt and Ċe 0·58, S⃛i 0·07=99·13, Mosander.
10.	" "	39·04	29·16	27·23, Ċa 0·96, Ṁg 2·30, Ṁn 0·21, C̶r 0·12, S⃛i 0·31=99·33, Mosander.
11.	*Hystatite*, Arendal,	24·19	53·01	19·91, Ċa 0·33, Ṁg 0·68, S⃛i 1·17=99·29, Mosander.
12.	" "	23·59	58·51	13·90, Ċa 0·86, Ṁg 1·10, C̶r 0·44, S⃛i 1·88 =100, Mosander.
13.	*Washingtonite*, Connecticut,	25·28	51·84	22·86=99·98, Kendall.
14.	" "	22·21	59·07	18·72=100, Marignac.
15.	*Titanic iron*, Uddewalla,	15·56	71·25	11·32, F, S⃛i, and loss 1·87=100, Plant.
16.	" Aschaffenberg,	14·16	75·00	10·04, Ṁn 0·80=100, Kobell.
17.	*Basenomelan*, Schweiz,	12·67	82·49	4·84=100, Kobell.
18.	*Titanic iron*, "	10·0	88·5	1·5 with Ṁn=100, Kobell.
19.	" Unkel,	11·51	48·07	39·16=98·74, Rammelsberg.
20.	" Binnen,	T̶i 8·58	F̶e 91·42=100, Rammelsberg.	

The proportion of peroxyd of titanium to peroxyd of iron in these analyses, according to the view of Rose, is as follows:—

	T̶i F̶e							
Anal. 1,	5 : 4	(G. 4·66)	=53·75	peroxyd of Ti,	to	46·25	peroxyd of	Fe.
2,	1 : 1	(G. 4·727)	=48·17	"	"	51·83	"	"
3—5,	4 : 5	(G. 4·77)	=42·64	"	"	57·36	"	"
6—9,	2 : 3	(G. 4·74)	=38·26	"	"	61·74	"	"
11,	1 : 3	(G. 4·93)	=23·65	"	"	76·31	"	"
14,	1 : 4	(G. 4·96)	=18·85	"	"	81·15	"	"
15,	1 : 6	(G. 4·78)	=13·41	"	"	86·59	"	"
17,	1 : 8		=10·41	"	"	89·59	"	"
20,	1 : 10	(G .5·127)	= 8·50	"	"	91·50	"	"

B.B. alone unchanged. With salt of phosphorus in the reduction flame, a dull red glass.

Fine crystals of ilmenite, sometimes an inch in diameter, occur in Warwick, Amity, and Monroe, Orange Co., 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.

The Washingtonite of Shepard occurs at Washington and Litchfield, Conn., in a quartz vein in mica slate, and at South Britain in rolled masses of quartz; also at Westerly, R. I. A titanic iron occurs at Goshen, Mass., in thin folia with spodumene.

MAGNETITE, *Haid.* Magnetic Iron Ore. Oxydulated Iron. Ferroso-ferric Oxyd. Magneteisenstein, Magneteisenerz. Fer Oxidulé, *H.*

Monometric. Octahedrons and dodecahedrons common; but occurs under most of the forms represented in the first twenty figures of pl. 1; also fig. 25, pl. 1. A crystal resembling figure 16 has been described by Breithaupt, having the angle B, 168° 39′, and C, 101° 53′. Cleavage parallel to the primary form, perfect—imperfect. The dodecahedral faces are commonly striated parallel to the longer diagonal. Compound crystals, fig. 129, pl. 2; also the same kind of composition with the secondary modifications. Massive, structure granular—particles of various sizes, sometimes impalpable.

H.=5·5—6·5. G.=4·9—5·2. Lustre metallic—submetallic. Color iron-black; streak black. Opaque. Fracture subconchoidal, shining. Brittle. Strongly attracted by the magnet, and sometimes possessing polarity.

Composition.—$\dot{\mathrm{F}}\mathrm{e}\,\dddot{\bar{\mathrm{F}}}\mathrm{e}$=Iron 72·40, oxygen 27·60, or $\dddot{\bar{\mathrm{F}}}\mathrm{e}$ 68·97, $\dot{\mathrm{F}}\mathrm{e}$ 31·03=100. Isomorphous with spinel and chromic iron.

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.

Magnetic iron ore 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.

The beds of ore at Arendal and nearly all the celebrated iron mines of Sweden, consist of massive magnetic iron. Dannemora, and the Täberg in Smäland, 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, 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.

Very extensive beds of magnetic iron occur in the counties of Warren, Essex, and Clinton, New York, in granite, syenite, 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. Dodecahedral crystals occur at Franconia, N. H., in epidote and quartz; at Warwick, N. Y.; and near Morgantown, Berks Co., Penn., in octahedrons and dodecahedrons. Octahedrons occur at Marlboro', Rochester, and Bridgewater, Vt., in chlorite or chlorite slate; at Swanzey, near Keene, and Unity, New Hampshire; at Deer Creek, Md.; at O'Neil mine, Orange Co., N. Y., along with the forms represented in figures 2 and 3, plate 1; at Webb's mine, Columbia Co., Penn. At Haddam, Conn., it presents the forms in figures 8 and 9, plate 1; occurs also at Hamburgh, near the Franklin furnace, N. J., and 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.

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.

FRANKLINITE.

Monometric. Octahedrons common. Cleavage octahedral, indistinct. Also massive, coarse or fine granular—particles strongly coherent.

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.—(Ḟe, Żn, Ṁn), (F̶e, M̶n), and consequently isomorphous with magnetic iron ore and spinel. Analyses: 1, Berthier, (Ann. des Mines, iv, 489); 2, Thomson, (Min. i, 438); 3, Abich, (Pogg. xxiii, 342):

	F̶e	M̶n	Żn
1.	66·	16·	17· =99, Berthier.
2.	66·10	14·96	17·43, S⃛i 0·20, Ḣ 0·56=99·25, Thomson.
3.	68·88	18·17	10·81, " 0·40, A̶l 0·73=98·99, Abich.

B.B. infusible. On charcoal affords oxyd of zinc at a high heat. Manganese reaction with borax.

Franklinite is stated to occur in amorphous masses at the mines of Altenberg, near Aix la Chapelle.

It is abundant at Hamburgh, N. J., near the Franklin furnace, with red oxyd of zinc and garnet, in calc spar. The most perfect crystals are imbedded in red zinc ore; those occurring in calc spar have their angles rounded. A still more remarkable deposit exists at Stirling, 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.

CHROMIC IRON. Chromite, *Haid.* Chromate of Iron. Chromiron. Chromeisenstein. Eisenchrom. Fer Chromaté, *H.*

Monometric. Octahedron most frequent form; fig. 9, pl. 1, from Hoboken, N. J., and Bare Hills, near Baltimore. Commonly massive, with the structure fine granular, or compact.

H.=5·5. G.=4·321 crystals, Thomson; 4·498, a variety from Styria. Lustre submetallic. Streak brown. Color between iron-black and brownish-black. Opaque. Fracture uneven. Brittle. Sometimes magnetic.

Composition.—Ḟe C̶̈r, or (Ḟe, Ṁg) (A̶l, C̶̈r); isomorphous with magnetic iron and spinel. Analyses: 1, Klaproth, (Beit. iv, 132); 2, 3, Berthier, (Ann. Ch. Phys. xvii, 59); 4, 5, Seybert, (Am. J. Sci. iv, 321); 6, 7, Abich, (Pogg. xxiii, 335); 8, 9, Laugier, (Ann. d. Mus. d'Hist. N. vi); 10, 11, T. S. Hunt, (Logan's Rep. Geol. Canada, 1849):

	Ḟe	Ṁg	C̶̈r	A̶l	S⃛i
1. Styria,	33·00	——	55·50	6·00	2·00, ign. 2·00=98 50, K.
2. I. à Vaches, *cryst.*	37·0	——	36·0	21·5	5·0 =99·5, Berthier.
3. Baltimore, *cryst.*	35·0	——	51·6	10·0	3·0 =99·6, Berthier.
4. Chester Co., Pa.,	35·14	——	51·56	9·72	2·90=99·32, Seybert.
5. Baltimore,	36·00	——	39·51	13·00	10·60=99·11, Seybert.
6. Baltimore, *massive*,	18·97	9·96	44·91	13·85	0·83=98·25, Abich.
7. " *cryst.*	20·13	7·45	60·04	11·85	——=98·45, Abich.
8. Siberia,	24·	——	53·	11·	1· Ṁn 1=100, Laugier.
9. Röraas,	25·66	5·36	54·08	9·02	4·83=98·95, Laugier.
10. Bolton, Canada,	35·68	15·03	45·90	3·20	——=99 81, Hunt.
11. L. Memphramagog,	21·28	18·13	49·75	11·30	——=100·46, Hunt.

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 verd-antique marble.

It occurs in the Gulsen mountains, near Kraubat in Styria; also 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], ii, 126); 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 county, six miles north of the Potomac; at Cooptown, Harford Co., and in the north part of Cecil Co., Md. In Pennsylvania, in W. Goshen, (cryst.), Nottingham, Mineral Hill, and elsewhere; Chester Co., near Unionville, abundant; near Texas, Lancaster Co., very abundant. It occurs both massive and in crystals at Hoboken, N. J., imbedded 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.

This ore affords the oxyd of chrome, which, both alone and in combination with the oxyds of other metals, is extensively used in oil-painting, dyeing, and in coloring porcelain. The ore employed in England is obtained mostly from Baltimore, Drontheim, and the Shetland Isles; it amounts to about 2000 tons annually.

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. Hydro-Oxidé, *H.* Bog Iron Ore, Raseneisentein (bog ore). Morasterz. Sumpferz. Bohnerz.

Usually in stalactitic and botryoidal or mammillary forms, having a fibrous 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.—$\bar{\mathrm{Fe}}^{2}\dot{\mathrm{H}}^{3}$=Peroxyd of iron 85·58, water 14·42=100. The bog iron ore is often mixed with phosphoric acid, (sometimes 10 or 11 per cent.), and also with some salts of organic acids formed in marshy grounds. Analyses: 1, 2, Kobell; 3, 4, Karsten, (Arch. xv, 1); 5, Hermann, (J. f. pr. Ch. xxvii, 53):

	$\bar{\mathrm{Fe}}$	$\dot{\mathrm{H}}$	$\dddot{\mathrm{Si}}$
1. Perm, *fibrous*,	83·38	15·01	1·61=100, Kobell.
2. Siegen, *Pitchy Iron Ore*,	82·87	13·46	0·67, $\bar{\mathrm{P}}$ 3·00, Mn, Cu, $\dot{\mathrm{Ca}}$ *trace*=100, Kobell.
3. *Bog ore*, New York,	66·33	26·40[a]	2·80, " 0·82, $\dot{\mathrm{Fe}}$ 3·6, $\bar{\mathrm{Mn}}$ 0·75=100, Karsten.
4. " Neumark,	57·50	29·50[a]	8·60, " 3·90, " 10·8, " 1·75, Sand 22·75=100, Karsten.
5. " Novgorod,	32·75	13·00	$\bar{\mathrm{Mn}}$ 1·00, $\bar{\mathrm{P}}$ 3·50, humic acid 2·5, Sand 47·5=100·25, Hermann.

[a] With organic acids.

Hermann writes for the last (his *Quellerz*) the formula, $\bar{\mathrm{Fe}}\dot{\mathrm{H}}^{2}$=$\bar{\mathrm{Fe}}$ 74·76, $\dot{\mathrm{H}}$ 25·24.

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 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 both in crystalline and secondary rocks, in beds and veins, associated at times with spathic iron, heavy spar, calcareous spar, arragonite, and quartz; and it is often associated 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 of limonite, accompanied by the ochrey iron ore, exist at Salisbury and Kent, Conn., connected with mica slate; 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. 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.

Kaliphite, Ivanoff. A mixture of brown iron ore, oxyd of manganese, and silicate of zinc with lime, from Hungary.

GÖTHITE, *Beud.* Onegite. Pyrosiderite, *Haus.* Lepidokrokite. Stilpnosiderite. Pecheisenerz (in part). Nadeleisenerz, *Naum.* Sammetblende. Rubinglimmer. Eisenrutil.

Trimetric. M : M=95° 14′, Levy, 96°, Yorke; $\bar{e}' : \bar{e}'=130° 27'$, Yorke, $a : a=116° 44'$. Cleavage parallel with the shorter diagonal, perfect. Also fibrous; reniform; foliated or in scales; massive.

H.—5. G.=4·0—4·4; 4·04, crystals from St. Just. Lustre imperfect adamantine. Color brown. Often transparent and blood-red by transmitted light. Streak brownish-yellow—ochre-yellow.

Composition.—$\overline{\text{F}}\text{e}\,\dot{\text{H}}$=Peroxyd of iron 89·89, water, 10·11. Analyses: 1—7, Kobell, (J. f. pr. Chem. i, 181, 319); 8, R. Brandes, (Nög. Geb. in Rheinl. Westph. i, 358); 9, Breithaupt, (J. f. pr. Chem. xix, 108); 10, Yorke, (Phil. Mag. [3], xxvii, 264):

		$\overline{\text{F}}\text{e}$	$\dot{\text{H}}$
1.	*Lepidokrokite*, Oberkirchen,	90·53	9·47=100, Kobell.
2.	“ H. Zug,	85·65	11·50, $\overline{\text{M}}\text{n}$ 2·50, $\dddot{\text{S}}\text{i}$ 0·35=100, Kobell.
3.	*Göthite*, Eiserfeld,	86·35	11·38, “ 0·51, “ 0·85, $\dot{\text{C}}\text{u}$ 0·90=99·99, K.
4.	*Stilpnosiderite*, Amberg,	86·24	10·68, $\overline{\text{P}}$ 1·08, $\dddot{\text{S}}\text{i}$ 2·00=100, Kobell.
5.	*Massive*, Maryland,	86·32	10·80, $\dddot{\text{S}}\text{i}$ 2·88=100, Kobell.
6.	“ Saxony,	86·34	11·66, “ 2·00=100, Kobell.
7.	“ Beresof,	86·87	11·13, “ 2·00=100, Kobell.
8.	*Lepidokrokite*, H. Zug,	88·00	10·75, $\overline{\text{M}}\text{n}$ 0·50, $\dddot{\text{S}}\text{i}$ 0·5=99·75, Breithaupt.
9.	*Chileite*, Chili,	83·5	10·3, $\dot{\text{C}}\text{u}$ 1·9, $\dddot{\text{S}}\text{i}$ 4·3=100, Breithaupt.
10.	*Crystals*, Lostwithiel, G. 4·37	89·55	10·07, $\overline{\text{M}}\text{n}$ 0·16, $\dddot{\text{S}}\text{i}$ 0·28=100·06, Yorke.

Before the blowpipe the varieties act like brown iron ore.

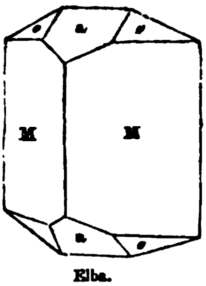
The Lepidokrokite of Oberkirchen occurs in prismatic radiating crystals, imbedded in fibrous red oxyd of iron, in quartz, and in nodules of chalcedony. It has been found at Spring Mills, Montgomery Co., Pa. The Göthite of Eiserfeld, in the county of Nassau, occurs in foliated crystallizations, (*rubinglimmer*), of a hyacinth-red color, with brown hematite. The Lepidokrokite of Hollerter Zug occurs in rounded masses, of a fibrous or lamellar structure. Stilpnosiderite, pitchy iron ore, or pecheisenerz, is found at Siegen. Other localities of crystallized specimens are at Clifton, near Bristol, near Lostwithiel in Cornwall, and at Lake Onega (*onegite*) in Siberia. A capillary variety (*sammetblende*) occurs at Przibram and elsewhere. *Eisenrutil* (iron rutile) is from Cornwall.

4. *Silicates of Iron.*

Many silicates of iron isomorphous with silicates of magnesia and lime, are described on preceding pages of this volume.* The following are here included:—

LIEVRITE,	$3(\dot{F}e, \dot{C}a)^3\overline{Si}+\rlap{-}Fe^2\overline{Si}$.
WEHRLITE.	
ESCHWEGITE.	
ANTHOSIDERITE,	$\rlap{-}Fe\,\overline{Si}^3+\dot{H}$.
CHLOROPAL,	$\rlap{-}Fe\,\overline{Si}^3+3\dot{H}$.
POLYHYDRITE.	
THURINGITE	$3\dot{F}e^3\overline{Si}+\rlap{-}Fe^2\overline{Si}+9\dot{H}$.
STILPNOMELANE,	$2\dot{F}e^3\overline{Si}^2+\rlap{-}Al\,\overline{Si}^2+6\dot{H}$.
CRONSTEDTITE,	$(\dot{F}e, \dot{M}n, \dot{M}g)^3\overline{Si}+\rlap{-}Fe\dot{H}^3$.
HISINGERITE,	$\dot{F}e^3\overline{Si}+2\rlap{-}Fe\overline{Si}+6\dot{H}$,
CROCIDOLITE,	$\dot{R}^6\overline{Si}^9\dot{H}^3$.
SIDEROSCHISOLITE,	$\dot{F}e^6\overline{Si}+3\dot{H}(?2\dot{H})$.
CHLOROPHÆITE,	$\dot{F}e\overline{Si}+6\dot{H}$.
GREEN EARTH.	

LIEVRITE, *W.* Yenite. Ilvait, *Haus.*



Elba.

Trimetric. M : M=111° 12′, (110° 10′, Dufrénoy); a : o=159° 13′, o : o=138° 26′, and 117° 34′, M : o=128° 34′. Lateral faces usually striated longitudinally. Cleavage parallel to the longer diagonal, indistinct. Also columnar or compact massive.

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.—$3(\dot{F}e, \dot{C}a)^3\overline{Si}+\rlap{-}Fe^2\overline{Si}$=Silica 28·8, peroxyd of iron 24·8, protoxyd of iron 33·4, lime 13·0. Analyses: 1, Stromeyer, (Untera. 372); 2, same corrected by Kobell, (Schw. J. lxii, 196); 3, Rammelsberg, (Pogg. l, 157, 340); 4, 5, *same*, iron only determined:

	$\overline{Si}$	$\rlap{-}Fe$	$\dot{F}e$	$\dot{C}a$	$\rlap{-}Al$	$\rlap{-}Mn$	$\dot{H}$
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=101·426, Kobell.
3. "	29·83	[24·58]	[30·73]	12·44	——	$\dot{M}n$ 1·51	——, Ramm.
4. "	"	22·80	33·07	"	——	"	——, "
5. "	"	21·79	34 20	"	——	"	——, "

B.B. on charcoal fuses easily to a black globule, vitreous in the external flame; in the

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* See Pyroxene, Hornblende, Chrysolite, and other magnesian silicates, also Garnet, Epidote, Spinel, Mica, Ottrelite, Lepidomelane, and other aluminous species.

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.

This mineral was first discovered on the Rio la Marina, in Elba, by M. Lelievre, in 1802, where it occurs in solitary crystals of considerable dimensions, and aggregated crystallizations in compact augite. It has also been observed at Fossum in Norway, in Siberia, near Andreasberg in the Hartz, 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; occurs also in Essex Co., N. Y.

The name *Lievrite* was given this mineral in honor of its discoverer. *Ilvaite* is from the name of the island (Elba) on which it was found. *Yenite* or Jenite, was applied by the French in commemoration of the battle of Jena, in 1806.

WEHRLITE, *Kobell.*

Massive, granular.

H.=6—6·5. G.=3·90. Lustre submetallic. Color iron-black. Streak greenish, and powder greenish-gray. Magnetic.

Composition.—Analysis by Wehrle, Silica 34·60, peroxyd of iron 42·38, protoxyd of iron 15·78, lime 5·84, peroxyd of manganese 0·28, alumina 0·12, water 1 00=100.

B.B. fuses with difficulty on the edges. Imperfectly dissolved in muriatic acid.

Wehrlite was described by Zipser and Wehrle, as a variety of Lievrite; and it is still doubtful whether it is distinct. Occurs at Szurraskö, in the Zemescher district, Hungary.

ESCHWEGITE.—This name is given by Döbereiner (Gilb. Ann. lxxiii, 111) to a silicated peroxyd of iron, containing 45 to 38 per cent. of silica, and 55 to 62 of peroxyd of iron. It occurs with micaceous iron in Brazil.

ANTHOSIDERITE, *Haus.*

In tufts of a fibrous structure, and sometimes collected into feathery flowers. Resembling Cacoxene.

H.=6·5. G.=3·6. Color ochre-brown, somewhat grayish. Opaque or slightly subtranslucent. Gives sparks with a steel. Tough.

Composition.—$\bar{F}e\,\dddot{S}i^3+\dot{H}$=Silica 60·89, peroxyd of iron 35·16, water 3·95=100. Analysis by Schnedermann, (Pogg. lii, 292):

$\dddot{S}i$ 60·08, $\bar{F}e$ 34·99, $\dot{H}$ 3·59=98·66.

B.B. becomes reddish-brown, then black, and fuses with difficulty to a black magnetic slag. Dissolves in muriatic acid.

This mineral comes from the province Minas Geraes, in Brazil, where it is associated with magnetic iron. The name anthosiderite is from *ανθος*, *flower*, and *σιδηρος*, *iron*.

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.—$\overline{\mathrm{Fe}}\,\dddot{\mathrm{Si}}^2+3\,\dot{\mathrm{H}}$=Silica 46·34, peroxyd of iron 40·12, water 13·54=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);

	$\dddot{\mathrm{Si}}$	$\overline{\mathrm{Fe}}$	$\overline{\mathrm{Al}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
1. Hungary, *compact*,	46·	33·	1·	2·	18·=100, Bernhardi and Brandes.
2. " *earthy*,	45·00	32·00	0·75	2·00	20·00=99·75, B. and Brandes.
3. Nontron, *Nontronite*,	44·0	29·0	3·6	2·1	18·7, clay 0·1=97·5, Berthier.
4. Villefranche, "	40·68	30·19	3·96	2·37	23·00=100·20, Dufrénoy.
5. Montmort, "	41·31	35·69	3·31	—	18·63, $\dot{\mathrm{Ca}}$ 0·19, $\dot{\mathrm{Cu}}$ 0·9=100·03, J.
6. Andreasberg, "	41·10	37·30	—	—	21·56=99·96, Biewend.

Kobell found, after expelling the water,

	$\dddot{\mathrm{Si}}$	$\overline{\mathrm{Fe}}$	$\overline{\mathrm{Al}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$
1. Haar,	52·10	40·60	3·00	1·60	1·08=98·38.
2. Hungary,	52·38	43·34	2·32	0·93	0·78=99·65.

This 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.

A mineral from Ceylon, resembling chloropal, afforded Thomson, (Min. i, 464):

$\dddot{\mathrm{Si}}$ 53·00, $\overline{\mathrm{Fe}}$ 26·04, $\dot{\mathrm{Mg}}$ 1·40, $\overline{\mathrm{Al}}$ 1·80, $\dot{\mathrm{H}}$ 18·00=100·24.

POLYHYDRITE, *Breit.* J. f. pr. Chem. xv, 321.

Massive.

G.=2·1—2·142. Color liver brown. Lustre resinous. Opaque.

Composition.—A silicated peroxyd of iron, containing 29·2 per cent. of water.

From Breitenbrunn in Saxony.

THURINGITE, *Breithaupt.*

Massive. Cleavage distinct in one direction.

H.=2—2·5. G.=3·151—3·157. Lustre pearly. Color olive green. Streak paler.

Composition.—$3\dot{\mathrm{F}}\mathrm{e}^3\dddot{\mathrm{Si}}+\overline{\mathrm{Fe}}^3\dddot{\mathrm{Si}}+9\dot{\mathrm{H}}$=Silica 24·65, peroxyd of iron 21.35, protoxyd of iron 43·29, water 10·71=100. Analysis by Rammelsberg, (Pogg, lxviii, 515):

$\dddot{\mathrm{Si}}$ 22·41, $\overline{\mathrm{Fe}}$ 21·94, $\dot{\mathrm{F}}\mathrm{e}$ 42·60, $\dot{\mathrm{Mg}}$ 1·16, $\dot{\mathrm{H}}$ 11·89=100,

and appears to correspond to a hydrous yenite. Yields water in a matrass. With the fluxes gives an iron reaction. Gelatinizes with muriatic acid.

From near Saalfeld in Thuringia.

STILPNOMELANE, *Glocker.*

Foliated, radiated, and also compact.

H.=3. G.=3—3·4. Lustre of cleavage surface between vitreous and pearly. Color black, greenish-black. Streak greenish.

Composition.—$2\,\dot{\mathrm{F}}\mathrm{e}^3\dddot{\mathrm{Si}}^2+\overline{\mathrm{Al}}\,\dddot{\mathrm{Si}}^3+6\,\dot{\mathrm{H}}$. Analysis by Rammelsberg, (Pogg. xliii, 127):

$\dddot{\mathrm{Si}}$ 46·17, $\dot{\mathrm{F}}\mathrm{e}$ 35·82, $\overline{\mathrm{Al}}$ 5·88, $\dot{\mathrm{Mg}}$ 2·67 $\dot{\mathrm{K}}$ 0·75, $\dot{\mathrm{H}}$ 8·72=100.

Dissolves imperfectly in the acids.

In a matrass yields water. B.B. fuses with some difficulty to a black shining globule; with the fluxes gives an iron reaction.

Occurs at Obergrund, with calc spar and quartz, sometimes intermixed with pyrites and magnetic iron ore. Probably mixed with chlorite, according to Rammelsberg.

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.—$(\dot{Fe}, \dot{Mn}, \dot{Mg})^3 \dddot{Si} + \ddot{\overline{Fe}} \dot{H}^3$, Kobell. Analyses: 1, Steinmann, (Schw. J. xxxii, 69); 2, same, as corrected by Kobell, (Schw. J. lxii, 196):

	$\dddot{Si}$	$\dot{Fe}$	$\ddot{\overline{Mn}}$	$\dot{Mg}$	$\dot{H}$
1.	22·452	58·853	2·885	5·078	10·700=99·968, Steinmann.
2.	22·452	27·112	2·885	5·078	10·700, $\ddot{\overline{Fe}}$ 35·350=108·577, Kobell.

B.B. froths and fuses on the edges, yielding, according to Kobell, a magnetic gray globule. With borax it 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.

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.—$\dot{Fe}^3 \dddot{Si} + 2 \ddot{\overline{Fe}} \dddot{Si} + 6 \dot{H}$, (Riddarhyttan, Rammelsberg)=Silica 30·06, peroxyd of iron 34·76, protoxyd of iron 23·46, water 11·72=100. $\dot{Fe}^3 \dddot{Si} + 2 \ddot{\overline{Fe}} \dddot{Si} + 9 \dot{H}$, (Gillinge, R.)=Silica 28·40, perox. of iron 32·83, protox. ib. 22·16, water 16·61=100. Hisinger's analysis of the latter afforded $\dot{Fe} \dddot{Si} + \ddot{\overline{Fe}} \dddot{Si} + 6 \dot{H}$. Kobell deduces for the Thraulite $\dot{Fe}^3 \dddot{Si}^2 + 3 \ddot{\overline{Fe}} \dddot{Si} + 15 \dot{H}$. Analyses: 1, 2, Hisinger, (Pogg. xiii, 505); 3, Kobell, (Pogg. xiv, 467); 4, Berzelius, (Pogg. xiii, 505); 5, 6, Rammelsberg, (Pogg. lxxv, 398); 7, Hermann, (J. f. pr. Chem. xlvi, 238):

	$\dddot{Si}$	$\ddot{\overline{Fe}}$	$\dot{Fe}$	$\dot{H}$
1. Riddarhyttan,	36·30	44·39		20·70=101·39, Hisinger.
2. Bodenmais, *Thraulite,*	31·77	49·87		20·00=101·64, "
3. " "	31·28	43·42	5·70	19·12=99·52, Kobell.
4. Gillinge,	27·50	51·50	——	11·75, $\ddot{\overline{Mn}}$ 0·77, $\ddot{\overline{Al}}$ 5·50=97·02 B.
5. Riddarhyttan,	33·07	34·78	17·59	11·54, $\dot{Ca}$ 2·56, $\dot{Mg}$ 0·46=100, R.
6. Gillinge,	32·18	30·10	8·63	19·37, $\dot{Ca}$ 5·50, $\dot{Mg}$ 4·22=100, R.
7. Orijervfi,	29·51	10·74	37·49	18·00, $\dot{Mg}$ 7·78=98·52, Hermann.

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.*

CROCIDOLITE. Krokidolite, *Hausmann.* Blue Asbestus. Blaueisenstein, *Klap.*

Fibrous, asbestus-like; fibres long but delicate and easily separable. Also massive.

H.=4. G.=3·2—3·265. Streak and color lavender-blue or leek-green. Opaque. Fibres somewhat elastic.

Composition.—$(\dot{\text{Na}},\dot{\text{Mg}})^3\dddot{\text{Si}}^4+3\dot{\text{Fe}}^3\dddot{\text{Si}}^2+x\dot{\text{H}}$, Berzelius, $(\dot{\text{R}}^6\dddot{\text{Si}}^6\dot{\text{H}}^x)$, which equals, substituting $4\dot{\text{H}}$ for $x\dot{\text{H}}$ in Berzelius's formula, this corresponding to the second analysis), Silica 51·1, protoxyd of iron 35·8, soda 6·9, magnesia 2·3, water 3·9=100. The same oxygen proportion affords the formula

$$4\dot{\text{Fe}}\dddot{\text{Si}}+\dot{\text{Na}}\dddot{\text{Si}}+(\dot{\text{Mg}},\dot{\text{Fe}})\dot{\text{H}}^3=5\dot{\text{R}}\dddot{\text{Si}}+\dot{\text{R}}\dot{\text{H}}^3;\ \text{or}\ \dot{\text{Mg}}^6\dddot{\text{Si}}^5+2\dot{\text{H}},$$

which last is near the formula of some steatite and also spadaite, (pp. 252, 253), excepting a replacement of the magnesia by protoxyd of iron and soda.

	$\dddot{\text{Si}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{Na}}$	$\dot{\text{H}}$
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, it melts easily to a black shining, opaque, and somewhat frothy glass, which is attractable by the magnet. The single fibres readily fuse in the flame of a spirit lamp. With borax it forms a green transparent bead, which, by adding saltpetre, is changed to brown.

It occurs in Africa, in the Grigna country, 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.

The name of this species is derived from κροκις, *woof*, in allusion to its wool-like fibrous structure.

SIDEROCHISOLITE, *Wernekink*, Pogg. i, 387.

In minute crystals. Massive.

H.=2—3. G.=3—3·4. Lustre splendent. Color pure velvet-black when crystallized, dark greenish-gray. Streak leek-green, greenish-gray. Opaque.

Composition.—$\dot{\text{Fe}}^6\dddot{\text{Si}}+3\dot{\text{H}}$ (? $2\dot{\text{H}}$). Analysis by Wernekink, (on three grains of the mineral, loc. cit.):

$\dddot{\text{Si}}$ 16·3, $\dot{\text{Fe}}$ $\dddot{\text{Fe}}$ 75·5, $\dddot{\text{Al}}$ 4·1, $\dot{\text{H}}$ 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, in small crystals, at Conghonas do Campo in Brazil. The mineral resembles cronstedtite.

Chamoisite, as analyzed by Berthier, (Ann. d. Mines, v, 393), has nearly the above composition, his result giving

$\dddot{\text{Si}}$ 14·3, $\dot{\text{Fe}}$ 60·5, $\dddot{\text{Al}}$ 7·8, $\dot{\text{H}}$ 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.

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 33·92, protoxyd of iron 26·43, water 39·65, a part of the iron being replaced by magnesia.

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.

GREEN EARTH. Grünerde *of the Germans.*

The name Green Earth is applied to different compounds, resembling one another in presenting a dark green color and nearly earthy appearance. The green earth occupying cavities in trap rocks, is usually referred to the species chlorite. Some are probably earthy forms of augite; others, impure silicates of iron. It has a foliated, granular, or earthy texture, with the softness of chlorite, and its olive-green color.

The Green Earth of Verona or *Talc Zographique* of Haüy, fills amygdaloidal cavities at Betonico north of Monte Baldo, near Verona. It has a clear celandine-green or apple-green color, a fine granular texture, unctuous feel, and moistened gives the peculiar argillaceous odor. G. 2·907, Delesse. *Composition* varying. Sometimes according to Delesse, (Anal. 2), near $8\dot{\mathrm{R}}\,\dddot{\mathrm{Si}}+\bar{\mathrm{Al}}\,\dddot{\mathrm{Si}}+6\dot{\mathrm{H}}$. Analyses of this and other green earths: 1, Klaproth, (Beit. iv, 239); 2, Delesse, (Bib. Univ. Genève, June, 1848, 106); 3, Vauquelin, (Ann. du Mus. ix, 81); 4, Klaproth:

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\bar{\mathrm{Fe}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
1. Mt. Baldo,	53·	—	28·	—	2·	10·	—	6· =99, Klaproth.
2. "	51·25	7·25	—	20·72	6·16	6·21	1·92	6·49, $\dot{\mathrm{Mn}}$ *trace*=100, Delesse.
3. "	52·0	7·0	23·0	—	6·0	7·5	—	4·0, Ca, $\bar{\mathrm{Mn}}$, HCl, *traces*, Vauq.
4. Cyprus,	51·5	—	20·5	—	1·5	18·0	—	8·0=99·50, Klaproth.

Composition of the *Green Grains* of the green sand formation of Gay Head, 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,

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Al}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{H}}$
1. Gay Head, Mass.	56·70	13·32	20·10	1·18	1·62	—	—	—=99·92, S. L. D.
2. Cauley's Pits, Woodstown, N. J.	48·45	6·30	24·31	—	*trace*	12·01	—	8·40=99·47, Rogers.
3. Sculltown, N. J.	51·50	6·40	24·30	*trace*	—	9·96	—	7·70=99·86, Rogers.
4. Poke Hill, Burlingt. Co., N. J.	50·75	6·50	22·14	—	—	12·96	—	7·50=99·85, Rogers.
5. S. E. of Phil. in N. J.	53·26	8·85	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.

When first dug the grains are very soft, and the mass is sometimes adhesive, but on exposure they nearly equal gypsum in hardness.

A Green Earth pseudomorph, imitative of augite, (altered augite), from Fassathal, afforded Rammelsberg, Silica 45·87, alumina 11·18, protoxyd of iron 24·63, lime 1·50, magnesia 0·28, water 9·82, alkali 6·72=100. A second, Silica 39·48, alumina 10·81, protoxyd of iron 15·66, magnesia 1·70, carb. lime 15·24, peroxyd of iron 8·94, alkali and water 8·67=100. (Pogg. xlix, 387).

The *Grengesite* of Breithaupt (Strahlige Grüneisenerde from Dalarne) has a specific gravity 3·1, a dark-green color, and a greenish, somewhat shining, streak. According to Hisinger it consists of Silica 27·01, protoxyd of iron 25·63, alumina 14·31, magnesia 14·31, oxyd of manganese 2·18, water 12·53.

5. *Carbonates, Phosphates, Arsenates, Chlorid.*

List of Species.

SPATHIC IRON,	$\dot{\mathrm{Fe}}\,\ddot{\mathrm{C}}$.*
OXALITE,	$2\dot{\mathrm{Fe}}\,\bar{\mathrm{C}}+3\dot{\mathrm{H}}$.
LAGONITE,	Borate of Iron?
COPPERAS,	$\dot{\mathrm{Fe}}\,\dddot{\mathrm{S}}+7\dot{\mathrm{H}}$.
COQUIMBITE,	$\bar{\mathrm{Fe}}\,\dddot{\mathrm{S}}^3+9\dot{\mathrm{H}}$.
COPIAPITE,	$\bar{\mathrm{Fe}}^2\,\dddot{\mathrm{S}}^5+18\dot{\mathrm{H}}$.
APATELITE,	$2\bar{\mathrm{Fe}}^2\,\dddot{\mathrm{S}}^3+3\dot{\mathrm{H}}$.

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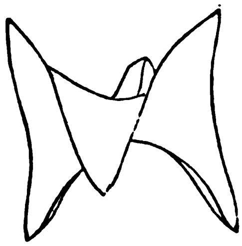
* For carbonates of lime and magnesia, isomorphous with Spathic Iron, see pages 204–212.

TECTIZITE.	
BOTRYOGEN,	$\dot{F}e^3\dddot{S}^2+3\bar{F}e\dddot{S}^2+36\dot{H}$.
TRIPHYLINE,	$\dot{R}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$.
VIVIANITE,	$\dot{F}e^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}+8\dot{H}$.
DUFRENITE,	$\bar{F}e^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}+2\frac{1}{2}\dot{H}$.
DELVAUXENE,	$\bar{F}e^2\overset{\cdot\cdot\cdot\cdot\cdot}{P}+24\dot{H}$.
PSEUDOTRIPLITE,	$(\bar{F}e\,\bar{M}n)^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}^2+2\dot{H}$.
SCORODITE,	$\bar{F}e\,\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+4\dot{H}$.
CARPHOSIDERITE.	
CACOXENE, (page 231),	$(\bar{F}e,\bar{A}l)^4\overset{\cdot\cdot\cdot\cdot\cdot}{P}^2+18\dot{H}$.
ARSENIOSIDERITE,	$\dot{C}a^6\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+4\bar{F}e^2\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+15\dot{H}$.
ALLUAUDITE,	$(\dot{M}n,\dot{N}a)^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}+\bar{F}e\overset{\cdot\cdot\cdot\cdot\cdot}{P}+\dot{H}$.
CUBE ORE,	$\dot{F}e^3\overset{\cdot\cdot\cdot\cdot\cdot}{A}s+\bar{F}e^3\overset{\cdot\cdot\cdot\cdot\cdot}{A}s^2+18\dot{H}$.
PITTICITE.	
DIADOCHITE,	$\bar{F}e^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}^2+2\bar{F}e\dddot{S}^3+36\dot{H}$.
SYMPLESITE.	
PYROSMALITE,	$4(\dot{F}e+\dot{M}n)^3\bar{S}i^2+Fe\,Cl^3+\bar{F}e\dot{H}^6$.

SPATHIC IRON. Carbonate of Iron. Sparry Iron. Siderite, *Haid.* Siderose, *Beud.* Brown Spar. Stahlstein. Sphærosiderite. Clay Iron Stone. Eisenspath and Spatheisenstein. Junkerite, *Dufrénoy*.

Rhombohedral. R : R=107° to 107° 5′, figs. 112, 113, plate 2; also 113, with the planes e of 119; e : e=136° 34′. The faces often curved, as below. Cleavage rhombohedral, perfect. Also in

1



2

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.=3·7317—3·829. Lustre vitreous—pearly. Streak white. Color ash-gray, yellowish-gray, greenish-gray, also brown, and brownish-red; sometimes white. Translucent—subtranslucent. Fracture uneven. Brittle.

Composition.—$\dot{F}e\ddot{C}$=Carbonic acid 37·94, and protoxyd of iron 62·06. But often containing oxyd of manganese, magnesia, lime, or equivalent to $(\dot{F}e, \dot{M}n, \dot{C}a, \dot{M}g,)\ddot{C}$. 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, Karsten.
2. Styria, *white*,	34·62	50·23	2·54	1·60	0·83	gangue 9·73=99·55, Karsten.
3. Hackenburgh, *white*,	38·64	50·41	7·51	2·35	—	gangue 0·32=99·23, Karsten.
4. Siegen, *yellowish*,	38·90	50·72	7·64	1·48	0·40	gangue 0·48=99·62, Karsten.
5. " "	38·85	47·20	8·34	3·75	0·63	gangue 0·95=99·72, Karsten.
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, $\dot{\overline{H}}$ 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	43·59	17·87	0·24	0·08=100, Schnabel.	

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 $\dot{Fe}\ddot{C}+\dot{Mn}\ddot{C}$.

In a brownish black crystallized spathic iron from Wolch, Rosengarten found, (Ramm. 3d Supp. 112):

$\ddot{C}$ with $\dot{\overline{H}}$ 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

$\dot{Fe}\ddot{C}$	$\dot{Mg}\ddot{C}$	$\dot{Mn}\ddot{C}$	$\dddot{\overline{Fe}}$	
74·28	16·40	6.56	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.

Sparry iron 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.

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 *Sphærosiderite* occurs in greenstone at Hanau, and many other places. Clay iron stone, which is a mixture of carbonate of iron and clay, occurs in coal beds in the neighborhood of Glasgow; also at Mouillar, Magescote, &c., in France.

At Roxbury, Conn., a vein of spathic iron occurs in quartz, traversing gneiss; also obtained 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. 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, described as a carbonate of iron occurring in rhombic prisms, has lately been shown by Breithaupt (Pogg. lviii, 278, 1843) to be nothing but common spathic iron.

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, $\dddot{\overline{Al}}$ 4·25, $\dddot{Si}$ 6·04=100. From the Siebengebirge. *Leonh. u. Bronn's Jahrbuch*, 1845, 200.

OXALITE, *Haus.* Oxalate of Iron. Humboldtine, *Mariano de Rivero*, Ann. de Ch. et de Ph. xviii, 207. Eisen Resin, *Breithaupt.* Humboldtit.

Crystallization undetermined. 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.—$2\dot{F}e\dddot{\bar{C}}+3\dot{\bar{H}}$=Protoxyd of iron 41·40, oxalic acid 42·69, water 15·91 =100. Analysis by Rammelsberg, (Pogg. xlvi, 283):

$\dot{F}e$ 41·18, Oxalic acid 42·40, $\dot{\bar{H}}$ (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 at Gross-Almerode, in Hessia.

LAGONITE.

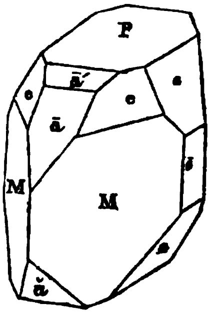
An earthy mineral of an ochreous yellow color. Supposed to be a borate of iron.

From the Tuscan Lagoons.

COPPERAS. Green Vitriol. Eisen-Vitriol, *Haus.* Sulphate of Iron. Melanterite, *Beud.*

Monoclinic; M : M=82° 21′, P : M=80° 37′, and 99° 23′; e : e=101° 35′, M : ė=138° 50′; ā : e=140° 48′. Cleavage perfect, parallel to P; less so parallel to M. Generally massive and pulverulent.

H.=2. G.=1·832. Lustre vitreous. Color various shades of green, passing into white; becomes yellowish on exposure. Streak uncolored. Subtransparent—translucent. Taste sweetish astringent, and metallic. Fracture conchoidal. Brittle.



Composition.—$\dot{F}e\dddot{S}+7\dot{\bar{H}}$=Sulphuric acid 29·01, protoxyd of iron 25·42, water 45·57.

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.

COQUIMBITE. White Copperas. Neutrales Schwefelsaures Eisenoxyd.

Hexagonal. Prisms usually with their terminal edges deeply replaced. P : e (a plane replacing the terminal edge, see fig. 125, pl. 2)=151°, M : e=119°, e : e=128° 8′. Cleavage imperfect, parallel to M. 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.—$\dddot{\bar{\text{Fe}}}\dddot{\text{S}}^3+9\dot{\bar{\text{H}}}$=Sulphuric acid 43·03, peroxyd of iron 28.00, water 28·97 =100. Analyses: 1, 2, H. Rose; 3, J. H. Blake, (Jour. Bost. Soc. Nat. Hist.):

	$\dddot{\text{S}}$	$\dddot{\bar{\text{Fe}}}$	$\dddot{\bar{\text{Al}}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dddot{\text{Si}}$	$\dot{\bar{\text{H}}}$
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, "
3. *Crystal,*	41·37	26·79	1·05	—	0·30	0·82	29·40=99·68, Blake.

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.

Blakeite.—The crystal analyzed by Blake, No. 3, was a regular octahedron, whence it would appear that this salt is dimorphous. The same form was assumed on recrystallization.

COPIAPITE, *Haid.* Yellow Copperas. Basisches Schwefelsaures Eisenoxyd.

In small grains, sometimes consisting of delicate hexagonal tables, too minute for the determination of their angles. Cleavage basal, perfect. Also fibrous and incrusting.

Lustre pearly. Color yellow. Translucent.

Composition.—Analyses: 1, 2, H. Rose, (Pogg. xxvii, 309); 3, Prideaux, (corrected):

	$\dddot{\text{S}}$	$\dddot{\bar{\text{Fe}}}$	$\dddot{\bar{\text{Al}}}$	$\dot{\text{Mg}}$	$\dddot{\text{Si}}$	$\dot{\text{Ca}}$	$\dot{\bar{\text{H}}}$
1. *Foliated,*	39·60	26·11	1·95	2·64	1·37	—	29·67=101·34, Rose.
2. *Fibrous,*	31·73	28·11	—	0·59	1·43	1·91	36·56=100·58, "
3. Chili,	28·9	34·4	—	—	—	36·7=100, Prideaux.	

The first gives the formula $\dddot{\bar{\text{Fe}}}^2\dddot{\text{S}}^5+18\dot{\bar{\text{H}}}$, and the second $2\dddot{\bar{\text{Fe}}}\dddot{\text{S}}^2+21\dot{\bar{\text{H}}}$. But it is doubted that they are pure chemical compounds. The third is the *Fibroferrite* of Prideaux.

It is found incrusting the Coquimbite, in the district of Copiapo, a province of Coquimbo.

Other sulphates of iron appear to exist in nature, but are yet little known.

The *Pittizite* of Beudant, or vitriol ochre, contains, according to Berzelius, sulphuric acid 15·9, peroxyd of iron 62·4, water 21·7=$\dddot{\bar{\text{Fe}}}^2\dddot{\text{S}}+6\dot{\bar{\text{H}}}$.

Another, presenting the yellow color and other external characters of the yellow copperas, (*Gelbeisenerz*, Breit.), contains, according to Rammelsberg, (Pogg. xliii, 132),

$\dddot{\text{S}}$ 32·111, $\dddot{\bar{\text{Fe}}}$ 46·736, $\dot{\text{K}}$ 7·882, $\dot{\text{Ca}}$ 0·643, $\dot{\bar{\text{H}}}$ and *trace* of Am 13·564,

or it is a compound of sulphate of iron and sulphate of potash—a *Potash Copperas.*

Still another—a *Soda Copperas*, analyzed by Scheerer, (Pogg. xlv, 188), contains

$\dddot{\text{S}}$ 32·42, $\dddot{\bar{\text{Fe}}}$ 49·37, $\dot{\text{Na}}$ 5·03, $\dot{\bar{\text{H}}}$ 13·13=99·95.

At Goslar in the Hartz a mixture of the sulphate of the protoxyds and peroxyds and other sulphates is called *Misy*.

APATELITE, *Meillet*, Ann. d. Mines, 4th ser. iii, 808.

Resembles the yellow copperas.

Composition.—$2\dddot{\overline{\mathrm{Fe}}}{}^{2}\dddot{\mathrm{S}}{}^{3}+3\dot{\mathrm{H}}$. Analysis by Meillet, (loc. cit.):

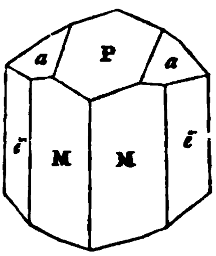
$\dddot{\mathrm{S}}$ 42·90, $\dddot{\overline{\mathrm{Fe}}}$ 53·30, $\dot{\mathrm{H}}$ 3·96=100·16.

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.

Triotizite, *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.

BOTRYOGEN. Red Iron-Vitriol. Neoplase, *Beud.* Rother Vitriol. Fer Sulfaté Rouge, *Duf.*

Monoclinic. M : M=119° 56′, M : $\breve{e}'$=160° 54′, $\breve{e}'$: $\breve{e}'$=99° 16′, *a* : *a*=141°, P : *a*=160° 30′; M and $\breve{e}'$ vertically striated. Cleavage parallel to M. 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.—$\dot{\mathrm{Fe}}{}^{3}\dddot{\mathrm{S}}{}^{2}+3\dddot{\overline{\mathrm{Fe}}}\dddot{\mathrm{S}}{}^{2}+36\dot{\mathrm{H}}$, Berz.=Sulphate of protoxyd of iron 18·95, sulphate of peroxyd of iron 48·39, water 32·66=100. Analysis by Berzelius, (Afh. iv, 307):

	$\dot{\mathrm{Fe}}\dddot{\mathrm{S}}$	$\dot{\mathrm{Fe}}\dddot{\overline{\mathrm{Fe}}}\dddot{\mathrm{S}}$	$\dot{\mathrm{Mg}}\dddot{\mathrm{S}}$	$\dot{\mathrm{Ca}}\dddot{\mathrm{S}}$	$\dot{\mathrm{H}}$ and loss.
1.	6·77	35·85	26·88	2·22	28·22=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 alternately the reduction and oxydizing flame, is changed into protoxyd or peroxyd of iron. Remains unaltered if kept dry, but when exposed to a moist atmosphere it becomes covered with a dirty yellowish powder. Boiling water dissolves only a part of it, leaving a yellow ochreous residue.

Occurs at the copper mine of Fahlun, in Sweden, where it coats gypsum or pyrites. The name is from *βοτρυς, a bunch of grapes.*

TRIPHYLINE, *Fuchs.* Tetraphyline. Perowskine.

Trimetric. M : M about 132°. Cleavage, basal perfect; parallel with M and one of the diagonals imperfect, the latter least so. Commonly massive.

H.=5. G.=3·6. Subresinous. Color greenish-gray; also bluish. Streak grayish-white. Translucent in thin fragments.

Composition.—$(\dot{\mathrm{Fe}}, \dot{\mathrm{Mn}}, \dot{\mathrm{Li}})^{3}\overset{.....}{\overline{\mathrm{P}}}$=Phosphoric acid 42·64, protoxyd of iron 49·16, of manganese 4·75, lithia 3·45. Analyses: 1, Fuchs, (J. f. pr. Chem. iii, 98, v, 319); 2, Berzelius and Nordenskiöld, (Jahresb. xv, 211):

	$\overset{.....}{\overline{\mathrm{P}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Li}}$	$\dot{\mathrm{H}}$
1. Bodenmais,	41·47	48·57	4·70	3·40	0·68, $\dddot{\mathrm{Si}}$, 0·53=99·35, Fuchs.
2. Keiti—*Tetraph.*,	42·6	38·6	12·1	8·2	—, $\dot{\mathrm{Mg}}$ 1·7=10·32, B. and N.

An altered Triphyline from Bodenmais afforded Fuchs,

$\overset{.....}{\overline{\mathrm{P}}}$ 35·70, $\dddot{\overline{\mathrm{Fe}}}$ 48·17, $\dddot{\overline{\mathrm{Mn}}}$ 8·94, $\dddot{\mathrm{Si}}$ 1·40, $\dot{\mathrm{H}}$ 5·30=99·51.

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. It was 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 above analysis, 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.

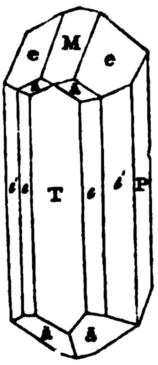
HETEROSITE, *Alluau*. Hetepozit.—A massive cleavable mineral, and probably, as considered by Fuchs, an altered triphyline. Color greenish-gray, or bluish—violet after exposure and submetallic. Streak bluish or reddish. G.=3·52; 3·39 after exposure.

Composition.—According to Dufrénoy, (Ann. Ch. Phys. xli, 342):

$$\ddot{\bar{P}}\ 41{\cdot}77,\quad \dot{F}e\ 34{\cdot}89,\quad \dot{M}n\ 17{\cdot}57,\quad \dot{\bar{H}}\ 4{\cdot}40,\quad \dddot{S}i\ 0{\cdot}22{=}98{\cdot}85.$$

B.B. fuses to a brown enamel of a submetallic lustre. Dissolves in acids.

VIVIANITE. Phosphate of Iron. Blue Iron Earth. Mullicite, *Thom.* Fer Phosphaté, *H.* Blaue Eisenerz, *Wern.* Eisenblau. Fer azuré, *H.* Glaukosiderit, Eisenphyllit.



Monoclinic, M : T=125° 18', e' : e'=108° 8', e : e=150° 50', P : e'=125° 56', T : e=165° 25', M : e=150° 30', M : e'=117° 40', T : ă=125° 25', Phillips. Surface P smooth, others striated. Cleavage highly perfect parallel with P; traces in other directions. Often reniform and globular. Structure divergent, fibrous or earthy; also incrusting.

H.=1·5—2. G.=2·661. Lustre pearly or metallic-pearly on P. The other faces vitreous. Color various shades of blue and green; deepens by exposure. Usually green when seen perpendicular to the cleavage face, and blue in a transverse direction; the two colors mingled, produce the dirty blue color which the mineral ordinarily presents. Streak bluish-white, soon changing to indigo-blue; the color of the dry powder, liver-brown. Transparent—translucent; opaque on exposure. Fracture not observable. Thin laminæ flexible. Sectile.

Composition.—$\dot{F}e^3\ddot{\bar{P}}+8\dot{\bar{H}}$ (=Protoxyd of iron 42, phosphoric acid 29, water 29), when colorless, being isomorphous with *Cobalt Bloom;* but changes readily, owing to oxydation of part of the iron; analysis afforded Rammelsberg $6(\dot{F}e^3\ddot{\bar{P}}+8\dot{\bar{H}})+(\ddot{\bar{F}}e^3\ddot{\bar{P}}^2+8\dot{\bar{H}})=$ Phosphoric acid 29·10, protoxyd of iron 33·00, peroxyd of iron 12·22, water 25·68=100.

Analyses vary in their results; 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):

	$\ddot{\bar{P}}$	$\dot{F}e$	$\ddot{\bar{F}}e$	$\dot{\bar{H}}$	
1. Bodenmais,	26·4	41·0	——	31·0 =98·4, 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.
4. " "	——[a]	33·98	12·06	27·49	
5. Hillentrup,	30·32	43·78	——	25·00, $\bar{A}l$ 0·7, $\dddot{S}i$ 0·02 =99·82, Brandes.	
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.	

[a] Undetermined.

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, 120); 4, Berthier, (loc. cit.):

			$\overset{.....}{\mathrm{P}}$	$\dot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{H}}$
1.	*Blue iron Earth*,	Alleyras,	23·1	43·0	32·4, $\bar{\mathrm{A}}\mathrm{l}$ 0·6, $\bar{\mathrm{M}}\mathrm{n}$ 0·3=99·4, Berthier.
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 $\dot{\mathrm{F}}\mathrm{e}^4\overset{.....}{\mathrm{P}}+4\dot{\mathrm{H}}$.

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 varieties occur in clay, and are sometimes associated with bog iron ore.

At St. Agnes in Cornwall, transparent crystals of an indigo color have been found, an inch in diameter and two in length, on magnetic pyrites. Bodenmais, and the gold mines of Vöröspatak in Transylvania, afford crystalline specimens. On the promontory of Kertsch in the Black Sea, it has been found in large indistinct crystals, occupying the interior of shells. The earthy variety, sometimes called *blue iron earth*, or *native Prussian blue*, (*fer azuré*), occurs in Greenland, Styria, Carinthia, Cornwall, &c. The friable varieties have been discovered in bog iron ore in several peat swamps in the Shetland Isles, and at Ballagh in the Isle of Man, accompanied with animal matter, particularly the horns of elk and deer, and near an old slaughter-house in Edinburgh.

Fine translucent crystals of Vivianite, presenting a dark-blue color, 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.

DUFRENITE, *Brongn.* Green Iron Ore. Kraurite. Grüneisenstein, *M.*

Fibrous and radiated.

H. nearly 3. G.=3·2—3·4. Lustre silky, weak. Color dull leek-green; alters on exposure to yellow and brown. Streak siskin-green. Subtranslucent.

Composition.—$\bar{\mathrm{F}}\mathrm{e}^2\overset{.....}{\mathrm{P}}+2\tfrac{1}{2}\dot{\mathrm{H}}$=Phosphoric acid 28·50, peroxyd of iron 62·52, water 8·98 =100. Analyses: 1, Karsten, (Arch. f. Bergb. u. Hütt. xv, 243); 2, Vauquelin, (Ann. Ch. Phys. xxx, 202):

1.	Siegen,	$\overset{.....}{\mathrm{P}}$ 27·72	$\bar{\mathrm{F}}\mathrm{e}$ 63·45	$\bar{\mathrm{M}}\mathrm{n}$ —	$\dot{\mathrm{H}}$ 8·56=99·73, Karsten.
2.	Haute Vienne,	27·85	56·20	6·76	9·29=100, Vauquelin.

B.B. Fuses easily to a clay. 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.

DELVAUXENE, *Dumont.* Delvauxit.

Massive and earthy, with a yellowish-brown, brownish-black, or reddish color.

H.=2·5. G.=1·85.

Composition.—$\overline{\text{Fe}}^{2}\dddot{\text{P}}+24\dot{\text{H}}$=Phosphoric acid 16·08, peroxyd of iron 35·27, water 48·65=100. Analyses by Dumont, (L'Institut, No. 276):

1. *Reddish brown,*	$\dddot{\text{P}}$ 16·04	$\overline{\text{Fe}}$ 34·20	$\dot{\text{H}}$ 49·76=100.
2. *Brownish black,*	16·57	36·62	46·81=100.

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.

PSEUDOTRIPLITE.

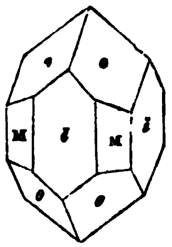
Resembles Triplite.

Composition.—$(\overline{\text{Fe}}, \overline{\text{Mn}})^{3}\dddot{\text{P}}^{2}+2\dot{\text{H}}$. Analysis by Delffs, (Blum's Lehrb. d. Orykt. 2, Aufl. 537):

$\dddot{\text{P}}$ 35·712, $\overline{\text{Fe}}$ 51·002, $\overline{\text{Mn}}$ 8·065, $\dot{\text{H}}$ 4·522, insoluble 0·699=100.

From Bodenmais.

SCORODITE. Neoctese, *Beud.* Martial Arseniate of Copper, *P.* Cupreous Arseniate of Iron, *Bournon.* Skorodit, *Breit.*



Trimetric. M : M=120° 10′; a vertical prism in the same vertical series with *o* has the angle 98° 1′ 20″, and this is assumed as the fundamental form by Descloizeaux. M : *ē*=150° 5′, *o* : *o*=114° 35′ and 103° 5′, M : *o*=141° 8′. Cleavage indistinct, parallel with the diagonals.

H.=3·5—4. G.=3·1—3·3; 3·18, Neoctese. Lustre vitreous—subadamantine. Streak white. Color pale leek-green or liver-brown. Subtransparent—translucent. Fracture uneven.

Composition.—$\overline{\text{Fe}}\,\dddot{\text{As}}+4\dot{\text{H}}$=Arsenic acid 50·20, peroxyd of iron 34·11, water 15·68. 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):

	$\dddot{\text{As}}$	$\overline{\text{Fe}}$	$\dot{\text{H}}$	$\dddot{\text{P}}$
1. Brazil, *Neoctese,*	50·78	34·85	15·55	0·67, $\dot{\text{Cu}}$ *trace*=101·85, Berzelius.
2. Popayan,	49·6	34·3	16·9	—, $\dot{\text{Pb}}$ 0·4=100·2, 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	—=99·86, " 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-colored variety occurs in the primitive 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., associated with arsenical pyrites, iron sinter, &c., in a vein in white limestone.

The name of this species is from *σκοροδον*, *garlic*, and alludes 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),

$\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s$ 48·05, $\overset{\cdot\cdot\cdot}{\bar{F}}e$ 36·41, $\dot{H}$ 15·54=100.

It forms an ochreous crust upon beryl, topaz, and quartz crystals.

CARPHOSIDERITE. Karphosiderit, *Breithaupt*.

In reniform masses.

H.=4—4·5. G.=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, alluding to the color, is from *καρφος*, *straw*, *σιδηρος*, *iron*.

ARSENIOSIDERITE, *Dufrénoy*.

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. G.=3·520, Duf., 3·88, Ramm. The powder is yellowish-brown, rather deeper in color than that of yellow ochre.

Composition.—$\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s^6$, $\overset{\cdot\cdot\cdot}{\bar{F}}e^7$, $\dot{C}a^6$, $\dot{H}^{13}$, (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):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s$	$\overset{\cdot\cdot\cdot}{\bar{F}}e$	$\overset{\cdot\cdot\cdot}{\bar{M}}n$	$\dot{C}a$	$\dot{K}$	$\dot{H}$
1.	34·26	41·31	1·29	8·43	0·76	8·75, $\dddot{S}i$ 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 $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s^3$, $\overset{\cdot\cdot\cdot}{\bar{F}}e^5$, (or $\overset{\cdot\cdot\cdot}{\bar{F}}e^6$), $\dot{C}a^3$, $\dot{H}^8$. 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,	$\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s$ 37·65	$\overset{\cdot\cdot\cdot}{\bar{F}}e$ 41·79	$\overset{\cdot\cdot\cdot}{\bar{M}}n$ 0·68	$\dot{C}a$ 10·53	$\dot{K}$ 0·40	$\dot{H}$ 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 $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s^5$, $\overset{\cdot\cdot\cdot}{\bar{F}}e^6$, $\dot{C}a^6$, $\dot{H}^{15}$, which affords the formula $\dot{C}a^6\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s+4\overset{\cdot\cdot\cdot}{\bar{F}}e^2\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s+15\dot{H}$=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 has the corresponding formula $\overset{\cdot\cdot\cdot}{\bar{F}}e^4\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{A}}s^2+18\dot{H}$; 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 Romanèche in the Department of Saone-et-Loire, France.

ALLUAUDITE, *Damour*.

Trimetric? Cleavages three, rectangular, unequal; one perfect. Massive.

H. above 4. G.=3·468. Color clove-brown. Streak yellowish. Lustre dull. Subtranslucent to opaque. Fracture shining, scaly.

Composition.—$(\dot{\mathrm{Mn}}, \dot{\mathrm{Na}})^3 \overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}} + \overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}\mathrm{e}} \overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}} + \dot{\mathrm{H}}$; mean of several analyses by Damour:

$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$ 41 25, $\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}\mathrm{e}}$ 25·62, $\overset{\cdot\cdot\cdot}{\bar{\mathrm{M}}\mathrm{n}}$ 1·06, $\dot{\mathrm{Mn}}$ 23·08, $\dot{\mathrm{Na}}$ 5·47, $\dot{\mathrm{H}}$ 2·65, $\overset{\cdot\cdot\cdot}{\mathrm{Si}}$ 0·60=99·73.

B.B. forms a magnetic globule and with the fluxes affords the reaction of phosphoric acid and oxyd of manganese. Dissolves in muriatic acid, forming a solution which is black when cold, and becomes yellowish-brown on heating.

From Chanteloub near Limoges in the Haute-Vienne, France, with Vivianite.

CUBE ORE. Pharmakosiderit, *Haus.* Würfelerz, *W.* Fer Arseniaté, *H.* Siderite. Beudantite.

Monometric. Figs. 28, 33, also 28 and 5 combined, plate 1. Cleavage cubic; imperfect. P sometimes striated parallel to its edge of intersection with a; (fig. 28.) Faces on the angles 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, commonly pale. Subtranslucent. Rather sectile.

Composition.—$\dot{\mathrm{F}}\mathrm{e}^3 \overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}} + \overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}\mathrm{e}}^3 \overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}^2 + 18\dot{\mathrm{H}}$=Arsenic acid 40·77, peroxyd of iron 27·70, protoxyd of iron 12·48, water 19·10. Analysis by Berzelius, (K. V. Ac. H. 1824, p. 354):

$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$	$\overset{\cdot\cdot\cdot}{\bar{\mathrm{F}}\mathrm{e}}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{H}}$
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 is obtained at the mines of Wheal Gorlan, Wheal Unity, and Carharrak in Cornwall, coating cavities in quartz, and associated with several of the ores of copper; also at St. Leonhard in France, and at Schneeberg and Schwarzenberg in Saxony.

The *Beudantite* is a variety from Horhausen in Nassau; the crystals have curved faces.

PITTICITE, *Haus.* Iron Sinter. Diarsenate of Iron. Eisensinter. 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, Langier, (Ann. Ch. xxx, 325); 3, Kersten, (Schw. J. liii, 176); 4, 5, Rammelsberg, (Pogg. lxii, 139):

	$\overset{..}{\bar{A}}s$	$\dddot{S}$	$\overline{Fe}$	$\overline{Mn}$	$\dot{H}$
1. Freiberg,	26·06	10·04	33·10	0·64	29·26=99·09, Stromeyer.
2. "	20·	14·	35·	*trace*	30· =99, Langier.
3. "	30·25	——	40·45	—	28·50=99·20, Kersten.
4. Seiglitsstollen,	24·67	5·20	54·66	—	15·47=100, Ramm.
5. "	28·45	4·36	58·00	—	12·59=100, Ramm.

Stromeyer's analysis corresponds to $\overline{Fe}^3\overset{..}{\bar{A}}s^2+\overline{Fe}\dddot{S}^2+30\dot{H}$; and No. 4 by Rammelsberg gives $5\overline{Fe}^2\overset{..}{\bar{A}}s+3\overline{Fe}^2\dddot{S}+40\dot{H}$. 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.

Gänsekötherz (Chenocoprolite) 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. Phosphor-Eisensinter, *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.—$\overline{Fe}^3\overset{..}{\bar{P}}^2+2\overline{Fe}\dddot{S}^2+36\dot{H}$=Phosphoric acid 13·90, sulphuric acid 15·62, peroxyd of iron 38·94, water 31·54=100. Analysis by Plattner, (Ramm. 1st Supp. 45):

$\overset{..}{\bar{P}}$ 14·811, $\dddot{S}$ 15·145, $\overline{Fe}$ 39·690, $\dot{H}$ 30·354=100.

It is considered by Rammelsberg 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.

SYMPLESITE, *Breithaupt*, J. f. prakt. Chemie, x, 501.

Monoclinic; in form resembling Cobalt Bloom. Cleavage perfect parallel with the larger lateral face.

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.

PYROSMALITE, *Haus.* Pyrodmalit, *Leonh.* Fer Muriaté, *H.*

Hexagonal. Common form a hexagonal prism with basal edges replaced; also in hexagonal tables. Cleavage basal, perfect. Also massive.

H.=4—4·5. G.=3·0—3·1. Lustre of base of prism, 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.—$4(\dot{\text{F}}\text{e}+\dot{\text{M}}\text{n})^3\,\dddot{\text{S}}\text{i}^2+\text{Fe Cl}^3+\not{\text{F}}\text{e}\,\dot{\text{H}}^3$=Silica 38·72, protoxyd of iron 22·10, protoxyd of manganese 22·43, peroxyd of iron 8·20, muriatic acid 5·72, water 2·83. Analysis by Hisinger, (Afhand. iv, 317):

	$\dddot{\text{S}}\text{i}$	$\not{\text{F}}\text{e}$	$\not{\text{M}}\text{n}$	$\not{\text{A}}\text{l}$	HCl	$\dot{\text{H}}$
1.	35·40	32·60	23·10	0·60		6·50=98·20.
2.	35·85	35·48	23·44	—	2·91	*undetermined*, $\dot{\text{C}}\text{a}$ 1·21=98·89.

As part of the iron is in the state of a basic chlorid, the second analysis becomes

$\dddot{\text{S}}\text{i}$ 35·85, $\dot{\text{F}}\text{e}$ 21·81, $\dot{\text{M}}\text{n}$ 21·14, Fe Cl^3 14·095, $\dot{\text{C}}\text{a}$ 1·210, $\dot{\text{H}}$ 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 it fuses to a black slag, which at last becomes a round globule, attractable by the magnet. With borax it fuses readily, and presents the appearances characteristic of iron and manganese. It dissolves perfectly in concentrated nitric acid.

Pyrosmalite occurs at Bjelkegrube, 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 from this locality, 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 ὀσμη, *odor*, and alludes to the odor given off before the blowpipe.

VII. MANGANESE.

Manganese has not been found native. It is a gray brittle metal when pure, somewhat resembling cast iron. G.=8. It occurs in nature in the state of sulphurets, oxyds, carbonates, phosphates, and arsenates, and its isomorphism with iron leads to many gradations into the iron compounds. For the same reason it also replaces magnesium, calcium, and aluminium in various species, as garnet, pyroxene. It is found combined with sulphur in a silicate of glucina called Helvin, (page 377).

1. *Sulphurets, Arseniurets.*

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.—Mn S=Sulphur 36·4, manganese 63·6. Analysis by Arfvedson, (K. V. Ac. H. 1822):

Sulphur 37·90, Manganese 62·10=100.

A specimen from Siebenburg afforded Klaproth, (Beit. iii, 85), Mn 82, S 11, $\ddot{C}$ 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, $\dddot{Si}$ 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.

HAUERITE, *Haid.* Naturwiss. Abhandl. of Vienna, 4to. 1847, i, pp. 101 and 107.

Monometric. Hemihedral, like pyrites. Figures 1, 2, 3, 42, 45, 49, plate 1, 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.—MnS^2=Sulphur 53·72, manganese 46·28. 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.

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^2As=Manganese 42·39, arsenic 57·61. Analysis by Mr. Kane, (Quarterly J. of Sci., New Ser., vi, 381):

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.

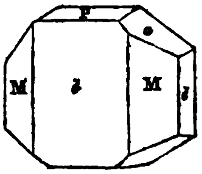
It is supposed to be from Saxony, and was first observed by Mr. R. J. Kane of Dublin, attached to a mass of galena.

2. *Oxyds.*

List of Species.

PYROLUSITE,	$\ddot{Mn}$.
HAUSMANNITE,	$\dot{Mn}\,\overline{\dddot{Mn}}$.
BRAUNITE,	$\overline{\dddot{Mn}}$.
HETEROCLIN, (Impure Braunite?)	
MANGANITE,	$\overline{\dddot{Mn}}\,\dot{H}$.
PSILOMELANE,	$\dot{R}$, $\ddot{Mn}$, $\dot{H}$.
CREDNERITE,	$(\dot{Ba}, \dot{Cu})^3\,\overline{\dddot{Mn}}^2$.
VARVACITE, NEWKIRKITE.	
WAD, CUPREOUS MANGANESE, EARTHY COBALT, GROROILITE, PELOKONITE.	

PYROLUSITE. Gray Ore of Manganese. Wad. Anhydrous Binoxide of Manganese, *Turner*. Graubraunsteinerz. Weichmangan.



Trimetric; M : M=93° 40′; M : ē=136° 50′; M : ĕ=133° 10′. Cleavage parallel to M and ĕ. 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.—$\ddot{\mathrm{M}}\mathrm{n}$=Manganese 63·4, oxygen 36·6. Analyses: 1, Arfvedson, (Schw. J., xlii, 210); 2, 3, Turner, (Edinb. Trans. 1828); 4, Scheffler, (Arch. d. Pharm., xxxv, 260):

	$\dot{\mathrm{M}}\mathrm{n}\ \overline{\dot{\mathrm{M}}}\mathrm{n}$	O	$\dot{\mathrm{B}}\mathrm{a}$	$\dddot{\mathrm{S}}\mathrm{i}$	$\dot{\mathrm{H}}$
1. Undenaes,	83·56	14·58	—	—	1·86=100, Arfvedson.
2. Elgersburg,	84·05	11·78	0·58	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, $\overline{\mathrm{F}}\mathrm{e}$ 1·8, $\dot{\mathrm{C}}\mathrm{a}$ 0·3, $\overline{\mathrm{A}}\mathrm{l}$ 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 Elgersburg, Ilmenau, and other places in Thuringia; also at Vorderehrensdorf near Mährish-Trübau, in Moravia, which place annually affords many hundred tons of this ore. Fine crystals occur near Johanngeorgenstadt, and at Hirschberg, in Westphalia; also found in Timor.

In the United States it occurs, associated with psilomelane, abundantly in different parts of Vermont, at Brandon, Irasburgh, Bennington, Monkton, Chittenden, &c., both crystallized similar to the above figure, and massive. It is found at Conway, Mass., in a vein of quartz; also at Plainfield and West Stockbridge, Mass.; at Winchester, N. H.; at Salisbury and Kent, Conn., forming velvet-like coatings on brown iron ore.

Pyrolusite parts with its oxygen at a red heat, and is extensively employed for discharging the brown and green tints of glass. It hence received its name from πυρ, *fire*, and λυω, *to wash;* and for the same reason is whimsically entitled by the French, *le savon de verriers*. It is easily distinguished from psilomelane by its inferior hardness.

Polianite, *Breit.* This mineral is identical in composition with Pyrolusite, being pure superoxyd of manganese ($\ddot{\mathrm{M}}\mathrm{n}$). Plattner obtained (Pogg. lxi, 192),

$\dot{\mathrm{M}}\mathrm{n}\ \overline{\dot{\mathrm{M}}}\mathrm{n}$ 87·274, O 12·111, $\overline{\mathrm{F}}\mathrm{e}$ and $\overline{\mathrm{A}}\mathrm{l}$ 0·165, quartz 0·132, $\dot{\mathrm{H}}$ 0·318=100.

It is peculiar in having the hardness nearly of quartz. H.=6·5—7. G.=4·84—4·88. Crystalline form nearly as above; M : M=92° 52′, *Breit.* Cleavage brachydiagonal perfect. Occurs near Platten in Bohemia, also at Schneeberg, Geyer, and Johanngeorgenstadt in Saxony and in Siegen.

HAUSMANNITE. Black Manganese. Red Oxyd of Manganese. Braunstein, *Haus.* Manganèse Oxydé Hydraté, *H.*

Dimetric. Fig. 57, pl. 1; a : a=105° 25′, a : a (in different pyramids)=117° 54′, a′ : a′=139° 56′. Cleavage rather perfect parallel to the base of the octahedron. Compound crystals, somewhat similar to figure 129: the same kind of composition sometimes takes place 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.—$\dot{\mathrm{Mn}}\,\bar{\mathrm{Mn}}$=Manganese 72·4, oxygen 27·6=$\bar{\mathrm{Mn}}$ 69, $\dot{\mathrm{Mn}}$ 31. Analyses: 1, Turner, (Trans. Roy. Soc. Edinb. xi); 2, Rammelsberg, (Pogg. xiv, 222):

	$\dot{\mathrm{Mn}}$	$\bar{\mathrm{Mn}}$	O	$\dot{\mathrm{Ba}}$	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{H}}$
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. It has been observed at Lebanon, Penn.

BRAUNITE. Hartbraunstein, *Haus.*

Dimetric. Form nearly the regular octahedron. A : A=109° 53′ and 108° 39′, Haidinger; 109° 46′ and 108° 53′, 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.—$\bar{\mathrm{Mn}}$ (=$\dot{\mathrm{Mn}}\bar{\mathrm{Mn}}$)=Manganese 69·75, oxygen 30·25. Analyses: 1, Turner, (Edinb. Trans. xi); 2, Tronsager, (Pogg. lxv. 276); 3, Damour, (Ann. d. Mines, [4], i, 400):

1. Elgersburg,	$\dot{\mathrm{Mn}}$ 86·94	O 9·85	$\dot{\mathrm{Ba}}$ 2·26	$\dot{\mathrm{H}}$ 0·95	$\dddot{\mathrm{Si}}$ *trace*=100, Tur.; G. 4·818.
2. Tellemark,	$\bar{\mathrm{Mn}}$ 86·40	—	—	1·98	6·22, $\bar{\mathrm{Fe}}$ 1·57, *gangue* 3·62 =99·79, Tronsager.
3. *Marceline*,	$\bar{\mathrm{Mn}}$ 67·37	$\dot{\mathrm{Mn}}$ 19·17	$\dot{\mathrm{Ca}}$ 1·22	—	7·71, $\bar{\mathrm{Fe}}$ 1·45, *gangue* 2·72 =99·64, Damour; G. 4·75.

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 Elgersberg in Thuringia; also near Ihlefeld in the Hartz, and at St. Marcel in Piedmont. 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.

HETEROCLIN, *Breithaupt; Evreinoff*, Pogg. xlix, 204.

Monoclinic. An oblique rhombic prism, in which M : M=128° 16′; usually the prism with the acute lateral edges truncated, two of the terminal edges replaced, (M : 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, inclining to brown. Fracture uneven to small conchoidal.

Composition.—Analyses by Evreinoff, (Pogg. xlix, 204):

	$\dddot{\mathrm{Si}}$	$\bar{\mathrm{Mn}}$	$\bar{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{K}}$
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. It was first instituted by Breithaupt, and named from ἑτεροκλινής, in allusion to [illegible]ique form of crystallization. It may be nothing but an impure Braunite.

obtained for a manganesian ore from Piedmont, $\dddot{\mathrm{Si}}$ 15·17, $\bar{\mathrm{Mn}}$ 75·80, $\bar{\mathrm{Fe}}$ 4·14, ·91.

MANGANITE. Gray Manganese Ore. Gray Oxyd of Manganese. Acerdèse, *Beud.* Grauer Bräunstein. Manganese oxydè, *H.*

Trimetric. M : M=99° 40′; fig. 15, plate 3, a compound crystal, composition parallel to the plane *a* on the acute solid angle; $\bar{o}:\bar{o}$=162° 39′ and 115° 10′, $\bar{e}:\bar{e}$=61°18′ and 118° 42′. Crystals longitudinally striated and often grouped. Also columnar and granular.

H.=4. G.=4·3—4·4. Lustre submetallic. Color dark steel-gray—iron-black. Streak reddish-brown, sometimes nearly black. Opaque; minute splinters cleaved off sometimes exhibit a brown color by transmitted light, when exposed to the direct light of the sun. Fracture uneven.

Composition.—$\dddot{\cancel{\text{M}}}\text{n}\,\dot{\text{H}}=\dddot{\cancel{\text{M}}}\text{n}$ 89·81 (Mn 62·64, O 27·17), $\dot{\text{H}}$ 10·19. Analyses: 1, Arfvedson, (Schw. J. xxvi, 262); 2, Gmelin, (ib. xlii, 208); 3, 4, Turner, (Edinb. Trans. 1828):

	Mn	O	$\dot{\text{H}}$
1. West Gothland,	89·92		10·08, Arfvedson.
2. Ihlefeld,	62·86	27·64	9·50, Gmelin.
3. "	62·68	27·22	10·10, Turner.
4. "	62·77	27·13	10·10, Turner.

B.B. alone infusible; 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 in Bohemia, Saxony, and Aberdeenshire; also at Undenaes, in West Gothland.

It is important in the manufacture of glass, and in bleaching operations.

PSILOMELANE, *Haid.* Compact and Fibrous Manganese Ore. Black Hematite. Compact Gray Oxyd of Manganese. Black Iron Ore. Psilomelanite. Schwarzeisenstein, *W.* Fasriger and Dichter Schwarzbraunstein, *Haus.* Dichtes Schwarzmanganerz, *L.* Manganese Oxydé Hydraté Concretionné, *H.*

Massive and botryoidal.

H.=5—6. G.=4—4·328. Lustre submetallic. Streak brownish-black, shining. Color iron-black, passing into dark steel-gray. Opaque.

Composition.—$\dot{\text{R}}\,\ddot{\text{M}}\text{n}^2+\dot{\text{H}}$ mixed with $\ddot{\text{M}}\text{n}$, 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).

	$\dddot{\cancel{\text{M}}}\text{n}$	$\ddot{\text{M}}\text{n}$	O	$\dot{\text{B}}\text{a}$	$\dot{\text{K}}$	
1. Schneeberg,	69·80		7·36	16·36	—,	$\dddot{\text{S}}\text{i}$ 0·26, $\dot{\text{H}}$ 6·22=100, Turner.
2. Romanèche,	70·97		7·26	16·69	—,	$\dddot{\text{S}}\text{i}$ 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,	$\dddot{\text{S}}\text{i}$ 0·53, $\dot{\text{C}}\text{u}$ 0·96, $\dddot{\cancel{\text{F}}}\text{e}$ 1·43, $\dot{\text{C}}\text{a}$ 0·38, $\dot{\text{N}}\text{a}$ and $\dot{\text{M}}\text{g}$ 0·32, $\dot{\text{H}}$ 3·39=100·61, Ramm.
5. Ilmenau,	——	77·28	15·82	0·12	5·29,	$\dot{\text{C}}\text{a}$ 0·91, $\dot{\text{C}}\text{u}$ 0·40, $\dddot{\text{S}}\text{i}$ 0·52=100·29, Cl.
6. "	83·3		9·8	5·8	—,	$\dot{\text{C}}\text{a}$ 1·8, $\dddot{\cancel{\text{A}}}\text{l}$ 2·1, $\dddot{\cancel{\text{F}}}\text{e}$ 0·3, $\dddot{\text{S}}\text{i}$ 1·7, $\dot{\text{H}}$ 4·3=99·1, Scheffler.
7. Gy, H. Saône,	——	70·60	14·18	6·55	4·05,	$\dot{\text{M}}\text{g}$ 1·05, $\dddot{\cancel{\text{F}}}\text{e}$ 0·77, $\dddot{\text{S}}\text{i}$ 0·60, $\dot{\text{H}}$ 1·67=99·47, Ebelmen.
8. Heidelberg,	——	70·17	15·16	8·08	2·62,	$\dot{\text{C}}\text{a}$ 0·60, $\dot{\text{M}}\text{g}$ 0·21, $\dot{\text{C}}\text{u}$ 0·30, $\dot{\text{C}}\text{o}$ 0·54, $\dddot{\text{S}}\text{i}$ 0·90, $\dot{\text{H}}$ 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 one of the most generally diffused ores of manganese. It frequently occurs in alternating layers of different thickness, with pyrolusite. It occurs in botryoidal and stalactitic shapes, in Devonshire and Cornwall; at Ihlefeld, in the Hartz; also in Hesse, Saxony, &c.

This species occurs in mammillary and botryoidal masses, at Chittenden, Irasburgh, and Brandon, Vt.

The name psilomelane is derived from ψιλος, *smooth* or *naked*, μελας, *black*, and was given it on account of its smooth botryoidal forms and black color.

VARVACITE, *R. Phillips.*

Occurs in thin plates and fibres, often radiating; and in pseudomorphs after scalenohedrons of calc spar; also in prisms, M : M=99° 36′, Breithaupt.

H.=2·5—3. G.=4·283—4·623. Lustre submetallic. Color steel-gray, iron-black. Streak black. Opaque.

Composition.—Analysis by R. Phillips; Manganese 63·3, oxygen 31·7, water 5; from Warwickshire.

By Duflos; $\dot{\mathrm{M}}\mathrm{n}$ 81·405, O 13·47, $\dot{\mathrm{H}}$ 5·125; from Ihlefeld.

Probably not a pure chemical compound.

It occurs in the county of Warwick, whence the name Varvacite. It has also been observed at Ihlefeld, in the Hartz.

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):

$\overline{\mathrm{M}}\mathrm{n}$ 56·30, $\overline{\mathrm{F}}\mathrm{e}$ 40·35, $\dot{\mathrm{H}}$ 6·70=103·35.

Forms a coating on red Hematite at Newkirchen, in Alsace.

CREDNERITE, *Rammelsberg.* Mangankupferoxyd, *Haus.* Mangankupfererz, *Credner.*

Monoclinic. Foliated crystalline. Cleavage very perfect in one direction; less distinct in two directions obliquely inclined to one another. H.=4·5. G.=4·9—5. Lustre metallic. Color iron-black to steel-gray. Streak black, brownish.

Composition.—$(\dot{\mathrm{B}}\mathrm{a}, \dot{\mathrm{C}}\mathrm{u})^3 \overline{\mathrm{M}}\mathrm{n}^2$=Oxyd of copper 42·85, oxyd of manganese 58·15; but often mixed with oxyd of manganese. Analysis: 1, Credner, (Pogg. lxxiv, 555); 2–6, Rammelsberg, (Pogg. lxxiv, 559):

		$\dot{\mathrm{M}}\mathrm{n}$	$\overline{\mathrm{M}}\mathrm{n}$	$\dot{\mathrm{C}}\mathrm{u}$	$\dot{\mathrm{B}}\mathrm{a}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{H}}$	O	
1.	Friederichsrode,	22·96	31·25	42·13	0·52	0·68	0·25	——	gangue 0·68=98·35, Cred.
2.	"	52·55	——	40·65	1·48	——	——	5·78=100·46, Ramm.	
3.	"	51·69	——	40·02	1·04	——	——	*undetermined*, Ramm.	
4.	"	54·72	——	34·65	2·71	——	——	6·51=98·59, Ramm.	
5.	"	56·29	——	32·35	3·08	0·76	——	8·58=99·06, Ramm.	
6.	"	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 Friedrichsrode, with volborthite, malachite and manganese ores. Rammelsberg observes that this ore is the source undoubtedly of the cupreous manganese, a secondary product.

WAD. EARTHY COBALT. CUPREOUS MANGANESE. Earthy Manganese. Bog Manganese. Manganschaum. Groroilite. 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—3·5. G.=3—3·7; 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 $\dot{R}\ddot{\mathrm{M}}\mathrm{n}+\dot{\mathrm{H}}$ (or $\dot{\mathrm{H}}^2$), 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 is a variety of it, from Groroi in Mayenne, France.

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 is a wad in which oxyd of cobalt sometimes amounts to 32 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, Klaproth, (Beit. ii, 308); 14, Döbereiner, (Gilb. Ann. lxvii, 333); 15, Rammelsberg, (Pogg. liv, 551); 16, Kersten, (Schw. J. lxvi, 1); 17, Rammelsberg, (Pogg. liv, 545); 18, Böttger, (ib.)

I. *Wad.*

	$\dot{\mathrm{M}}\mathrm{n}$	$\dddot{\overline{\mathrm{Mn}}}$	O	$\dddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{B}}\mathrm{a}$	$\dot{\mathrm{C}}\mathrm{o}$	$\dot{\mathrm{C}}\mathrm{u}$	$\dot{\mathrm{H}}$
1. Clausthal,	68·		——	6·5	1·0	——	——	17·5, $\dddot{\mathrm{Si}}$ 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, $\overline{\mathrm{Al}}$ 7·0=100·9, Berthier.
5. *Groroilite*,	62·4	——	12·6	6·0	——	——	——	15·8, clay, 3·0=100, Berthier.
6. Baden,	——	32·73	——	9·33	——	——	4·0	31·33, $\dot{\mathrm{P}}\mathrm{b}$ 12·33, Pb 8·0, $\overline{\mathrm{Ce}}$ 0·33, $\dddot{\mathrm{Si}}$ 0·13, quartz 2·60, W.
7. Ilmenau,	66·5	——	12·1	1·0	8·1	——	——	9·8, $\dddot{\mathrm{Si}}$ 2·5=100, Scheffler.
8. Rübeland,	67·50	——	13·48	1·01	0·36	——	——	10·30, $\dddot{\mathrm{Si}}$ 0·47, $\dot{\mathrm{C}}\mathrm{a}$ 4·22, $\dot{\mathrm{K}}$ 3·66 =100, Ramm.
9. Westgothland,	——	82·51	——	0·77	——	——	——	5·58, $\dddot{\mathrm{Si}}$ 1·43, $\overline{\mathrm{Al}}$ 6·30, $\dot{\mathrm{C}}\mathrm{a}$ 1·91, $\dot{\mathrm{M}}\mathrm{g}$ 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), $\overline{\mathrm{Al}}$ 10·7, quartz 1·6, Berthier.

II. *Earthy Cobalt.*

	$\dot{\mathrm{M}}\mathrm{n}$	$\dddot{\overline{\mathrm{Mn}}}$	O	$\dddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{B}}\mathrm{a}$	$\dot{\mathrm{C}}\mathrm{o}$	$\dot{\mathrm{C}}\mathrm{u}$	$\dot{\mathrm{H}}$
13. Oberlausitz,	——	16·0	——	——	——	19·4*	0·2	17·0, $\dddot{\mathrm{Si}}$ 24·8, $\overline{\mathrm{Al}}$ 20·4=97·8, K.
14. Camsdorf,	31·21	——	6·78	——	——	32·05	——	22·90=92·94, Döbereiner.
15. "	40·05	——	9·47	4·56	0·50	19·45	4·35	21·24, $\dot{\mathrm{K}}$ 0·37=99·94, Ramm.

* With oxyd of manganese.

III. *Cupreous Manganese.*

	$\dot{\mathrm{Mn}}$	$\overline{\mathrm{Mn}}$	O	$\overline{\mathrm{Fe}}$	$\dot{\mathrm{Ba}}$	$\dot{\mathrm{Co}}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{H}}$
16. Schlackenwald,	——	74·10	——	0·12	——	——	4·80	20·10, $\dddot{\mathrm{Si}}$ 0·3, gypsum 1·05=100·47, Kersten.
17. Camsdorf,	49·99	——	8·91	4·70	1·64	0·49[b]	14·67	14·46, $\dot{\mathrm{Mg}}$ 0·69, $\dot{\mathrm{K}}$ 0·52, $\dddot{\mathrm{Si}}$ 2·74 $\dot{\mathrm{Ca}}$ 2·25=101·06, R.
18. "	53·22	——	9·14	1·88	1·70	0·14[b]	16·85	16·94, $\dot{\mathrm{K}}$ 0·65 $\dot{\mathrm{Ca}}$ 2·85=103·34, Böt.

[b] With oxyd of nickel.

The following fomulas have been suggested for several of the above results:—

No. 5.—$\overline{\mathrm{Mn}}\,\mathrm{H}=\overline{\mathrm{Mn}}$ 83·17, $\dot{\mathrm{H}}$ 16·83.

7 and 8.—$(\dot{\mathrm{Mn}}, \dot{\mathrm{Ca}}, \dot{\mathrm{Ba}}, \dot{\mathrm{K}})\,\ddot{\mathrm{Mn}}^2+3\dot{\mathrm{H}}$, mixed with $\ddot{\mathrm{Mn}}$ (*Ramm.*), suggesting a relation to Psilomelane. For No. 8, $\dot{\mathrm{R}}\,\ddot{\mathrm{Mn}}^4+3\dot{\mathrm{H}}$, *Berz.*

9.—$2(\overline{\mathrm{Mn}}, \overline{\mathrm{Al}})+\dot{\mathrm{H}}$, *Svanberg.*

14.—$(\overline{\mathrm{Co}}, \overline{\mathrm{Mn}})+6\dot{\mathrm{H}}$?

15.—$(\dot{\mathrm{Co}}, \dot{\mathrm{Cu}})\,\ddot{\mathrm{Mn}}^2+4\mathrm{H}$ mixed with $\ddot{\mathrm{Mn}}$—or near Psilomelane, *Ramm.*

16.—$\overline{\mathrm{Mn}}+2\dot{\mathrm{H}}$, mixed with $\dot{\mathrm{Cu}}$, *Kersten.*—$\dot{\mathrm{Cu}}\,\overline{\mathrm{Mn}}^2+6\,\overline{\mathrm{Mn}}\,\dot{\mathrm{H}}^2$, *Berz.*—or $\dot{\mathrm{Cu}}\,\overline{\mathrm{Mn}}\,\mathrm{H}^2+3\overline{\mathrm{Mn}}^2\,\dot{\mathrm{H}}^2$.

17, 18.—$\dot{\mathrm{R}}\,\ddot{\mathrm{Mn}}^2+2\dot{\mathrm{H}}$, *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 evidently 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 decomposition of brown spar; 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. Abundant at Mine La Mott, Missouri, containing 100 per cent. of oxyd of cobalt, and 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 Saalfield.

Pelokonite is from Chili, where it occurs with Chrysocolla, (Richter, Pogg. xxi, 591; Kersten, Schw. J. lxvi, 7).

3. *Silicates.*

List of Species.

RHODONITE, Isomorphous with Augite,	$\dot{\mathrm{Mn}}^3\,\dddot{\mathrm{Si}}^2$.
TEPHROITE, Isomorphous with Chrysolite,	$\dot{\mathrm{Mn}}^3\,\dddot{\mathrm{Si}}$.
KNEBELITE, Isomorphous with Chrysolite,	$(\dot{\mathrm{Fe}}, \dot{\mathrm{Mn}})^3\,\dddot{\mathrm{Si}}$.
A Black silicate, according to Klaproth,	$\dot{\mathrm{Mn}}^3\,\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$.

RHODONITE, *Beud.* Manganese Spar. Bisilicate of Maganese, *Thomson.* Rother Mangankiesel. Kieselmangan. Photizite, *Dumenil.* Allagite. Corneous Manganese. Bustamite, *Brongn.* Fowlerite. Marceline, *Beud.* Opsimose, *Beud.* Dyssnite, *Kobell.*

Monoclinic. M : M=87° 6′, as in Augite, P on the axis 74°. Cleavage perfect parallel with M; less perfect parallel with P; also massive.

H.=5·5—6·5. G.=3·4—3·68; 3·612, Längbanshytta; 3·634, Siberia; 3·63, Stirling. Lustre vitreous. Streak white. Color light brownish-red, flesh-red, sometimes greenish, or yellowish, when impure. Transparent—opaque. Fracture conchoidal—uneven. Brittle.

Fowlerite is the cystallized Rhodonite of Franklin, N. J.; it is often black externally from alteration.

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, has a grayish-red color, and at times a somewhat fibrous texture; it contains much lime. *Allagite* has a greenish-gray color, verging towards black, and is somewhat fibrous, resembling altered bustamite.

Opsimose of Beudant, from Franklin, N. J., is the fowlerite partially altered.

The *dysenite* 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.—$\dot{M}n^3 \dddot{S}i^2$=Silica 46·33, protoxyd of manganese 53·67=100, or a true manganese augite; usually $(\dot{M}n, \dot{C}a)^3 \dddot{S}i^2$. Analyses: 1, Berzelius, (Afhandl. i, 110, iv, 382); 2, 3, Ebelmen, (Ann. d. Mines, [4], vii, 3); 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, (private communication):

	$\dddot{S}i$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{F}e$
1. Långbanshytta,	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	5·48	——	——=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, $\dot{C}a \ddot{C}$ 12·27=99·90, Ebelmen.
6. Stirling, N. J.,	46·48	31·52	4·50	3·09	7·23, $\dot{Z}n$ 5·85, ign. 1·00=99·67, Hermann. G.=3·63.
7. Cummington,	48·91	46·74	2·35	2·00	*trace*=100, Hermann. G.=3·42.
8. "	51·21	42·65	2·98	*trace*	4·34=101·18, Schlieper.

In Hermann's analysis the oxygen of the protoxyds is to that of the silica as 11·85 to 25·38; and in Schlieper's as 11·36 to 26·6: the former gives the ratio 4 : 8½; the latter 4 to 9, characteristic of Hornblende. Through much of the ore, silica is distributed at times in visible points or grains, and it is probable, as Schlieper states, that the excess of silica which makes the constitution that of hornblende rather than augite, is attributable to this, a mechanical source. If the mingled silica bears any proportion to the invisible carbonates, we need no other explanation.

Schlieper found his specimen (one furnished by the author and seemingly pure) to consist partly of carbonate of manganese and other bases. By digestion in concentrated muriatic acid, the soluble portion of the mineral separates; he thus obtained in one hundred parts 90·15 of the silicate of manganese, and 9·85 soluble portion. The soluble portion afforded on analysis,

$\dot{M}n \ddot{C}$ 50·52, $\dot{F}e \ddot{C}$ 8·60 $\dot{C}a \ddot{C}$ 37·17, $\dot{M}g \ddot{C}$ 2·44, $\dot{H}$ and loss 1·27=100.

The presence of carbonic acid in this mineral had been previously observed by Prof. Hitchcock, who states that he found 10 per cent. in one specimen.

B.B. becomes dark brown, and melts to a reddish-brown glassy globule; with the fluxes gives the reaction of manganese. In powder, partly dissolved in muriatic acid, and the insoluble part becomes of a white color. Darkens on exposure to the air, and often nearly black.

The foreign variety on which this species was first instituted, occurs at Långbanshytta, 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.

The fowlerite is found at the Franklin Furnace, Hamburgh, N. J., in granular limestone with magnetic iron, franklinite, and garnet; also at Stirling, N. J.

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),

$\dddot{Si}$ 42·40 $\dot{Mn}$ 50·72 $\dot{Fe}$ 6·76=99·88.

And this sets aside his measurements, or at least throws doubt upon them. He found the specific gravity 3·586.

A rose-colored ore from Kapnik, in concretionary forms afforded Brandes, $\dddot{Si}$ 53·50, $\dot{Mn}$ 41·33, $\dot{Fe}$ 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 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.

TEPHROITE, *Breithaupt.*

Massive granular.

H.=6. G.=4—4·12. Color ash-gray. Streak pale-gray. Darkens, on exposure, to brown and black.

Composition.—$\dot{Mn}^3\dddot{Si}$=Silica 30·15, protoxyd of manganese 69·85. Analyses: 1, Thomson, (Min. i, 514); 2, Rammelsberg, (Pogg. lxii, 145):

1. Franklin, $\dddot{Si}$ 29·64 $\dot{Mn}$ 66·60 $\dot{Fe}$ 0·92, Moisture 2·70=99·86, Thomson.
2. Sparta, 28·66 68·88 $\dot{Fe}$ 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, afforded Klaproth, (Beit. iv. 137),

$\dddot{Si}$ 25·0, $\dot{Mn}$ 55·8, $\dot{H}$ 13·00=93·8;

for which Berzelius reckons the formula $\dot{Mn}^3\dddot{Si}+3\dot{H}$, agreeing with the Tephroite, excepting the percentage of water. Klaproth obtained 60 per cent. of $\dot{Mn}\dddot{\bar{Mn}}$, whence the above is deduced. It has an iron-black color, submetallic lustre, and yellowish-brown streak.

KNEBELITE.

Massive, with an uneven and cellular surface, and quite hard.

G.=3·71. Lustre glistening. Color gray, spotted dirty-white, red, brown, and green. Opaque. Brittle. Fracture subconchoidal.

Composition.—$(\dot{Fe}, \dot{Mn})^3\dddot{Si}$, $\dot{Fe}$ and $\dot{Mn}$ being in equal proportions. Analysis by Döbereiner, (Schw. J. xxi, 49); Silica 32·5, protoxyd of iron 32, protoxyd of manganese 35. Unaltered alone before the blowpipe. Fuses with borax to a dark olive-green pearl.

Locality unknown. It was named by Döbereiner in honor of Major von Knebel.

4. *Carbonates and Phosphates.*

List of Species.

DIALLOGITE,—Isomorphous with calcite and spathic iron,	$\dot{Mn}\ddot{C}$.
MANGANOCALCITE, " " arragonite,	$(\dot{Mn}, \dot{Fe}, \dot{Ca}, \dot{Mg})\ddot{C}$.
TRIPLITE,	$(\dot{Mn}, \dot{Fe})^4 \overset{\cdot\cdot\cdot\cdot\cdot}{P}$.
ZWIESELITE,—Isomorphous with apatite ?	$3(\dot{Fe}, \dot{Mn})^3 \overset{\cdot\cdot\cdot\cdot\cdot}{P} + Fe F$.
HUREAULITE,	$(\dot{Mn}, \dot{Fe})^5 \overset{\cdot\cdot\cdot\cdot\cdot}{P}^2 + 8\dot{H}$.

DIALLOGITE, *Beud.* Carbonate of Manganese. Brown Spar, *in part.* Red Manganese. Manganspath.

Rhombohedral, R : R=106° 51′; 107° 20′, Levy and Breithaupt. Form like fig. 119, pl. 2. Cleavage rhombohedral, perfect. Also globular and botryoidal, having a columnar structure, sometimes indistinct. Also granular massive; occasionally impalpable.

H.=3·5—4·5. G.=3·592, var. from Kapnik. Lustre vitreous inclining to pearly. Color shades of rose-red; brownish. Streak white. Translucent—subtranslucent. Fracture uneven. Brittle.

Composition.—$\dot{Mn}\ddot{C}$=Manganese 61·73, carbonic acid 38·27; or coming under the general formula $(\dot{Mn}, \dot{Ca}, \dot{Fe}, \dot{Mg})\ddot{C}$. Analyses: 1, Berthier, (Ann. d. Mines, vi, 593); 2, 3, 4, Stromeyer, (Gött. gel. Anz. 1833, p. 1081); 5, Kersten, (J. f. pr. Ch. xxxvii, 163); 6, 7, R. Kane, (Phil. Mag. Jan. 1848):

	$\dot{Mn}\ddot{C}$	$\dot{Fe}\ddot{C}$	$\dot{Ca}\ddot{C}$	$\dot{Mg}\ddot{C}$
1. Freiberg,	82·2	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 and sand 0·33, organic matters and loss 10·11=100, Kane.
7. "	79·94	11·04	2·43	clay and sand 0·37, organic matters and loss 6·22=100, Kane.

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 County 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.—This is a hydrated carbonate of manganese, considered a variety of diallogite. It is from Gonzen, near Sargans in Switzerland.

MANGANOCALCITE, *Breit.*

In rhombic prisms like Arragonite, and closely related to that species.

Composition.—Same general formula as Diallogite. Analysis by Rammelsberg. (Pogg. lxviii, 511):

$\dot{\text{Mn}}\ddot{\text{C}}$ 67·48, $\dot{\text{Fe}}\ddot{\text{C}}$ 3·22, $\dot{\text{Ca}}\ddot{\text{C}}$ 18·81, $\dot{\text{Mg}}\ddot{\text{C}}$ 9·97=99·48.

From Schemnitz.

TRIPLITE. Ferruginous Phosphate of Manganese. Eisenpecherz, (in part), *W.* Pitchy Iron Ore.

Trimetric. Imperfectly crystalline. Cleavage in three directions perpendicular to each other, one the most distinct.

H.=5—5·5. G.=3·439—3·775. Lustre resinous, inclining to adamantine. Color brown or blackish-brown. Streak yellowish-gray. Subtranslucent—opaque. Fracture small conchoidal.

Composition.—$(\dot{\text{Mn}}, \dot{\text{Fe}})^4 \overset{\cdot\cdot\cdot}{\text{P}}$=Phosphoric acid 33·51, protoxyd of iron 32·99, protoxyd of manganese 33·50=100. Analysis by Berzelius, (Schw. J. xxvii, 70):

$\overset{\cdot\cdot\cdot}{\text{P}}$ 32·8, $\dot{\text{Mn}}$ 32·6, $\dot{\text{Fe}}$ 31·9, $\dot{\text{Ca}}^3 \overset{\cdot\cdot\cdot}{\text{P}}$ 3·2=100·5.

B.B. 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.

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.—$3(\dot{\text{Fe}}, \dot{\text{Mn}})^3 \overset{\cdot\cdot\cdot}{\text{P}} + \text{Fe F}$, or analogous to that of apatite. Analysis by Fuchs, (J. f. pr. Ch. xviii, 499):

$\overset{\cdot\cdot\cdot}{\text{P}}$ 35·60, $\dot{\text{Fe}}$ 35·44, $\dot{\text{Mn}}$ 20·34, F 3·18, Fe 4·76, $\overset{\cdot\cdot\cdot}{\text{Si}}$ 0·68.

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.

HUREAULITE, *Vauquelin*, Ann. Chim. Ph. xxx, 302.

Monoclinic. In oblique rhombic prisms, with the lateral solid angles deeply replaced. M : M=117° 30′, P : M=101° 12′; *a* : *a* =88°. M : *a*=116° 56′. Cleavage none.

H.=5. G.=2·27. Lustre vitreous or resinous. Color reddish-yellow, a little lighter than the color of hyacinth-red. Translucent.

Composition.—$(\frac{4}{5}\dot{M}n+\frac{1}{5}\dot{F}e)^5\dddot{\dot{P}}^2+8\dot{H}$. Analysis by Dufrénoy, (Ann. Ch. Phys. xli, 337):

$\dddot{\dot{P}}$ 38·00, $\dot{F}e$ 11·10, $\dot{M}n$ 32·85, $\dot{H}$ 18·00=99·95.

B.B. very fusible to a black globule with a metallic lustre. In a matrass yields water. Insoluble in acids.

Occurs in minute crystals, occupying small veins or geodes in granite, near Limoges in the Commune of Hureaux, whence its name.

Hureaulite resembles zircon in color, but is readily distinguished by the irregular form of its crystals and its inferior hardness.

VIII. COBALT AND NICKEL

The metals cobalt and nickel do not occur native. They are usually in combination with arsenic or sulphur, and sometimes also with antimony and bismuth; and as oxyds they are found combined with sulphuric and arsenic acids, and rarely with carbonic acid. The uncombined oxyds are not found excepting in an impure earthy state, and in this respect the metals are very unlike iron and manganese.

Cobalt, when pure, is a brittle reddish-white metal; G.=8·53. Nickel is white and malleable; G.=8·27.

1. *Sulphurets, Arseniurets, Antimoniurets.*

Among the following species there are many cases of isomorphism, and also of dimorphism; and if we include the corresponding compounds of the allied metals, many instances of trimorphism may be pointed out. The sulphurets and arseniurets have been considered isomorphous by Frankenheim. Although this view seems incorrect, as shown by G. Rose, still there is an interesting parallelism between the groups. The analogous compounds RS^2 and RAs^2, if the atomic weight of arsenic is halved, (or $R\,S^2$ and $R^2\,As^2$, if not halved, as adopted in the following pages), have a certain degree of relation in crystallization. The following table exhibits the groups of isomorphs that occur among these species, and also the cases of dimorphism. The species of any group, *a*, *b*, or *c*, are isomorphous; and under any general division, I, II, &c., the species in the group *a*, are dimorphous with those of *b*, or trimorphous with those of *b* and *c*. We add in a second parallel column, for comparison, the corresponding compounds of other metals. The system of crystallization is indicated by Roman numerals.*

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* I. Monometric system.
II. Dimetric system.
III. Trimetric system.
IV. Monoclinic system.
V. Triclinic system.
VI. Hexagonal or Rhombohedral system.

A. *Cobalt and Nickel.*

I.	
a. [Syepoorite,	Co S.
b. Millerite, VI,	Ni S.
II.	
a. Copper Nickel, VI,	$\mathrm{Ni^2 As}$.
Breithauptite, VI,	$\mathrm{Ni^2 Sb}$.
III.	
a. Smaltine, I,	Co As.
Rammelsbergite, I,	Ni As.
b. Chloanthite, III,	Ni As.
IV.	
a. Cobaltine, I,	$\mathrm{Co S^2 + Co As}$.
Nickel Glance, I,	$\mathrm{Ni S^2 + Ni As}$.
Ullmannite, I,	$\mathrm{Ni S^2 + Ni (Sb, As)}$.
b. Glaucodot, III,	$\mathrm{Co S^2 + (Co, Fe) As}$.

B. *Lead, Copper, Silver, Iron, Manganese, Zinc.*

I.	
a. Galena, I,	Pb S.
Cuproplumbite,	(Ɵu, Pb) S.
Erubescite, I,	(Ɵu, Fe) S.
Manganblende, I,	Mn S.
Blende, I,	Zn S.
Vitreous silver, I,	Ag S.
Clausthalite, I,	Pb Se.
Selensilver, I,	Ag Se.
[Rionite, ?	Zn Se.
b. Greenockite, VI,	Cd S.
Cinnabar, VI,	Hg S.
[Onofrite,	Hg (Se, S).
Magnetic Pyrites, VI,	Fe S? ($\mathrm{Fe^7 S^8}$?).
c. Stromeyerite, III,	(Ag, Ɵu) S.
Copper Glance, III,	(Ɵu) S.
Eucairite,	(Ɵu, Ag) Se.
Berzelianite,	Ɵu Se.
II.	
[Kaneite, ?	$\mathrm{Mn^2 As}$.
III.	
a. [Telluric Lead, I?	Pb Te.
b. Leucopyrite, III,	Fe As.
IV.	
b. Mispickel, III,	$\mathrm{Fe S^2 + Fe As}$.

Besides the above, there are also

1. *Ores of Cobalt and Nickel.*—V. Linnæite, I, $\mathrm{Co^2 S^3}$, or $\mathrm{Co^3 S^4}$.—VI. Skutterudite, I, $\mathrm{Co^2 As^3}$.—VII. Placodine, IV, $\mathrm{Ni^4 S}$.—VIII. Bismuth Nickel, I.

2. *Ores of Iron, Copper, etc.*—IX. Copper Pyrites, II, (Ɵu, Fe)^2 $\mathrm{S^4}$.—X. *a.* Pyrites, I, $\mathrm{Fe S^2}$; Hauerite, I, $\mathrm{Mn S^2}$.—*b.* Marcasite, III, $\mathrm{Fe S^2}$; [Covelline, Ɵu $\mathrm{S^2}$].—XI. Domeykite, Ɵu^3 As.—XII. *a.* Antimonial Silver, $\mathrm{Ag^4 Sb}$.

SYEPOORITE, *Nicol.* Subsulphuret of Cobalt, *Middleton.* Kobaltsulfuret, *Ramm.*

Massive, disseminated in grains or veins.

G.=5·45. Color steel-gray, inclining to yellow.

Composition.—Co S=Sulphur 35·24, cobalt 64·76. 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.

MILLERITE, *Haid.* Capillary Pyrites. Sulphuret of Nickel. Haarkies, Schwefelnickel. Nickel Sulfuré, *Levy.* Nickel Natif, *H.*

Rhombohedral, R : R=144° 8′, Miller. Cleavage rhombohedral, perfect. Usually in delicate capillary crystallizations.

H.=3—3·5. G.=5·26—5·65. Lustre metallic. Color brass-yellow, inclining to bronze-yellow, with a gray iridescent tarnish. Brittle.

Composition.—Ni S=Sulphur 35·63, nickel 64·37. Analyses: 1, Arfvedson, (K. V. Ac. H. 1822, 457); 2, Rammelsberg, (1st Supp. 67):

1. S 34·26 Ni 64·35=98·61, Arfvedson.
2. Saalfeld, " 35·79 " 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.

It occurs in thin capillary crystals in the cavities, and among the crystals of other minerals, at Joachimstahl in Bohemia, Johanngeorgenstadt in Saxony, Andreasberg, Cornwall, and other places. Near Merthyr Tydvil, at Dowlais, it is found in regular crystals, occupying cavities in nodules of spathic iron. Occurs in delicate capillary crystals with spathic iron in crystals at the Sterling Mine, Antwerp, N. Y.: the largest crystal yet observed was about a fifth of a line in diameter. It is partly in tufts implanted on spathic or specular iron, and in some cases crystals of spathic iron are transfixed by the needles of capillary pyrites. (Am. J. Sci. [2], ix, 287).

The *Sulphuret of iron and nickel* (*Eisennickelkies* of Scheerer) has the crystallization of the above, and the composition, except that iron replaces two-thirds of the nickel. Analysis gave, (Pogg. lviii, 315),

Sulphur 36·86, Iron 40·86, Nickel 22·28, corresponding to $(\frac{1}{3}\mathrm{Ni}+\frac{2}{3}\mathrm{Fe})\mathrm{S}$.

It has a light bronze-yellow color, and light bronze-brown streak; G.=4·6. Occurs with copper pyrites in a hornblende rock near Lillehammer in Southern Norway.

COPPER NICKEL. Arseniet of Nickel, *Thom.* Kupfernickel, *W.* Arseniknickel, *L.* Nickel Arsenical, *H.* Nickelkies. Rothnickelkies.

Hexagonal, and isomorphous with Breithauptite. 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.—$Ni^2 As$=Arsenic 55·98, nickel 44·02. Analyses: 1, Stromeyer, (Gött. gel. Anz. 1817, 204); 2, Pfaff, (Schw. J. xxii, 256); 3, Berthier, (Ann. Ch. Phys. xiii, 52); 4, Scheerer, (Pogg. lxv, 292):

	As	Ni	Fe	Pb	Co	Sb	S
1. Riecheladorf,	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, Pfaff.
3. Allemont,	48·80	39·94	—	—	0·16	8·00	2·00=99·90, Berth.
4. Krageroe, G. 7·663,	54·35	44·98	0·21	—	Cu 0·11		0·14=99·79, Scheer.

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, it emits arsenical fumes and fuses to a white globule, which darkens by exposure to the air. In nitric acid it 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 Wheal Chance, and at the Leadhills, Scotland.

It is found at Chatham, Conn., in gneiss, associated with smaltine.

BREITHAUPTITE, *Haid.* Antimonial Nickel. Antimoniet of Nickel. Antimonnickel.

Hexagonal. 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.—$Ni^2 Sb$=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.

It was found in the Andreasberg mountains, associated with calcareous spar, galena, and smaltine, but the locality was long since exhausted.

SMALTINE. Gray Cobalt. Tin-white Cobalt, *J.* Binarseniet of Cobalt, *Thom.* Tesseralkies, *Breit.* Weisser-Speiskobold, *W.* Speisskobalt, *Haus.* and *L.* Cobalt Arsenical, *H.*

Monometric: figures 1—10, and fig. 16, plate 1; also several of these forms in combination. Cleavage octahedral, distinct; also in traces parallel to the faces of the cube. Also massive and in reticulated and other imitative shapes.

H.=5·5. G.=6·466—7·2. Lustre metallic. Color tin-white, inclining, when massive, to steel-gray, sometimes iridescent from tarnish. Streak grayish-black. Opaque. Fracture granular and uneven. Brittle.

Composition.—Co As=Arsenic 71·81, cobalt 28·19; often (Co, Fe, Ni) As. Analyses: 1, Stromeyer, (Gött. gel. Anz. 1817, 72); 2, Varrentrapp, (Pogg. xxv, 485); 3, Hofmann, (ibid.); 4, Kobell; 5, Sartorius, (Ann. d. Ch. u. Pharm. lxvi, 278):

	As	Co	Fe	Cu	Ni	
1. Riechelsdorf,	74·21	20·81	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,	73·53	9·17	2·24	*trace*	14·06	S 0·94=99·94, Sartorius.

The varieties containing much iron have a high specific gravity. The last includes much nickel with the cobalt, and is therefore intermediate between this species and white nickel.

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.

Smaltine usually occurs in veins, accompanying other ores of cobalt and ores of silver and copper; also, in some instances, with copper nickel and mispickel.

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 Wheal Sparnon in Cornwall, and at Riechelsdorf in Hesse, in veins in the copper schist; at Tunaberg in Sweden, Allemont in Dauphiné.

At Chatham, Conn., it occurs in veins traversing gneiss, associated with mispickel and copper nickel.

The presence of copper nickel, which is a very common associate with this species, is the cause of no small annoyance to the miner; for even a minute quantity suffices to destroy the fine blue color obtained from cobalt. The ore, when separated from this attendant, is roasted to drive off the arsenic, and finely pulverized, and is then prepared for giving the blue color employed in painting porcelain and stone-ware. With silex and potash it affords smalt.

The *Bismuth Cobalt ore* of Karsten is supposed to be a mechanical mixture of smaltine and sulphuret of bismuth.

RAMMELSBERGITE, *Haid.* White Nickel. Binarseniet of Nickel, *Thom.* Chloanthite, *Breit.* Chathamite, *Shepard.* Weissnickelkies, Arseniknickel.

Monometric; figs. 2 and 5, pl. 1. Occurs also massive.

H.=5·5—6. G.=6·4—6·8; 6·423—6·565, Breit. Lustre metallic. Color tin-white, but tarnishes gray to black. Fracture uneven. Not at all ductile.

Composition.—$\mathrm{Ni\,As}$=Arsenic 71·77, nickel 28·23. Analyses: 1, Booth, (Am. J. Sci. xxix, 241); 2, 3, Rammelsberg, (1st Supp. 15); 4, C. U. Shepard, (Min. 2d ed. p. 158, and Am. J. Sci. xlvii, 351):

	As	Ni	Co	Fe
1. Riechelsdorf,	72·64	20·74	3·37	3·25=100, Booth.
2. Kamsdorf, G.=6·735,	70·34	28·40	——	*trace*=98·74, Rammelsberg.
3. "	70·93	29·50	——	*trace*=100·43, "
4. *Chathamite*,	70·00	12·16	1·35	17·70=101·21, Shepard.

B.B. evolves arsenical fumes, and fuses to a brittle metallic button. Gives the reaction of nickel with the fluxes.

Occurs in crystals in the cobalt mine of Riechelsdorf in Hesse; also massive at Schneeberg, mixed with quartz, and often covered with a thin coating of nickel green; also massive at Chatham, Conn. with smaltine.

CHLOANTHITE, *Breithaupt.*

Trimetric; M : M=123°—124°, or near Leucopyrite.

H.=5·5—6. G.=7·099—7·188, Breit. Slightly ductile. Otherwise like the preceding.

Composition.—The same as for Rammelsbergite, $\mathrm{Ni\,As}$. Analysis: 1, Hoffmann, (Pogg. xv, 491, 494):

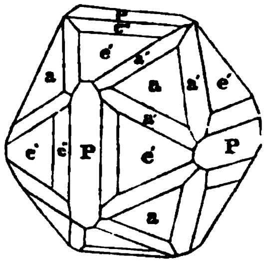
Schneeberg, As 71·30, Ni 28·14, Bi 2·19, Cu 1·50, S 0·14=102·27.

Occurs at Schneeberg and at Riechelsdorf. It was first separated from the tesseral white nickel by Breithaupt. The name Chloanthite was given by this author to the former; but, Haidinger's name being adopted there, Chloanthite may properly be used for the trimetric crystals.

COBALTINE, *Beud.* Silver White Cobalt. Bright White Cobalt. Glance Cobalt. Glanzkobalt, *W.* Kobalt Glanz, *Haus.* and *L.* Cobalt Gris, *H.*

Monometric; hemihedral. Figs. 42—47 inclusive, plate 1, also the annexed figure. P : e″=166° 30′, P : e′=153° 26′ 5½″. Cleavage cubic, perfect. Planes P striated. Also massive, granular or compact.

H.=5·5. G.=6—6·3. Lustre metallic. Color silver-white, inclining to red. Streak grayish-black. Fracture uneven and lamellar. Brittle.



Composition.—$CoS^2 + CoAs$=Sulphur 19·35, arsenic 45·18, cobalt 35·47. Analyses: 1, Stromeyer, (Schw. J. xix, 336); Schnabel, (Ramm. 3d Supp. 65):

	S	As	Co	Fe
1. Skutterud,	S 20·084	As 43·46	Co 33·101	Fe 3·232=99·882, Stromeyer.
2. Siegen,	19·10	44·75	29·77	6·38=100, Schnabel.

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, like the preceding species. 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 Botallick 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.

NICKEL-GLANCE. Nickelglanz. Nickelarsenikglanz. Nickelarsenikkies.

Monometric: hemihedral. Figs. 2, 5, 43, plate 1. Cleavage cubic, highly 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.—Analyses: 1, Berzelius, (K. V. Ac. H. 1820); 2, Pfaff, (Schw. J. xxii, 260); 3, Rammelsberg, (Pogg. lxviii, 511); 4, Kobell, (J. f. pr. Ch. xxxiii, 402); 5, Löwe, (Berichte Fr. Nat. in Wien, 1847); 6, Döbereiner, (Schw. J. xxvi, 270); 7, Rammelsberg, (Handw. ii, 14); 8, 9, Löwe, (Pogg. lv, 503, and Ramm. 2d Supp. 102); 10, 11, 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, $\ddot{S}i$ 0·9=100·58, Berzelius.
2. " "	45·90	12·36	24·42	10·46	——=98·14, Pfaff.
3. Harzgerode, G, 5·65,	44·01	18·83	30·30	6·00	——, Sb 0·86=100, Ramm.
4. *Amoibite,* G. 6·08,	45·34	14·00	37·34	2·50	*trace*, Pb 0·82=100, Kobell.
5. Prakendorf,	46·10	16·25	28·75	8·90	——=100, Löwe.
6. Kamsdorf,	48·	14·	27·	11·	——=100, Döbereiner.
7. Lobenstein,	48·02	20·16	31·82	——	——=100, Rammelsberg.
8. *Gersdorffite,*	49·83	14·13	26·14	9·55	——=99·65, Löwe.

	As	S	Ni	Fe	Co
9. Schladming, 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	11·18	14·12=100·28, 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, $\dot{C}a$ 12·58, $\dot{F}e$ 8·26, $\dot{M}n$ 1·02=87·25, Ludwig.

Analysis 1 gives the formula NiS^2+NiAs (=$As^1S^2Ni^2$)=Arsenic 45·16, sulphur 19·33, nickel 35·51=100; and 3 leads to the same, excepting a replacement of part of the nickel by iron. Pfaff's analysis (No. 2) is unsatisfactory on account of the loss.

Analysis 4 (*Amoibite*) afforded Kobell $Ni^2S^3+2NiAs$(=$As^2S^3Ni^4$)=Arsenic 47·4, sulphur 15·2, nickel 37·4. The ratio is more nearly 2 : 3 : 4½, which gives arsenic 45·3, sulphur 14·5, nickel 40·2, and leads to the formula $3NiS^2+2Ni^3As^2$.

Analysis 5 corresponds nearly to Kobell's formula for the Amoibite—$(Ni, Fe)^2S^3+2NiAs$=Arsenic 47·7, sulphur 15·3, nickel 28·1, iron 8·9. This is equivalent to 1 of $[NiS^2+NiAs]$ and ½ of copper nickel.

Analysis 8, *Gersdorffite*, according to Löwe, has the formula just mentioned for No. 5. The ratio 3 : 4 : 6 is nearer the analysis than 2 : 3 : 4, and affords the formula $Ni^2As^3+4(FeNi)S$=Arsenic 48·6, sulphur 13·8, nickel 25·5, iron 12·1. This is equivalent to 1 of $[NiS^2+NiAs]$ and ½ of copper nickel. Analysis 6 may belong here or under the formula for No. 5.

Analyses 10 to 12 by Pless, give the formula $2NiS+NiAs$. The Oelsnitz ore, No. 13, was mixed with spathic iron and calc spar. It corresponds to $NiS^2+2NiAs$, or 1 of $[NiS^2+NiAs]$+1 of Rammelsbergite.

These discordant results do not seem to admit of being harmonized entirely. Frankenheim, making As and S^2 isomorphous, writes the first formula $Ni(As, S^2)$; or with the halved atomic weight of Arsenic $\dot{N}i\,(As, S)^2$.

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, and in the Albertine mine, near Harzgerode in the Hartz; it is associated with copper pyrites, galena, calcareous spar, fluor spar, and quartz; also 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. The *Gersdorffite* is from Schladming, where it occurs in crystals. Pless's analyses, it will be observed, are also of Schladming crystals.

ULLMANNITE, *Fröbel*. Nickel Stibine. Nickeliferous Gray Antimony. Nickelspiesglanzerz. Antimonnickelglanz. Nickelantimonglanz. Antimoine Sulfuré Nickelifère, *H.*

Monometric. Cleavage cubic, perfect. Occurs also massive; structure granular.

H.=5—5·5. G.=6·451; 6·506, Rammelsberg. Lustre metallic. Color steel-gray, inclining to silver-white. Brittle.

Composition.—$NiS^2+Ni(Sb, As)$, Ramm.=(arsenic excluded) Nickel 26·84, antimony 58·55, sulphur 14·61;—therefore isomorphous with Nickel-Glance. 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, Ullmann.
3. "	——	55·76	15·98	27·36=99·10, H. Rose.
4. "	——	54·47	15·55	28·04=98·06, H. Rose.
5. "	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 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.

A variety containing Lead.—Rammelsberg calls this variety *Bournonit-Nickelglanz.* It occurs in cubes; H.=4·5. G.—3·685—5·706. Analysis, (Pogg. lxxvii, 254):

As 28·00, Sb 19·53, S 16·86, Ni 27·04, Co 1·60, Pb 5·18, Cu 1·38 Fe 0·51=100.

It comes from Wolfsberg in the Hartz. Rammelsberg considers this and a *nickel-bournonite,* (see under Bournonite), compounds of nickel glance and bournonite, and shows by calculation that the atomic volume of nickel glance and bournonite are the same.

GLAUCODOT, *Breithaupt and Plattner*, Pogg. Ann. 1849, lxxvii, 127.

Trimetric, like Mispickel; M : M=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, or precisely $(Co_{\frac{2}{3}}+Fe_{\frac{1}{3}})S^2+(Co_{\frac{2}{3}}+Fe_{\frac{1}{3}})As$ =Sulphur 19·40, arsenic 45·46, cobalt 23·33, iron 11·31=100. Analysis by C. F. Plattner, (loc. cit.):

S 20·210, As 43·200, Co (and trace of Ni) 24·774, Fe 11·900=100·084.

B.B. gives the reaction of cobalt, iron, sulphur, and arsenic.

Occurs in chlorite slate with cobaltine, in the province of Huasco, Chili.

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.

LINNÆITE, *Haid.* Cobalt Pyrites. Sulphuret of Cobalt. Kobaltkies. Schwefelkobalt.

Monometric. Figs. 2, 3, and others, plate 1. Cleavage cubic, imperfect. Also massive, granular to impalpable.

H.=5·5. G.=6·3—6·4. Lustre metallic. Color pale steel-gray, tarnishing copper red. Streak blackish-gray. Fracture uneven or subconchoidal.

Composition.—Co^2S^3=Sulphur 44·98, cobalt 55·02; $CoS+Co^2S^3$, (Frankenheim)= Sulphur 42·09, cobalt 57·91. Analyses: 1, Hisinger, (Afhandl. iii, 319); 2, 3, Wernekink, (Schw. J. xxxix, 306, and Leonh. Zeit. f. Min. 1826):

	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.

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.

SKUTTERUDITE, *Haidinger.* Tesseralkies, *Breit.* Hartkobaltkies. Arsenikkobaltkies. Modumite, *Nicol.*

Monometric. Figs. 1, 4, 7, 16. Cleavage cubic, distinct; also massive granular.

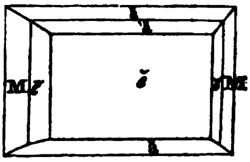
H.=6. G.=6·74—6·84. Lustre bright metallic. Color between tin-white and pale lead-gray, sometimes iridescent.

Composition.—$Co^2 As^3$=Arsenic 79·26, cobalt 20·74. Analyses: 1, Scheerer, (Pogg. xlii, 546); 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.

PLACODINE. Plakodin, *Breithaupt*, Pogg. liii, 631, 1841. *Plattner*, Pogg. lviii, 283.



Monoclinic. M : M=64° 32′; M : ĕ=122° 16′, ĕ : ĕ′=133° 28′, ĕ′ : ĕ′ (over ĕ)=86° 54′, ĕ : ă=115° 4′, ĕ : ā=120° 5′. Cleavage in traces parallel with M and the shorter diagonal. Also crystalline massive. H.=5—5·5. G.=7·988—8·062. Lustre metallic. Color bronze-yellow, little lighter than magnetic pyrites. Streak black. Fracture conchoidal—uneven.

Composition.—$Ni^4 As$=Arsenic 38·86, nickel 61·14. Analysis by Plattner, (Pogg. lviii, 283),

As 39·707, S 0·617, Ni 57·044, Co 0·910, Cu 0·862, Fe *trace*=99·140.

B.B. on charcoal fuses easily with an arsenical odor. With borax gives a cobalt reaction; with more borax than of nickel. Forms a green solution with nitric acid.

Found at the Jungfer mine, Müsen, where it occurs along with spathic iron and Gersdorffite. The crystals are tabular, and hence Breithaupt's name, derived from πλακωδης, *tabular*.

BISMUTH NICKEL. Grünauite, *Nicol.* Nickelwismuthglanz.

Monometric. In octahedrons and cubes. 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.—Analysis by Kobell, (J. f. pr. Chem. vi, 332),

S 38·46, Bi 14·11, Ni 40·65, Fe 3·48, Co 0·28, Cu 1·68, Pb 1·58=100·24.

Frankenheim writes the formula $(Ni S+Ni^2 S^3)$ $(Ni S+Bi^2 S^3)$, the analysis giving nearly 6 of the first member to 1 of the second, which is equivalent to 2 Bi, 19 Ni, 28 S =Nickel 45·86, bismuth 17·37, sulphur 36·77. Considering Bi and Ni isomorphous, he reduces the above formula to $Ni S+(Ni^2 S^3, Bi^2 S^3)$, and makes the species isomorphous with linnæite and magnetic iron. In these formulas, bismuth is taken at 1330·4. But it seems improbable, judging from the analogous compounds, that a compound of the constitution suggested by Frankenheim should be monometric in crystallization, and especially as Rose has shown that bismuth is isomorphous with antimony and the allied metals, and therefore not with nickel. But the compounds of nickel, cobalt, &c., with arsenic and the allied, are partly tesseral. The proportion 1 : 10 : 14 for the bismuth, nickel, and sulphur, adopting 1330·4 as the number for bismuth, (equivalent to 1 : 20 : 28, with 2660·8), gives us the formula $Ni^2 Bi^2+14Ni^2 S^3$; and if arsenic (and therefore bismuth) is taken as isomorphous with sulphur, the formula is identical essentially with the first of linnæite. We have written it upon the halved atomic weight, because it is in this relation that Frankenheim compares the arsenic group with sulphur. The formula becomes, adopting 2660·8 for bismuth, $Ni^4 Bi^2+28Ni^2 S^3$.

B.B. fuses easily on charcoal to a brittle gray magnetic bead, and colors the coal yellowish; with borax a nickel reaction. A greenish solution with nitric acid, and a deposition of sulphur.

Occurs at Grünau, in the district of Sayn Altenkirk, with quartz and copper pyrites.

2. *Carbonates, Sulphates, Arsenates.*

List of Species.

Emerald Nickel,	$\dot{Ni}^3\ddot{C}+6\dot{H}$
Cobalt Vitriol,	$(\dot{Co},\dot{Mg})\dddot{S}+7\dot{H}$
Cobalt Bloom,	$\dot{Co}^3\bar{\ddot{As}}+8\dot{H}$
Nickel Green,	$\dot{Ni}^3\bar{\ddot{As}}+8\dot{H}$

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.—$\dot{Ni}^3\ddot{C}+6\dot{H}(=\dot{Ni}^3\ddot{C}^1\dot{H}^6)$, but often containing magnesia in place of part of the oxyd of nickel. Analysis by B. Silliman, Jr., (Am. J. Sci. [2], vi, 248):

$\dot{Ni}$ 58·811, $\ddot{C}$ 11·691, $\dot{H}$ 29·498.

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.

COBALT VITRIOL. Bieberite, *Haid.* Red Vitriol. Sulphate of Cobalt. Kobaltvitriol. Rhodalose, *Beud.*

Monoclinic. Usually in stalactites and crusts, investing other minerals. Lustre vitreous. Color flesh and rose-red. Subtransparent—translucent. Friable. Taste astringent.

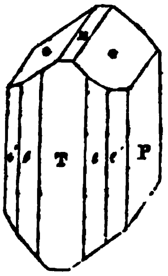
Composition.—$(\dot{Co},\dot{Mg})\dddot{S}+7\dot{H}$, from Winkelblech's analysis. Analyses: 1, Kopp, (Gehlen's J. [2], vi, 157); 2, Winkelblech, (Ann. d. Pharm. xiii, 265); 3, Beudant:

1.	Bieber,	$\dddot{S}$ 19·74	$\dot{Co}$ 38·71	$\dot{H}$ 41·55=100, Kopp.
2.	"	29·053	19·909	46·830, $\dot{Mg}$ 3·864=99·656, Winkelbech.
3.	"	30·2	28·7	41·2, $\ddot{\bar{Fe}}$ 0·9, Beudant.

In a matrass yields water, and when strongly heated, sulphurous acid. Communicates a blue color to glass of borax.

It occurs in the rubbish of old mines at Bieber, near Hanau, and also at Leogang in Saltzburg.

COBALT BLOOM. Erythrine, *Beud.* Prismatic Red Cobalt, *J.* Red Cobalt Ochre. Arseniate of Cobalt. Cobalt Mica. Kobaltblüthe, *Haus.* Cobalt Arseniaté, *H.*



Schneeberg.

Monoclinic; M : T=124° 51′ and 55° 9′, M : e=149° 12′ e : e=118° 28′, T : *e*=155° 5′, T : *e′* =137° 6′, *e* : *e*=130° 10′, *e′* : *e′*=94° 12′: surface P and T vertically striated. Cleavage parallel to P highly perfect; indistinct parallel to M and T. Also in globular and reniform shapes, having a drusy surface and a columnar structure: sometimes stellate, and thus aggregated. Also pulverulent, incrusting other minerals.

H.=2—2·5; the lowest on P. G.=2·948. Lustre of P pearly; of other faces, adamantine, inclining to vitreous; also dull and earthy. Color crimson and peach-red, sometimes pearl or greenish-gray. The red tints incline to blue, perpendicular to P. 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.—$\dot{\mathrm{Co}}^{3}\ddddot{\bar{\mathrm{As}}}+8\dot{\bar{\mathrm{H}}}$=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):

	$\ddddot{\bar{\mathrm{As}}}$	$\dot{\mathrm{Co}}$	$\dot{\bar{\mathrm{H}}}$	
1. Riechelsdorf,	37·	39·	22·	=98, Bucholz.
2. Allemont,	40·0	20·5	24·5,	$\dot{\mathrm{Ni}}$ 9·2, $\dddot{\bar{\mathrm{Fe}}}$ 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,	$\dot{\mathrm{Ca}}$ 8·00=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.

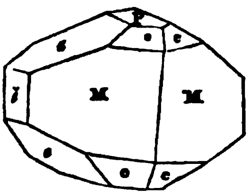
The *earthy cobalt bloom*, of a peach blossom color, (Kobaltbeschlag), is shown by Kersten to be cobalt bloom with some free arsenous acid. He obtained,

	$\dddot{\bar{\mathrm{As}}}$	$\ddddot{\bar{\mathrm{As}}}$	$\dot{\mathrm{Co}}$	$\dot{\mathrm{Fe}}$	$\dot{\bar{\mathrm{H}}}$
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 Saalfield in Thuringia; and at Riechelsdorf in Hessia. Occurs also on the north shore of Lake Superior at Prince's Mine. The earthy peach-blossom varieties have been observed 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.

Cobalt bloom, when abundant, is valuable for the manufacture of smalt. This species resembles red antimony, and capillary red copper ore. From both of these minerals, however, the effects under the blowpipe readily distinguish it. Moreover, the color of the former is more sombre, of the latter, more brilliant than cobalt bloom.



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.

Trimetric; M : M=132° 48′. P : *a*=158°2′. Cleavage distinct and brilliant, parallel to *ĕ*. 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 quanties 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.

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.

NICKEL GREEN. Nickelocker. Nickelblüthe. Nickel Arseniaté, *H.*

Triclinic? Hausmann. In capillary crystals; also massive and disseminated.

Soft. Color fine apple-green. Streak greenish-white. Fracture uneven, or earthy.

Composition.—$\dot{N}i^3\,\overset{\cdots}{\bar{A}}s+8\dot{H}$=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):

	$\overset{\cdots}{\bar{A}}s$	$\dot{N}i$	$\dot{C}o$	$\dot{H}$
1. Allemont,	36·8	36·2	2·5	25·5=100, Berthier.
2. Riechelsdorf,	36·97	37·35	——	24·32, $\ddot{\bar{F}}e$ 1·13, $\dddot{S}$ 0·23=100, S.; some $\dot{C}o$ with $\dot{N}i$.
3. Schneeberg,	38·30	36·20	1·53	23·91, $\ddot{\bar{F}}e$ 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, $\overset{\cdots}{\bar{A}}s$ 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 probably 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 Saalfield, 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.

ZINC AND CADMIUM.

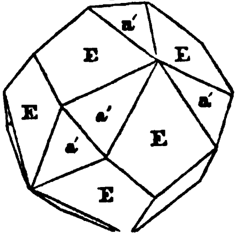
Zinc and Cadmium are not found native. Zinc occurs in combination with sulphur or oxygen, forming but three distinct native species; besides these, the oxyd forms native sulphates, silicates, and carbonates, and with oxyd of iron and magnesia enters into the constitution of Franklinite, (p. 435), and some varieties of Spinel, (p. 370).

Cadmium is occasionally associated sparingly with zinc in its ores, and forms also a native sulphuret. Zinc is a white metal, slightly bluish, rather brittle. G.=6·195. Fuses at 773° F. Cadmium is white and harder than tin; it is malleable, and G.=8·67. Fuses at 442°. Zinc is dimorphous. It has been observed in hexagonal prisms by Nöggerath, and in tesseral forms by Nickles.

1. *Combined with Sulphur.*

BLENDE. Sulphuret of Zinc. Black Jack. Zinc Sulfuré, *H.*

Monometric: hemihedral. Figs. 1, 6, 8, 9, 30, 32, pl. 1; also the annexed figure, in which the acute solid angles are replaced by two instead of four secondary planes. Cleavage dodecahedral, highly perfect. Compound crystals similar to fig. 129, pl. 2; sometimes parallel to the same faces (A, fig. 4, or a, fig 8) in several of the secondary forms; and this composition is often repeated. Also botryoidal, and other imitative shapes; structure columnar to impalpable; also massive compact.



Lockport.

H.=3·5—4. G.=4—4·2. Lustre adamantine—resinous. Color brown, black, yellow, red, green; yellow when pure. Streak white—reddish-brown. Transparent—translucent. Fracture conchoidal. Brittle.

Composition.—Zn S=Sulphur 33·10, zinc 66·90. Analyses: 1, Arfvedson, (K. V. Ac. H. 1822, 438, and Pogg. i, 62); 2, Berthier, (Ann. des Mines, ix, 419); 3, 4, Löwe, (Pogg. xxxviii, 161); 5, Kersten, (Pogg. lxiii, 132); 6, Scheerer, (Pogg. lxv, 300); 7, 8, 9, Jackson, (Geol. Rep. N. Hampshire, 208); 10, Lecanu, (J. de Pharm. ix, 457); 11, Berthier; 12, 13, Boussingault, (Pogg. xvii, 379):

		S	Zn	Fe	Cd
1.		33·66	66·34	—	—=100, Arfvedson.
2.	Pyrenees,	33·6	63·0	3·4	—=100, Berthier.
3.	Przibram, *fibrous*,	33·15	61·40	2·29	1·50=98·34, Löwe.
4.	" "	32·75	62·62	2·20	1·78=99·35, "
5.	Carinthia, Raibel, *rh. yw.*	32·10	64·22	1·32	*trace*, Sb and $\dot{Pb}$ 0·72, $\dot{H}$ 0·80=99·16, K.
6.	Christiania, *fibrous*,	33·73	53·17	11·79	—, Mn 0·74, Cu *trace*=99·43, Scheer.
7.	Eaton, N. H. *ywh. bn.*	33·22	63·62	3·10	0·6 including loss=100, Jackson.
8.	Shelburne, N. H.	32·6	52·0	10·0	3·2, Mn 1·3=99·1, Jackson.
9.	Lyman, N. H.	33·4	55·6	8·4	2·3=99·7, Jackson.
		Zn S	Fe S		
10.	Charente,	82·76	13·71=96·47, Lecanu.		
11.	England,	91·8	6·4=98·2, Berthier.		
12.	*Marmatite*, Marmato,	77·5	22·5=100, Boussingault.		
13.	" "	76·8	23·2=100, "		

Part of the zinc, as shown by the analyses, is often replaced by iron and cadmium. The *Marmatite* affords the formula $3\,ZnS+FeS=77\,ZnS$, and 23 Fe S.

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 it frequently occurs in silver mines.

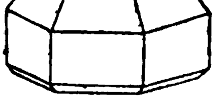
Derbyshire, Cumberland, and Cornwall, afford the black varieties; also Transylvania, Hungary, and the Hartz. Sahla in Sweden, Ratieborzits in Bohemia, and many Saxon localities, afford splendid black and brown crystals. A variety having a divergent fibrous structure and presenting botryoidal forms, is 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 an extensive lead vein in millstone grit, and is occasionally crystallized 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 southeast of Spraker's Basin. In Massachusetts it occurs at Sterling of a cherry-red color, with galena; also a yellowish-brown variety at the Southampton lead mines; at Hatfield with galena. In New Hampshire at the Eaton lead mine it is abundant; at Warren there is a large vein of black blende. In Maine it occurs at the Lubec lead mines; also at Bingham, Dexter, and Parsonsfield. In Connecticut a yellowish-green variety is met with at Brookfield; at Berlin of a yellow color; brownish-black at Roxbury, and yellowish-brown at Lane's mine, Monroe. 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. 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.

GREENOCKITE, *Brooke* and *Connel*, Jameson's Jour. xxviii, 390; *Breithaupt*, Pogg. li, 274. Sulphuret of Cadmium.

Hexagonal: possibly hemihedral. P : e′=136° 24′, P : e=117° 42′, P : e″=154° 32′, M : e′=133° 36′, M : e=152° 18′, M : e″=115° 28′, e″ : e″ (adjoining) =155° 29′, e′ : e′ (adjoining)=139° 39′, e′ : e′ (over M)=87° 13′, e : e (adjoining)=127° 26′. Cleavage lateral, distinct; basal imperfect.



H.=3—3·5. G.=4·8, Brooke; 4·9—4·909, Breithaupt. 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).

Composition.—Cd S=Sulphur 22·4, cadmium 77·8. 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 Bisheptown 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.

RIONITE. Seleniet of Zinc. Selenquecksilberzink. Eulebrite, *Brooke*.

Massive.

G.=5·56. Lustre metallic or earthy. Streak blackish, when the color is lead-gray. Color lead-gray—cochineal-red.

Composition.—Of the gray variety, according to Del Rio,

Selenium 49, zinc 24, mercury 19, sulphur 1·5, with 6 of lime from the gangue.

B.B. burns with a fine violet-colored flame, and exhales selenium with the strong odor of horse-radish. When heated in a retort, selenium, mercury, and a little sulphur, sublime.

Discovered by Del Rio, in 1817, at Calebras, in the mining district of El Doctor, in Mexico, where it occurs in limestone which is imbedded in red sandstone.

VOLTZITE. Voltzine.

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.—$4\,ZnS+ZnO$=Sulphuret of zinc 82·77, oxyd of zinc 17·23. Analysis by Fournet, (Ann. Ch. Phys. xli, 426):

ZnS 82·92, ZnO 15·34, $\bar{\mathrm{Fe}}$ 1·84, resinous matter *trace*=100·10.

B.B. like blende. In muriatic acid affords fumes of sulphuretted hydrogen.

Occurs at Rosières in Puy de Dome. Observed by Kersten in the slags of the iron works of Freiberg and Altenberg.

2. *Combined with Oxygen, Chlorine, Bromine.*

RED ZINC ORE. Red Zinc, Red Oxyd of Zinc. Manganesian Oxyd of Zinc. Zinkoxyd, *L.* Zinc Oxydé. Rothzinkerz.

Hexagonal. Form nearly of figure 2 under quartz, p. 239, observed by Levy; pyramidal face on prism 152° 20′. Cleavage basal, eminent. Usual in grains or coarse particles and disseminated; 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.—$\dot{\mathrm{Zn}}$=Oxygen 19·74, zinc 80·26; containing protoxyd 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. $\dot{\mathrm{Zn}}$ 88· $\dot{\mathrm{Mn}}\bar{\mathrm{Mn}}$ 12=100, Berthier.
2. 94·45 $\bar{\mathrm{Mn}}$ *trace*, gangue (franklinite) 4·49, ign 1·09=100·08, Whitney.
3. 96·19 3·70, undecomp. 0·10=99·99, Whitney.
4. 93·48 $\dot{\mathrm{Mn}}$ 5·50, $\bar{\mathrm{Fe}}$ 0·36, scales of specular iron 0·44=99·78, Hayes.

Mr. Hayes has since confirmed his result that the manganese is protoxyd and only an impurity, and finds also that the coloring matter is intermixed scales of red oxyd of iron. He observes, (in a private communication), "the variety of scaly peroxyd of iron which is produced when chlorid of iron is decomposed by vapor of water was obtained, and this oxyd being transparent and blood red, gives, by being interleaved with the crusts of the zinc sublimate, the red color."

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 Franklin and Stirling, N. J. 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.

IODID AND BROMID OF ZINC.

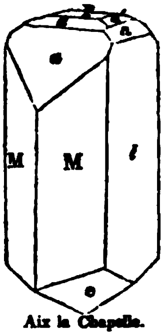
Iodine and bromine are stated by Mentzel to occur along with a cadmiferous zinc in Silesia, and hence it is inferred that iodid and bromid of zinc must exist in nature, though not yet distinguished.

3. *Silicates, Carbonates, Sulphates, Arsenates.*

List of Species.

Electric Calamine,	$\dot{\mathrm{Zn}}^3\dddot{\mathrm{Si}}+1\tfrac{1}{2}\dot{\mathrm{H}}$ (or $2\dot{\mathrm{H}}$).
Willemite,	$\dot{\mathrm{Zn}}^3\dddot{\mathrm{Si}}$.
Mancinite,	$\dot{\mathrm{Zn}}\dddot{\mathrm{Si}}$.
Hopeite.	
Calamine, Isomorphous with calcite,	$\dot{\mathrm{Zn}}\ddot{\mathrm{C}}$.
Zinc Bloom,	$\dot{\mathrm{Zn}}^3\ddot{\mathrm{C}}+3\dot{\mathrm{H}}$.
Aurichalcite,	$\dot{\mathrm{Cu}}^3\ddot{\mathrm{C}}+\dot{\mathrm{Zn}}^3\ddot{\mathrm{C}}+3\dot{\mathrm{H}}$.
Buratite,	$(\dot{\mathrm{Zn}}, \dot{\mathrm{Cu}}, \dot{\mathrm{Ca}})^3\ddot{\mathrm{C}}+\dot{\mathrm{H}}$.
White Vitriol,	$\dot{\mathrm{Zn}}\dddot{\mathrm{S}}+7\dot{\mathrm{H}}$.
Köttigite,	$(\dot{\mathrm{Zn}}, \dot{\mathrm{Co}}, \dot{\mathrm{Ni}})^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+8\dot{\mathrm{H}}$.

ELECTRIC CALAMINE, *M.* Siliceous Oxyd of Zinc. Hydrous Silicate of Zinc, *Thom.* Galmey, (in part). Zinkglas, *Haus.* Zinkkieselerz, *Berz.* Kieselzinkerz. Zinc Oxidé Silicifère, *H.*



Aix la Chapelle.

Trimetric: hemihedral. M : M=103° 56′, and 76° 4′, M : $\breve{e}$=128° 2′, P : a′=154° 14′, P : a=124° 37′, P : *a′*=148° 40′, P : *a*=118° 23′. Cleavage perfect parallel to M, traces parallel to P. Also stalactitic, mammillated, botryoidal, and fibrous forms; also massive and granular.

H.=4·5—5, the latter when crystallized. G.=3·434, Smithson; 3·379, Levy. Lustre vitreous, subpearly on P, sometimes adamantine. Streak white. Color white; sometimes blue, green, yellow, or brown. Transparent—translucent. Fracture uneven. Brittle. Pyro-electric.

Composition.—$\dot{\mathrm{Zn}}^3\dddot{\mathrm{Si}}+1\tfrac{1}{2}\dot{\mathrm{H}}$=Silica 25·48, oxyd of zinc 67·07, water 7·45. Perhaps in some or all cases, one third more water, or $\dot{\mathrm{Zn}}^3\dddot{\mathrm{Si}}+2\dot{\mathrm{H}}$=Silica 24·86, oxyd of zinc 65·45, water 9·69. Analyses: 1, Smithson, (Nicholson's Journ. vi, 78); 2, 3, Berzelius, (K. V. Ac. H. 1819, 141); 4, 5, Berthier, (J. d. Mines, xxviii, 341); 6, Thomson, (Phil. Mag. 1840); 7, 8, Hermann, (J. f. pr. Ch. xxxiii, 98):

		$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Zn}}$	$\dot{\mathrm{H}}$
1. Retzbanya,		25·0	68·3	4·4 =97·7, Smithson.
2. Limburg,		26·23	66·37	7·40=100, Berzelius.
3. "		24·893	66·837	7·460, $\dot{\mathrm{P}}$b and $\dot{\mathrm{Z}}$n 0·276, $\ddot{\mathrm{C}}$ 0·54=99·916, B.
4. "		25·0	66·0	9·0 =100, Berthier.
5. Breisgau,		25·5	64·5	10·0 =100, Berthier.
6. Leadhills,	G.=3·164,	23·2	66·8	10·8 =100·8, Thomson.
7. Nertschinsk,	G.=3·871,	25·38	62·85	9·07, $\dot{\mathrm{P}}$b 2·70=100, Hermann.
8. "	G.=3·435,	25·96	65·66	8·38=100, Hermann.

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.

Electric calamine and calamine are usually found associated in veins in calcareous rocks accompanying ores of blende, iron, and lead, as at Aix la Chapelle, Bleiberg, Tarnowitz, and Mendip Hills, &c. Pseudomorphs imitative of calcareous spar are common in Derbyshire, and also at Schemnitz in Hungary. Large crystals have been found at Nertschinsk.

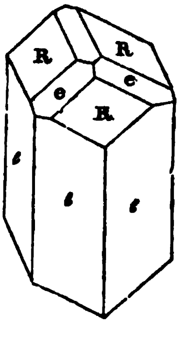
In the United States, it occurs with calamine in Jefferson county, Missouri; also at the Perkiomen lead mine, and near Cooperstown in Lehigh county, and on the Susquehanna, opposite Selimsgrove, and abundantly at Austin's mines in Wythe Co., Virginia.

MANCINITE.

Plumose and shining, with two unequal cleavages inclined to one another, 92°. Color brown.

Composition.—$\dot{\mathrm{Z}}$n $\dddot{\mathrm{Si}}$, probably according to Jacquot, (Ann. d. Mines, [3], xix, 703). From Mancino near Leghorn.

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.*



Rhombohedral. In Troostite, R : R=115°, R : e=147° 30′, e : e (½ R) (by calculation) 142° 52′, R : *e*=122° 10′; Shepard's measurements with the common goniometer gave R : R=115°, R : e=147° 30′, R : *e*=122°, and as the faces are not polished and hardly smooth, they do not admit, as the author has found, of more accurate measurement. The crystals often an inch through and several inches long. Crystals of Willemite, hexagonal prisms intermediate to that in the figure, like figure 112, plate 2, the planes of the trihedral summit (*r*) making a horizontal edge with a prismatic face (*a*), *r* : *r*=128° 30′, *r* : *a*=120° 7′; prismatic planes bright, pyramidal seldom smooth. Cleavage lateral distinct; basal also distinct. Also in grains or massive.

H.=5·5. G.=3·935, Willemite, Thomson; 4·16—4·18, Levy: 3·89—4, Troostite, Vanuxem and Keating; 4·02, Hermann. 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.—$\dot{Z}n^3\,\dddot{S}i$=Silica 72·47, oxyd of zinc 27·53. 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); 6, Rosengarten, (Ramm. 3d Supp. 65):

	$\dddot{S}i$	$\dot{Z}n$
1. Stirling,	25·44	68·06, $\bar{F}e$ and $\bar{M}n$ 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, $\dot{M}n$ 9·22, $\dot{M}g$ 2·91, $\dot{F}e$ trace, ign. 1·00=100, Hermann.
4. Moresnet,	26·97	68·77, $\bar{F}e$ 1·48, $\bar{A}l$ 0·66, ib. and trace $\dot{Z}n$, $\bar{F}e$ 0·78, $\dot{H}$ 1·25=99·91, Thomson.
5. "	27·05	68·40, " 0·75, ign. 0·30=96·50, Levy.
6. Upper Silesia,	27·34	70·82, $\dot{F}e$ 1·81=99·97, Rosengarten.

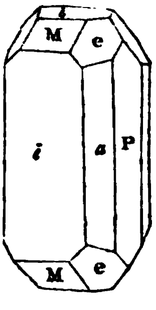
A. Schlieper has recently made a qualitative examination of the so-called *troostite*, at the author's request, and found oxyd of zinc and silica, with not more than one per cent. of oxyd of manganese.

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 in concentrated muriatic acid.

From Moresnet, in small crystals and massive. The crystals are but two or three millimeters long, and one thick. The prisms are terminated by a different rhombohedron from those of New Jersey; perhaps $\frac{4}{5}$ R, which would have the angle 127° 33′. Found also at Rosengarten in Silesia, and at Raibel in Carinthia. In New Jersey it occurs at Stirling, and also sparingly at Franklin.

This species was first fully and correctly described by Vanuxem and Keating. Their analysis was afterwards set aside by Thomson, who announced that the species they examined was an ore of manganese.

HOPEITE, *Brewster*. Trans. Royal Soc. Edinb. x, 107. Zinkphyllit, *Breit.*



Trimetric. M : M=101° 24′, 101°, Levy, M : ē=140° 42′, M : ĕ=129° 18′, *a* : *a* (over ĕ)=81° 34′, ĕ : *a*=130° 47′, P : *a*=139° 13′; ĕ′ (plane adjoining ĕ forming parallel intersections between e and e) : ĕ′=120° 26′, Levy, ĕ : ĕ′=150° 13′, P : ĕ′=119° 47′, P : *a*=139° 13′. Cleavage parallel with ĕ highly perfect. Plane P striated. Occurs also in reniform masses, and amorphous.

H.=2·5—3. G.=2·76—2·8. Lustre vitreous; somewhat pearly upon ĕ. 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 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 compound of phosphoric acid and zinc, with a small portion of cadmium, and some water.

It has been observed in the calamine mines of Altenberg, near Aix la Chapelle. It was named in honor of Prof. Hope of Edinburgh.

CALAMINE. Zinkspath, *L.* Carbonate of Zinc. Smithsonite, *Beud.* Kapnite, *Breit.* Galmey, (in part).

Rhombohedral; R : R=107° 40′, a' : a'=113° 31′, and 66° 29′. Planes R generally curved and rough. Cleavage rhombohedral, 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, Berthier, (Ann. d. Mines, [3], iii, 51); 4, Kobell, (J. f. pr. Ch. xxviii, 480); 5, 6, 7, Monheim, (Ramm. 2d Supp. 181):

		$\ddot{C}$	$\dot{Zn}$
1.	Somersetshire, G.=4·334,	35·2	64·8=100, Smithson.
2	Derbyshire,	34·8	65·2=100, Smithson.
3.	Belgium,	34·0	57·4, $\dot{Fe}$ 4·0, gangue 4·2=99·6, Berthier.
		$\dot{Zn}\ddot{C}$	$\dot{Fe}\ddot{C}$
4.	Nertschinsk,	96·00	2·03, $\dot{Pb}\ddot{C}$ 1·12=99·15, Kobell.
5.	Altenberg, G.=4·15,	60·35	32·21, $\dot{Mn}\ddot{C}$ 4·02, $\dot{Ca}\ddot{C}$ 1·90, $\dot{Mg}\ddot{C}$ 0·14, Elect. Cal. 2·49=101·11, Monheim.
6.	" G.=4·04,	55·89	36·46, $\dot{Mn}\ddot{C}$ 3·47, $\dot{Ca}\ddot{C}$ 2·27, Elect. Cal 0·41=98·50, M.
7.	" G.=4·20,	84·92	1·58, $\dot{Mn}\ddot{C}$ 6·80, $\dot{Ca}\ddot{C}$ 1·58, $\dot{Mg}\ddot{C}$ 2·84, Elect. Cal. 1·85=99·57, Monheim.

The variety containing more than 15 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.

Calamine 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 electric calamine.

Fine specimens of calamine 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 Dognatska 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, calamine is found in great abundance in Jefferson county, Missouri, at a lead mine called Valle's diggings. Hamburg, 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. At a lead mine in Lancaster Co., Pa., it is abundant.

ZINC BLOOM, *Smithson.* Dicarbonate of Zinc. Zinconise, *Beud.* Zinkblüthe.

Earthy incrustations.

H.=2—2·5. G.=3·58—3·6. Lustre dull. Color white, grayish, or yellowish. Opaque.

Composition.—$\dot{Zn}^3\ddot{C}+3\dot{H}$ or $\dot{Zn}\ddot{C}+\dot{Zn}^3\dot{H}^2$=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.

B.B. gives off abundant white fumes, which are deposited on the charcoal.

Occurs with ores of zinc and lead at Bleiberg and Raibel, and probably has resulted from the decomposition of calamine.

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.—$\dot{Cu}^2\ddot{C}+\dot{Zn}^3\ddot{C}+3\dot{H}$, or as given by Hermann $(\dot{Cu}^2\ddot{C}+\dot{H})+(\dot{Zn}^3\ddot{C}+2\dot{H})$ =Oxyd of copper 29·17, oxyd of zinc 44·71, carbonic acid 16·19, water 9·93. 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 drusy cavities; also at Matlock, of a pale-green color, laminated structure and pearly lustre.

BURATITE, *Delesse*, Ann. Ch. Phys. 3d ser. xviii, 478.

In radiated acicular crystals or plumose. Color azure-blue. G.=3·32.

Composition.—$(\dot{Zn}, \dot{Cu}, \dot{Ca})^2\ddot{C}+\dot{H}$, or a malachite, in which part of the copper is replaced by zinc and 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 Volterra in Tuscany, Framont in Tyrol. Closely related to aurichalcite. 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.

WHITE VITRIOL. Goslarite, *Haid.* Sulphate of Zinc. Zinc Sulfaté, *H.* Zink-Vitriol.

Trimetric; M : M=90° 42′, M : e=129° 2′, M : ĕ=134° 39′, e : e=127° 27′. Cleavage perfect parallel to ĕ, or the shorter diagonal.

H.=2—2·5. G.=2·036. Lustre vitreous. Color white. Transparent—translucent. Brittle. Taste astringent, metallic, and nauseous.

Composition.—$\dot{Zn}\dddot{S}+7\dot{H}$=Sulphuric acid 27·92, oxyd of zinc 28·22, water 43·76=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 Harts, 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 vitriol, 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.

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 a 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.—$(\dot{Z}n, \dot{C}o, \dot{N}i)^3 \ddot{\bar{A}}s+8\dot{H}$, or analogous to cobalt bloom. Analysis by Köttig, (loc. cit.):

$\ddot{\bar{A}}s$ (by loss) 37·17, $\dot{Z}n$ 30·52, $\dot{C}o$ 6·91, $\dot{N}i$ 2·00, $\dot{C}a$ *trace*, $\dot{H}$ 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.

HERRERITE, *Del Rio.*

Massive, reniform. Cleavage in three directions, and hence supposed to be rhombohedral. Surfaces curved. H.=4—5. G.=4·3. Lustre vitreous to pearly. Color pistachio, emerald or grass green. Streak yellowish-gray. Translucent.

Composition.—According to Herrera, Carbonic acid 31·86, tellurium 55·58, peroxyd of nickel 12·32. Del Rio found zinc in place of tellurium. It is a doubtful species. B.B. on charcoal becomes gray and evolves white fumes which cover the charcoal; in the inner flame becomes grass-green.

Occurs at Albarradon in Mexico, in stratified limestone, in a vein consisting chiefly of ores of lead, and native silver with horn silver.

X. LEAD.

Lead occurs rarely native. It is usually in combination with sulphur, constituting the common ore galena. It is also found combined with oxygen, selenium, and tellurium; with antimony and sulphur; with carbonic, phosphoric, arsenic, vanadic, chromic, antimonic, molybdic, and tungstic acids. The last two ores will be found on page 406.

The antimonial compounds are closely related to sulphuret of antimony, page 417.

1. *Native.*

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—of doubtful existence—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.

2. *Combined with Sulphur, Selenium, Tellurium, Antimony.*

List of Species.

GALENA,—Monometric,	PbS.
CUPROPLUMBITE,—Isomorphous with galena,	$(Cu, Pb)S$.
CLAUSTHALITE,—Monometric, isomorphous with galena,	$PbSe$.
" varieties,	$PbSe$ with $CuSe$, $CoSe$, $AgSe$.
ALTAITE,—Monometric,	$PbTe$.
NAGYAGITE,—Dimetric,	$PbTe$, with $AuTe$.
ZINKENITE,	$PbS + SbS^3$.
DUFRENOYSITE,	$2PbS + AsS^3$.
HETEROMORPHITE,	$2PbS + SbS^3$.
BOULANGERITE,	$3PbS + SbS^3$.
JAMESONITE,	$3PbS + 2SbS^3$.
PLAGIONITE,	$4PbS + 3SbS^3$.
GEOCRONITE,	$5PbS + (Sb, As)S^3$.
KOBELLITE,	$2(Fe, Pb)S + (Sb, Bi)S^3$.
STIENMANNITE.	

GALENA. Sulphuret of Lead. Blue Lead. Bleiglanz. Blau-Bleierz, *W.* Plomb Sulfuré, *H.*

Monometric. Figures from 1 to 23, on plate 1, and frequently several of them combined in the same crystal. Cleavage highly perfect and easily obtained, parallel to the faces of the cube. In compound crystals like fig. 129, pl. 2; the same kind of composition frequently repeated. Also reticulated, tabular, and coarse or fine granular—sometimes impalpable; occasionally fibrous.

H.=2·5—2·75. G.=7·3—7·7. Lustre metallic. Color and streak pure lead-gray. Surface of crystals occasionally tarnished. Fracture flat subconchoidal, or even. Frangible.

Composition.—PbS=Sulphur 13·34, lead 86·66; 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.	PbS to ZnS as 6 : 1.
3. " G.=7·324,	14·18	83·61	2·18=99·97, L.	PbS to ZnS as 12 : 1.

The silver present is detected easily by cupellation. The galena of the Harts affords ·03 to ·05 per cent. of silver; the English ·02 to ·08; 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.

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 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.

The most extensive deposits of this ore in the United States, are met with 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 lead, 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 principal indications in the eyes of the miners, as stated by Mr. Owen, are the following: fragments of calc spar in the soil, unless very abundant, which then indicate that the vein is wholly calcareous, or nearly so; red color of the soil on the surface, arising from the ferruginous clay in which the lead ore is often imbedded; fragments of lead ("gravel mineral") along with the crumbling magnesian limestone, and dendritic specks distributed over the rock; also a depression of the country, or elevation, in a straight line, or "sink holes," or a peculiarity of vegetation in a linear direction, indicates often the course of a vein. 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; and at the new digging on the west branch of the Peccatonica, not over 12 feet deep, two men raised 2,000 lbs. per day; and in one of the townships two men raised 16,000 lbs. in a day. 500 lbs. is the usual day's labor from the mines of average productiveness. The mines of the Upper Mississippi afford about 760,000 pigs annually, and those of Missouri 125,000 to 150,000 pigs.

Galena occurs also at Cave-in-Rock, in Illinois, associated with fluor spar. A vein at Rossie, in St. Lawrence Co., N. Y., traverses, nearly perpendicularly, the gneiss of the region, varying from one to three or four feet in width. It contains also calc spar, iron, and copper pyrites, and some blende and celestine. Near Wurtzboro, Sullivan Co., a large vein occurs in millstone grit; the ore is abundant and is associated with blende, iron and copper pyrites. The Ancram lead mines, Columbia Co., have afforded considerable lead, but are no longer worked. 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. 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, Ct.; Bath, Haverhill, Eaton, Shelburne, and other places in New Hampshire, (C. T. Jackson), and traces of silver occur in the lead of the Mississippi valley.

The *supersulphuretted lead* from Dufton, analyzed by Johnston, afforded PbS 90·38, S 8·71; and as Rammelsberg remarks, it is probably galena with disseminated sulphur. Thomson found in another from Ireland, (Min. i, 552), PbS 98·21, S 1·79.

CUPROPLUMBITE, *Breit.*

Tesseral. Occurs massive. Cleavage cubic.

H.=2·5. G.=6·408—6·428. Lustre metallic. Color blackish lead-gray. Streak black. Rather sectile and brittle.

Composition.—Ꞓu S+2 Pb S, or (Ꞓu, Pb) S=Sulphur 15·15, lead 64 99, copper 19·86. Analysis by Platter, (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.

CLAUSTHALITE. Seleniuret of Lead. Seleniet of Lead. Selenblei. Plomb Seleniuré, *Levy.*

Monometric. Occurs commonly in fine granular masses; some specimens foliated. Cleavage cubic.

H.=2·5. G.=7·187—8·8. Lustre metallic. Color lead-gray, somewhat bluish. Streak dark-gray. Opaque. Fracture granular and shining. Rather sectile.

Composition.—Pb Se=Selenium 27·3, lead 72·7, 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):

	Se	Pb	
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.	
5. Tilkerode, (selenbleikupfer),	34·26	47·43, Cu 15·45, Ag 1·29, Ꞙe and Ṗb 2·08=100·51, R.	
6. " (selenkupferblei),	29·96	59·67	7·86, Fe 0·33, Fe and Pb 0·44, *undecomp.* 1·00=99·26, Rose.
7. Glasbachgrunde, "	30·00	53·74	8·02, Ag 0·05, Ꞙe 2·00, S *trace*, quartz 4·5 =98·31, Kersten.
8. " "	29·35	63·82	4·00, 0·07, Fe and S *traces*, quartz 2·06 =99·30, 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. 5 gives the formula, Pb Se+Cu Se; G.=5·6.

Nos. 6, 7=2Pb Se+Cu Se; G.=6·9—7·04.

No. 8=4Pb Se+Cu Se; G.=7·4—7·45. Color dark lead-gray; powder grayish-black.

No. 4 corresponds to 6Pb Se+Co Se^3

B.B. in addition to the usual phenomena arising from the presence of lead, it gives off the odor of horse-radish, 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.

Clausthalite 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, and Tilkerode, and Lerbach; and at Reinsberg near Freiberg, in Saxony.

The *Selenid of Mercury and Lead,* (Selenquecksilberblei), from Tilkerode, may be a mechanical mixture of Clausthalite with selenid of mercury. It is described as having the structure and color of Clausthalite; G.=7·8. Analyses by Rose:

	Se	Pb	Hg
1.	24·97	55·84	16·94=97·75.
2.	27·98	27·33	44·69=100.

Gives the odor of selenium before the blowpipe, and affords mercury with soda.

ALTAITE, *Haid.* Tellurid of Lead. Tellurblei.

Monometric: usually massive. Cleavage cubic.

H.=3. G.=8·159. Lustre metallic. Color tin-white, resembling that of native antimony, with a yellow tarnish. Sectile.

Composition.—Pb Te=Tellurium 38·3, lead 61·7. Analysis by G. Rose, (Pogg. xviii, 68),

Tellurium 38·37, Silver 1·28, Lead 60·35.

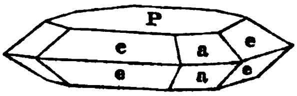
B.B. volatilizes in the reducing flame, excepting a minute bead of silver. Colors the flame blue.

It occurs at Savodinsky in the Altai mountains, mixed with telluric silver.

NAGYAGITE, *Haid.* Foliated Tellurium. Bitelluret of Lead, *Thom.* Black Tellurium, *P.* Tellurium Glance. Nagyager-erz, *W.* Blättertellur, *Haus.* and *L.* Blätterenz. Tellure Natif Auro-Plombifère, *H.*

Dimetric. P : e=110°, e : e=140°, P : a=118° 35′, a : a=122° 50′. Cleavage perfect, parallel with P. Occurs 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.—According to Berzelius probably Pb Te, mixed with telluric gold and galena. Analyses: 1, Klaproth, (Beit. iii, 32); 2, Brandes, (Schw. J. xxxv, 409):

	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.

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 21 S, 6 Te, 2 Sb, 18 Pb, 1 Au.

ZINKENITE, *G. Rose*, Pogg. vii. Brewster's Journal, vi, 17.

Hexagonal. Common form a hexagonal prism, with a low hexagonal pyramid at summit; M : face of pyramid=102° 42′. Lateral faces longitudinally striated; G. Rose found, in some instances, the interfacial angle M : M equal to 120° 39′, and hence makes the fundamental form a prism of this angle, and the observed crystals compound forms similar to fig. 3 or 6, pl. 4. The crystals sometimes form fibrous and massive varieties. Cleavage not distinct.

H.=3—3·5. G.=5·303—5·35. Lustre metallic. Color and streak steel-gray. Opaque. Fracture uneven.

Composition.—$Pb\,S+Sb\,S^3$=Sulphur 21·68, antimony 43·45, lead 34·87=100. Analyses by H. Rose, (Pogg. viii, 99):

1.	Wolfsberg,	S 22·58	Sb 44·39	Pb 31·84	Cu 0·42=99·23.
2.	"	undet.	44·11	31·97	undet.
3.	"	"	46·28	30·63	"

B.B. alone on charcoal it decrepitates briskly, and fuses as readily as gray antimony, affording small metallic globules, which are soon volatilized, and the charcoal is covered with a white coating of oxyd of lead. With carbonate of soda it yields globules of metallic lead. With muriatic acid forms chlorid of lead.

It occurs in the antimony mine of Wolfsberg in the Hartz. Its groups of columnar crystals occur on a massive variety of the same species in quartz. These crystals sometimes exceed half an inch in length, and have a breadth of two or three lines; but frequently they are extremely thin and form fibrous masses. It was named in honor of Mr. Zinken, the director of the Anhalt mines, by G. Rose, to whom we are indebted for the first description of it. It has been reported from St. Trudpert in the Schwarzwald.

It much resembles gray antimony and bournonite, but may be distinguished by its superior hardness and specific gravity.

DUFRENOYSITE, *Damour.* Gotthardite, *Rammelsberg.*

Monometric. In dodecahedrons. Cleavage not distinct.

G.=5·549. Lustre metallic. Color steel gray. Streak reddish-brown. Brittle.

Composition.—$2\,Pb\,S+As\,S^3$=Sulphur 22·14, arsenic 20·74, lead 57·12, 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.

HETEROMORPHITE, *Ramm.* Feather Ore. Plumose Antimonial Ore. Federerz.

In fine capillary crystallizations, resembling a cobweb. Also massive.

H.=1—3. G.=5·67—5·9; 5·679, massive. Lustre dull metallic. Color dark lead-gray—steel-gray, sometimes irised.

Composition.—$2\,Pb\,S+Sb\,S^3$=Sulphur 19·32, antimony 30·97, lead 49·71. Analyses: 1, H. Rose, (Pogg. xv, 471); 2, Rammelsberg, (Pogg. Ann. lxxvii, 241); 3, Poselger, (Ramm. 3d Supp. 44):

		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	2·88	1·84, Cu 1·01=100, R.
3.	*massive,*	20·32	32·98	48·48=101·78, Poselger. G.=5·6788.		

Fuses instantly in the flame of a candle, evolving white fumes.

It occurs at Wolfsberg in the Eastern Hartz; also at Andreasberg and Clausthal; at Freiberg and Schemnitz ; in the Anhalt at Pfaffenberg and Meiseberg.

The name Feather Ore being inapplicable since a massive variety has been found, Rammelsberg has substituted Heteromorphite.

ZUNDERERZ, (Tinder Ore), supposed formerly to be Red Antimony, proves to be an impure arsenical sulphuret of antimony and lead. Borntråger 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. It is supposed to be mixed with red silver ore and mispickel.

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.

H.=2·5—3. G.=5·75—5·97. Lustre metallic. Color bluish lead-gray ; often covered with yellow spots from oxydation.

Composition.—$3\,PbS+SbS^3$=Sulphur 18·09, antimony 24·13, lead 57·78. 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):

	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.

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; at Wolfsberg. Specimens from the last mentioned locality gave Rammelsberg G.=5·75, and pulverized 5·96.

JAMESONITE, *Haid.* Bleischimmer.

Trimetric. M : M=101° 20′ and 78° 40′. Cleavage basal, highly perfect. 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.—$3\,PbS+2\,SbS^3$=Sulphuret of antimony 49·7, sulphuret of lead 50·3 (=sulphur 20·28, antimony 36·19, lead 43·53). Analyses: 1, 2, 3, H. Rose, (Pogg. viii, 101); 4, Schaffgotsch, (Pogg. xxxviii, 403):

	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. "	undet.	33·47	40·35	2·96	0·21, Rose.
4. Estremadura,	21·78	32·62	39·97	3·63, Bi 1·06, Zn 0·42=99·48, Schaffgotsch.	

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. It was named in honor of Prof. Jameson of Edinburgh.

GEOCRONITE, *Svanberg*, K. V. Ac. H. 1839, p. 184. Kilbrickenite, *Apjohn*.

Trimetric. Massive, with imperfect cleavage in one direction. 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.—5 Pb S+(Sb, As) S^3. Analyses: 1, Svanberg, (Jahresb. xx, 208); 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):

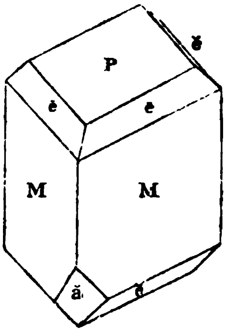
		S	Sb	As	Pb	Cu	Fe
1. Sala, Sweden,	G.=6·54,	16·26	9·58	4·69	66·45	1·51	0·42, Zn 0·11=99·08, Sv.
2. Merido,	G.=6·43,	16·90	16·00	—	64·89	1·60	——=99·39, Sauvage.
3. Tuscany,	G.=6·45—6·47,	17·32	9·69	4·72	66·55	1·15	1·73=100·95, Kerndt.
4. *Kilbrickenite*,	G.=6·407,	16·36	14·39	—	68·87	—	0·38=100, Apjohn.
5. Fahlun,	G.=6·484,	15·16	5·66	4·62	64·17	4·17	0·08, Ag 0·24, Zn 0·52, Cu 4·17, Al 1·9=98·35, Svanberg.

Svanberg deduces for the last the same formula as above, excepting 6 instead of 5 Pb S.

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 χρονος, *Saturn*, the alchemistic name for lead.

PLAGIONITE, *G. Rose*, Pogg. xxviii, 421, 1833.



Monoclinic. P : M=138° 52′, M : M=120° 40′; P : ă (adjacent)=107° 32′, P : ĕ=134° 20′, P : ė=149°, ė : ė=142° 03′, ĕ′ : ĕ′=134° 30′, Rose. Crystals thick tabular. The plane P shining and smooth; others striated. Cleavage lateral, perfect, but seldom affording smooth surfaces. Also massive, granular.

H.=2·5. G.=5·4. Lustre metallic. Color blackish lead-gray. Opaque. Brittle.

Composition.—4 Pb S+3 Sb S^3=Sulphur 20·71, antimony 38·30, lead 40·99. 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. It was named by Rose, in allusion to its oblique form of crystallization, from πλαγιος, *oblique.*

KOBELLITE, *Setterberg*, K. V. Ac. H. 1839, p. 188,—Berz. Jahresb. xx, 215.

Resembles sulphuret of antimony, but with a brighter lustre; structure radiated.

G.=6·29—6·32. Soft. Color blackish lead-gray to steel-gray. Streak black.

Composition.—$(3FeS+2SbS^3)+(3PbS+BiS^3)=2(Fe,Pb)S+(Sb,Bi)S^3$. Analysis by Setterberg, (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. It was named in honor of von Kobell.

STEINMANNITE.

Monometric. Usual in octahedrons; cleavage cubic. Also massive.

H.=2·5. G.=6·833, Zippe. Lustre metallic. Color lead-gray. Fracture uneven.

Composition.—Undetermined. On charcoal fumes of sulphurous acid and antimony are given off, and finally a globule of lead is obtained, which contains silver.

Occurs at Przibram. According to Zippe, the so-called *Bleischweif* of the Germans is a mixture of this species and galena.

2. *Combined with Oxygen or Chlorine.*

List of Species.

Minium,	Pb^3O^4.
Plumbic Ochre,	PbO.
Plattnerite,	PbO^2.
Cotunnite,	$PbCl$.
Mendipite,	$PbCl+2PbO$.
Percylite.	
Corneous lead,	$PbCl+\dot{P}b\ddot{C}$.

MINIUM. Mennige, *Haus.* Plomb Oxidé Rouge, *H.*

Pulverulent, occasionally exhibiting, under the microscope, crystalline scales. The crystal, according to M. Kapper, is a right rhombic prism of 93° 44′.

G.=4·6. Color vivid red, mixed with yellow.

Composition.—Pb^3O^4 [$=\ddot{P}b+2\dot{P}b$?]=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 Badenweiler in Baden; in Brillon in Westphalia, island of Anglesey; and Grassington Moor and Weirdale, in Yorkshire It is usually associated with galena, and also with calamine.

It is abundant at Austin's mine, Wythe Co. Va., along with cerusite.

PLUMBIC OCHRE. Lead-ochre. Bleiglätte.

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.—$\dot{\mathrm{Pb}}$=Oxygen 7·17, lead 92·83; more or less impure. Analysis by John (Schw. J. iv, 219 and xxxii, 106),

$\dot{\mathrm{Pb}}$ 89·10, $\ddot{\mathrm{C}}$ 3·84, $\overline{\mathrm{Fe}}$ and $\dot{\mathrm{Ca}}$ 0·48, $\dddot{\mathrm{Si}}$ 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. Geralt 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. (Am. J. Sci. [2], viii, 420).

Occurs at Austin's mines, Wythe Co., Va.

PLATTNERITE, *Haid.* Superoxyd of Lead. Schwerbleierz, *Breit.*

Hexagonal. Cleavage indistinct.

G.=9·39—9·44. Lustre metallic adamantine. Color iron-black. Streak brown.

Composition.—$\mathrm{Pb\,O^2}$=Lead 86·62, oxygen 13·38.

Probably from Leadhills, Scotland.

COTUNNITE. Cotunnia, *Monticelli.* Cotunnite, *von Kobell.* Chlorid of Lead, *Thom.*

In acicular crystals.

May be scratched by the nail. Lustre adamantine; inclining to silky or pearly. Color white. Streak white.

Composition.—Pb Cl=Chlorine 25·48, lead 74·52.

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.

This mineral was observed by Monticelli and Covelli, in the crater of Vesuvius, after the eruption of 1822. It was accompanied by chlorid of sodium, and chlorid and sulphate of copper. It was named in honor of a distinguished medical man at Naples.

MENDIPITE, *Breit.* Muriate of Lead. Dichlorid of Lead. Berzelite, *Levy.* Kerasine, *Beud.* Kerasite, *Shepard.* Cerasite.

Trimetric; M : M=102° 27′. Occurs in fibrous or columnar masses, often radiated. Cleavage highly perfect, parallel to M.

H.=2·5—3. G.=7—7·1. Lustre pearly upon cleavage faces. Color white, with a tinge of yellow or red. Streak white. Feebly translucent—opaque.

Composition.—Pb Cl+2PbO=Chlorid of lead 38·4, oxyd of lead 61·6. Analyses: 1, 2, Berzelius, (K. V. Ac. H. 1823, and Pogg. i, 272); 3, Berzelius's analysis altered for corrected atomic weight, (Ramm. 1st Supp. 24); 4, Schnabel, (ib. 3d Supp. 78):

1.	H Cl 6·54	$\ddot{\mathrm{C}}$ 2·68	$\dot{\mathrm{Pb}}$ 90·20	$\dot{\mathrm{H}}$ 0·68=100, Berzelius.
2.	6·84	1·08	90·18	0·54, $\dddot{\mathrm{Si}}$ 1·46=100, Berzelius.
3.	Pb Cl 39·82	$\dot{\mathrm{Pb}}$ 60·18=100, Berzelius by Rammelsberg.		
4.	" 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.

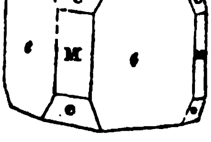
PERCYLITE, *H. J. Brooke*, Phil. Mag. 3d ser. xxxvi, 131, 1850.

Monometric. In minute cubes. Color sky-blue.

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 also be added, and writes the formula $(\mathrm{Pb\,Cl}+\mathrm{Pb\,O})+(\mathrm{Cu\,Cl}+\mathrm{Cu\,O})+\mathrm{Aq}$. 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.

CORNEOUS LEAD. Murio-Carbonate of Lead. Chloro-Carbonate of Lead, *Thomson.* Plomb Chloro-Carbonaté, *Duf.* Bleihornerz *of the Germans.* Phosgenite, *Breit.* Hornblei, *Haus.*



Dimetric; forms similar to figs. 53 and 61, pl. I.; and also combinations of the two; also the annexed figure. M : *e*=135°; M : e=146° 54′. P : e=123° 6′, Brooke. Cleavage bright parallel to M, and the diagonals.

H.=2·75—3. G.=6—6·1. Lustre adamantine. Streak white. Color white, gray, and yellow. Transparent—translucent. Rather sectile.

Composition.—$\mathrm{Pb\,Cl}+\grave{\mathrm{Pb}}\,\ddot{\mathrm{C}}$=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.

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.

The localities of this rare mineral are Matlock, in Derbyshire, and Hausbaden, near Badenweiler in Germany, where it accompanies other ores of lead; also reported to occur at Vesuvius.

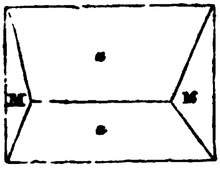
3. *Combined with Carbonic and other acids.*

CERUSITE,—Isomorph with arragonite,	$\dot{Pb}\ddot{C}$.
ANGLESITE,—Isomorph with celestine,	$\dot{Pb}\dddot{S}$.
LINARITE,	$\dot{Pb}\dddot{S}+\dot{Cu}\dot{H}$.
CALEDONITE,	
LEADHILLITE,	$\dot{Pb}\dddot{S}+3\dot{Pb}\ddot{C}$.
LANARKITE,	$\dot{Pb}\dddot{S}+\dot{Pb}\ddot{C}$.
PYROMORPHITE,	$3\dot{Pb}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}+PbCl$.
MIMETENE,	$3\dot{Pb}^3\overset{\cdot\cdot\cdot\cdot\cdot}{As}+PbCl$.
VANADINITE,	$3\dot{Pb}^3\dddot{V}+PbCl$.
VANADATE OF LEAD AND COPPER.	
SELENATE OF LEAD.	
CROCOISITE,	$\dot{Pb}\dddot{Cr}$.
MELANOCHROITE,	$\dot{Pb}^3\dddot{Cr}^2$.
VAUQUELINITE,	$\dot{Cu}^3\dddot{Cr}^2+2\dot{Pb}^3\dddot{Cr}^2$.
BLEINIERITE,	$\dot{Pb}^3\overset{\cdot\cdot\cdot\cdot\cdot}{Sb}+4\dot{H}$.
PLUMBO-RESINITE,	$\dot{Pb}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}+6\dddot{\overline{Al}}\dot{H}^3$.

CERUSITE, *Haid.* White Lead Ore. Carbonate of Lead. Ceruse. Weissbleierz. Iglesiasite. Bleierde, *Wern.*

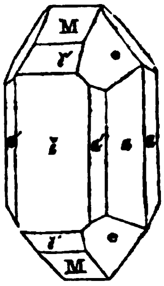
Trimetric. M : M=117° 13′, and 62° 47′, M : ĕ=121° 24′, M : ĕ′=150° 2′, *a* : *a*=140° 15′, and 39° 45′, ĕ : *a*′=145° 20′,

1



Johanngeorgenstadt.

2



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ĕ : *a*=109° 53′. Cleavage parallel to M often perfect. Compound crystals, figs. 5, 6, 8, pl. 4, often stellated. 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. The former is sometimes 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.—$\dot{\mathrm{Pb}}\,\ddot{\mathrm{C}}$=Carbonic acid 16·4, oxyd of lead 83·6=100. Analyses: 1, Klaproth, (Beit. iii, 167); 2, Bergemann, (Chem. Unters. Bleib. 167, 175); 3, Thomson, (Min. i, 558); 4, 5, John, (Schw. iv, 227, xxxii, 114, 117); 6, Bergemann; 7, Kersten:

1. Leadhills,	$\ddot{\mathrm{C}}$ 16·	$\dot{\mathrm{Pb}}$ 82=98, Klaproth.	
2. Eifel,	16·49	83·51=100, Bergemann.	
3.	16·41	83·53, $\dot{\mathrm{H}}$ 0·06=100, Thomson.	
4. Eschweiler, *earthy*,	16·62	81·34	1·75, $\dot{\mathrm{Ca}}$ and $\cancel{\mathrm{Fe}}$ 0·29=100, John.
5. Kall, *earthy*,	15·81	77·07	6·32 0·80=100, John.

6. " " *red*, $\dot{\mathrm{Pb}}\,\ddot{\mathrm{C}}$ 94·233 $\dot{\mathrm{H}}$ 2·566, quartz 1·07, $\cancel{\mathrm{Fe}}$ and $\cancel{\mathrm{Al}}$ 2·2, Bergemann.
7. Sardinia, *Iglesiasite*, " 92·10, $\dot{\mathrm{Zn}}\,\ddot{\mathrm{C}}$ 7·02, Kersten, G.=5·9.

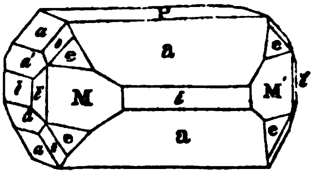
B.B. decrepitates, becomes yellow, then red, and finally, with care on charcoal a globule of lead may be obtained; dissolves readily, and with effervescence in dilute nitric acid.

Leadhills and Wanlockhead are among the best localities of this mineral. At these places it occurs with other ores of lead in Silurian slate. Beautiful crystals are met with 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, it has been observed at Alston Moor, Keswick, and particularly in Cornwall, where, in the mine of St. Minvers, it occurs in exceedingly delicate crystals. Opaque pseudomorphs, imitative of crystals of Anglesite, have been met with at Leadhills.

Fine crystals have been obtained in Pennsylvania, at Phenixville; also at the Perkiomen lead mines, near Philadelphia. It also occurs at Valle's Diggings, Jefferson Co., Missouri, and in other mines of the West. Brigham's mines, near the Blue Mounds, afford it in considerable quantities. It occurs as an incrustation, at Southampton, Mass. The lead mines of St. Lawrence Co., N. Y., afford sparingly this ore. Splendid crystallised specimens are obtained at Austin's mines, Wythe Co., Virginia, and especially at King's Mine, in Davidson county, North Carolina.

ANGLESITE, *Beud.* Sulphate of lead. Lead Vitriol. Bleivitriol. Vitriolbleierz, *W.*

Trimetric. M : M=103° 49′, M : $\breve{e}$=128° 6′, P : a=140° 36′, P : e=115° 40′, P : $\dot{e}$ or $\breve{e}$=90°. Cleavage parallel to M and P, but interrupted. The planes M and $\bar{e}$ are often vertically striated, and a, 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.—$\dot{\mathrm{Pb}}\,\dddot{\mathrm{S}}$=Sulphuric acid 26·4, oxyd of lead 73·6=100. Analyses: 1, 2, Klaproth, (Beit. iii, 162); 3, Stromeyer, (Unters. 226); Thomson, (Min. i, 559):

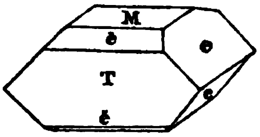
	$\dddot{\mathrm{S}}$	$\dot{\mathrm{Pb}}$	$\cancel{\mathrm{Fe}}^2\dot{\mathrm{H}}^3$	$\dot{\mathrm{H}}$
1. Anglesea,	24·8	71·0	1·0	2·0=98·8, Klaproth.
2. Wanlockhead,	25·75	70·50	—	2·25=98·50, Klaproth.
3. Zellerfeld,	26·09	72·47	0·09	0·51, $\cancel{\mathrm{Mn}}$ 0·07=99·23, Strom.
4. Leadhills,	25·65	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 is 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 are several inches in diameter; Pary's mine in Anglesea, Mellanoweth in Cornwall, Clausthal and Zellerfeld in the Hartz, and Badenweiler in Breisgau, are other localities. 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 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.; at Phenixville and Perkiomen, Pennsylvania.

LINARITE, *Brooke*. Cupreous Anglesite. Cupreous Sulphate of Lead, *Brooke*. Bleilasur. Kupferbleispath. Linarit.



Monoclinic. M : T=95° 45′; e : e=119°, Haidinger. Cleavage very perfect parallel to M and T.

H.=2·5—3. G.=5·2—5·5. Lustre vitreous or adamantine. Color deep azure blue. Streak pale blue. Translucent. Fracture conchoidal.

Composition.—$\dot{\mathrm{Pb}}\dddot{\mathrm{S}}+\dot{\mathrm{Cu}}\dot{\mathrm{H}}$=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):

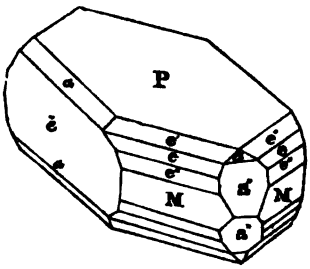
1. Wanlockhead,	$\dot{\mathrm{Pb}}\dddot{\mathrm{S}}$ 75·4	$\dot{\mathrm{Cu}}$ 18·0	$\dot{\mathrm{H}}$ 4·7=98·1,	Brooke,
2. "	74·8	19·7	5·5=100,	Thomson; G.=5·2137.

In the blowpipe flame, it affords indications of copper and lead.

This mineral occurs at Leadhills, and is even there an exceedingly rare mineral; also at Roughton Gill, in Cumberland. Linares in Spain has been reported as another locality.

CALEDONITE, *Beud.* Cupreous Sulphato-Carbonate of Lead, *Brooke*, Ed. Phil. Jour. iii, 117. Halbazurblei, *Ramm.*

Trimetric. M : M=95°. Secondary form, e′ : e′=108°, M : ĕ =132° 30′, P : *a*=126°, P : e′=126° P : e=115° 30′, a″ : a″=143° 42′, Brooke. Cleavage parallel to M and P indistinct, more obvious parallel to ĕ. Crystals sometimes large, but usually minute, and occasionally in bunches diverging from a point.



H.=2·5—3. G.=6·4; 5·0, Thomson. 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.

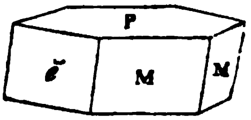
Composition.—Analyses: 1, Brooke, (Ed. Phil. J. iii, 119); 2, Thomson, (Phil. Mag. 1840, Dec. 402):

1.	$\dot{Pb}\dddot{S}$ 55·8	$\dot{Pb}\ddot{C}$ 32·8	$\dot{Cu}\ddot{C}$ 11·4=100, Brooke.
2.	52·88	$\ddot{C}$ 31·91	$\dot{Cu}$ 13·37, $\dot{H}$ and impurities 1·84=100, Thom.

B.B. easily reduced. Soluble in nitric acid.

Occurs at Leadhills accompanying other ores of lead; also reported from Tanne in the Harts, and from Mine la Motte, Missouri.

LEADHILLITE. Sulphato-tricarbonate of Lead, *Brooke*, Ed. Phil. Jour. iii, 117. Rhomboidal Carbonate of Lead. Bleisulphotricarbonat, *Ramm.* Ternärbleierz.



Monoclinic. P : M=89° 36′, M : M=59° 40′; M : ĕ=119° 50′. Cleavage basal, very perfect; in traces in the direction of M and ĕ. Often in compound crystals of three individuals, having a resemblance to a rhombohedral crystal.

H.=2·5. G.=6·0—6·5. Lustre of the basal planes pearly, other parts resinous, somewhat adamantine. Color white, passing into yellow, green or gray. Streak uncolored. Transparent—translucent. Conchoidal fracture, scarcely observable. Rather sectile.

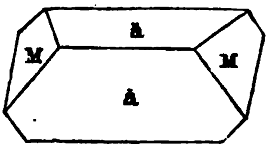
Composition.—$\dot{Pb}\dddot{S}+3\dot{Pb}\ddot{C}$=Sulphate of lead 27·44, carbonate of lead 72·56. Analyses: 1, Brooke, (Edinb. Phil. J. new ser. iii, 117, 138); 2, Berzelius, (Jahresb, iii, 184); 3, Stromeyer, (Gött. gel. Anz. 1825, 113):

1.	$\dot{Pb}\dddot{S}$ 27·5	$\dot{Pb}\ddot{C}$ 72·5=100, Brooke.
2.	28·7	71·0=99·7, Berzelius.
3.	27·3	72·7=100, Stromeyer.

B.B. intumesces at first, and then turns yellow; but returns to a white color 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 in a vein traversing graywacke; Grenada is also stated to be a locality of it, and the island of Serpho, Grecian Archipelago. The compound forms are very complex. The crystals seldom exceed an inch in length, and are commonly smaller.

LANARKITE, *Beud.* Dioxylite. Sulphato-Carbonate of Lead, *Brooke*, Ed. Phil. Jour. iii, 117.



Monoclinic. Plane M usually rounded, and the crystals aggregated lengthwise, and seldom distinct. Cleavage basal, perfect; also parallel to the shorter diagonal. Laminæ flexible like 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.—$\dot{Pb}\dddot{S}+\dot{Pb}\ddot{C}$=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, and 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, but without a perceptible effervescence.

Occurs at Leadhills, with other ores of lead. A massive variety is reported from Siberia, and also from Tanne in the Hartz.

PYROMORPHITE. Phosphate of Lead. Braunbleierz, Grünbleierz, *Wern.* and *Hoff.* Traubenblei, *Haus.* Buntbleierz. Nussierite, *Danhauser.* Polysphærite. Miesite, *Beud.*

Hexagonal. Secondary form, fig. 125, pl. 2; M : *e*=150°, M : e =130° 22′, e : e=142° 12′ and 80° 44′. Cleavage in traces parallel to M. M 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 $3\dot{\mathrm{P}}\mathrm{b}^3\ddot{\mathrm{P}}+\mathrm{Pb\,Cl}$; more correctly $(\mathrm{Pb\,Cl, Ca\,Fl})+3(\dot{\mathrm{P}}\mathrm{b}, \dot{\mathrm{C}}\mathrm{a})^3\ddot{\mathrm{P}}$, with the phosphoric acid sometimes replaced partly by arsenic acid. Analyses: 1, Bergemann, (Chem. Unt. Bleib. 204); 2, 3, 4, Wöhler, (Pogg. iv, 161); 5—9, Kersten, (Schw. J. lxii, 1, and Pogg. xxvi, 489); 10, 11, Lerch, (Ann. Ch. u. Pharm. xlv, 328):

	$\dot{\mathrm{P}}\mathrm{b}^3\ddot{\mathrm{P}}$	$\dot{\mathrm{P}}\mathrm{b}^3\ddot{\mathrm{A}}\mathrm{s}$	PbCl	CaFl	$\dot{\mathrm{C}}\mathrm{a}^3\ddot{\mathrm{P}}$	
1. Mechernich,	92·55	—	7·45	—	—	=100, Bergemann.
2. Zschopau, *green*,	89·94	—	10·05	—	—	=99·99, Wöhler.
3. " *white*,	80·37	9·01	10·09	—	—	=99·47, Wöhler.
4. Leadhills, *orange*,	88·16	*trace*	9·91	—	—	=98·07, Wöhler.
5. Freiberg, *brown Polysphærite*,	77·02	—	10·84	1·09	11·05	=100, Kersten.
6. Mies, *brown*,	81·65	—	10·64	0·25	7·46	=100, Kersten.
7. " " *cryst.*	89·27	—	9·66	0·22	0·85	=100, Kersten.
8. Bleistadt, *brown cryst.*,	89·17	—	9·92	0·14	0·77	=100, Kersten.
9. Poullaouen, *cryst.*,	89·91	—	10·09	—	—	=100, Kersten.
10. Bleistadt, *brown cryst.*	87·38	—	10·23	0·07	0·86,	$\dot{\mathrm{F}}\mathrm{e}^3\ddot{\mathrm{P}}$ 0·77=90·31, Lerch.
11. " " "	88·42	—	9·57	0·20	1·58,	0·50=100·27, Lerch.

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 accompanies other ores of lead.

Fine specimens occur at Leadhills and Wanlockhead; at Poullaouen and Huelgoet in Britanny; 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; Beresof in Siberia; at Cornwall and Wicklow in Ireland.

Pyromorphite has been found in good specimens at the Perkiomen lead mine near Philadelphia, but it is not abundant; also in Maine, at Lubec and Lenox; in New York, a mile south of Sing Sing; sparingly at Southampton, Massachusetts, and Bristol, Conn. Crystallizations of great beauty, presenting bright green and gray colors, are obtained at the lead mine in Davidson Co., N. C.

The name Pyromorphite is from *πυρ*, *fire*, *μορφη*, *form*, and alludes 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, Dept. of Rhone, France.

MIMETENE. Green Lead Ore. Arsenate of Lead. Grünbleierz, *W.* Traubenblei. *Haus.* Kampylite, *Breit.* Hedyphane. Mimetite.

Hexagonal, and isomorphous with pyromorphite; e : e=142° 39′, M : e=129° 50′. Cleavage basal, imperfect; parallel with M in traces.

H.=3·5. G.=7·19—7·25, Mimetene; 5·4—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.—$3(\dot{Pb}, \dot{Ca})^3 (\dddot{\ddot{As}}, \dddot{\ddot{P}}) + Pb\,Cl$, or allied to pyromorphite, excepting the presence of arsenic acid in place of phosphoric. Analyses: 1, Wöhler, (Pogg. iv, 167); 2, 3, Dufrénoy, (Traité, iii, 46); 4, Kersten, (Schw. J. lxii):

	$Pb^3\dddot{\ddot{As}}$	$Pb^3\dddot{\ddot{P}}$	$PbCl$
1. Johanngeorgenstadt,	82·74	7·50	9·60=99·84, Wöhler.
2. Hornhausen,	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, $\dot{Ca}^3\dddot{\ddot{P}}$ 15·51, $\dot{Ca}^3\dddot{\ddot{As}}$ 12·98=98·88,K.

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 Wheal Unity, near Redruth, in Cornwall, and in 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, it occurs in capillary crystals; at Johanngeorgenstadt, in fine crystals of a yellow color; at Nertschinsk, Siberia, in reniform masses of a brownish-red color; 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, $\dot{Pb}$ 58·81, $\dot{Cu}$ 0·92, $\dddot{\ddot{As}}$ 11·55, $\dddot{\ddot{P}}$ 5·13, $\dddot{V}$ 1·86, $\dot{Ca}$ 7·96, $\overline{\dddot{Al}}$, $\ddot{Zr}$? $\overline{\dddot{Fe}}$ 1·10, clay 2·00, ign. 1·12=99·00.

It is associated with a vanadate of lead and copper.

VANADINITE. Vanadate of Lead. Vanadinbleierz.

Hexagonal, and considered isomorphous with pyromorphite: occurs mostly 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.—$3\dot{Pb}^3\dddot{V} + Pb\,Cl$. 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, $\overline{\dddot{Fe}}^2\dot{H}^3$ 0·67=100, Berz.

2. Wicklow, $\dddot{V}$ 23·44, $\dot{Pb}$ 66·33, Pb 7·06, H Cl 2·45, $\overline{\dddot{Fe}}$ and $\dddot{Si}$ 0·16=99·43, T.
3. ? 15·86, 63·73, 6·62, Cl 2·26, $\dot{Zn}$ 6·35, $\dot{Cu}$ 2·96, $\dot{H}$ 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; at Matlock in Derbyshire.

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.

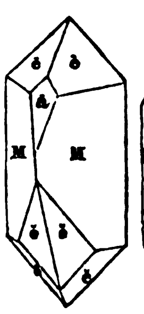
Occurs with seleniuret of antimony and lead, malachite, etc., at the Friederichsglück mine, near Hilburghausen, and at Eisfeld.

CROCOISITE, *Kobell*. Chromate of Lead. Red Lead Ore. Krokoit, *Breit*. Rothbleierz. Plomb Chromaté.

Monoclinic; M : M=93° 40′, P : M=99° 11′. P : ē=102° 20′, M : ē=136° 50′, M : ĕ=133° 10′, ē : ē=119°, ĕ : ĕ=107° 40.′ Cleavage lateral, tolerably distinct; basal, less so. Surface M 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.

1



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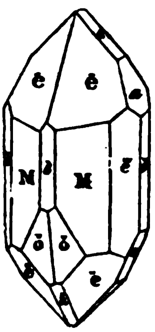


Composition.—$\dot{P}b\,\dddot{C}r$=Oxyd of lead 68·15, chromic acid 31·85. Analyses: 1. Pfaff, (Schw. J. xviii, 72); 2, Berzelius, (ib. xxii, 54):

1. $\dot{P}b$ 67·912, $\dddot{C}r$ 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 without 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, fine crystallized specimens are met with in decomposed granite. Found also at Retzbanya in Hungary, at the mine of St. Anthony; and at Moldawa in the Bannat.

MELANOCHROITE, *Hermann*. Phœnikochroite, *Glocker*. Subsesquichromate of Lead, *Thom*.

Trimetric. Crystals usually tabular, and reticularly interwoven. 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.—$\dot{\mathrm{P}}\mathrm{b}^3\,\dddot{\mathrm{C}}\mathrm{r}^2$=Chromic acid 23·64, protoxyd of lead 76·36. 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).

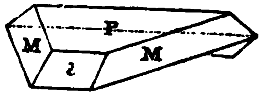
B.B. on charcoal fuses readily to a dark mass, which is crystalline when cold. In the reducing flame on charcoal, lead is sublimed. Gives the reaction of chrome with fluxes.

Occurs in limestone at Beresof, in the Ural, with chromate of lead, vauquelinite, pyromorphite, and galena. It was first analyzed and described by Hermann.

The name melanochroite is from μελας, *black*, and χροα, *color*.

VAUQUELINITE. Chromate of Lead and Copper, *Phil.*

Monoclinic. Usually in minute irregularly aggregated crystals, of a dark green or black color. Compound crystals, similar to the annexed figure; composition parallel to a plane on the acute solid angles; P : P (of the two individuals)=134° 30′, and P : ē= 149° nearly. Also reniform or botryoidal, and granular; also amorphous.



H.=2·5—3. G.=5·5—5·78. Lustre adamantine to resinous, often faint. Color dark-green, sometimes nearly black. Streak siskin-green or brownish. Faintly translucent—opaque. Fracture uneven. Rather brittle.

Composition.—$\dot{\mathrm{C}}\mathrm{u}^3\,\dddot{\mathrm{C}}\mathrm{r}^2+2\dot{\mathrm{P}}\mathrm{b}^3\,\dddot{\mathrm{C}}\mathrm{r}^2$=Oxyd of lead 60·78, oxyd of copper 10·80, chromic acid 28·42. Analysis by Berzelius, (Afhandl. vi, 246),

$\dot{\mathrm{P}}\mathrm{b}$ 60·87, $\dot{\mathrm{C}}\mathrm{u}$ 10·80 $\dddot{\mathrm{C}}\mathrm{r}$ 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.

Vauquelinite occurs with chromate of lead at Beresof in Siberia, generally in mammillated or amorphous masses, or thin crusts. It has also been observed at Pont Gibaud in the Puy de Dome; it is stated to occur along with the chromate of lead of Brazil. Levy gives its specific gravity at 6·8—7·2, and hardness above 4·0.

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.

BLEINIERITE, *Nicol.* Bleinière, *Haus.* Antimonate of Lead. Antimonsaures Bleioxyd.

Amorphous, reniform, spheroidal; also earthy or incrusting. Structure often curved lamellar.

H.=4. G.=3·938, Karsten; 4·6—4·76, Hermann. Lustre resinous, dull, or earthy. Color gray, brownish, yellowish. Streak grayish or yellowish. Opaque.

Composition.—$\dot{Pb}^3\bar{\ddot{Sb}}+4\dot{H}$, Hermann=Antimonic acid 31·32, oxyd of lead 62·01, water 6·67. Analyses: 1, Pfaff, (Schw. J. xxvii, 1); 2, Hermann, (J. f. pr. Chem. xxxiv, 179):

1. $\bar{\ddot{Sb}}$ 43·96, $\bar{\ddot{As}}$ 16·42, $\dot{Pb}$ 33·10, $\dot{Cu}$ 3·24, $\bar{\ddot{Fe}}$ 0·24, $\dddot{Si}$ 2·34, $\dddot{S}$ 0·62, Fe Mn 3 32=103·23, P.

2. $\bar{\ddot{Sb}}$ 31·71, $\dot{Pb}$ 61·83, $\dot{H}$ 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.

Pfaff is supposed to have analysed an impure mineral. Arsenic acid is often present.

From Nertschinsk, Siberia, and supposed to have resulted from the decomposition of other ores of Antimony.

PLUMBO-RESINITE. Gummispath, *Br.* Plomb hydro-alumineux, *H.* Plombgomme, *Laumont.* Bleigummi *of the Germans.*

Aggregations of columnar particles presenting externally reniform or globular shapes; also impalpable.

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.—$\dot{Pb}\bar{\ddot{Al}}^2+6\dot{H}$, Berzelius; $\dot{Pb}^3\bar{\ddot{P}}+6\bar{\ddot{Al}}\dot{H}^3$, Damour. Analysis: 1, Berzelius, (Schw. J. xxvii, 65); 2, Dufrénoy, (Ann. Ch. Phys. lix, 440); 3, Damour, (Ann. d. Mines, [3], xvii, 191):

	$\dot{Pb}$	$\bar{\ddot{Al}}$	$\dot{H}$	$\bar{\ddot{P}}$
1. Huelgoet, G.=6·4,	40·14	37·00	18·80	—, $\dddot{S}$ 0·20, $\dot{Ca}$ $\bar{\ddot{Fe}}$ $\bar{\ddot{Mn}}$ 1·80, $\dddot{Si}$ 0·6=98·54, Berz.
2. Nussière, G.=4·88,	37·51	34·23	16·13	—, $\dot{Pb}^3\bar{\ddot{P}}$ 7·79, quartz, &c., 2·11=97·77, Duf.
3. Huelgoet,	35·10	34·32	18·70	8·06, $\bar{\ddot{Fe}}$ 0·20, $\dddot{S}$ 0·30, PbCl 2·27, $\dot{Ca}$ 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 Poullaouen, in Brittany, associated with galena, blende, iron pyrites, and pyromorphite; also in a lead mine at Nussière, near Beaujeu; at Roughton 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),

$\dot{Pb}$ 10·0, $\dot{Cu}$ 3·0, $\bar{\ddot{Al}}$ 23·0, $\bar{\ddot{P}}$ with trace of $\bar{\ddot{As}}$ 25·5, $\dot{H}$ 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 $\bar{\ddot{Al}}^4\bar{\ddot{P}}^3$, and phosphate of lead, $\dot{Pb}^3\bar{\ddot{P}}$.

XI. COPPER.

Copper is met with native, and in this state is not uncommon. Its usual ores are sulphurets and oxyds, the former being far most abundant. It is also found combined with arsenic, selenium, antimony, (often along with iron or silver), also with carbonic, sulphuric, phosphoric, arsenic, vanadic, and silicic acids; also with chlorine.

Ꞓu (or Cu^2) has been shown to be isomorphous with Ag, Pb, Fe, and other allied metals.

Copper is monometric in crystallization. Crystals obtained recently by Mr. W. P. Blake as a result of galvanic deposition, were hexagonal prisms, showing that the metal is dimorphous.

1. *Native.*

COPPER. Gediegen Kupfer *of the Germans.* Cuivre Natif, *H.* Venus, *Alchem.*

Monometric. In octahedrons, figs. 1—11, inclusive, pl. 1. Cleavage none. Compound crystals, composition parallel to a face of the octahedron; variously modified. Usually massive and also arborescent and filiform.

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 fibrous 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 United States, particularly in Massachusetts, Connecticut, and still more abundantly in New Jersey, where it has been met with at several different places, 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.

But no known locality in the world exceeds in the abundance of native copper, the Lake Superior copper region, near Kewenaw Point. Masses of great size were observed in this district near the Ontanawgaw river by Mr. Schoolcraft in 1821, and a large boulder described by him, (Am. J. Sci. iii, 201), and weighing 3704 lbs., is now in Washington, while another from the same vicinity, weighing 187 lbs., has been many years in the Yale College collections. One large mass recently laid open at the "Cliff Mine" has been estimated to weigh 80 tons; it was a flat mass lying vertically in the rock as in a vein, and measured 50 feet long, 6 feet deep, and averaged 6 inches in thickness. 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 by the heat of the trap when first thrown up.

Copper is of very extensive application in the arts. In the pure state, it is used for various utensils, the sheathing of ships, &c. Alloyed with zinc, it constitutes brass, and with tin it forms bell metal. A similar alloy, in different proportions, constitutes the material of which the ancients made their *brass* weapons and cutting instruments. The proportion in these instruments was about five of copper to one of tin, which is the ratio that affords an alloy of maximum hardness.

2. *Combinations with Sulphur, Selenium, Arsenic, Antimony.*

List of Species.

COPPER GLANCE,—Trimetric,	Ɵu S.
DIGENITE,	Ɵu^5 S^4.
BERZELIANITE,	Ɵu Se.
COVELLINE,	Ɵu S^2.
ERUBESCITE,—Octahedral,	(Ɵu, Fe) S ; 3 Ɵu S+Fe^{2}S^3 ?
COPPER PYRITES,—Dimetric,	Ɵu S+Fe^2 S^3.
DOMEYKITE,	Cu^3 As or Ɵu^3 As^2.
GRAY COPPER,—Monometric, tetrahedral,	4 R S+(Sb, As) S^3.
TENNANTITE,—Monometric,	4 R S+As S^3.
APHTHONITE,	7 R S+(Sb, As) S^3.
WOLFSBERGITE,	Ɵu S+Sb S^3.
WÖLCHITE.	
BOURNONITE,—Trimetric,	3 (Ɵu, Pb) S+Sb S^3.

COPPER GLANCE. Vitreous Copper. Sulphuret of Copper. Redruthite, *Nicol.* Glance Copper. Kupferglas, *W.* Kupferglanz, *Haus.* and *L.* Cuivre Sulfuré, *H.*

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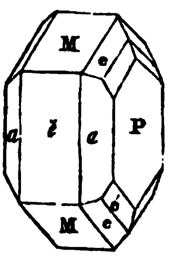

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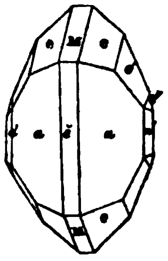

Bristol, Ct.

Trimetric. M : M=119° 35′. Secondary forms, P : a=117° 10′, a : a (over $\breve{e}$)=125° 40′, (125° 43′, D., mean of five measurements of a crystal from Bristol, Ct.), M : e=152° 41′, M : e′=122° 44′. Cleavage indistinct, parallel to M. Compound crystals: stellated forms similar to those of Arragonite; very frequent. 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.

Composition.—$\bar{\mathrm{C}}\mathrm{u}\,\mathrm{S}$=Sulphur 20·2, copper 79·8. Analyses: 1, Ullmann, (Syst. tab. Uebers. 243); 2, 3, Scheerer, (Pogg. lxv, 290); 4, Klaproth, (Beit. iv, 37); 5, Schnabel, (Ramm. 4th Supp. 121):

	S	Cu	Fe
1. Siegen,	19·00	79·50	0·75, $\bar{\bar{\mathrm{Si}}}$ 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. Katharinenburg,	18·50	78·50	2·25, $\bar{\bar{\mathrm{Si}}}$ 0·75=100, Klaproth.
5. Siegen, *massive*,	21·50	74·73	1·26, $\bar{\bar{\mathrm{Si}}}$ 2·00=99·49, Schnabel.

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 made the crystallization hexagonal, which appears to have been an error.

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 of this species, 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. Y. A vein at Bristol, Conn., affords large and brilliant crystallizations, and the ore is profitably mined. In Virginia it occurs in the U. S. copper mine district, Blue Ridge, Orange Co. Between Newmarket and Taneytown, Maryland, east of the Monocacey, associated 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.

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 $\bar{\mathrm{C}}\mathrm{u}\,\mathrm{S}+3\mathrm{Cu}\,\mathrm{S}(=\mathrm{Cu}^5\,\mathrm{S}^4)$, making it a compound of 1 of copper glance and 3 of covelline.

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.—$\bar{\mathrm{C}}\mathrm{u}\,\mathrm{Se}$=Selenium 38·46, copper 61·54. 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 Lerbach in the Hartz. Beudant gives the name *Berzeline* to this species, which, as it has other applications in the science, we have changed to another form, as above.

COVELLINE, *Beud.* Indigo Copper. Kuferindig. Blue Copper.

Hexagonal. Also 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. Sectile.

Composition.—$\mathrm{Ꞓu\,S^2}$ or $\mathrm{Cu\,S}$=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.	

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; at Kielce in Poland; at Sangerhausen in Saxony; at Mansfeld in Thuringia; and at Vesuvius on lava, where it was found by Covelli.

ERUBESCITE, *D.* Variegated Copper. Bornite, *Haid.* Purple Copper, *P.* Liver-colored Copper Ore. Phillipsite, *Duf.* Buntkupfererz, *W.* and *L.* Bunter Kupferkies, *Haus.* Cuivre Pyriteux Hepatique, *H.*

Monometric. Figures 1, 2, and 3, plate 1. Cleavage octahedral in traces. Compound crystals, fig. 129, pl. 2. Imperfect crystallizations, structure granular, strongly connected.

H.=3. G.=5·003. Lustre metallic. Color between copper-red and pinchbeck brown. Streak pale grayish-black, and slightly shining. Fracture small conchoidal, uneven. Brittle. Speedily tarnishes.

Composition.—$\mathrm{Fe\,S+2Ꞓu\,S}$ or $\mathrm{(Fe,\,Ꞓu)S}$, Berzelius=Sulphur 23·7, copper 62·5, iron 13·8. $\mathrm{3Ꞓu\,S+Fe^2S^3}$, Ramm.=Sulphur 28·1, copper 55·5, iron 16·4, but mixed often with copper glance.* Analyses: 1, 2, Klaproth, (Beit. ii, 281); 3, 4, 5, Berthier, (Ann. d. Mines, [3], iii, 48, vii, 540, 556); 6, Phillips (Ann. Phil. 1822, 297;) 7, Brandes, (Schw. J. xxii, 354); 8—12, Plattner, (Pogg. xlvii, 351); 13, Varrentrapp, (ib); 14, Hisinger, (Afh. i Fys. iv, 362); 15, Chodnew, (Pogg. lxi, 395;) 16, 17, Bodemann, (Pogg. lv, 115); Staaf, (Ofv. K. V. Ak. Förh. 1848, 66):

	S	Cu	Fe
1. Hitterdal, Norway,	19·0	69·5	7·5, O 4·0=100, Klaproth.
2. Rudelstadt, Silesia,	19·	58·	18· 5· =100, Klaproth.
3. Nadaud, Frankreich,	20·0	70·0	7·9=97·9, Berthier.
4. Montecastelli, Tuscany,	21·4	67·2	6·8, gangue 4·0=99·4, Berthier.
5. St. Pancrasse,	22·8	59·2	13·0, gangue 5·0=100, Berthier.
6. Ross I., L. Killarney,	23·75	61·07	14·0, quartz 0·5=99·32, Phillips.
7. Siberia,	21·65	61·63	12·75, 3·5=99·53, Brandes.
8. Sangerhausen, *massive*,	22·58	71·00	6·41=99·99, Plattner.
9. Eisleben, *massive*,	22·65	69·73	7·54=99·91, Plattner.
10. Woitzki, White Sea, *mass.*,	25·06	63·03	11·56=99·65, Plattner.
11. Condurra M., Cornw. *cryst.*,	28·24	56·76	14·84=99·84, Plattner.
12. Dalarne, *massive*,	25·80	56·10	17·36, $\overline{\mathrm{Si}}$ 0·12=99·39, Plattner.
13. "	26·98	58·20	14·85=100·03, Varrentrapp.
14. Vestanforsa, Westmannland,	24·70	63·33	11·80=99·83, Hisinger.
15. Redruth, *cryst.*,	26·84	57·89	14·94, gangue 0·04=99·71, Chodnew.
16. Bristol, Ct., *massive*,	25·70	62·75	11·64, quartz 0·04, Bodemann.
17. " " "	undet.	62·65	11·42, " 0·02, Bodemann.
18. Westmannland,	——	60·56	10·24, gangue 4·09=99·11, Staaf.

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* Of the analyses, No. 11 corresponds nearly to Rammelsberg's formula above given.
Nos. 13 and 15=the same+$\mathrm{(Ꞓu\,S+FeS)}$; or $\mathrm{(Ꞓu,\cdot Fe)^7\,S^8}$.
Nos. 10, 16, 17, 18=(nearly) the same+$\mathrm{2Ꞓu\,S}$=$\mathrm{(5Ꞓu\,S+Fe^2S^3)}$; or $\mathrm{(Ꞓu,\,Fe)^7\,S^8}$.
Nos. 9, 10, 14=$\mathrm{(Ꞓu,\,Fe)S}$; the first $\mathrm{9Ꞓu\,S+Fe\,S}$; the second $\mathrm{4Ꞓu\,S+Fe\,S}$.

B.B. blackens and becomes red on cooling; at a higher temperature fuses to a globule, attractable by the magnet. Mostly dissolved by nitric acid.

Occurs with other copper ores in primitive and secondary rocks.

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. At Cheshire, it is met with in small cubes, along with heavy spar, malachite, and vitreous copper.

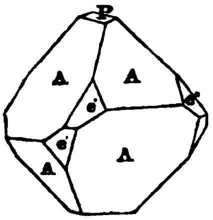
This species is a valuable ore of copper. Its name alludes to its liability to tarnish, thus receiving a reddish hue.

The name bornite applied to this mineral by Haidinger has another application in the science.

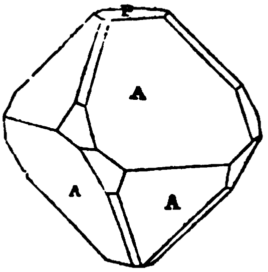
COPPER PYRITES. Chalcopyrite, *Beud.* Yellow Copper Pyrites. Pyritous Copper. Yellow Copper Ore. Kupferkies. Cuivre Pyriteux.

Dimetric: hemihedral. A : A (over a terminal edge)=109° 53′, A : A (over a basal edge)=108° 40′, Phillips. Secondary forms:

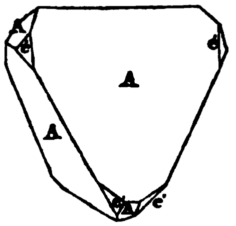
1



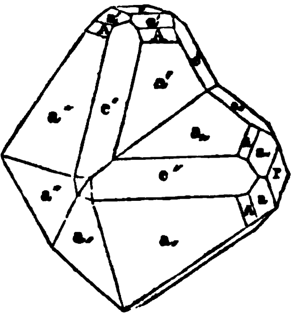
2



3



A : e′=140° 46′, e′ : e′ (over A)=101° 49′, over base=126° 11′, e″ : e″ (over a″)=108° 18′, a′ : a′=132° 19′, a″ : a″=100° 44′. Cleavage sometimes distinct parallel with e′; parallel with P, indistinct. Compound crystals: 1. Composition parallel to A, producing a form resembling fig. 129, pl. 2. Very complex forms result when this composition takes place, parallel to each of the faces A. 2. Composition parallel to e, as represented in the annexed figure; repetition of this composition parallel to each of the terminal edges, produces some of the most complex forms in the mineral kingdom.* Also globular, botryoidal, stalactitic, and other shapes. Also granular massive, often impalpable.



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* These forms have been accurately delineated and described by Haidinger, in the third volume of Brewster's Journal, in a highly finished article on twin crystals, continued from vol. i, of the same Journal, into several of the succeeding volumes.

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.—$\mathrm{\overline{Cu}\,S+Fe^2\,S^3}$, Ramm.=$\mathrm{(\overline{Cu}, Fe)^3\,S^4}$=Sulphur 35·05, copper 34·47, iron 30·48=100. Analyses: 1, 2, H. Rose, (Gilb. lxxii, 185); 3, Hartwall, (Leonh. Handb. 646):

1. Sayn,	S 35·87	Cu 34·40	Fe 30·47	quartz 0·27=101·01,	Rose.
2. Fürstenberg,	36·52	33·12	30·00	0·39=100·03,	Rose.
3. Finnland,	36·33	32·20	30·03	2·23=100·79,	Hartwall.

Other analyses give the same result. 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.

Copper pyrites 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 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; abundant also 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 Strafford, where it is profitably worked; and at Corinth, Waterbury, and Shrewsbury: in New Hampshire, at Franconia, in gneiss; at Unity, on the estate of Jas. 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 New York, at the Ancram lead mine; five miles from Rossie, beyond DeLong's mills; at the Rossie lead mine in crystals; and in crystals and massive at the mine near Wurtzborough, Sullivan Co.; in Virginia, at the Phenix copper mines, Fauquier Co., and the Walton gold mine, Louisa Co.; in the Catoctin Mts., Maryland, and between Newmarket and Taneytown. In Michigan it is not abundant; but it occurs at Presque Isle, at Mineral Point, and in Wisconsin, where it is the prevailing ore. In Canada, in Perth, there is a good vein.

Allan says, speaking of the Cornwall ores, "Though copper pyrites occurs in vast profusion, it is by no means a rich ore; what is picked for sale at Redruth rarely yielding 12, generally only 7 or 8, and occasionally so little as 3 or 4 per cent. of metal. In the latter case, such poverty of ore is only made up by its facility of transport, the moderate expense of fuel, or the convenience of smelting. 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 assuredly a poor ore, being mixed 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 account of which it cannot be cut off in slices, like the latter metal; and moreover gold is not attacked by nitric acid.

CUBAN, *Breithaupt*, Pogg, 325, 1843.—A sulphuret of Iron and Copper, occurring in cubes or massive. Color between bronze and brass-yellow. Streak black. H.=4.

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* For analyses of different ores from New Hampshire, see Geol. Rep. of that State, by C. T. Jackson, p. 214.

G.=4·026. Breithaupt obtained in repeated trials, 19 per cent. of copper. B.B. fuses easily, giving off fumes of sulphur, but no arsenic. It was brought from the island of Cuba.

DOMEYKITE, *Haid.* Arsenical Copper. Cuivre Arsenical, *Duf.* Weisskupfererz, *W.* Arsenikkupfer. Condurrite, *Faraday.*

Reniform and botryoidal; also massive and disseminated.

H.=3—3·5. G.=4·5. Lustre metallic. Color tin white, slightly yellowish, often with an iridescent tarnish. Fracture uneven. Also black and soft, soiling the fingers (*Condurrite*) when impure.

Composition.—$\text{Ꞓu}^3\,\text{As}^2$=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); Ann. d. Ch. u. Pharm. lxvi, 1848, 362):

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, $\dot{\text{S}}$ 2·33, $\dot{\text{H}}$ 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 analysed the soluble and insoluble portions separately, obtaining

1. Soluble, As 13·89, Cu 12·81, S 2·20, $\ddot{\text{A}}\text{s}$ 3·70, Ꞓu 62·29, $\dot{\text{H}}$ 5·88, 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 finds the composition of the soluble part, $\ddot{\text{A}}\text{s}$ 8·03, Ꞓu 79·00, $\overline{\text{F}}\text{e}$ 3·47, $\dot{\text{H}}$ 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.

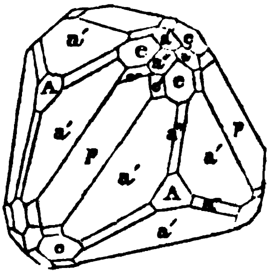
B.B. fuses easily, with the odor of arsenic. Not dissolved in muriatic acid. The *Condurrite* affords in a tube fumes of arsenous acid and water, and with soda and borax yields a globule of copper.

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 Wheal Druid mine at Carn Brae, near Redruth, Cornwall.

GRAY COPPER. Fahlerz, *P.* Schwarzerz, *W.* Kupferfahlerz. Schwarzgiltigerz, *Haus.* Cuivre Gris, *H.* Aphthonite, *Svanberg.* Aftonite.

Monometric: hemihedral; figs. 7, 16, 30, 32, 34, 35, 36. Cleavage octahedral, in traces. Compound crystals, composition parallel to a face of the octahedron. Also granular, coarse or fine, to impalpable, compact.

H.=3—4. G.=4·5—5·104. Lustre metallic. Color between steel-gray and iron-black. Streak sometimes inclined to brown, but generally the same as the color. Opaque. Fracture subconchoidal, uneven. Rather brittle.



Composition.—$4(\bar{\mathrm{C}}\mathrm{u}, \mathrm{Ag}, \mathrm{Fe}, \mathrm{Zn})\,\mathrm{S}+(\mathrm{Sb}, \mathrm{As})\,\mathrm{S}^3$. Analyses: 1, Klaproth, (Beit. iv), 2—6, H. Rose, (Pogg. xv, 576); 7, 8, Kersten, (Pogg. lviii, 161, lxvii, 428); 9, Bromeis, (Pogg. lv, 117); 10, Amelung, (Ramm. 3d Supp. 51); 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); 19, Scheidthauer, (Pogg. lviii, 161); 20, H. Weidenbusch, (Pogg. 1849, lxxvi, 86):

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=99·44, Rose.
5. Dillenburgh,	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=98·41, Kersten.
8. V. di Angina,	23·40	27·47	——	35·90	1·93	6·24	0·33 " 2·70, Au *trace* gangue and loss 2·03, Kersten.
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.

II. *Containing Silver.* G. of Number 15, 4·87; of 16, 4·852; of 17, 4·892—4·946; of 18, 4·526.

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, *cryst.*,	24·80	26·56	——	30·47	3·52	3·39	10·48, Pb 0·78=100, Ramm.
17. Neudorf, massive,	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.

III. *Containing Quicksilver*, (see also, Nos. 7, 8, above). G. of No. 20=5·107.

19. Iglo, Hungary,	23·34	18·48	3·98	35·90	4·90	1·01	*trace*, Hg 7·52, quartz 2·73=97·86, S.
20. Schwatz, Tyrol,	22·96	21·35	——	34·57	2·24	1·34	——, Hg 15·27, insol. 0·80=98·93, Wied.

The ore of Moschellandsberg, according to Zincken, also 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, they dissolve 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 imbedded in red manganese. The *Silberfahlerz* has a light steel-gray color, G.=4·8—5·1.

It is associated usually with copper pyrites, and is worked as an ore of copper.

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 $7\,\mathrm{R}\,\mathrm{S}+(\mathrm{Sb}, \mathrm{As})\,\mathrm{S}^3$. It resembles an argentiferous fahlerz.

TENNANTITE. Graukupfererz. Kupferblende, *Breit.*

Monometric; figs. 5, 6, 32, 36, pl. 1. Cleavage dodecahedral, imperfect. Has not been 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.—$4(\cancel{\mathrm{C}}\mathrm{u}, \mathrm{Fe})\,\mathrm{S}+\mathrm{As}\,\mathrm{S}^{2}$, or analogous to *gray copper*, with which mineral it is isomorphous. 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 *trace*, quartz 0·08=99·45, K.
4. 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.

This species occurs in the Cornish mines, particularly near Redruth and St. Days. It commonly occurs in very splendent crystals investing other ores of copper. It is also found at Skutterud in Norway.

The *Kupferblende* of Breithaupt, from near Freiberg, has part of the iron replaced by zinc: it has a brownish-red or dirty cherry-red streak; G.=4·2—4·4.

WOLFSBERGITE, *Nicol.* Antimonial Copper. Sulphuret of Copper and Antimony, *H. Rose*, Pogg. xxxv, 357. Kupferantimonglanz, *Zincken.*

Trimetric. Occurs in small aggregated tabular prisms, which, according to G. Rose, are right rhombic with their edges deeply truncated.

H.=3—4. G. 4·748. Lustre metallic. Streak black. Color between lead-gray and iron-gray. Opaque. Fracture conchoidal.

Composition.—$\cancel{\mathrm{C}}\mathrm{u}\,\mathrm{S}+\mathrm{Sb}\,\mathrm{S}^{2}$=Sulphur 25·08, antimony 50·26, copper 24·66=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 in the state of pyrites, and the lead in that of feather ore.

B.B. decrepitates, fuses readily, and gives on charcoal fumes of antimony; also after a strong heat a globule of copper.

From Wolfsberg in the Hartz, in nests imbedded in quartz. It is usually covered with a coating of pyrites.

WÖLCHITE, *Haid.* Antimonial Copper Glance. Antimonkupferglanz, *Breit.*

Massive, with a rhombic cleavage.

H.=3. G.=5·7—5·8. Color blackish lead-gray. Fracture conchoidal to uneven. Brittle.

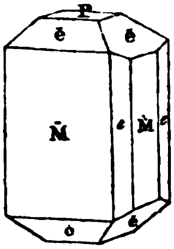
Composition.—Analysis by Schrötter, (Baumgart. Zeit. viii, 284):

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 Wölch or St. Gertraud, in Carinthia.

BOURNONITE. Endellionite, *Bournon.* Schwarz-spiessglaserz, *W.* Bleifahlerz. Spiessglanz-bleierz, *Haus.* Wheel Ore. Radelerz. Antimoine Sulfuré Plombo-cuprifère, *H.*

Trimetric. P : ē=133° 34′, P : ĕ=136° 50′, $\bar{M}$: *e*=138° 15½′, *e* : *e* (over $\bar{M}$)=96° 31′, ė : ē (over M)=92° 52′, other macrodiagonal prisms 115° 16′, 129° 9′, and 56° 6′, ĕ : ĕ (over $\breve{M}$)=86° 20′, other brachydiagonal prisms 123° 51′ and 50° 15′. Cleavage imperfect, parallel with $\bar{M}$ and $\breve{M}$, and P; $\breve{M}$ the most distinct; also in traces parallel with *e*. Compound crystals: composition of the second kind, parallel to ĕ; cruciform crystals often occur, resulting from this kind of composition. These crystals cross at angles of 93° 40′ and 86° 20′. Also massive, granular, compact.



H.=2·5—3. G.=5·766, Hatchett. Lustre metallic. Color and streak steel-gray, inclining to blackish lead-gray or iron-black. Opaque. Fracture conchoidal or uneven. Brittle.

Composition.—3 (Ɵu, Pb) S+Sb S^3, or (3 Ɵu S+Sb S^3)+2 (3 Pb S+Sb S^3), Rammelsberg=Sulphur 19·46, antimony 26·01, copper 12·76, lead 41·77. 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	9·06, Ni and 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), has an iron-black color, 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.

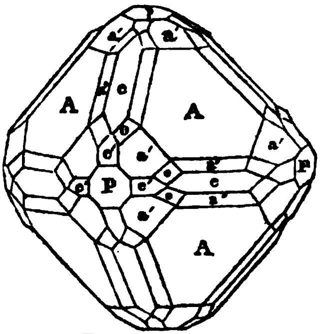
In the last analysis, part of the lead is replaced by nickel and cobalt. The specific gravity is 5·524—5·590. Rammelsberg calls the mineral *Nickel-bournonite.*

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.

The finest crystallizations of this species occur in the mines of Neudorf in the Hartz, where they occasionally exceed an inch in diameter. It accompanies quartz, gray copper ore, 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.

3. *Combined with Oxygen, Chlorine.*

RED COPPER. Cuprite, *Haid.* Red Oxyd of Copper. Oxydulated Copper, *P.* Tile Ore. Rothkupfererz, Ziegelerz, *W.* Cuivre Oxidé Rouge, Cuivre Oxidulé, *H.* Zigueline.



Monometric. Figs. 2, 3, 5, 6, 7, 8, 9, 10, 11, &c., plate 1, also the annexed figure. Cleavage octahedral. Also massive, granular. Sometimes earthy.

H.=3·5—4. G.=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.—Ċu=Copper 88·88, oxygen 11·12. 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 varieties. These usually present a brick-red or reddish-brown color, and are frequently mixed with oxyd of iron. They occur in the Bannat, at Camsdorf and Saalfield, in Thuringia, and in Cornwall. Fine translucent crystals of red copper ore occur with native copper and quartz at Wheal 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. Cornwall and Rheinbreitenbach, on the Rhine, afford a *capillary* ore, which is the *chalcotrichite* of Glocker.

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., and with green malachite in trap, two miles from Ladenton, Rockland Co., N. Y.

When found in large quantities, this species is valuable as an ore of copper.

CHALCOTRICHITE, *Glocker.* Capillary Red Oxyd of Copper. Haarformiges Rothkupfererz. Kupferblüthe, *Haus.*

Rhombohedral. R : R=99° 15′. Usually in fine capillary crystallizations grouped or reticulated. Cleavage rhombohedral, perfect.

G.=5·8. Color cochineal and crimson-red.

Composition.—Considered identical with Red Copper.

Occurs at Rheinbreitenbach, Moldawa, and in Cornwall, at Wheal Gorland, Carharrack, and St. Day.

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.—$\dot{\mathrm{C}}\mathrm{u}$=Oxygen 20·13, copper 79·86.

Found on lava at Vesuvius, in minute scales from $\frac{1}{20}$ to $\frac{1}{4}$ of an inch in diameter, often hexagonal and sometimes triangular. Usually associated with common salt.

MELACONITE.—Black oxyd of copper. Kupferschwärze. The black oxyd of copper has the composition of Tenorite ($\dot{\mathrm{C}}\mathrm{u}$) and is supposed to be the same species. It has been found only in small quantities, and usually pulverulent, earthy, or massive, until the discovery near Eagle River, Kewenaw Point, Lake Superior, where about 40,000 lbs. of the ore have been removed. It there occurs not only compact massive, but also in crystals, as first observed by J. E. Teschemacher. The following characters of the specimens are from Teschemacher and Hayes, (private communication).

Usually amorphous, and compact or granular; but the central portions of large masses often contain crystals, which are cubes or allied forms. H.=3—6. G. of crystals 5·141; of compact portions 5·386. Color grayish-black or nearly a pure black. Streak black and shining. Lustre submetallic and earthy, or metallic and bright. B.B. in the inner flame yields easily a globule of copper. Composition nearly pure black oxyd of copper, mixed with small portions of ferruginous clay, and sometimes penetrated by bluish-green seams of chrysocolla. Mr. Teschemacher attributes its origin to the action of heat on the red oxyd of copper, and in connection with Mr. Hayes has been through experiments which give this result. The contiguity of the copper to a region of trap injections, and the character of the copper deposits are sufficient evidence of the agency of heat at some former period.

The explorations of the black copper at Copper Harbor are now abandoned.

ATACAMITE, *Jameson*. Salzkupfererz, *W.*

Trimetric. M : M=107° 10′; usual in modified rectangular prisms, and rectangular octahedrons. Cleavage basal, perfect; lateral, less distinct.

H.=3—3·5. G.=4—4·3; 3·7, Breit. Lustre adamantine—vitreous. Streak apple-green. Color various shades of bright green, rather darker than emerald, sometimes blackish-green. Translucent—subtranslucent.

Composition.—$\mathrm{Cu\,Cl}+3\dot{\mathrm{C}}\mathrm{u}+3\dot{\bar{\mathrm{H}}}$=Oxyd of copper 55·94, chlorid of copper 31·48, water 12·58=100; [oxyd of copper 74·46, muriatic acid 17·09, water 12·68=104·23.] Others afford the formula $\mathrm{Cu\,\bar{C}l}+3\dot{\mathrm{C}}\mathrm{u}+6\dot{\bar{\mathrm{H}}}$=Oxyd of copper 49·57, chlorid of copper 27·94, water 22·49=100; [oxyd of copper 66·08, muriatic acid 15·16, water 22·49=103·73]. Analyses: 1, Klaproth, (Beit. iii, 196, reckoned anew by Rammelsberg); 2, J. Davy, (Phil. Trans. 1812); 3, 4, Proust, (Ann. Chim. xxxii, 26); 5, Berthier, (Ann. d. Mines, [3], vii, 542); 6, Ulex, (Ann. Ch. u. Pharm. lxix, 361):

	H Cl	$\dot{\mathrm{C}}\mathrm{u}$	$\dot{\bar{\mathrm{H}}}$
1. Chili, *massive*,	16·3	72·0	11·7=100, Klaproth.
2. “ *cryst.*,	16·2	73·0	10·8=100, Davy.
3. “ *massive*,	10·5	76·5	12·5=99·5, Proust.
4. “ “	11·5	70·5	18·0=100, Proust.
5. Bolivia, Cobija,	Cl 14·92	50·00	21·75, Cu 13·33=100, Berthier.
6. Chili,	“ 16·12	56·23	11·99 “ 14·56, $\bar{\mathrm{S}}\mathrm{i}$ 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.

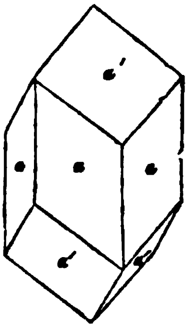
This species was originally found in the state of sand in the Atacama desert, between Chili and Peru. It occurs also at Los Remolinos, in Chili, and in veins in the district of Tarapaca. It also invests some of the lavas of Vesuvius and Etna, being formed by the action of the volcano; Schwarzenberg in Saxony, is another reported locality.

It is ground up in Chili, and sold under the name of *Arsenillo*, as a powder for letters.

4. *Combined with Silica.*

DIOPTASE, *Haüy*. Emerald Copper, *Phillips*. Emerald Malachite. Achirite. Kupfer-Smaragd, *W*. Smaragdo-Chalcit, *Br*.

Primary form, an obtuse rhombohedron : R : R=126° 17′. Secondary form, figure 118, a' : a' =95° 48′, a' : a=132° 6′, a : a=120°. Cleavage rhombohedral, perfect.



H.=5. G.=3·278. 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 38·76, oxyd of copper 49·92, water 11·32=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	$\bar{A}l$ 2·36, $\dot{C}a$ 3·39, $\dot{M}g$ 0·22=99·43, Hess.
3.	36·47	50·10	11·40	$\bar{F}e$ 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. It was named Achirite, after this merchant.

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 34·82, oxyd of copper 44·83, water 20·35; 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, 13); 7, Beck, (Am. J. Sci. xxxvi, 111); 8, Scheerer, (Pogg. lxv, 289); 9, C. T. Jackson, (Private communication).

	$\dddot{\mathrm{Si}}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{H}}$	
1. Siegen,	40·	40·	12·	$\ddot{\mathrm{C}}$ 8=100, Ullman.
2. Bogoslowsk,	36·54	40·00	20·20,	gangue 2·10, $\bar{\mathrm{F}}\mathrm{e}$ 1·00=99·84, Kobell.
3. "	35·0	39·9	21·0	" 1·1, " 3·0=100, Berthier.
4. Canaveilles, Pyrenees,	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. Somerville, N. J.,	37·25	45·17	17·00=99·43, Bowen.	
7. Franklin, N. J.,	40·00	42·60	16·00 (with loss),	$\bar{\mathrm{F}}\mathrm{e}$ 1·40=100, Beck.
8. Arendal, Norway,	35·14	43·07	20·36,	$\bar{\mathrm{F}}\mathrm{e}$, $\ddot{\bar{\mathrm{A}}}\mathrm{l}$, $\dot{\mathrm{C}}\mathrm{a}$, $\dot{\mathrm{K}}$ 1·09=99·66, Scheerer.
9. Copper Harbor,	37·85	27·97	20·00,	$\bar{\mathrm{F}}\mathrm{e}$ 8·90, $\ddot{\bar{\mathrm{A}}}\mathrm{l}$ 4·8=99·55, C. T. Jackson.

Ullman's analysis, (No. 1), affords the formula $\dot{\mathrm{Cu}}^3\,\dddot{\mathrm{Si}}^2+3\,\dot{\mathrm{H}}$; Nos. 2, 6, 8=$\dot{\mathrm{Cu}}^3\,\dddot{\mathrm{Si}}^2+6\,\dot{\mathrm{H}}$; No. 4, $\dot{\mathrm{Cu}}^3\,\dddot{\mathrm{Si}}^2+12\,\dot{\mathrm{H}}$.

Another sample from Copper Harbor gave Dr. Jackson 38·92 per cent. of oxyd of copper, and a third 44·28 p. c. The following are analyses of impure varieties: 1 Thomson. (Min. 1.); 2, Klaproth, (Beit. iv, 34); 3, Kobell, (J. f. pr. Chem. xxxix, 208); 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·	50·	17·	7=100, Klaproth.
3. Turinsk, Ural, *brown*,	9·66	18·00	18·00	$\bar{\mathrm{F}}\mathrm{e}$ 59·00=99·66, Kobell.
4. Chili,	7·1	46·8	15·0	$\dddot{\mathrm{S}}$ 10·1, $\bar{\mathrm{F}}\mathrm{e}$ 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 *Kupferpechers;* 4, some sulphate of copper.

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.

He considers it a hydrosilicate of alumina and copper. The analysis affords—

$$\dddot{\mathrm{Si}}^4\ \ddot{\bar{\mathrm{A}}}\mathrm{l}^3\ \dot{\mathrm{Cu}}^6\ \dot{\mathrm{H}}^{30}=2\,\dot{\mathrm{Cu}}^3\,\dddot{\mathrm{Si}}+\ddot{\bar{\mathrm{A}}}\mathrm{l}^3\,\dddot{\mathrm{Si}}^3+30\,\dot{\mathrm{H}};$$

but it is doubtful whether it can be considered a true chemical compound.

The ore of Mineral Point, Wisconsin, is a mixture of carbonate and silicate.

Blackens in the interior flame of the blowpipe on charcoal, without melting. With borax it melts to a green glassy globule, and is partly reduced.

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.

It accompanies other copper ores in Cornwall; at Libethen in Hungary; at Falkenstein and Schwatz in the Tyrol; in Siberia, the Bannat, Thuringia, Chili.

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.

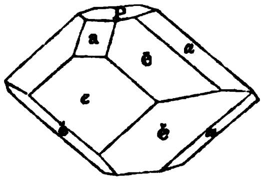
5. *Carbonates, Sulphates.*

List of Species.

MALACHITE,	$\dot{\mathrm{Cu}}^2\,\ddot{\mathrm{C}}+\dot{\mathrm{H}}$.
AZURITE,	$2\,\dot{\mathrm{Cu}}\,\ddot{\mathrm{C}}+\dot{\mathrm{Cu}}\,\dot{\mathrm{H}}$.
BLUE VITRIOL,	$\dot{\mathrm{Cu}}\,\dddot{\mathrm{S}}+5\,\dot{\mathrm{H}}$.
BROCHANTITE,	$\dot{\mathrm{Cu}}\,\dddot{\mathrm{S}}+3\,\dot{\mathrm{Cu}}\,\dot{\mathrm{H}}$.
LETTSOMITE,	$\dot{\mathrm{Cu}}^6$, $\ddot{\bar{\mathrm{A}}}\mathrm{l}$, $\dddot{\mathrm{S}}^2$, $\dot{\mathrm{H}}^{18}$.
CONNELLITE,	Sulphato-Chlorid of $\dot{\mathrm{Cu}}$?

AZURITE. Blue Copper. Blue Carbonate of Copper. Blue Malachite. Chessy Copper. Kupferlasur, *W.*

Monoclinic. M : M=98° 50′, P : M=91° 30′, P : ē=92° 21′, a : ē=134° 56′, *a* : *a* (over P)=99° 32′. Cleavage, lateral perfect; basal, difficult. Also massive, and presenting imitative shapes, having a columnar composition; also dull and earthy.



H.=3·5—4·25. G.=3·5—3·831. Lustre vitreous, almost adamantine. Color various shades of azure-blue, passing into azure and Berlin-blue. Streak blue, lighter than the color. Transparent—subtranslucent. Fracture conchoidal. Brittle.

Composition.—$2\,\dot{C}u\,\ddot{C}+\dot{C}u\,\dot{H}$ [$=\dot{C}u^3\,\ddot{C}^2\,\dot{H}$]=Carbonic acid 25·69, protoxyd of copper 69·09, water 5·22. 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 =100, 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.

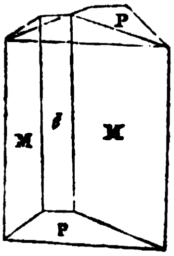
Azurite occurs in splendid crystallizations, at Chessy, near Lyons, whence it derived the name *Chessy Copper*. It also occurs in fine crystals in Siberia; at Moldawa, in the Bannat: at Wheal Buller, near Redruth, in Cornwall; also in small quantities at Alston Moor, and Wanlockhead.

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 the red shale.

If abundant, blue malachite 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.

MALACHITE. Green Carbonate of Copper. Cuivre Carbonaté Vert, *H.* Mountain Green. Atlaserz.

Monoclinic. M : M=103° 42′, P : ē (plane truncating the front lateral edge)=118° 11′. Cleavage basal, highly perfect; less distinct, parallel to ē or the clinodiagonal. Compound crystals, composition parallel with the obtuse lateral edge of the prism. Also in fascicular groups. Surface usually tuberose, botryoidal, or stalactitic, and structure divergent; also delicately compact fibrous, and banded in color; frequently granular, compact, or earthy.



H.=3·5—4. G.=3·7—4·008. Lustre adamantine, inclining to vitreous; fibrous varieties often silky; others 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 20, protoxyd of copper 71·82, water 8·18. Analyses: 1, Klaproth, (Beit. ii, 287); 2, Vanquelin, (Ann. du Mus. xx, 1); 3, Phillips, (Jour. Roy. 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, Vanquelin.
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, and in the old mine at Sandlodge, in Shetland; the compact occurs at Schwatz, in the Tyrol; also in Cornwall. At the copper mines of Nischne Tagilsk, belonging to M. Demidoff, a bed of malachite was not long since opened, which it was supposed would yield 1000 cwt. of this ore; and among the specimens many were exceedingly splendid. A mass since laid open measured at top 9 feet by 18; and the portion uncovered contained at least half a million pounds of pure malachite.

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 Co., Penn., in beautiful specimens; at the Perkiomen lead mine; 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.

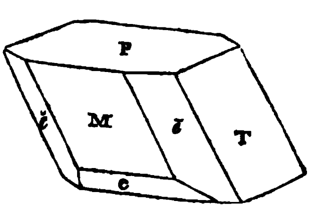
Lime Malachite. (Kalk-malachit, *Zincken*).—Massive, reniform, botryoidal; structure fibrous and foliated.

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.

Buratite, page 486, has been considered a malachite, with part of the copper replaced by zinc and lime. Berzelius makes the species a malachite, with calcite and zinc bloom as impurities.

BLUE VITRIOL. Cyanose, *Beud.* Sulphate of Copper. Kupfervitriol.



Triclinic. P : M=109° 32′, P : T =127° 40′, M : T=123° 10′. Cleavage 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.

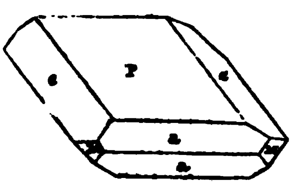
Composition.—$\dot{C}u\,\dddot{S}+5\dot{H}$=Sulphuric acid 31·72, oxyd of copper 32·14, water 36·14.

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 vitriol 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, and consume 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, affording each ton 16 cwt. of pure copper.

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.

BROCHANTITE. Brochantit, *Levy.* Konigine, *Levy.* Krisuvigite, *Forchhammer.*



Trimetric. M : M=114° 20′, P : *a* =148° 30′, *a* : *a* (over P)=117°, a : a (adjacent planes)=150° 30′, P : a=104° 45′. Surface M blackish and dull. Cleavage parallel to M. Also massive; reniform with a columnar structure.

H.=3·5—4. G.=3·7—3·9. Lustre vitreous. Color emerald-green, blackish-green. Streak paler green. Transparent.

Composition.—$\dot{\mathrm{Cu}}\,\overline{\mathrm{S}}+3\dot{\mathrm{Cu}}\,\dot{\mathrm{H}}[=\dot{\mathrm{Cu}}^4\,\overline{\mathrm{S}}\,\dot{\mathrm{H}}^3]$=Sulphuric acid 17·76, protoxyd of copper 70·28, water 11·96. Analyses: 1, 2, Magnus, (Pogg. xiv, 141); 3, Forchhammer, (J. f. pr. Ch. xxx, 396); 4, Berthier, (Ann. Ch. Phys. l, 360):

	$\overline{\mathrm{S}}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{Zn}}$	$\dot{\mathrm{Pb}}$	$\dot{\mathrm{H}}$
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 $\dot{\mathrm{Cu}}^4\,\overline{\mathrm{S}}\,\dot{\mathrm{H}}^4$.

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 at Retzbanya. The Krisuvigite occurs in small beds at Krisuvig in Iceland.

Brochantite was named by Levy in honor of 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.—$\dot{\mathrm{Cu}}^6\,\cancel{\mathrm{A}}\mathrm{l}\,\overline{\mathrm{S}}^3\,\dot{\mathrm{H}}^{12}$, Percy=Sulphuric acid 16·78, oxyd of copper 49·85, alumina 10·76, water 22·59. Analyses by J. Percy, (Phil. Mag. [3], xxxvi, 100):

$\overline{\mathrm{S}}$	$\cancel{\mathrm{A}}\mathrm{l}$	$\cancel{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{H}}$
15·38	11·70		48·16	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.

CONNELLITE. Sulphato-chlorid of Copper, *Connel,* Proc. Brit. Assoc. for 1847.

Rhombohedral. In hexagonal prisms with replaced angles. 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.

6. *Phosphates, Arsenates, Vanadate of Copper.*

List of Species.

THROMBOLITE,	$\dot{\mathrm{Cu}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}^2+6\dot{\mathrm{H}}$?
PHOSPHOROCHALCITE,	$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\frac{1}{2}\dot{\mathrm{H}}$.
" Kühn and Rhodius,	$\dot{\mathrm{Cu}}^6\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+3\dot{\mathrm{H}}$.
" Kühn (*Prasine*),	$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\dot{\mathrm{H}}$.
EHLITE, Breithaupt,	$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+3\dot{\mathrm{H}}$. $\dot{\mathrm{Cu}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\dot{\mathrm{H}}$.
TAGILITE, Hermann,	$\dot{\mathrm{Cu}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+3\dot{\mathrm{H}}$.
LIBETHENITE,	$\dot{\mathrm{Cu}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\dot{\mathrm{H}}$.
OLIVENITE, Isomorphous with Libethenite,	$\dot{\mathrm{Cu}}^4(\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}},\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}})+\dot{\mathrm{H}}$.
CONICHALCITE, " "	$(\dot{\mathrm{Cu}},\dot{\mathrm{Ca}})^4(\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}},\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}})+\dot{\mathrm{H}}$.
EUCHROITE,	$\dot{\mathrm{Cu}}^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+7\dot{\mathrm{H}}$.
TYROLITE,	$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+10\dot{\mathrm{H}}+\dot{\mathrm{Ca}}\ddot{\mathrm{C}}$(?).
ERINITE,	$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+2\dot{\mathrm{H}}$.
CORNWALLITE,	$\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+5\dot{\mathrm{H}}$.
APHANESITE,	$\dot{\mathrm{Cu}}^6\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+3\dot{\mathrm{H}}$.
COPPER MICA,	$\dot{\mathrm{Cu}}^8\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+12\dot{\mathrm{H}}$.
LIROCONITE,	$5\dot{\mathrm{Cu}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+\overset{\cdot\cdot\cdot}{\overline{\mathrm{Al}}}^5\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+75\dot{\mathrm{H}}$.
VOLBORTHITE,	$(\dot{\mathrm{Cu}},\dot{\mathrm{Ca}})^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{V}}+\dot{\mathrm{H}}$.

THROMBOLITE, *Breit.*

Amorphous.

H.=3—4. G.=3·38—3·40. Lustre vitreous. Color emerald, leek, or dark green. Opaque.

Composition.—$\dot{\mathrm{Cu}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}^2+6\dot{\mathrm{H}}$?=Phosphoric acid 45·22, oxyd of copper 37·68, water 17·10. Analysis (approximate) by Plattner, (J. f. pr. Ch. xv, 321):

Phosphoric acid 41·0, Oxyd of copper 39·2, Water 16·8=97·0.

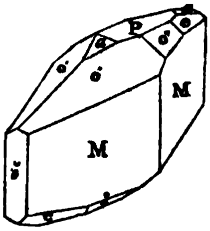
B.B. colors the flame blue and then green. On charcoal, fuses easily to a black globule, and finally yields a bead of copper. With boracic acid and iron, gives the reaction of phosphoric acid. In a matrass yields water.

From Retzbanya, Hungary.

PHOSPHOROCHALCITE, *Kobell.* Pseudomalachite. Hydrous Phosphate of Copper. Dihydrite, *Herm.* Kupferdiaspore, *Kühn.* Lunnite, *Bernhardi.*

Monoclinic. M : M=38° 56′, P : ĕ=90°, M : M=141° 4′, M : ĕ=109° 28′. Cleavage in indistinct traces parallel to ĕ or the orthodiagonal; also it is stated parallel to P. 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.—$\dot{C}u^5\,\overset{\cdot\cdot\cdot\cdot\cdot}{P}+2\tfrac{1}{2}\dot{H}$ (Nos. 3, 4, 6)=Phosphoric acid 24·44, oxyd of copper 67·86, water 7·70=100. $\dot{C}u^6\,\overset{\cdot\cdot\cdot\cdot\cdot}{P}+3\dot{H}$ (Kühn) (Nos. 7, 8, 10)=Phosphoric acid 21·22, oxyd of copper 70·75, water 8·03. Analyses: 1, Klaproth, (Beit. iii, 201); 2, Arfvedson,(Jahresb. iv, 143); 3, 4, 5, 6, Hermann, (J. f. pr. Chem. xxxvii,); 7, 8, 9, , Kühn, (Ann. d. Ch. u. Pharm. xxxiv, 218, and li, 124); 10, Rhodius, (Pogg. lxii, 369):

1. Rheinbreitenbach,		$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 30·95	$\dot{C}u$ 68·13=99·08, Klaproth.		
2. "		24·70	68·20	$\dot{H}$ 5·97=98·87, Arfvedson.	
3. Nischne Tagilsk,	G.=4·25,	23·75	68·75	7·50=100, Hermann.	
4. " "	G.=4·00,	23·47	67·73	8·80=100, Hermann.	
5. " *Dihydrite*,	G.=4·4,	25·30	68·21	6·49=100, Hermann.	
6. Rheinbreitenbach,	G.=4·4,	24·55	67·25	8·20=100, Hermann.	
7. "		21·52	68·74	8·64=98·90, Kühn.	
8. Hirschberg, Voigtland,		20·87	71·73	7·40=100, Kühn.	
9. " *Kupferdiaspore*,		24·13	69·61	6·26 (or loss)=100, Kühn.	
10. Libethen, Rheinbreitenbach,		20·4	70·8	8·4 =99·6, Rhodius.	

The compound $\dot{C}u^5\,\overset{\cdot\cdot\cdot\cdot\cdot}{P}+2\dot{H}$ of Kühn (Nos. 9, 5, 2), 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.

Phosphorochalcite 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.

Ehlite, *Breithaupt.*—This mineral is near phosphorocalcite 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.*—$\dot{C}u^5\,\overset{\cdot\cdot\cdot\cdot\cdot}{P}+3\dot{H}$ =Phosphoric acid 24·06, oxyd of copper 66·84, water 9·10. Rhodius's analyses gives $\dot{C}u^4\,\overset{\cdot\cdot\cdot\cdot\cdot}{P}+2\dot{H}$.

Analyses: 1, Bergemann; 2, Hermann, (J. f. pr. Chem. xxxvii); 3, Rhodius, (Ann. d. Chem. u. Pharm. lxii, 371):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$	$\dot{C}u$	$\dot{H}$
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.

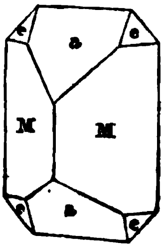
The title of the species to the rank of a distinct mineral is yet uncertain.

Tagilite, *Hermann.*—Occurs in reniform masses on brown iron ore. Structure fibrous and earthy. H.=3. G.=3·5. Color emerald green to mountain green. *Composition.*—$\dot{C}u^4\,\overset{\cdot\cdot\cdot\cdot\cdot}{P}+3\dot{H}$=Phosphoric acid 27·77, oxyd of copper 61·72, water 10·51=100. Analyses by Hermann, (J. f. pr. Chem. xxxvii),

$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 26·44	$\dot{C}u$ 61·29	$\dot{H}$ 10·77	$\overset{\cdot\cdot\cdot}{Fe}$ 1·50=100.
26·91	62·58	10·71	——=100.

From Nischne Tagilsk.

LIBETHENITE. Phosphate of Copper. Cuivre Phosphaté, *H.* Phosphatischer Olivenchalcit, *Br.*



Trimetric; isomorphous with olivenite. M : M =95° 2′; a : a (over the apex)=111° 58. Rose gives these angles 92° and 109° 30′. The angle a : a corresponds to M : M in Olivenite. Cleavage very indistinct.

H.=4. G.—3·6—3·8. Lustre resinous. Color olive-green, generally dark. Streak olive-green. Subtranslucent. Fracture subconchoidal—uneven. Brittle.

Composition.—$\dot{\text{C}}\text{u}^4\,\ddot{\bar{\text{P}}}+\dot{\text{H}}$=Phosphoric acid 29·86, oxyd of copper 66·37, water 3·77 =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.):

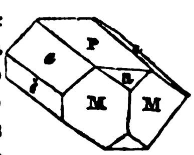
	$\ddot{\bar{\text{P}}}$	$\dot{\text{C}}\text{u}$	$\dot{\text{H}}$
1. Libethen, *cryst.*	28·7	63·9	7·4 =100, Berthier.
2. " "	29·44	66·94	4·05=100·43, Kühn.
3. " "	28·61	65·89	5·50=100, Hermann.
4. " *massive,*	22·8	64·8	9·0, $\ddot{\text{C}}$ 1·0, $\ddot{\bar{\text{F}}}\text{e}$ 1·6=99·2, Berthier.

The first analysis by Berthier is identical with Rhodius's analysis of Ehlite, on the preceding page=$\dot{\text{C}}\text{u}^4\,\ddot{\bar{\text{P}}}+2\dot{\text{H}}$.

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; also in small quantities near Gunnislake in Cornwall; and in the Ural.

OLIVENITE. Prismatic Arseniate of Copper, *Bournon.* Pharmakochalcit, *Haus.* Olivenerz, *W.*



Trimetric; $a : a$ (over P)=92° 30′; M : M=110° 50′; P : a=136° 15′, M : ē=124° 35′, a : a (over P)=84° 45′. Cleavage in traces parallel to M and a, the former a little the most distinct. 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. Substransparent—opaque. Fracture when observable, conchoidal—uneven. Brittle.

Composition.—$\text{Cu}^4(\ddot{\bar{\text{A}}}\text{s}, \ddot{\bar{\text{P}}})+\dot{\text{H}}$ (the arsenic to the phosphoric acid as 3 : 1)=Arsenic acid 31·78, phosphoric acid 6·57, oxyd of copper 58·34, water 3·31=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.):

	$\ddot{\bar{\text{A}}}\text{s}$	$\ddot{\bar{\text{P}}}$	$\dot{\text{C}}\text{u}$	$\dot{\text{H}}$
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	3·83, $\dot{\text{F}}\text{e}$ 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 arsenic fumes and a white 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. 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.

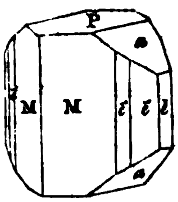
H.=4·5. G.=4·123. Color pistachio-green, inclining to emerald-green; streak the same. Subtranslucent. Fracture splintery.

Composition.—$(\dot{C}u, \dot{C}a)^4 (\overset{\cdot\cdot\cdot\cdot\cdot}{P}, \overset{\cdot\cdot\cdot\cdot\cdot}{As})+1\frac{1}{2}\dot{H}$, 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.):

$\overset{\cdot\cdot\cdot\cdot\cdot}{As}$ 30·68, $\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 8·81, $\dddot{V}$ 1·78, $\dot{C}u$ 31·76, $\dot{C}a$ 21·36, $\dot{H}$ 5·61.

From Cordova in Andalusia, Spain.

EUCHROITE, *Breithaupt.*



Trimetric; M : M=117° 20′; P : *a*=133° 56′, *ĕ* : *a*=136° 4′, M : *ĕ*=121° 20′. Cleavage lateral, distinct. Faces M vertically striated.

H.=3·75. G.=3·389. Lustre vitreous. Color bright emerald or leek-green. Streak pale apple-green. Transparent—translucent. Fracture small conchoidal—uneven. Rather brittle.

Composition.—$\dot{C}^4 \overset{\cdot\cdot\cdot\cdot\cdot}{As}+7\dot{H}$=Arsenic acid 34·21, oxyd of copper 47·09, water 18·70=100. Analyses: 1, Turner, (Edinb. Phil. Jour. iv, 301); 2, 3, Kühn, (Ann. d. Ch. u. Pharm. li, 128); 4, Wöhler, (ib. 285):

		$\overset{\cdot\cdot\cdot\cdot\cdot}{As}$	$\dot{C}u$	$\dot{H}$
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, $\dot{C}a$ 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*.

TYROLITE, *Haid.* Copper Froth. Cupriferous Calamine, *P.* Zinc Hydraté Cuprifère, *Levy.* Kupferschaum. Pharmacosiderite. Kupaphrite, *Shepard.*

Trimetric? Usually reniform, massive; structure radiate foliaceous, surface drusy.

H.=1·5—2. G.=3·098. Lustre pearly to vitreous. Color pale apple-green and verdigris-green, inclining to sky-blue. Streak a little paler than the color. Translucent—subtranslucent. Fracture not observable. Very sectile. Thin laminæ flexible.

Composition.—$\dot{C}u^5 \overset{\cdot\cdot\cdot\cdot\cdot}{As}+10\dot{H}+\dot{C}a\ddot{C}$(?)=Arsenic acid 25·37, oxyd of copper 43·67, water 19·82, carbonate of lime 11·14=100. The carbonate of lime may be an impurity. Analysis by Kobell, (Pogg. xviii, 253):

Falkenstein, Tyrol $\dddot{A}s$ 25·01 $\dot{C}u$ 43·88 $\dot{H}$ 17·46 $\dot{C}a\ddot{C}$ 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 Libethen in Hungary; Nertschinsk in Siberia; Falkenstein and Schwatz in the Tyrol; Saalfield in Thuringia; Riechelsdorf in Hessia; Schneeberg in the Erzebirge; and at Matlock in Derbyshire.

Rammelsberg suggests that this species may be related to Aurichalcite.

ERINITE, *Haid.*

In mammillated crystalline groups, consisting of concentric coats of a fibrous structure, and presenting rough surfaces, arising from the terminations of very minute crystals; the layers compact, and often easily separable.

H.=4·5—5. G.=4·043. Lustre almost dull, slightly resinous. Color a fine emerald-green, slightly inclining to grass-green. Streak green, paler than the color. Subtranslucent—nearly opaque. Brittle.

Composition.—$\dot{C}u^5\dddot{A}s+2\dot{H}$=Arsenic acid 34·75, oxyd of copper 59·82, water 5·43=100. Analysis, (approximative), by Turner, (Ann. Phil. [2], 1828, iv, 154):

$\dddot{A}s$ 33·78, $\dot{C}u$ 59·44, $\dot{H}$ 5·01, $\dddot{\bar{A}}l$ 1·77=100.

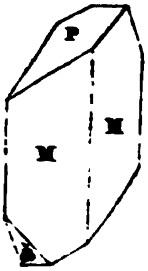
Erinite occurs associated with other arsenates of copper, in the county of Limerick, Ireland. It was first described by Haidinger, and named from *Erin*, in allusion to its occurring in Ireland.

CORNWALLITE.—Zippe thus names an arsenate of copper from Cornwall, which afforded Lerch, (Ramm. 4th Supp. 122):

$\dddot{A}s$	$\dddot{P}$	$\dot{C}u$	$\dot{H}$
29·78	2·54	55·00	12·68=100,
30·65	1·77	54·22	13·36=100,

leading to the formula $\dot{C}u^5\dddot{A}s+5\dot{H}$. Specific gravity 4·166. It is associated with olivenite.

APHANESITE, *Beud.* Abichite, *Haid.* Klinoclas, *Breit.* Strahlerz, *Hof.* Strahlenkupfer. Siderochalcit, *Br.* Cuivre Arseniaté Ferrifère, *H.*



Monoclinic. M : M=56°, P : M=85°; M : M=124°, P : ă=99° 30′. Cleavage basal, highly perfect. Also massive, hemispherical; structure radiated fibrous.

H.=2·5—3. G.=4·19—4·36. Lustre of face P pearly. Color dark verdigris-green, inclining to blue; also dark blue. Streak verdigris-green. Subtranslucent. Not very brittle.

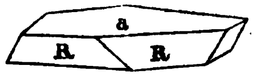
Composition.—$\dot{C}u^6\dddot{A}s+3\dot{H}=\dot{C}u^3\dddot{A}s+3\dot{C}u\dot{H}$=Arsenic acid 30·30, oxyd of copper 62·59, water 7·11=100. Analyses: 1, Rammelsberg, (2d Supp. 78); 2, Damour, (Ann. Ch. Phys. [3], xiii):

		$\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{P}}}$	$\dot{\mathrm{C}}\mathrm{u}$	$\dot{\mathrm{H}}$	
1. Cornwall,	G.=4·258—4·359,	29·71	0·64	60·00	7·64,	$\overset{\cdot\cdot\cdot}{\overline{\mathrm{Fe}}}$ 0·39, $\dot{\mathrm{C}}\mathrm{a}$ 0·50, $\overset{\cdot\cdot\cdot}{\mathrm{Si}}$ 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.

COPPER MICA. Chalcophyllite. Kupferglimmer, *W.* and *L.* Kupferphyllit, *Br.*



Rhombohedral. R : R=68° 45′; R : a=108° 40′. Cleavage highly perfect parallel to the plane a, which is sometimes striated in triangular directions. Also foliated massive, and in druses.

H.=2. G.=2·4—2·66. Lustre of a, pearly; of other faces, vitreous. Color emerald or grass-green. Streak somewhat paler than the color. Fracture scarcely observable. Sectile.

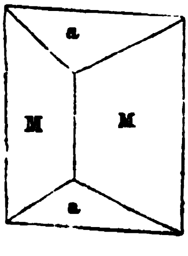
Composition.—From Chenevix's analysis, $\dot{\mathrm{C}}\mathrm{u}^8\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}+12\dot{\mathrm{H}}$=Arsenic acid 21·31, oxyd of copper 58·71, water 19·98.—From Hermann's analysis, $\dot{\mathrm{C}}\mathrm{u}^8\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}+23\dot{\mathrm{H}}$=Arsenic acid 18·02, oxyd of copper 49·61, water 32·37.—From Damour's analyses, $\dot{\mathrm{C}}\mathrm{u}^6\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}+12\dot{\mathrm{H}}$. Analyses: 1, Chenevix, (Phil. Trans. 1801); 2, Hermann, (J. f. pr. Ch. xxxiii, 294); 3, 4, Damour, (Ann. Ch. Phys. [3], xiii, 404):

		$\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}$	$\dot{\mathrm{C}}\mathrm{u}$	$\dot{\mathrm{H}}$
1. Cornwall,		21·	58·	21=100, Chenevix.
2. "	G.=2·435,	17·51	44·45	31·19, $\dot{\mathrm{F}}\mathrm{e}$ 2·92, $\overset{\cdot\cdot\cdot}{\overline{\mathrm{Al}}}$ and $\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{P}}}$ 3·93=100, H.
3. "	G.=2·659,	19·35	52·92	23·94, $\overset{\cdot\cdot\cdot}{\overline{\mathrm{Al}}}$ 1·80, $\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{P}}}$ 1·29=99·30, Dam.
4. "	"	21·27	52·30	22·58, $\overset{\cdot\cdot\cdot}{\overline{\mathrm{Al}}}$ 2·18, $\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{P}}}$ 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, Wheal Gorland, and Wheal Unity, near Redruth, are its principal localities in Cornwall. It is stated to have been observed in minute crystals at Herrengrund in Hungary, and Moldawa in the Bannat.

LIROCONITE. Octahedral Arseniate of Copper. Linsenerz, *Wern.* Linsenkupfer, *Haus.* Cuivre Arseniaté Octaèdre Obtus, *H.* Chalcophacite, *Glocker.*



Trimetric. M : M=119° 45′; a : a=71° 59′. 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.

Composition.—25 $\dot{\mathrm{Cu}}$, 5 $\dddot{\overline{\mathrm{Al}}}$, 6 ($\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}\tfrac{5}{6}+\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{P}}}\tfrac{1}{6}$), 75 $\dot{\mathrm{H}}$; [$=5\ \dot{\mathrm{Cu}}^{5}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}+\dddot{\overline{\mathrm{Al}}}^{3}\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{P}}}+75\ \dot{\mathrm{H}}$]. 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):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{P}}}$	$\dot{\mathrm{Cu}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{H}}$	
1. Cornwall,	20·79	3·61	35·19	8·03	22·24,	$\dddot{\overline{\mathrm{Fe}}}$ 3·41, $\dddot{\mathrm{Si}}$ 4·04, gangue 2·95=100·26,
2. "	23·05	3·73	36·38	10·85	25·01,	0·98=100, Hermann. [Wacht.
3. "	22·22	3·49	37·18	9·68	25·49=98·06, Damour.	
4. "	22·40	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 $\dddot{\overline{\mathrm{Al}}}$, 6 $\overset{\cdot\cdot\cdot\cdot\cdot}{\overline{\mathrm{As}}}$, 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 affords a green globule, and undergoes a partial reduction. Dissolves in nitric acid without effervescence.

Crystals of this mineral have occasionally been observed an inch in diameter; usually they are quite small. It occurs, associated with various ores of copper, pyrites, and quartz, at Wheal Gorland and Wheal Unity, in Cornwall; also in minute crystals at Herrengrund in Hungary, and in Voigtland.

VOLBORTHITE, *Hess*, Bulletin of the Imp. Acad. Sci. of St. Petersburg, iv, No. 2.

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 ($\dot{\mathrm{Cu}}$, $\dot{\mathrm{Ca}}$)^{4} $\dddot{\mathrm{V}}+\dot{\mathrm{H}}$; and when $\dot{\mathrm{Cu}}$ to $\dot{\mathrm{Ca}}$=5 : 2 (analysis 1)=Vanadic acid 37·39, oxyd of copper 45·81, lime 13·16, water 3·64=100; when 3 : 2 (analyses 2, 3)=Vanadic acid 38·18, oxyd of copper 39·29, lime 18·32=100. Analyses of specimens from Friedericksrode, by Credner, (Pogg. lxxiv, 546):

	$\dddot{\mathrm{V}}$	$\dot{\mathrm{Cu}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{H}}$	
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 was 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 is supposed to have come from the mines between Miask and Katherinenberg. Also found at Friedericksrode in Thuringia.

A vanadate of copper (=$\dot{\mathrm{Cu}}\dddot{\mathrm{V}}$) 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.—$\dot{P}b^6\,\ddot{V}+\dot{C}u^6\,\ddot{V}$. Analyses by Domeyko, (loc. cit.):

	$\ddot{V}$	$\bar{\dot{A}}s$	$\bar{\dot{P}}$	$\dot{C}u$	$\dot{P}b$	PbCl	$\dot{C}a$	$\bar{F}e$, $\bar{A}l$	$\bar{S}i$	$\dot{H}$
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 detected by J. E. Teschemacher (as communicated by him to the author) among specimens from the Cliff Mine, in the Lake Superior Copper Region. With both blowpipe and acid tests the presence of vanadium was ascertained by him. A. A. Hayes has confirmed these results and formed from the mineral the vanadates of lead and silver by double decomposition. The color of the mineral is a dark chocolate, and also a bright yellow. The exact state of composition of the vanadic acid is still 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.

BEAUMONTITE. Native crenated hydrosilicate of copper, *Jackson*, Am. Jour. Sci. xxxvii, 398.

Amorphous, looking like clay. Soft. Color bright blue, becomes green on exposure.

Composition.—According to Jackson, Silica 21·0, oxyd of copper 46·8, crenic acid 15·8, water 10·0, alumina and oxyd of iron 4·4, carbonic acid 2·0=100. Appears to be a mechanical mixture of silicate and crenate of copper, with some alumina and iron.

This species was detected by Dr. C. T. Jackson among some copper ores from the Chessy copper mines in France, and named in honor of Prof. L. Elie de Beaumont.

QUICKSILVER.

Mercury exists in the native state, but occurs mostly as a sulphuret, (cinnabar). It is also found combined with chlorine, iodine, silver, and gold, but very sparingly. It has been observed in some gray copper ore, (see page 514), replacing apparently the copper or silver.

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.

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and to dull in friable varieties. Color cochineal-red, the darker varieties inclining to brownish-red and lead-gray. Streak scarlet-red. Subtransparent—subtranslucent—opaque. Fracture subconchoidal, uneven. Sectile.

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):

	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, $\overline{\text{F}}$e 0·2, $\overline{\text{A}}$l 0·55, Cu 0·02, $\overline{\text{S}}$i 0·65, C 2·3=99·27, Klaproth.
4. Japan,	17·5	78·4, " 1·7, " 0·7, $\dot{\text{C}}$a 1·3, $\overline{\text{M}}$n 0·2, Cu 0·2=100, John.
5. Westphalia,	13·67	86·79=100·46, Schnabel.
6. Wetzlar,	13·78	84·55, gangue 1·02=99·35, Schnabel.

B.B. in a matrass wholly sublimes; and with soda yields mercury, sulphurous fumes escaping.

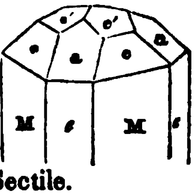
The *hepatic cinnabar* or *liver ore* is an impure variety; it sometimes affords a brownish streak in consequence of its impurities, and is occasionally slaty, though commonly granular or impalpable in structure.

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 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 great source of the mercury of commerce, from which it is obtained by sublimation. When pure it is identical with the manufactured vermillion of commerce, which is a valuable pigment. It was highly esteemed for its brilliancy of color by the ancients, and was employed as a paint for various sacred purposes.

NATIVE CALOMEL. Horn Quicksilver. Muriate of Mercury. Dichlorid of Mercury, *Thom.* Chlorquecksilber. Quecksilberhornerz. Mercure Chloruré, *Duf.*



Dimetric. M : *e*=135°, M : e=158°, M : e′=129° 32′, *e* : a=120° 5′. Cleavage lateral, indistinct. Also in crystalline coats, and granular.

H.=1—2. G.=6·482, Haid. Lustre adaman-ine. Color yellowish-gray, or ash-gray, also gray-h and yellowish-white. Streak white. Trans-icent—subtranslucent. Fracture conchoidal. Sectile.

Composition.—Hg^2 Cl=Chlorine 14·88, mercury 85·12.

When pure it is entirely volatilized before the blowpipe, on charcoal. It is insoluble water.

he principal locality is Moschellandsberg in Deuxponts, where it occurs coating the ities of a ferruginous gangue, associated with cinnabar. The crystals are often large well defined. It has also been observed at the quicksilver mines of Idria in Car-a, at Almaden in Spain, and Horzowitz in Bohemia.

COCCINITE, *Haid.* Iodic Mercury, *Del Rio.* Mercure iodurè, *Duf.* Iodquecksilber, *H.*

In particles of a reddish-brown color on selenid of mercury, in Mexico at Casas Viejas.

Composition.—Probably HgI=Mercury 44·3, iodine 55·7.

ONOFRITE, *Haid.* Selenid of Mercury. Merkurglanz, *Br.* Selenschwefelquecksilber.

Massive ; texture compact granular ; no cleavage.

H.=2·5. Lustre metallic. Streak shining. Color steel to blackish lead-gray.

Composition.—$HgSe+4HgS$, or $Hg(S, Se)$. Analysis by H. Rose, (Pogg. xlvi, 315),

Selenium 6·49, Sulphur 10·30, Mercury 81·33=98·12.

Or, Selenid of mercury 23·10, and sulphuret of mercury 75·11=98·21.

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. It has nearly the color and lustre of Fahlerz.

AMMIOLITE, *D.* Antimonite of Quicksilver, *Domeyko*, Annales des Mines, 4th ser. vi, 183. Quecksilberoxyd Antimonigsaures.

A red powder, consisting, according to Domeyko, of

$\overset{::}{\text{Sb}}$ 12·5, $\dot{\text{Hg}}$ 14·0, $\overset{\cdots}{\text{Fe}}$ 22·3, $\dddot{\text{Si}}$ 26·5, $\dot{\text{H}}$ 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. The name Ammiolite is derived from αμμιον, a Greek name for vermilion.

XIII. SILVER.

Silver is common native, and also in combination with sulphur, antimony, or chlorine. It occurs, besides, combined with iodine, bromine, selenium, tellurium, bismuth, and mercury.

There is one native salt, the carbonate. A small percentage of silver is often found in galena, and some ores of copper.

1. *Native.*

SILVER. Gediegen Silver, *W.* Argent Natif, *H.*

Monometric. Figs. 2, 3, 4, 16, and others intermediate, plate 1. Cleavage none. Compound crystals: fig. 129, plate 2. 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 54; 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.

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 principally in arborescences and filiform shapes, in veins of calcareous spar or quartz, traversing gneiss, slate, and other ancient rocks. The structure of these forms is sometimes quite peculiar; they being composed of one or more series of octahedrons, either closely united or arranged perpendicularly 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. A mine on the estate of Alva, in Stirlingshire, about the middle of last century, afforded £40,000 or £50,000 of silver; but it was long since abandoned.

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. Of the 8,000,000 sterling, which it is calculated is the value of silver annually afforded by the mines of the world, about two-thirds are obtained from Mexico.

In the United States it is disseminated through much of the copper of Michigan, and is found in considerable abundance. 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.

The uses of silver, as a material for coins, also in the manufacture of plate and various articles of luxury, are well known. For coinage it is alloyed with copper, by which it is rendered harder, and consequently more durable; in the United States, 1000 parts of alloy contain 100 of copper. It is less malleable than gold, and cannot be beaten into unbroken leaves thinner than the one hundred and sixty thousandth part of an inch, which is more than one-third thicker than gold leaf.

2. *Sulphurets, Arseniurets, Seleniurets, Tellurets.*

List of Species.

SILVER GLANCE,	$Ag\,S.$
HESSITE,	$Ag\,Te.$
NAUMANNITE,	$Ag\,Se.$
EUCAIRITE,	$(\text{Ɵu}, Ag)\,Se.$
STROMEYERITE,	$(\text{Ɵu}, Ag)\,S.$
ANTIMONIAL SILVER,	$Ag^4\,Sb$, and $Ag^6\,Sb.$
FLEXIBLE SILVER ORE.	
STERNBERGITE,	$Ag\,S+2\,Fe^2\,S^3.$
MIARGYRITE,	$Ag\,S+Sb\,S^3.$
PYRARGYRITE,	$3Ag\,S+Sb\,S^3.$

PROUSTITE,	$3\mathrm{Ag\,S}+\mathrm{As\,S^3}$.
FRIESLEBENITE,	$(\mathrm{Pb\,S}+\mathrm{Sb\,S^3})+2(3\mathrm{Pb},\mathrm{Ag})\mathrm{S}+\mathrm{Sb\,S^3})$?
POLYBASITE,	$9(\mathrm{Ag},\mathrm{Cu})\,\mathrm{S}+(\mathrm{Sb},\mathrm{As})\,\mathrm{S^3}$.
STEPHANITE,	$6\mathrm{Ag\,S}+\mathrm{Sb\,S^3}$.
XANTHOKON,	$(3\mathrm{Ag\,S}+\mathrm{As\,S^5})+2(3\mathrm{Ag\,S}+\mathrm{As\,S^3})$.
BISMUTH SILVER.	

SILVER GLANCE. Vitreous Silver. Sulphuret of Silver. Glaserz, *Haus.* Silberglanz, *L.* Argent Sulfuré, *H.* Argentite, *Haid.*

Monometric. Figs. 1—9, inclusive, plate 1, also 14, 15, 16. 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.—Ag S=Sulphur 12·96, silver 87·04=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.

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.

HESSITE, *Fröbel.* Telluric Silver. Petzite, *Haid.* Bitelluret of Silver, *Thomson.* Tellursilber *of the Germans.*

Monometric. Cubic, according to G. Rose. In coarse-grained masses, and granular.

H.=2—2·5. G.=8·3—8·9. Lustre metallic. Color between lead-gray and steel-gray. Slightly malleable.

Composition.—Ag Te=Tellurium 37·23, silver 62·77. 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 it 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 new mine of Savodinski, about forty wersts from the rich silver mine of Siränowski, on the river Buchthorma in Siberia, where it is found in a talcose rock, containing small quantities of iron pyrites, black blende, and copper pyrites. Specimens in the museum of Barnaul, on the Ob, where this mineral was first observed, are a cubic foot in size. It was first described and analyzed by G. Rose.

NAUMANNITE, *Haid.* Selensilber, *Rose.* Silberphyllinglanz, *Breit.*

Monometric. 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 27, silver 73. 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 *Silberphyllinglans* of Breithaupt, 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. Massive, with one perfect cleavage. From Deutsch Pilsen, in gneiss.

EUCAIRITE. Seleniuret of Silver and Copper, *P.* Argentiferous Seleniet of Copper. Selenkupfersilber. Cuivre Sélenié Argental, *H.*

Massive; in black metallic films, staining the calcareous spar in which it is contained.

Soft; easily cut by the knife. Lustre metallic. Streak shining. Color between silver-white and lead-gray.

Composition.—$\text{Ȼu Se}+\text{Ag Se}=(\text{Ȼu, Ag})\ \text{Se}$=Selenium 31·58, copper 25·26, silver 43·16. 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 serpentine 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.

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. Also massive, compact.

H.=2·5—3. G.=6·2—6·3. Lustre metallic. Color dark steel-gray. Streak shining. Fracture subconchoidal. Sectile.

Composition.—(Ɛu, Ag) S, or Ɛu S+Ag S. 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.

The formula given is deduced from the first two analyses. Those by Domeyko are not entirely satisfactory, yet seem to prove the identity of this species in general constitution with copper glance.

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, depositing 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.

This species is of rare occurrence. It is found associated with copper pyrites at Schlangenberg, near Kolyvan, in Siberia, and 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.

ANTIMONIAL SILVER. Antimoniet of Silver, Spiesglas-Silber, *W.* Silber-Spiessglanz, *Haus.* Antimon-silber, *L.* Argent Antimonial, *H.*

Trimetric. M : M nearly 120°; a : a=132° 42′, 92°, 106° 40′. Cleavage, basal distinct. Compound crystals in stellate forms and hexagonal prisms like those of Arragonite and Cerusite. 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.—$\mathrm{Ag^4\,Sb}$=Antimony 23, silver 77=100. Also $\mathrm{Ag^6\,Sb}$=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. 1793, 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 Furstenberg, Wittichen in Swabia, 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 found in sufficient quantity, this would be a valuable ore of silver; but it is yet a rare mineral.

ARSENIC SILVER, (Arseniksilber).—A tin-white mineral, with a black streak, and G.=7—8. It consists of arsenic, iron, antimony, and silver, and is shown to be a mixture of mispickel, arsenical iron, and antimonial silver, (Pogg. lxxvii, 262). From Andreasberg in the Harz.

FLEXIBLE SILVER ORE. Ferro-Sulphuret of Silver. Argent Sulfurè Flexible, *Bour*.

Monoclinic. Occurs in small tabular crystals, whose primary form, according to Bournon, is a right rhomboidal prism; M : T (fig. 90, pl. 2)=125°, *e* : *e*=96° 78′, *e*′ : *e*′=137°. Cleavage highly perfect in one direction, Also massive.

Very soft, yields readily to the knife. Lustre metallic. Color externally nearly black. Streak shining. Opaque. Flexible in thin laminæ.

Consists, according to Wollaston, of silver, sulphur, and a little iron.

This rare species has been found in small quantities at Himmelsfürst, near Freiberg.

STERNBERGITE, *Haidinger*, Edinb. Phil. Trans. xi, 1, and Brewster's Journal, vii, 242.

Trimetric; M : M=119° 30, M : ĕ=120° 15′, e : e=118°. Cleavage basal, highly eminent. Commonly in implanted crystals, forming rose-like aggregations. The crystals are sometimes compound.

H.=1—1·5. G.=4·215. Lustre of P highly metallic. Color pinchbeck-brown, with occasionally a violet-blue tarnish on e. Streak black. Opaque. Thin laminæ flexible; may be smoothed down by the nail when bent, and in this respect resembles tin-foil. Very sectile. Leaves traces on paper like plumbago, which may be removed by caoutchouc.

Composition.—$\mathrm{Ag\,S}+2\,\mathrm{Fe}^2\mathrm{S}^3$=Sulphur 34·21, silver 32·83, iron 32·96. 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, and is covered with metallic silver. This globule acts on the magnetic needle, and exhibits the properties of sulphuret of iron. With borax, a globule of silver may be obtained.

Occurs with ores of silver, particularly the red and brittle silver ores, at Joachimstahl in Bohemia, and Johanngeorgenstadt in Saxony. It was first noticed by Haidinger in a specimen in the public college at Prague, of which Count Caspar Sternberg was the patron and supporter, and named by him in honor of this nobleman.

MIARGYRITE.

Monoclinic; M : M=86° 4′, P : M=101° 6′; e : e=128° 59′. Lateral planes deeply striated. Cleavage lateral, imperfect.

H.=2—2·5. G.=5·234. Lustre submetallic-adamantine. Color iron-black. Streak dark cherry-red. Opaque, except in thin splinters, which, by transmitted light, present a deep blood-red color. Fracture subconchoidal. Very sectile.

Composition.—$\mathrm{Ag\,S}+\mathrm{Sb\,S}^3$=Sulphur 21·35, antimony 42·79, silver 35·86. 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.

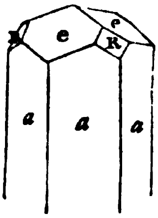
This rare species has been observed only in a mine at Braünsdorf, near Freiberg in Saxony, associated with argentiferous arsenical pyrites. It was first distinguished from red silver ore by Mohs. Its name is derived from *μειων*, *less*, *αργυρος*, *silver*, and was given it because it contained less silver than some kindred ores.

The *Hypargyrite* of Breithaupt contains, according to Plattner, 85 per cent. silver, and is probably a variety of the above.

PYRARGYRITE. Dark red Silver Ore. Ruby Silver, *P.* Black Silver. *Æroxite*, Rothgültigerz, *W.* Dunkles Rothgültigerz, *G.* Argent Antimonié Sulfuré, *H.* Antimonsilberblende. Pyrargyrit, *Glocker.* Argentum rubrum, *Linn.*

Rhombohedral. R : R=108° 18′, Mohs. R : e=144° 9′, e : e =137° 39′; the crystals are often differently modified at their two extremities. Cleavage rhombohedral, sometimes pretty distinct. Compound crystals, composition parallel to e; this composition taking place parallel with each plane e at one extremity of the crystal, gives rise to the form represented in figure 3, which is composed of four individuals; also parallel with *e*; also to the face *a*. Also massive, structure granular, sometimes impalpable.

1



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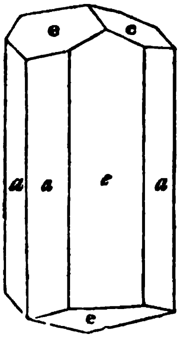

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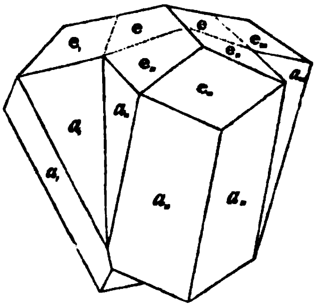


H.=2—2·5. G.=5·7—5·9. Lustre metallic-adamantine. Color black, sometimes approaching cochineal-red. Streak cochineal-red. Translucent—opaque. Fracture conchoidal. Sectile, yielding readily to the knife.

Composition.—$3\,AgS+SbS^3$=Sulphur 17·56, antimony 23·46, silver 58·98. 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. In Saxony, Hungary, Norway, and at Gaudalcanal in Spain, are other localities. 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 a miargyite.

PROUSTITE. Light red Silver Ore. Lichter Rothgültigerz. Arseniksilberblende.

Rhombohedral. R : R=107° 48′. Forms similar to figures 116 and 119, pl. 2. Compound crystals 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 inclining to aurora-red. Subtransparent—subtranslucent. Fracture conchoidal—uneven.

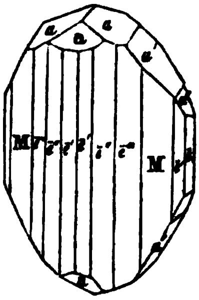
Composition.—$3\,Ag\,S+As\,S^3$=Sulphur 19·46, arsenic 15·16, silver 65·38. Analysis by H. Rose, (Pogg. xv, 472),

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. A group of crystals from the last mentioned place several inches long and weighing upwards of six pounds, is now in the national museum at Prague.

FREISLEBENITE, *Haid.* Antimonial Sulphuret of Silver. Sulphuret of Silver and Antimony, *P.* Schilfglaserz, *Freisleben.* Silber-und-Antimon. Argent Sulfuré Antimonifère et Cuprifère, *Levy.*



Trimetric. M : M=100° 8′, *a* : *a*=130° 8′, *a″* : *a″*=122° 15′, *ĕ* : *a″*=118° 63′, M : *ĕ′*=146° 30′, M : *ĕ″*=160° 30′, M : *ĕ‴*=170° 10′. M, longitudinally striated. Cleavage perfect, parallel with M.

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.

Composition.—$(Pb\,S+Sb\,S^3)+2[3(Pb,\,Ag)S+Sb\,S^3]$, or

$(Pb\,S+Sb\,S^3)+[(3Pb\,S+Sb\,S^3)+(3Ag\,S+Sb\,S^3)]=7(Pb,\,Ag)S+3\,Sb\,S^3$, Wöhler.

$9(Pb,\,Ag)S+4\,Sb\,S^3$, is even nearer the analysis, and this may correspond to

$$3(Pb,\,Ag)S+Sb\,S^3,$$

together with ⅓ $Sb\,S^3$ (or gray antimony) as impurity; and this view of the composition is favored by its similarity in crystallization to bournonite, which species has essentially the formula just deduced. Analyses by Wöhler, (Pogg. xlvi, 146),

1.	S 18·77	Sb 27·72	Pb 30·00	Ag 22·18,	Fe 0·11,	Cu 1·22=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 vitreous silver, 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 in Michigan.

POLYBASITE, *H. Rose*. Eugenglanz.

Rhombohedral. R : R=84° 48′. Usually in short tabular hexagonal prisms; terminal planes striated parallel to the alternate terminal edges. Cleavage not observable. Also massive and disseminated.

H.=2—3. G.=6·214. Lustre metallic. Color iron-black. Streak iron-black. Opaque. Fracture uneven.

Composition.—$9(\mathrm{Ag}, \bar{\mathrm{C}}\mathrm{u})\mathrm{S}+(\mathrm{Sb}, \mathrm{As})\mathrm{S}^3$? Analyses by H. Rose, (Pogg. xv, 573),

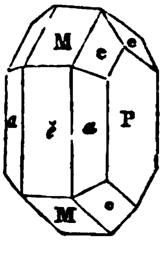
	S	Sb	As	Ag	Cu	Fe	Zn	
1. Durango, Mexico,	17·04	5·09	3·74	64·29	9·93	0·06	——	=100·15.
2. Schemnitz,	16·83	0·25	6·23	72·43	3·04	0·33	0·59	=99·70.
3. Freiberg,	16·35	8·39	1·17	69·99	4·11	0·29	——	=100·30.

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.

It occurs in the mine of Guanaxuato and Gaudalupe y Calvo in Mexico; also at Guasamez in Durango, with copper pyrites and calcareous spar.

The name Polybasite is derived from πολυς, *much*, and βασις, *base*, in allusion to the large amount of the base sulphuret of silver, as compared with the acids, the sulphurets of arsenic and antimony.

STEPHANITE, *Haid.* Brittle Silver Ore. Brittle Silver Glance. Black Silver. Brittle Sulphuret of Silver. Sprödglaserz, *W.* Sprödglanzerz, *Haus.* Argent Noir, Argent Antimonié Sulphuré Noir, *H.* Argent Sulphuré Fragile.



Trimetric. M : M=115° 39′, M : e=142° 10′, e : e=130° 16′, and 104° 19′, *a* : *a* (over ĕ)=107° 29′, P : *a*=126° 6½′. Cleavage imperfect and interrupted, parallel to M and ĕ. Compound crystals: composition producing forms similar to those of Cerusite and Arragonite; very 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.—$6\mathrm{Ag\,S}+\mathrm{Sb\,S}^3$=Sulphur 15·6, antimony 14·0, silver 70·4. Analyses: 1, Klaproth, (Beit. i, 162); 2, Brandes, (Schw. J. xxii, 344); 3, H. Rose, (Pogg. xv, 474):

	S	Sb	Ag	Fe	Cu	As	
1. Freiberg,	12·0	10·0	66·5	5·0	0·5,		gangue 1·5=95·0, Klaproth.
2. "	19·40	——	65·50	5·46	3·75	3·30	" 1·00=98·41, Brandes.
3. Schemnitz,	16·42	14·68	68·54	——	0·64	——	=100·28, Rose.

In an open tube gives a sublimate of arsenic acid, or of oxyd of antimony. B.B. it 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; also massive and pulverulent at Wheal Duchy and Herland in Cornwall.

The *schwarzgültigerz* of Werner, includes the compact varieties of this species, and his *weiss-gültigerz* is merely a mechanical mixture of brittle silver, galena, and gray antimony.

It is a valuable ore of silver.

XANTHOKON, *Breithaupt*, J. f. prakt. Chem. xx, 67, and Pogg. lxiv, 272.

Rhombohedral. R : a=110° 30′. 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.

Composition.—$(3AgS+AsS^5)+2(3AgS+AsS^3)$. 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, in the neighborhood of Freiberg. It was named by Breithaupt, in allusion to its yellow powder, from ξανθος, *yellow*, and κονις, *powder*.

The *Fireblende* (*Feuerblende*) of Breithaupt is referred by Rammelsberg to Xanthokon. It occurs in delicate crystals grouped like stilbite, and with one perfect cleavage. H.=2. G.=4·2—4·3. Lustre pearly adamantine. Color hyacinth-red. Translucent. Contains 62·3 per cent. of silver, according to Plattner, along with sulphur and antimony. From the Kurprinz mine near Freiberg, and from Andreasberg.

BISMUTH SILVER. Bismuthic Silver Ore. Wismuthsilbererz. Wismuthbleierz, *Haus.* 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 Schnapbach, in Baden; also in the cupreous shale of Mansfeld, Thuringia. It was formerly worked as an ore of silver.

A *bismuth silver* from 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 was from the mine of San Antonio. A farther examination is required.

3. *Chlorids, Iodids, Bromids.*

HORN SILVER. Kerate, *Haid.* Muriate of Silver. Chlorid of Silver. Hornerz, *Wern.* Silberhornerz. Hornsilber, *Haus.* Buttermilcherz. Argent Muriaté, *H.*

Monometric. Figures 2, 3, 4, 5, 6, 7, pl. 1. Cleavage none. Usually massive and looking like wax; rarely columnar, or bent columnar; often in crusts.

H.=1—1·5. G.=5·552; 5·31—5·43, Domeyko; 4·702, Dufrénoy. Lustre resinous, passing into adamantine. Color pearl-gray, passing into violet-blue; also into greenish-white and green. Streak shining. Becomes brown on exposure. Translucent—feebly subtranslucent. Fracture more or less perfectly conchoidal. Sectile.

Composition.—$AgCl$=Chlorine 24·67, silver 75·33. This constitution corresponds with Klaproth's analyses, (Beit. i, 132, and iv, 10).

Fuses in the flame of a candle, with an emission of fumes of muriatic acid. On charcoal it is easily reduced; and if rubbed with a plate of moistened zinc or iron, the surface of zinc or 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 and Mexico, where it occurs with native silver. In Chili it is the most abundant ore of silver. At Chanaveillo veins one to two inches thick are not uncommon, consisting of stalactitic forms and concretions. The veins often contain a nucleus of native silver. It was formerly obtained in the Saxon mining districts of Johanngeorgenstadt and Freiberg, but is now rare. A mass, weighing six and three-quarter pounds, from this locality, is now in the Zwinger collection, at Dresden. It also occurs in Siberia; at Kongsberg in Norway; 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, when found in large quantities, is valuable as an ore of silver.

IODIC SILVER. Iodite, *Haid.* Argent ioduré, *Duf.* Iodsilber, *M.*

In thin plates with a lamellar structure.

Soft. G.=5·504. Lustre resinous. Streak semi-metallic. Color pale citron-yellow to yellowish-green. Translucent. Plates flexible.

Composition.—Domeyko obtained, (Ann. d. Mines, [4], vi, 160, 1844), Iodine 46·89, and silver 64·25; while Vauquelin, (Ann. Ch. Phys. xxix, 99), found only 18·5 per cent. of iodine. AgI would require 22 per cent. of iodine; and AgI^3 53·9 per cent. of iodine.

B.B. on charcoal, fuses immediately, producing a vapor which tinges the flame of a fine violet color, and affording a globule of silver.

Iodic silver occurs in thin veins in steatite, at Abarradon, near Mazapil, in Zacatecas, Mexico. It was first recognized by Vauquelin. It has also been found at Guadalajara in Spain.

BROMIC SILVER. Bromite, *Haid.* Bromsilber. Bromure d'Argent, *Berth.*, Ann. d. Mines, 4th ser. ii, 526, 1842. Plata Verde *of the Mexicans.*

Monometric. Occurs in small concretions, and rarely in crystals. H.=1—2. G.=5·8—6. Lustre splendent. Generally green without, and bright yellow within.

Composition.—Ag Br=Bromine 42, silver 58. 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, at the mine of San Onofre, seventeen leagues from Zacatecas, associated with chlorid of silver and carbonate of lead; also at Chanaveillo, Chili, with chlorid of silver; also at Huelgoet in Brittany, with horn silver.

EMBOLITE, *Breithaupt*, Pogg. Ann. lxxvii, 184.

Monometric; in octahedrons with truncated angles. Cleavage cubic in traces. Also massive.

H.=2. G.=5·79—5·81. Internal color sulphur-yellow when fresh; sometimes siskin-green; externally olive-green and asparagus-green. Lustre adamantine. Fracture hackly.

Composition.—2 Ag Br+3 Ag Cl=Ag (Cl, Br)=Silver 66·96, bromine 19·84, chlorine 13·20. Analysis by Plattner, (loc. cit.):

Silver 66·862, Bromine 20·088, Chlorine 13·050.

From the Mine Colorada at Copiapo, Chili, with native silver. The crystals are implanted in crystallized calc spar.

4. *Carbonate.*

SELBITE, *Haid.* Carbonate of Silver. Silberoxyd kohlensäures. Grausilber, *Haus.* Plata Azul.

Massive, and incrusting, or earthy. Very soft. Lustre weak or earthy. Color ash-gray to black.

Composition.—$\dot{A}g\ddot{C}$=Oxyd of silver 84, carbonic acid 16=100. Analysis by Selb, (Aikin's Dictionary, ii, 295):

Carbonic acid 12·0, Oxyd of silver 72·5, Oxyd of antimony 15·5=100,

which gives, separating the antimony, carbonic acid 14·2, oxyd of silver 85·8.

Easily reduced. Effervesces in nitric acid.

Occurs with other ores of silver at Wolfach in Baden; also at Real de Catorce in Mexico, where it is called *Plata azul.*

XIV. PLATINUM, IRIDIUM, RHODIUM, PALLADIUM.

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; 17·33 is the average or most usual specific gravity. 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, 311, 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, Ča 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. Tagilak,	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=$Fe\,Pt^2$.

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. It has of late years been discovered in considerable abundance at Nischne Tagilsk, and Goroblagodat, in the Ural. It occurs here as elsewhere in alluvial or drift material; but the courses of the detritus have 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. They are not a legal tender, but pass conventionally, and are principally current in the southern provinces of the empire. Russia affords annually about 800 cwt. of platinum, which is nearly 10 times the amount from Brazil, Columbia, St. Domingo, and Borneo. The amount coined from 1826 to 1844, equals 2¼ millions of dollars. Platinum is also found on Borneo; in the sands of the Rhine; in those of the river Jocky, St. Domingo; and recently in the California gold region, and in traces with gold in Rutherford Co., North Carolina. Borneo affords 600 or 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. Its specific gravity was 18·94. In the year 1822 a mass of platinum from Condoto was deposited in the Madrid museum, measuring two inches and four lines in diameter, and weighing 11,641 grains. A more remarkable specimen was found in the year 1827, in the Ural, not far from the Demidoff mines, which weighed 10 $\frac{54}{96}$ Russian pounds, or 11·57 pounds troy, and similar masses are not now uncommon; the largest yet seen weighed 21 pounds troy, and is in the Demidoff cabinet. The alluvial deposits afford 1 to 3 pounds of platinum for 3700 of sand.

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. The vessels employed in the concentration of sulphuric acid are now made of platinum, which is unaffected by this corrosive acid. Platinum is also employed for crucibles and capsules in chemical analysis; for covering other metals, and for painting on porcelain. It admits of being 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. For many years after its discovery, it was almost useless on account of the difficulty of obtaining it in masses. The grains weld when heated, but because of their small size, this was interminable labor, and moreover the metal was not pure. Dr. Wollaston introduced the process now in use, which consists in dissolving the metal in nitro-muriatic acid, and throwing down from the solution an orange precipitate by means of muriate of ammonia. This precipitate (a double chlorid of platinum and ammonium) is then heated and thus reduced to the metallic state; the platinum is now in an extremely minute state of division. This black powder ("spongy platinum") is next compressed in steel moulds by the aid of heat and strong pressure; and when sufficiently compact, is forged under the hammer and then reduced at last to solid masses.

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 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.

IRIDOSMINE. Native Iridium. Osmium-Iridium. Irid-osmium. Newjanskite, *Haid.* Sisserskite, *Haid.*

Hexagonal. Fig. 125, pl. 2; P : e=136° 28′, e : e=139° 56′, P : e″=117°. Rose shows that both iridium and osmium are isomorphous with arsenic, and states the angle of the rhombohedron at 84° 52′. Also monometric, according to Rose, (Pogg. lv, 329), who makes both this metal and palladium dimorphous. Cleavage basal, easily obtained; lateral, indistinct. 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 49·34, 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.

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 2·6=100, *Thomson*. From Brasil. 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.

PLATIN-IRIDIUM, *Svanberg.*

In small grains with Platinum. G.=16—17. 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.

PALLADIUM.

Monometric. In minute octahedrons, Haid. Also in rhombohedral crystals, Rose. 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 palladium are brought from Brazil. 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 splendent steel-like lustre, which does not tarnish. A cup weighing 3½ 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.

The *Selenpalladite* of Zinken from Tilkerode has been acknowledged by him to be native palladium. The *Eugenesite* of Zinken, from the same locality, contains, according to this author, palladium, silver, and gold, with selenium. Rammelsberg suggests that the selenium may proceed from a mechanical mixture with selenid of lead.

PALLADIUM OCHRE. Palladiumoxydul.

A brown ochreous substance associated with the Palladium gold of Brazil.

Soluble in muriatic acid. Detected by Johnson and Lampadius, (J. f. pr. Chem. xi, 309).

IRITE, *Hermann.*

In grains or scales. Structure thin foliated. Color black. Lustre shining. G.=6·506. Magnetic.

Composition.—$2\dot{\text{F}}\text{e}^3(\text{Ir}^2\text{O}^3, \text{Cr}^2\text{O}^3)^3 + \dot{\text{F}}\text{e}\,\ddot{\text{O}}\text{s}$—Perhaps $(\dot{\text{I}}\text{r}, \dot{\text{O}}\text{s}, \dot{\text{F}}\text{e})(\text{Ir}^2\text{O}^3, \text{Os}^2\text{O}^3, \text{Cr}^2\text{O}^3)$. 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.

RUTHENIUM.

The metal Ruthenium has not been observed native in a separate state. It was detected by Claus in the solution of platinum. The platinum of the Urals and Columbia, S. A., affords about half per cent. In iridosmine it occurs in three to six per cent. As obtained from this last mentioned ore, it is a brittle metal, of the specific gravity 8·6, almost insoluble in acids, and only dissolved in traces by aqua regia.

GOLD.

GOLD. Gediegen Gold, *W.* Or Natif, *H.* Sol, *Alchym.* Rex Metallorum.

Monometric. Figures 1—11, inclusive, plate 1, also figs. 14, 15, 16. Cleavage none. Compound crystals, composition like 129, plate 2, but occurring in the form exhibited in fig. 16, pl. 1. Common in filiform, reticulated, and arborescent shapes—also in thin laminæ; often in flattened grains or scales and rolled masses in gravel or sand detritus.

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 proportion of silver in the *electrum* of Klaproth, is Gold 64, and silver 36, or two of gold to one atom 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):

	Gold.	Silver.	Proportion.
1. Linarowski, Altai,	60·08	38·38, Cu 0·33=98·79, Rose.	2 : 1
2. Vöröspatak, Siebenburg,	60·49	38·74=99·23, Rose.	"
3. Santa Rosa,	64·93	35·07=100, Boussingault.	"
4. Transylvania,	64·52	35·48=100, Boussingault.	"
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.	2 : 1
7. Titiribi, Columbia,	73·40	26·00=100, Bouss.	"
8. Guano,	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. Nischne Tagilsk,	83·85	16·15=100, Rose.	
14. Santa Barbara, Siebenburg,	84·80	14·68, Cu 0·04, Fe 0·13=99·65, Rose.	
15. Goruschka, near N. Tagilsk,	87·31	12·12, Cu 0·08=99·51, Rose.	8 : 1
16. Petropawlowski,	86 81	13·19, Cu 0·3, Fe 0·24, Rose.	
17. Near Miask,	87·40	12·07, Cu 0·09=99·56, Rose.	
18. Chaudière, Canada,	86·73	13·27=100, Hunt.	
19. California, G.=15·63,	86·57	12·33, Cu 0·29, iron 0·54=99·73, Henry.	
20. Senegal, Africa,	86·97	10·53, =97·50, Darcet.	
21. Rio Sucio, near Mariquita,	87·94,	12·06=100, Bouss.	
22. Baia, near Pamplona,	88·15	11·85=1900, Bouss.	
23. Malpaso, near Mariquita,	88·24	11·76=100, Bouss.	

	Gold.	Silver.
24. Llana, near Vega de Supia,	88·54	11·42=99·96, Bouss.
25. Near Miask,	89·35	10·65=100, Rose.
26. California, G.=17·4,	87·6	8·7, $\overline{\overline{F}}e$, $\overline{\overline{A}}l$, $\dot{C}a$ 1·7, $\dddot{S}i$, ign. loss 2·0=100, O.
27. California, G.=14·6, fused, 17·48,	90·70	8·80, Fe 0·38=99·88, Rivot.
28. California, G.=15·96,	90·01	9·01, Cu with Fe *trace* 0·86=99·88, Hen.
29 California,	89·61	10·05, Cu and Fe undet.=99·66, Hofmann.
30. Boruschka, near N. Tagilsk,	90·76	9·02=99·78, Rose.
31. Beresof,	91·88	·8·03, Cu 0·02, Rose. 12 : 1
32. Katharinenburg, G. 17·74—18·35,	91·21	8·03, Cu, Fe and loss 0·76, Awd.
33. Bogota,	92·00	8·00=100, Bouss.
34. California, G.=16·33,	92·00	7·00=99, Teschemacher.
35. Perroe-Pawlowsk, near Kath.,	92·60	7·08=99·78, Rose.
36. Czarewo-Nikolajewsk,	92·47	7·27=99·74, Rose.
37. Katharinenburg, G. 18·11—18·4,	92·23	6·17, Cu, Fe and loss 1·6, Awd.
38. “ “ “	92·71	6·51, “ “ 0·78, Awd.
39. “	92·80	7·02, Fe 0·08, Rose.
40. “	93·34	6·28, Cu 0·06, Fe 0·32=99·94, Rose.
41. “	93·75	6·01, Cu, Fe and loss 0·24, Awd.
42. “	93·66	5·72, “ “ 0·52, Awd.
43. “	93·54	5·62, “ “ 0·80, Awd.
44. “	94·09	5·55, “ “ 0·36, Awd.
45. Brazil,	94·00	5·85=99·85, Darcet.
46. Boruschka,	94·41	5·28, Cu 0·39, Fe 0·04=100·07, Rose.
47. Katharinenburg, G. 18·77—18·89,	95·5	4·0, Cu, Fe and loss 0·5, Awd.
48. “ “	95·3	3·86 “ “ 0·84, Awd.
49. “ G. 18·79,	95·81	3·58 “ “ 0·61, Awd.
50. “ “	95·83	4·34 “ “ 0·33, Awd.
51. Schabrowski, near Katharinenburg, G.=19·099,	98·96	0·16=99·12, Rose.

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.

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.

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 Phillippines.

Nearly all the gold of commerce comes from Asiatic Russia, Brazil, Bohemia, and Transylvania, Africa, the East India Islands, and the United States: the whole amount annually obtained has been estimated at 36 tons.

The Russian mines have recently been 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 veins 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 75,358 troy pounds, and $16,500,000.

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 the Southern United States have produced of late 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 Canaan, N. H., Dedham, Mass., Albion, Maine, and on the Chaudière river in Canada.

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 Culpepper county, at the 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 Pickens county, adjoining Georgia. There is gold also in eastern Tennessee.

Viewing the gold region of the 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.

The California mines are mostly alluvial. 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 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 both platinum and diamonds have been reported.

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, though 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, ("steelyard 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 the Institute of Mining Engineers at St. Petersburgh.

An examination of a gold rock for gold is an extremely 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 a repetition of the 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.

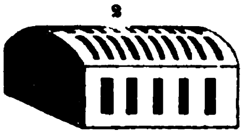
The operation of hand washing is called in Virginia *panning*. With a small iron pan, they wash the earth in a tub or in some brook, and thus extract much gold from the gravel or soil, which is said to *pan well* or *pan poorly*, according to the result. Masses rtz, with no external indication of gold, examined in the above way at a Virginia led an average of more than eight dollars to the bushel of gold rock.

d is alloyed with copper or silver, the mode of assay for separating the copon the process of cupellation; and that for separating the silver, on the ric acid to dissolve silver without acting on gold.

s of cupellation consists in heating the assay 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. The shape of the cupel is shown in fig. 1. 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, (fig. 2); it is of infusible stone-ware, 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.

1

2



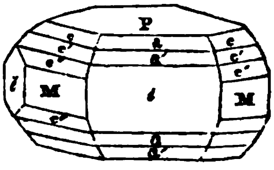
In the cupellation of gold containing copper, lead is melted with the assay. The lead on being fused in a draft of air oxydizes, and also promotes the oxydation of the copper, and both oxyds disappear in the pores of the cupel, leaving the gold behind, and the silver alloyed with it. In this process 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 its 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 continued until the surface of the metal is quiet and bright, when the cupellation is finished; the metal then is slowly cooled and removed. 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 4½ 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.

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 is 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 one 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 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.

GRAPHIC TELLURIUM. Sylvanite, *Haid.* Graphic Gold. Schrifterz. Schrift-tellur. Tellure Natif Auro-argentifére, *H.*



Trimetric. M : M=107° 44′; P : a=141° 30′, P : a′=129° 12′, P : e=151° 40′, P : e′=136° 42′, P : e″=132° 45′. Cleavage highly perfect, parallel with M; less so parallel with P. Compound crystals, 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. Fracture uneven. Very sectile.

Composition.—$AgTe+2AuTe^2$=Tellurium 59·40, gold 26·30, silver 14·30=100. Analyses: 1, Klaproth, (Beit. iii, 16); 2, Berzelius, (Jahresb. xiii, 162, analysis imperfect); 3, 4, Petz, (Pogg. lvii, 472):

	Tellurium.	Gold.	Silver.
1. Offenbanya,	60·	30·	10· =100, Klaproth.
2. "	52·	24·	11·3, Pb 1·5, Cu, Fe, Sb, S, As, *traces*, B.
3. " *needles*,	59·97	26·97	11·47, Pb 0·25, Sb 0·58, Cu 0·76=100, P.
4. " *imperf. cryst.*	58·81	26·47	11·31, Pb 2·75, Sb 0·66=100, Petz.

Rammelsberg remarks that the formula $3AgTe+7AuTe^2$, corresponds still more nearly with the results of analysis.

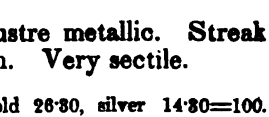
B.B. fuses easily, tinging the flame greenish-blue, and covering the charcoal with a white oxyd; finally a ductile metallic globule is obtained. Dissolves in nitric acid.

Occurs with gold at Offenbanya in Transylvania, in narrow veins, which traverse porphyry; also at Nagyag in the same country.

Its name alludes to the peculiar arrangement of the crystals, resembling writing characters.

The large amount of gold it contains renders it a highly valuable ore.

AUROTELLURITE. Mullerite, *Haid.* Yellow Ore of Tellurium. White Ore of Tellurium. Weisstellur. Tellursilberblei.



Trimetric. M : ē=142 45′, M : ĕ=127° 15′, P : a=108° 30′, P : *a*=143° 5′. Cleavage in traces. Occurs in small crystals and imbedded crystalline laminæ.

Soft. G.=7·9—8·4. Lustre metallic. Color silver-white, much inclining to brass-yellow. Opaque. Rather brittle.

Composition.—$(Ag, Pb)(Te, Sb)+2Au(Te, Sb)^3$, or essentially graphic tellurium. Analyses: 1, Klaproth, (Beit. iii, 20); 2—6, Petz, (Pogg. lvii, 473):

	Tellurium.	Sb	Gold.	Silver.	Pb
1. *Gelberz*,	44·75	——	26·75	8·50	19·50, S 0·5=100, K.
2. *White cryst.*, G.=8·27,	55·39	2·50	24·89	14·68	2·54=100, Petz.
3. " G.=7·99,	48·40	8·42	28·98	10·69	3·51=100, Petz.
4. *Yellow cryst.*, G.=8·33,	51·52	5·75	27·10	7·47	8·16=100, Petz.
5. " *massive*,	44·54	8·54	25·31	10·40	11·21=100, Petz.
6. " "	49·96	3·82	29·62	2·78	13·82=100, Petz.

These analyses afford the above formula. B.B. like the preceding species.

The only known locality is at Nagyag, in Transylvania, where it is associated with graphic tellurium and manganblende.

The preceding species has been united with aurotellurite on the ground of their composition.

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.

VII. RESINS—ORGANIC COMPOUNDS.

AMBER. Yellow Mineral Resin, *M.* Bernstein *of the Germans.* Succin, *H.* Succinite, *Breit.* Succinum. Ηλεκτρον. Λυγκουριον. Lyncurion, *Dancotr.*

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	$\dddot{Al}$	$\bar{Si}$	Total.
1.	80·99	7·31	6·73	1·54	1·10	0·63,	97·90.
2.	78·824	10·229	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 the Urals, Russia; in Switzerland, near Bâle; in France, near Paris in clay, in the department of the Lower Alps, with bituminous coal, also in the departments 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 struggle for 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 our word *electricity*. It was called by some Lyncurium, though this name was applied, as is supposed, also to 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 employed for 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 $C^4 H^3$. 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 to 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.

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.—$C^{20} H^{10} + H O$; 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, and 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 odor: 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.

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 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: O 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. H.=1·5; G.=1·22.

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.

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.*—$C^6 H^6$. 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 up in large bubbles. The ascent to the lake from the sea, a distance of three-quarters of a mile, is covered with the hardened pitch, on which trees and vegetation flourish, and about Point La Braye the masses of pitch look like black rocks among the foliage.

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.*

Naphtha affords both fuel and lights to the inhabitants of Badku, on the Caspian. It is also employed in Persia and the Birman 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 embalming. 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.

IDRIALINE. Idrialite, *Schrötter, Nicol.* Quecksilberbranderz.

Massive, with 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.—Carbon 94·9, hydrogen 5·1=100, Dumas. Insoluble in water, and
r ether. Fuses at 400° F.
h cinnabar at Idria. It is sometimes called, from its combustibility,
or *inflammable cinnabar.*

BREWSTERLINE.

rless. Transparent. Expands one-fourth its size
nt of 30° F., or is nearly 32 times more expansible
an increment of 30° of heat at the temperature of

cavities in crystals of topaz, chrysoberyl, quartz crystals from Quebec,
Siberia, where it was detected by Sir David Brewster.
ht proper to recognize this fluid among minerals and name it,
fectly described. The fluid expands with the heat of the hand. Its
less than that of water. It was sometimes indurated in the cavity
xposure, the fluid undergoes quick motions and changes, and finally
minute particles, which from the moisture of the hand alone, sud-
again, and extended and contracted as before. This was indefinitely
idue is volatilized by heat, and dissolves in the acids without efferves-

second fluid was also distinguished in the same crystals that contained
often in the same cavities; yet they were not miscible, and remained
re 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 to 40 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, 278), 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, Forchhammer, (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 $C^{8}\ H^{6}$.

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=$C^{2}\ H$. Kraus, (Pogg. xliii, 141), obtained C 92·49, H 7·42, specimen from Uznach; and Trommsdorf, (Ann. d. Pharm. xxi, 126), C 92·429, H 7·571, specimen from Redwitz.

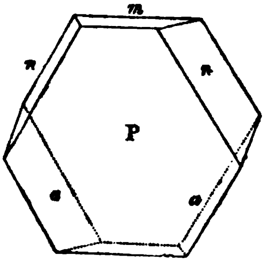
In brown coal at Uznach, and near Redwitz, Bavaria, in the Fichtelgebirge.

FICHTELITE, *Bromeis*, Ann. der Pharm. xxxvi, 304. *Schrötter*, Pogg. 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 88·9, 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.

HARTITE, *Haidinger*, Pogg. liv, 261.



Monoclinic. Angle M : M 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^6H^5; Carbon 87·478, 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.

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*, from an Irish peat swamp, contains C 75·05, H 12·56, O 12·39=$C^{33} H^{32} O^3$+H O. It fuses at 51° C., (124° F.), and dissolves easily in alcohol.

IXOLYTE, Ixolyt, *Haidinger*, Pogg. lvi, 345.

Amorphous. Occurs in seams 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 resembles closely 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, having the consistency of soft wax or spermaceti. G. at 60° F.=0·916. Lustre nacreous. Color white, becoming black and opaque on long exposure. Transparent. Feel greasy.

Composition.—According to Johnston, (Phil. Mag. xii, 338, 1838), Carbon 85·910, hydrogen 14·624=100·584. 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 minute pearly fibres, from which the ether may be separated by agitation or compression.

Occurs with the iron ores of the coal measures in Glanmorganshire. 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):

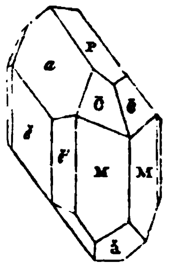
	Moldavia.	Moldavia.	Urpeth.
Hydrogen,	15·15	13·787	14·06
Carbon,	85·75=100·90, M.	86·204=99·991, S.	86·80=100·86, J.

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 Gallicia, (a variety fusing at 59° C., and boiling at 300° C.); also at the Urpeth colliery, Newcastle-on-Tyne, England. It has been made into candles.

OXALATE OF LIME, *H. T. Brooke*, Phil. Mag. xvi, 449.

Monoclinic. M : M=100° 36′, P : M=103° 14′, P : *a*=127° 25′, P : ă=109° 28′, P : ê=143° 4′, M : ĕ=129° 42′. Cleavage parallel with P; also less perfect parallel with M, and the longer diagonal. All the planes bright except M and ẹ, which are vertically striated. Twin crystals occur compounded parallel with the plane ă.



H.=2·5—2·75. Lustre like sulphate of lead. Very brittle. Fracture conchoidal.

This species was observed by Brooke in crystals from a tenth to a fourth of an inch on calc spar; but the locality of the spar is not known.

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.

Figure 55, pl. 1, and also with the terminal or lateral solid angles truncated. Cleavage octahedral, very indistinct. Also in massive nodules.

H.=2—2·5. G.=1·55—1·597. Lustre resinous, inclining to vitreous. Streak white. Color honey-yellow, often reddish or brownish; rarely white. Transparent—translucent. Fracture conchoidal. Sectile.

Composition.—$\bar{\bar{A}}l\,\bar{M}^3+18\dot{\bar{H}}$=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 Luschits near Bilin in Bohemia; near Walchow in Moravia.

PART VI.

CHEMICAL CLASSIFICATION.

A perfect Chemical Classification of minerals is strictly and completely, in every feature, *a Natural System.* We learn from a general study of inorganic nature, that very many of those distinctions which the eye seizes upon at first as essential and fundamental, are of little value as a basis of a scientific arrangement; that, for true distinctions, we must look beneath the surface to those characters which are indicative of the fundamental forces or qualities upon which the existence of the species depends. Hardness, lustre, density, were the characters earliest appealed to in the grouping of minerals, and they have been accepted in some modern systems, as the proper basis of a *natural* arrangement; yet nothing can be more untrue to nature. Even metallic lustre, which has separated the so-called "blendes" from the "glances" and "pyrites," is an unimportant characteristic, since species that are related in all essential qualities, may be widely unlike as regards the reflection of light—the property on which lustre depends.

But in educing a chemical arrangement, a disregard of all physical characters leads as widely from the true line, as a neglect of chemistry. The first step with regard to the great principle of isomorphous substitutions was taken through crystallographic comparisons in connection with chemical analysis; and crystallography sustains an equally high ground in many questions bearing on the classification of inorganic substances,—the crystalline structure being a true exhibition, in one mode, of the fundamental molecular character of a substance. If we undertake to arrange compounds under the prominent element in their constitution, without reference to isomorphism, whether it be the so-called electro-negative element, or the electro-positive, (adopting or not the order of relative negativity or positivity of the elements), and follow this rule undeviatingly, we necessarily produce unnatural groupings of species. Or if we are guided by the oxygen proportions of the constituents, the arrangement is no less artificial. The minerals of the scapolite group, and even the *varieties* of the species scapolite, have in these ways been widely separated in some chemical arrangements, notwithstanding the fact taught by crystallization, that on some ground, and this of the most essential importance, these varieties are intimately related. The feldspar family has in like manner been hardly recognized in most chemical classifications, notwithstanding the close relation of the species.

The errors of most chemical systems hitherto proposed, have arisen partly from regarding almost solely the particular elements present, rather than the relations of the different elements; and partly from the mistaken idea that minerals constitute a complete Kingdom in nature by themselves, instead of being excerpts from the great Inorganic Kingdom—and forgetting therefore that they are to be classified not by themselves alone, but as they happen to fall in the wider system of Inorganic Nature. In judging such mistakes we should remember that a complete system of classification, exhibiting correctly all the affinities of species, with due reference to their comparative importance, is the very last result of a perfected science. With the rapid progress of chemistry through past years, nothing else than what appears in the history of mineralogy was to be expected.

Neither can we now hope to propose an arrangement that shall fare better than its predecessors: for some of those points that lie at the foundation of classification are in discussion and doubt, and other questions of no less importance are probably yet to arise. The extension of knowledge relating to the isomorphous relations of elements—that is, in effect, their relative atomic forces—is preparing the way for a better understanding of the affinities of inorganic compounds. In the system here brought forward, there is a reference throughout to the distinctions and affiliations thus exhibited. The arrangement presents at a glance the coincidences among different compounds which have been brought to light by the labors of different chemists, among we mention especially Kopp, Frankenheim, Otto, the Professors Rose and Rammelsberg.

In many cases, we have as yet no safe guide in our groupings. We cannot say how far *hydrous* and *anhydrous* species should be kept separate. Scheerer's principle, if true, breaks down the seeming importance of this distinction. Yet as this principle, and others that lead the same way, are not established, we have chosen to draw a line between them.*

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* There is a special difficulty here, arising from the tendency of some anhydrous species to become hydrated by the absorption of water. Thus *iolite* may receive water, so that new compounds are formed. These new compounds have been taken as original species, and the relations of the water to the other constituents estimated according to a proposed theory, when in fact the original bases still remain unaltered in their relation to the silica, and the only change is the absorption of water in one, two, or more atoms. The new mineral is a pseudomorph. In some micas, water appears to enter in the same way, the original proportions of the constituents being unchanged. The mica as crystallized was probably anhydrous, though now hydrous, (and perhaps brittle as a consequence); and any speculations therefore, or assumptions made without taking this point

Again, certain compounds seem to authorize us in assuming that alumina and silica may replace one another; while, at the same time, some of the most distinguished chemists of the day urge the claims of a system in which alumina and all related peroxyds replace the protoxyds according to a certain ratio. While such important points remain in discussion, it is evident that we are still far from knowing the whole truth, and the following classification must partake of the ignorance. In deciding to separate the salts of protoxyds and peroxyds, where distinct, we have chosen one of two doubtful courses.

At times, when without isomorphism to aid, we have sought to place species together which appeared to be closest in chemical and physical relations, these two points being considered together. But in numerous instances much remains to be done before the general plan proposed can be carried out. The hydrous silicates are among those that are with difficulty arranged in groups.

The basis of the classification is presented in the arrangement of the elements, on page 152, which we here repeat, (inverting it however), that the key to the system may be at hand for comparison.

1. *a*. Hydrogen.
b. Gold, Platinum, Palladium, Rhodium, Ruthenium.
c. Silver, Mercury, Copper, Sodium, Potassium, Lithium.
d. Lead, Baryum, Strontium, Calcium, Magnesium, Zinc, Cadmium;—Nickel, Cobalt, Manganese, Iron, Chromium, Aluminium;—Glucinum;—Zirconium, Norium;—Yttrium, Erbium, Terbium, Didymium, Lanthanum, Cerium.
2. Uranium;—Columbium, Niobium, Pelopium;—Tin, Titanium;—Tungsten, Molybdenum.
3. Iridium, Osmium, Vanadium, Tellurium; Bismuth, Antimony, Arsenic, Phosphorus;—Nitrogen.
4. Carbon, Silicium, Boron.
5. Oxygen;—Sulphur, Selenium;—Fluorine, Chlorine, Bromine, Iodine.

In our classification we keep in view in general the order of the elements here given. The above is not intended as a lineal order

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into view, must be erroneous. There are many species that admit of a similar change, and it is a question to be settled by proof, and not assertion, whether the water is original with the species and at the basis of its form and structure, or whether of subsequent introduction. The facts with regard to iolite are illustrations of a general principle of wide importance, and they show that the mere presence of water, even a large percentage, is *no proof* that it belonged to the original compound, even though that hydrous character may pervade the same mineral over considerable areas. A hydrous feldspar, or mica, therefore, is not to be received as a hydrous species *originally*, without evidence sufficient to remove doubt, obtained by special investigation. Such hydrous minerals are promising to become numerous, and unless their titles are fully tested, they will soon prove to be a burden to the science. Mineralogy has already received *nine or ten species*, thus made out of iolite, (see pages 293, 294—and iberite, page 295, should probably be added); but in this case, happily, the derivative character has been detected.

of affinities, for such is not nature. Group 2 affiliates more strongly with 4, through titanium and silicium, than with 3 through molybdenum and vanadium; while group 3 appears to affiliate with group 5, through arsenic and sulphur. The affinities in nature are by complicated reticulations, and not simple straight lines.

The prominent divisions adopted in the proposed classification, are as follows:

I. The Elements occurring native.

II. Combinations of the elements with Tellurium, Antimony, Arsenic, Sulphur, Selenium.

III. Combinations with Oxygen.*

IV. Combinations with Fluorine, Chlorine, Bromine, Iodine.

V. Combinations of bases with acids of metals of group 2, forming Titanates, Columbates, Niobates, Pelopates, Tungstates, Molybdates.

VI. Combinations of bases with acids of metals of group 3, forming Vanadates, Antimonates, Arsenates, Phosphates, Nitrates.

VII. Combinations of bases with oxygen acids of sulphur, and selenium, forming Sulphates and Selenates.

VIII. Combinations of bases with carbonic acid, forming Carbonates.

IX. Combinations of bases with boracic acid, forming Borates.

X. Combinations of bases with silica, or Silicates.

XI. Organic compounds, as the Resins.

The species of the same group are related in crystallization and chemical constitution, and are properly isomorphs. The system of crystallization is pointed out in each case by Roman numerals, as follows:

I. Monometric System.
II. Dimetric System.
III. Trimetric System.
IV. Monoclinic System.
V. Triclinic System.
VI. Hexagonal System.

The various cases of dimorphism and trimorphism among the species are also apparent, from the nature of the arrangement, as will be observed without explanation.† As an example, we mention,—the *Galena Group*, *Copper Glance Group*, and *Greenockite Group*, on page 569, constitute an instance of trimorphism, the first having a *monometric*, the second a *trimetric*, and the third a *hexagonal* form.

After the name of each species we have given the page on which it is described in the foregoing part of this Treatise.

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* The oxyds have close relations to the sulphurets. But the affinity of the sulphurets to the arseniurets among minerals is so great and of such interest, that we have placed the oxyds in a separate division. In an arrangement on paper, which is necessarily linear, and therefore not altogether natural, many of the affinities must be left undisplayed, or be exhibited by drawing out the groups into parallel series.

† When the connection of a species with the group to which it is attached is doubtful, owing to the crystalline form of the species being unknown, the name is preceded by a bracket. The bracket is used in the same manner on page 468.

CLASSIFICATION OF MINERALS.

I. NATIVE ELEMENTS.

1. Gold Group.	Gold, 549.
	Platinum, 546.
	Palladium, 548.
	Ruthenium, 549.
	Rhodium, 550.
2. Silver Group.	Silver, 534.
	Mercury, 531.
	Amalgam, 532.
	Copper, 507.
3. Iron Group.	Iron, 423.
	Nickel, 423.
	Lead, 487.
4. Tin Group.	Tin, 384.
	Titanium, 386.
5. Arsenic Group.	Arsenic, 419.
	Antimony, 415.
	Bismuth, 411.
	Tellurium, 411.
	Iridosmine, 547.
	Platiniridium, 548.
6. Sulphur Group.	Sulphur, 183.
	Sulphurine, (Monoclinic Sulphur), 183.
	Selenium, 184.
7. Carbon Group.	Diamond, 175.
	Graphite, 180.
	Mineral Coal, 177.

II. COMBINATIONS WITH ELEMENTS OF THE SULPHUR OR ARSENIC SERIES.

1. *Simple Sulphurets, Arseniurets, &c.*

1. Aurotellurite Gr.—III.	Aurotellurite, 554.
	Graphic Tellurium, 554.

2. GALENA GR.—I.	Galena, 488.	Pb S.
	Cuproplumbite, 490.	(Pb, Ȼu) S.
	Erubescite, 510.	(Ȼu, Fe) S.
	Manganblende, 455.	Mn S.
	Blende, 479.	Zn S.
	[Syepoorite, 469.	Co S.
	Silver Glance, 536.	Ag S.
	Clausthalite, 490.	Pb Se.
	Naumannite, 537.	Ag Se.
	Rionite, 481.	Zn Se (?)
3. COPPER GLANCE GR.—III.	Copper Glance, 508.	Ȼu S.
	Stromeyerite, 537.	(Ag, Ȼu) S.
	Eucairite, 537.	(Ȼu, Ag) Se.
	Berzelianite, 509.	Ȼu Se.

A. *Sulphur Series.**		B. *Arsenic Series.*	
4A. GREENOCKITE GR.—VI.		4B. COPPER NICKEL GR.—VI.	
Greenockite, 480.	Cd S.	Copper Nickel, 469.	$Ni^2 As$.
Millerite, 469.	Ni S.	Breithauptite, 470.	$Ni^2 Sb$.
Cinnabar, 532.	Hg S.	[Kaneite, 456.	$Mn^2 As$.
[Onofrite, 534.	Hg (S, Se).		
Magnetic Pyrites, 427.	Fe S (or Fe^7S^8).		
5A. PYRITES GR.—I., hemihedral.		5B. SMALTINE GR.—I.	
Pyrites, 424.	$Fe S^2$.	Smaltine, 470.	Co As.
Hauerite, 456.	$Mn S^2$.	Rammelsbergite, 471.	Ni As.
		Altaite, 491.	Pb Te.
		Hessite, 536.	Ag Te.
6A. MARCASITE GR.—III.		6B. LEUCOPYRITE GR.—III.	
Marcasite, 425.	$Fe S^2$.	Chloanthite, 471.	Ni As.
[Covelline, 510.	Ȼu S^2.	Leucopyrite, 428.	Fe As.

7. COBALTINE GR.—I.	Cobaltine, 472.	$Co S^2 + Co As$.
	Nickel Glance, 472.	$Ni S^2 + Ni As$.
	Ullmannite, 473.	$Ni S^2 + Ni (Sb, As)$.
8. MISPICKEL GR.—III.	Mispickel, 428.	$Fe S^2 + Fe As$.
	Glaucodot, 474.	$(Co, Fe) S^2 + (Co, Fe) As$.
9. LINNÆITE GR.—I.	Linnæite, 474.	$Co S + Co^2 S^3$.
	[Bismuth Nickel, 475, and Appendix.	

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* The corresponding groups in the sulphur and arsenic series, here presented in parallel columns, are approximately similar in crystallization. See remarks towards bottom of page 467. $Ni^2 As$ becomes Ni As (corresponding to Cd As) if the atomic weight of arsenic is halved, as adopted in the Berzelian tables: so Co As becomes $Co As^2$, and $CoS^2 + Co As$ becomes $Co S^2 + Co As^2$, or $Co (S, As)^2$. Frankenheim makes thus the Pyrites, Smaltine, and Cobaltine groups isomorphous; and so also the Marcasite, Leucopyrite, and Mispickel groups.

10. Nagyagite Gr.—II.	Nagyagite, 491.	
11. Copper Pyrites Gr.—II.	Copper Pyrites, 511.	$(\text{Ꞓu}, Fe)^3 S^4$.
12. Domeykite Gr.	Domeykite, 513.	$\text{Ꞓu}^3 As^2$.
13. Skutterudite Gr.—I.	Skutterudite, 474.	$Co^2 As^3$.
14. Antim. Silver Gr.—III.	Antimonial Silver, 538.	$Ag^4 Sb$.
15. Placodine Gr.—IV.	Placodine, 475.	$Ni^4 As$.

2. *Elements of the Sulphur and Arsenic Groups with one another.*

1. Molybdenite Gr.—VI.	Molybdenite, 389.	$Mo S^2$.
2. Realgar Gr.—IV.	Realgar, 420.	$As S^2$.
3. Orpiment Gr.—III.	Orpiment, 420.	$As S^3$.
	Antimony Glance, 417.	$Sb S^3$.
	Bismuthine, 412.	$Bi S^3$.
4. Ars. Antimony Gr.—VI.	Arsenical Antimony, 419.	$Sb As^3$.
5. Schreibersite Gr.	Schreibersite, 430.	Phosphuret of iron & nickel.

3. *Compound Sulphurets, Arseniurets, &c.*

1. Sternbergite Gr.—III.	Sternbergite, 539.	$Ag S+2 Fe^2 S^3$.
2. Miargyrite Gr.—IV.	Miargyrite, 539.	$Ag S+Sb S^3$.
	[Flexible Silver Ore, 539	
3. Wolfsbergite Gr.—III.	Wolfsbergite, 515.	$\text{Ꞓu} S+Sb S^3$.
	[Berthierite, 418, (in part).	$Fe S+Sb S^3$.
4. Zinkenite Gr.—VI.	Zinkenite, 491.	$Pb S+Sb S^3$.
5. Red Silver Gr.—VI.	Pyrargyrite, 540.	$3 Ag S+Sb S^3$.
	Proustite, 541.	$3 Ag S+As S^3$.
	Xanthokon, 543.	
6. Bournonite Gr.—III.	Bournonite, 516.	$3 (\text{Ꞓu}, Pb) S+Sb S^3$.
	Aciculite, 414.	$3 (\text{Ꞓu}, Pb) S+Bi S^3$.
	Freislebenite, 541.	(?) $3 (Pb, Ag) S+Sb S^3$.
	Wölchite, 515.	
	Boulangerite, 493.	$3 Pb S+Sb S^3$.
	Stephanite, 542.	$6 Ag S+Sb S^3$.
7. Jamesonite Gr.—III.	Jamesonite, 493.	$3 Pb S+2 Sb S^3$.
8. Heteromorphite Gr. III?	Heteromorphite, 492.	$2 Pb S+Sb S^3$.
	Kobellite, 495.	$2 (Pb, Fe) S+(Sb, Bi) S^3$.
9. Dufrenoysite Gr.—I.	Dufrenoysite, 492.	$2 Pb S+As S^3$.
	[Steinmannite, 495.	
10. Fahlerz Gr.—I.	Gray Copper, 513.	$4 R S+(Sb, As) S^3$.
	Tennantite, 515.	$4 R S+As S^3$.
eocronite Gr.—III.	Geocronite, 494.	$5 Pb S+(Sb, As) S^3$,
		or $6 Pb S+(Sb, As) S^3$.
lybasite Gr.—VI.	Polybasite, 542.	$9 (Ag, \text{Ꞓu}) S+(Sb, As) S^3$.

13. PLAGIONITE GR.—IV.	Plagionite, 494.	$4\,\mathrm{Pb\,S}+3\,\mathrm{Sb\,S}^3$.
14. TETRADYMITE GR.—VI.	Tetradymite, 414.	$2\,\mathrm{Bi\,Te}^3+\mathrm{Bi\,(S,\,Se)}^3$.
	Bornite, 415.	$\mathrm{Bi\,S}^3+3\,\mathrm{Bi\,Te}$.
	Pilsenite, 415.	$4\,\mathrm{Bi\,Te}^3+\mathrm{Bi\,S}^3$.
15. TIN PYRITES GR.—I.	Tin Pyrites, 386.	$2\,\mathrm{R\,S}+\mathrm{Sn\,S}^2$.
Unarranged Species.	Cupreous Bismuth, 414.	$\overline{\mathrm{Cu}}\,\mathrm{S}+\mathrm{Bi\,S}$?
	Bismuth Silver, 543.	
	Irite, 548.	Oxyds of Ir, Os, Fe, Cr.

III. OXYDS.

1. *Oxyds of the Elements of Group* I.

a. Anhydrous.

1. PERICLASE GR.—I.	Periclase, 200.	Mg O.
	Red Copper Ore, 517.	$\overline{\mathrm{Cu}}$ O.
	[Plumbic Ochre, 496.	Pb O.
2. RED ZINC GR.—VI.	Chalcotrichite, 517.	$\overline{\mathrm{Cu}}$ O.
	Red Zinc Ore, 481.	Zn O.
3. CORUNDUM GR.—VI.	Corundum, 222.	$\dddot{\overline{\mathrm{Al}}}$.
	Specular Iron, 430.	$\dddot{\overline{\mathrm{Fe}}}$.
	Ilmenite, 432.	$(\dddot{\overline{\mathrm{Fe}}},\,\dddot{\overline{\mathrm{Ti}}})$.
	Chromic Ochre, 422.	$\dddot{\overline{\mathrm{Cr}}}$.
4. BRAUNITE GR.—II.	Braunite, 458.	$\dddot{\overline{\mathrm{Mn}}}$.
5. CHRYSOBERYL GR.—III.	Chrysoberyl, 376.	$(\dddot{\overline{\mathrm{Be}}},\,\dddot{\overline{\mathrm{Al}}})$— ? $\dot{\mathrm{Be}}\,\dddot{\overline{\mathrm{Al}}}$
6. SPINEL GR.—I.	Spinel, 370.	$(\dot{\mathrm{Mg}},\,\dot{\mathrm{Ca}},\,\dot{\mathrm{Fe}},\,\dot{\mathrm{Zn}})\,\dddot{\overline{\mathrm{Al}}}$
	Magnesian,	$\dot{\mathrm{Mg}}\,\dddot{\overline{\mathrm{Al}}}$
	Pleonaste,	$(\dot{\mathrm{Mg}},\,\dot{\mathrm{Fe}})\,\dddot{\overline{\mathrm{Al}}}$
	Automolite,	$\dot{\mathrm{Zn}}\,\dddot{\overline{\mathrm{Al}}}$
	Hercinite,	$\dot{\mathrm{Fe}}\,\dddot{\overline{\mathrm{Al}}}$
	Chlorospinel,	$\dot{\mathrm{Mg}}\,(\dddot{\overline{\mathrm{Al}}},\,\dddot{\overline{\mathrm{Fe}}})$.
	Dysluite,	$(\dot{\mathrm{Zn}},\,\dot{\mathrm{Mn}})\,(\dddot{\overline{\mathrm{Al}}},\,\dddot{\overline{\mathrm{Fe}}})$.
	Kreittonite,	$(\dot{\mathrm{Zn}},\,\dot{\mathrm{Fe}})\,(\dddot{\overline{\mathrm{Al}}},\,\dddot{\overline{\mathrm{Fe}}})$.
	Sapphirine,	$(\dot{\mathrm{Mg}},\,\dot{\mathrm{Fe}})\,\dddot{\overline{\mathrm{Al}}}$
	Magnetite, 434.	$\dot{\mathrm{Fe}}\,\dddot{\overline{\mathrm{Fe}}}$.
	Franklinite, 435.	$(\dot{\mathrm{Mn}},\,\dot{\mathrm{Fe}},\,\dot{\mathrm{Zn}})\,(\dddot{\overline{\mathrm{Fe}}},\,\dddot{\overline{\mathrm{Mn}}})$.
	Chromic Iron, 435.	$(\dot{\mathrm{Mg}},\,\dot{\mathrm{Fe}})\,(\dddot{\overline{\mathrm{Cr}}},\,\dddot{\overline{\mathrm{Al}}})$.
7. HAUSMANNITE GR.—III.	Hausmannite, 457.	$\dot{\mathrm{Mn}}\,\dddot{\overline{\mathrm{Mn}}}$.
8. CREDNERITE GR.—IV.	Crednerite, 460.	$(\dot{\mathrm{Ba}},\,\dot{\mathrm{Cu}})^3\,\dddot{\overline{\mathrm{Mn}}}^2$.
9. TENORITE GR.—VI.	Tenorite, 518.	$\overline{\mathrm{Cu}}\,\mathrm{O}^2$.
	Plattnerite, 496.	$\mathrm{Pb\,O}^2$.
10. MELACONITE GR.—I.	Melaconite, 518.	$\overline{\mathrm{Cu}}\,\mathrm{O}^2$.
11. PYROLUSITE GR.—III.	Pyrolusite, 457.	$\mathrm{Mn\,O}^2$.
12. MINIUM GR.—III.	Minium, 495.	$\dot{\mathrm{Pb}}^2\,\ddot{\mathrm{Pb}}$.

b. Hydrous.

1. Diaspore Gr.—III.	Diaspore, 223, and Appendix.	$\ddot{\overline{\text{Al}}}\,\dot{\text{H}}$.
	Göthite, 437.	$\ddot{\overline{\text{Fe}}}\,\dot{\text{H}}$.
	Manganite, 459.	$\ddot{\overline{\text{Mn}}}\,\dot{\text{H}}$.
2. Gibbsite Gr.	Gibbsite, 224.	$\ddot{\overline{\text{Al}}}\,\dot{\text{H}}^3$.
	Bog Ore, (in part), 436.	$\ddot{\overline{\text{Fe}}}\,\dot{\text{H}}^3$.
3. Brucite Gr.	Brucite, 200.	$\dot{\text{Mg}}\,\dot{\text{H}}$.
4. Völknerite Gr.	Völknerite, 201.	$6\,\dot{\text{Mg}}\,\dot{\text{H}}^2+\ddot{\overline{\text{Al}}}\,\dot{\text{H}}^3$
5. Limonite Gr.	Limonite, 436.	$\ddot{\overline{\text{Fe}}}^2\,\dot{\text{H}}^3$.
6. Psilomelane Gr.	Psilomelane, 459.	$\dot{\text{R}}\,\ddot{\text{Mn}}^2+\dot{\text{H}}$ (or $2\,\dot{\text{H}}$).
	Wad, 461.	
	Earthy Cobalt, 461.	
	Cupreous Manganese, 461.	

2. *Oxyds of the Elements of Groups* II, III.

1. Molybdic Ochre Gr.	Molybdic Ochre, 390.	$\dddot{\text{Mo}}$.
	Tungstic Ochre, 390.	$\dddot{\text{W}}$.
	Uranic Ochre, 407.	$\ddot{\overline{\text{U}}}$.
2. Pitchblende Gr.	Pitchblende, 407.	$\dot{\text{U}}\,\ddot{\overline{\text{U}}}$.
3. White Antim. Gr.—III.	White Antimony, 416.	$\ddot{\overline{\text{Sb}}}$.
4. Arsenite Gr.—I.	Arsenous Acid, 419.	$\ddot{\overline{\text{As}}}$.
	[Bismuth Ochre, 412.	$\ddot{\overline{\text{Bi}}}$.
5. Cervantite Gr.	Cervantite, 417.	$\text{Sb}\,\text{O}^4$.
6. Red Antimony Gr.—IV ?	Red Antimony, 417.	$\text{Sb}\,(\text{O},\text{S})^3$.
7. Tin Ore Gr.—II.	Tin Ore, 385.	$\ddot{\text{Sn}}$.
	Rutile, 387.	$\ddot{\text{Ti}}$.
	[Telluric Ochre, 411.	$\ddot{\text{Te}}$.
8. Brookite Gr.—III.	Brookite, 388.	$\ddot{\text{Ti}}$.
9. Anatase Gr.—III.	Anatase, 389.	$\ddot{\text{Ti}}$.
10. Stiblite Gr.	Stiblite, 417.	$\text{Sb}\,\text{O}^4+\dot{\text{H}}$.

3. *Oxyds of the Elements of Group* IV.

1. Carbonic Acid Gr.	Carbonic Acid, 181.	$\ddot{\text{C}}$.
2. Quartz Gr.	Quartz, 239.	$\dddot{\text{Si}}$.
3. Opal Gr.	Opal, 245.	$\dddot{\text{Si}}\,\dot{\text{H}}^n$.
	Randanite, 246.	$\dddot{\text{Si}}\,\dot{\text{H}}^3$.
4. Sassolin Gr.	Sassolin, 181.	$\ddot{\overline{\text{B}}}\,\dot{\text{H}}^3$.

4. *Oxyds of the Elements of Group* V.

1. Sulphuric Acid Gr.	Sulphuric Acid, 183.	$\dddot{\text{S}}\,\dot{\text{H}}$.
2. Sulphurous Acid Gr.	Sulphurous Acid, 184.	$\ddot{\text{S}}\,\dot{\text{H}}^n$.

IV. FLUORIDS, CHLORIDS, BROMIDS, IODIDS.

1. *Simple or compound Fluorids, Chlorids, Bromids, or Iodids.*

1. Rock Salt Gr.—I.	Fluor Spar, 216.	$Ca\,F$.
	Yttrocerite, 238.	$(Ca, Ce, Y)\,F$.
	Rock Salt, 191.	$Na\,Cl$.
	Sylvine, 191.	$K\,Cl$.
	Sal Ammoniac, 185.	$(N\,H^4)\,Cl$.
	Horn Silver, 544.	$Ag\,Cl$.
	Bromic Silver, 545.	$Ag\,Br$.
	[Iodic Silver, 544.	$Ag\,I$ or $Ag\,I^2$.
	Embolite, 545.	$Ag\,(Cl, Br)$.
2. Cotunnite Gr.	Cotunnite, 496.	$Pb\,Cl$.
3. Calomel Gr.—II.	Native Calomel, 533.	$Hg^2\,Cl$.
	[Coccinite, 534.	Hg and I.
4. Cryolite Gr.—III.	Cryolite, 233.	$3\,Na\,F + Al^2\,F^3$.
	Chiolite, 233.	$3\,Na\,F + 2\,Al^2\,F^3$.
	Chodneffite, 234.	$2\,Na\,F + Al^2\,F^3$.
	[Fluellite, 234.	

2. *Fluorids or Chlorids with Oxyds.*

1. Mendipite Gr.—III.	Mendipite, 496.	$Pb\,Cl + 2\,Pb\,O$.
2. Percylite Gr.—I.	Percylite, 497.	
3. Fluocerine Gr.—I.	Fluocerine, 237.	$Ce^2\,F^3 + 3\,\dddot{Ce}\,\dot{H}$.
4. Fluocerite Gr.—VI.	Fluocerite, 237.	
5. Atacamite Gr.—III.	Atacamite, 518.	$Cu\,Cl + 3\,Cu\,O + 3\,H\,O$.

V. TITANATES, COLUMBATES, TUNGSTATES, MOLYBDATES.

1. *Proper Titanates, Columbates, &c.*

1. Pyrochlore Gr.—I.	Perovskite, 390.	$\dot{Ca}\,Ti$.
	Pyrochlore, 397.	$(\dot{Ca}, Th, \dot{Ce})^2\,Ta$.
	Microlite, 398.	$\dot{Ca}\,Ta$?
2. Pyrrhite Gr.—I.	Pyrrhite, 397.	$\bar{Zr}\,Ta$?
3. Columbite Gr.—III.	Columbite, 401.	$\bar{R}^3\,(Ta, \bar{Ni}, Pe)^2$.
	Yttro-columbite, 399.	$\dot{Y}^3\,Ta$.
	Ferrotantalite, 402.	$\bar{R}\,(Ta, \bar{Ni}, Pe)$.
	Polymignite, 396.	
	Mengite, 396.	
	Euxenite, 400.	
	Polycrase, 400.	

	Æschynite, 395.	
	Samarskite, 403.	
	Wolfram, 408.	$(\dot{Fe}, \dot{Mn})\dddot{W}$.
4. FERGUSONITE GR.—II.	Fergusonite, 399.	$(\dot{Y}, \dot{Ce})^6 Ta$.
	Scheelite, 405.	$\dot{Ca}\dddot{W}$.
	Scheeletine, 406.	$\dot{Pb}\dddot{W}$.
	Wulfenite, 406.	$\dot{Pb}\overline{Mo}$.

2. *Silico-Titanates or Silico-Columbates.*

1. SPHENE GR.—IV.	Sphene, 391.	$\dot{Ca}^3\dddot{Si}^2\ddot{Ti}^3$.
2. WÖHLERITE GR.	Wöhlerite, 394. Eukolite, 395.	$\overline{Zr}^2 Ta + 10(\dot{Na}, \dot{Ca})^3\dddot{Si}$.
3. KEILHAUITE GR.	Keilhauite, 393.	$3\dot{Ca}^3\dddot{Si} + \overline{R}\dddot{Si} + \dot{Y}\ddot{Ti}^3$.
4. ŒRSTEDITE GR.—II.	Œrstedite, 393. Azorite, 396.	
5. SCHORLOMITE GR.—VI.	Schorlomite, 394.	$2\dot{R}^3\dddot{Si}^2 + 3\dot{R}^2\ddot{Ti}$.
6. WARWICKITE GR.—IV.	Warwickite, 398.	$3\dddot{Si}, 5\ddot{Ti}, 11\dot{R}, 2\overline{Al}, 6\dot{H}$.
7. MOSANDRITE GR.	Mosandrite, 383.	

VI. PHOSPHATES, ARSENATES, ANTIMONATES, VANADATES, CHROMATES.

1. *Anhydrous Species.*

1. CROCOISITE GR.—IV.	Crocoisite, 504.	$\dot{Pb}\dddot{Cr}$.
2. MONAZITE GR.—IV.	Monazite, 235.	$(\dot{Ce}, \dot{La}, \dot{Th})^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$.
	Wagnerite, 216.	$\dot{Mg}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P} + Mg\,F$.
	Magnesian Pharmacolite, 220.	$(\dot{Ca}, \dot{Mg}, \dot{Mn})^3\overset{\cdot\cdot\cdot\cdot\cdot}{As}$.
3. TRIPHYLINE GR.—III.	Triphyline, 448.	$(\dot{Fe}, \dot{Mn}, \dot{Li})^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$.
4. XENOTIME GR.—II.	Xenotime, 237.	$\dot{Y}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$.
	Cryptolite, 236.	$(\dot{La}, \dot{Ce})^3\overset{\cdot\cdot\cdot\cdot\cdot}{P}$.
5. APATITE GR.—VI.	Apatite, 214.	$3\dot{Ca}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P} + Ca\,(Cl, F)$.
	Talc Apatite, 215.	$3(\dot{Ca}, \dot{Mg})^3\overset{\cdot\cdot\cdot\cdot\cdot}{P} + Ca\,(Cl, F)$.
	Pyromorphite, 502.	$3\dot{Pb}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P} + Pb\,(Cl, F)$.
	Mimetene, 503.	$3\dot{Pb}^3\overset{\cdot\cdot\cdot\cdot\cdot}{As} + Pb\,Cl$.
	Hedyphane, 503.	$3(\dot{Pb}, \dot{Ca})^3\overset{\cdot\cdot\cdot\cdot\cdot}{As} + (Pb, Ca)Cl$.
	Vanadinite, 503.	$3\dot{Pb}^3\dddot{V} + Pb\,Cl$.
	Zwieselite, 466 and Appendix,	Fuchs, $3(\dot{Fe}, \dot{Mn})^3\overset{\cdot\cdot\cdot\cdot\cdot}{P} + FeF$. Ramm., $\dot{Fe}^3\overset{\cdot\cdot\cdot\cdot\cdot}{P} + Fe\,F$.
6. MELANOCHROITE GR.—III.	Melanochroite, 505.	$\dot{Pb}^3\dddot{Cr}^2$.
VAUQUELINITE GR.—IV.	Vauquelinite, 505.	$\dot{Cu}^3\dddot{Cr}^2 + 2\dot{Pb}^3\dddot{Cr}^2$.
TRIPLITE GR.—III.	Triplite, 466.	$(\dot{Mn}, \dot{Fe})^4\overset{\cdot\cdot\cdot\cdot\cdot}{P}$.
Unarranged species.	Vanadate of Lead and Copper, 530.	$\dot{Cu}^6\dddot{V} + \dot{Pb}^6\dddot{V}$.

7. AMBLYGONITE GR.—III.	Amblygonite, 282.	
	[Herderite, 282.	
	[Childrenite, 283.	
8. ROMEINE GR.—II.	Romeine, 416.	$\dot{Ca}^4 \ddot{Sb}^3$.
	[Antimonite of Mercury, 584.	$\bar{Hg}$ and $\ddot{Sb}$.
9. NITRE GR.—III.	Nitre, 189.	$\dot{K}\overset{\cdot\cdot\cdot\cdot\cdot}{N}$.
10. NITRATINE GR.—VI.	Soda Nitre, (Nitratine), 190.	$\dot{Na}\overset{\cdot\cdot\cdot\cdot\cdot}{N}$.

2. *Hydrous Species.*

a. Salts of protoxyds.

1. VIVIANITE GR.—IV.	Vivianite, 449.	$\dot{Fe}^3 \overset{\cdot\cdot\cdot\cdot\cdot}{P}+8\dot{H}$.
	Cobalt Bloom, 477.	$\dot{Co}^3 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+8\dot{H}$.
	Nickel Green, 478.	$\dot{Ni}^3 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+8\dot{H}$.
	Symplesite, 454.	$\dot{Fe}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}$, Aq.
	Köttigite, 487.	$(\dot{Zn}, \dot{Co}, \dot{Ni})^3 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+8\dot{H}$.
2. BLEINIERITE GR.	Bleinierite, 506.	$\dot{Pb}^3 \ddot{\bar{Sb}}+4\dot{H}$.
3. PHARMACOLITE GR.—IV.	Pharmacolite, 219.	$\dot{Ca}^3 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+6\dot{H}$.
4. HAIDINGERITE GR.—III.	Haidingerite, 220.	$\dot{Ca}^3 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+4\dot{H}$.
5. HOPEITE GR.—III.	Hopeite, 484.	$\dot{Zn}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{P}$, $\dot{H}$?
6. STRUVITE GR.—III.	Struvite, 186.	$(NH^4O+\dot{Mg})\overset{\cdot\cdot\cdot\cdot\cdot}{P}+4\dot{H}$.
	[Stercorite, 186.	$(NH^4O+\dot{Na})\overset{\cdot\cdot\cdot\cdot\cdot}{P}+9\dot{H}$.
7. OLIVENITE GR.—III.	Olivenite, 526.	$\dot{Cu}^4 (\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}, \overset{\cdot\cdot\cdot\cdot\cdot}{P})+\dot{H}$.
	Libethenite, 525.	$\dot{Cu}^4 \overset{\cdot\cdot\cdot\cdot\cdot}{P}+\dot{H}$.
	Conichalcite, 527.	$(\dot{Cu}, \dot{Ca})^4 (\overset{\cdot\cdot\cdot\cdot\cdot}{P}, \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}})+\dot{H}$.
8. EUCHROITE GR.—III.	Euchroite, 527.	$\dot{Cu}^4 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+7\dot{H}$.
9. COPPER MICA GR.—VI.	Copper Mica, 529, Chenevix,	$\dot{Cu}^8 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+12\dot{H}$.
	Damour,	$\dot{Cu}^6 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+12\dot{H}$.
	Hermann,	$\dot{Cu}^8 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+23\dot{H}$.
APHANESITE GR.—IV.	Aphanesite, 528.	$\dot{Cu}^6 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+3\dot{H}$.
	Phosphorochalcite(in part),524.	$\dot{Cu}^6 \overset{\cdot\cdot\cdot\cdot\cdot}{P}+3\dot{H}$.
Unarranged species.	Phosphorochalcite(in part),524.	$\dot{Cu}^5 \overset{\cdot\cdot\cdot\cdot\cdot}{P}+2\frac{1}{2}\dot{H}$.
	Prasine, 525.	$\dot{Cu}^6 \overset{\cdot\cdot\cdot\cdot\cdot}{P}+2\dot{H}$.
	Erinite, 528.	$\dot{Cu}^5 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+2\dot{H}$.
	Ehlite, 525.	$\left\{\begin{matrix}\dot{Cu}^5 \overset{\cdot\cdot\cdot\cdot\cdot}{P}+3\dot{H}\\ \dot{Cu}^4 \overset{\cdot\cdot\cdot\cdot\cdot}{P}+2\dot{H}\end{matrix}\right.$
	Tagilite, 525.	$\dot{Cu}^4 \overset{\cdot\cdot\cdot\cdot\cdot}{P}+3\dot{H}$.
	Cornwallite, 528.	$\dot{Cu}^5 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+5\dot{H}$.
	Tyrolite, 527.	$\dot{Cu}^8 \overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}+10\dot{H}+\dot{Ca}\ddot{C}$?
	Thrombolite, 524.	$\dot{Cu}^3 \overset{\cdot\cdot\cdot\cdot\cdot}{P}^2+6\dot{H}$.
	Liroconite, 530.	$25\,\dot{Cu}, 5\,\dddot{\bar{Al}}, 6\,(\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}, \overset{\cdot\cdot\cdot\cdot\cdot}{P}), 75\,\dot{H}$.
10. VOLBORTHITE GR.—VI.	Volborthite, 530, 1st var.	$5\,\dot{Cu}^4 \dddot{V}+2\,\dot{Ca}^4 \dddot{V}+7\dot{H}$.
	2d var.	$3\,\dot{Cu}^4 \dddot{V}+2\,\dot{Ca}^4 \dddot{V}+5\dot{H}$.

11. Nitrocalcite Gr.	Nitrocalcite, 204.	$\dot{\mathrm{Ca}}\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}+\dot{\mathrm{H}}$.
	Nitromagnesite, 204.	$\dot{\mathrm{Mg}}\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}+\dot{\mathrm{H}}$.

b. Salts of peroxyds.

1. Scorodite Gr.—III.	Scorodite, 451.	$\bar{\mathrm{Fe}}\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+4\,\dot{\mathrm{H}}$.
2. Turquois Gr.	Turquois, 229.	$\bar{\mathrm{Al}}^2\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+5\,\dot{\mathrm{H}}$?
	[Fischerite, 230.	$\bar{\mathrm{Al}}^2\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+8\,\dot{\mathrm{H}}$.
3. Wavellite Gr.—III.	Wavellite, 231.	$\bar{\mathrm{Al}}^4\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}{}^3+18\,\dot{\mathrm{H}}+\tfrac{1}{2}\,\mathrm{Al\,F}^3$.
	Cacoxene, 231.	$(\bar{\mathrm{Fe}},\bar{\mathrm{Al}})^4\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}{}^3+18\dot{\mathrm{H}}+\tfrac{1}{2}\mathrm{AlF}^3$.

Unarranged phosphates of protoxyds of Iron.

	Carphosiderite, 452.	
	Dufrenite, 450.	$\bar{\mathrm{Fe}}^2\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+2\tfrac{1}{2}\,\dot{\mathrm{H}}$.
	Delvauxene, 451.	$\bar{\mathrm{Fe}}^2\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+24\,\dot{\mathrm{H}}$ (or $18\,\dot{\mathrm{H}}$).
	Pseudotriplite (al'd triphyline), 451.	

c. Salts of protoxyds and peroxyds.

4. Cube Ore Gr.—I.	Cube Ore, 453.	$\dot{\mathrm{Fe}}^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+\bar{\mathrm{Fe}}^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}{}^2+18\,\dot{\mathrm{H}}$.
5. Alluaudite Gr.—III. ?	Alluaudite, 453.	$(\dot{\mathrm{Mn}},\dot{\mathrm{Na}})^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\bar{\mathrm{Fe}}\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\dot{\mathrm{H}}$.
6. Lazulite Gr.—IV.	Lazulite, 229.	$2\,\dot{\mathrm{R}}^3\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\bar{\mathrm{Al}}^4\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}{}^3+6\,\dot{\mathrm{H}}$.
7. Arseniosiderite Gr.	Arseniosiderite, 452.	$\dot{\mathrm{Ca}}^6\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+4\,\bar{\mathrm{Fe}}^2\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}+15\,\dot{\mathrm{H}}$.
8. Uranite Gr.	Uranite, 409.	$\dot{\mathrm{Ca}}^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\bar{\mathrm{U}}^4\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+16\,\dot{\mathrm{H}}$.
	Chalcolite, 409.	$\dot{\mathrm{Cu}}^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+\bar{\mathrm{U}}^4\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+16\,\dot{\mathrm{H}}$.
9. Plumboresinite Gr.	Plumboresinite, 506.	$\dot{\mathrm{Pb}}^3\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}+6\,\bar{\mathrm{Al}}\,\dot{\mathrm{H}}^3$.

Unarranged phosphates or arsenates of peroxyds and protoxyds.

	Heterosite, (alter'd triphyline), 449.	
	Hureaulite, 466, " "	

d. Arsenate and sulphate.

1. Pitticite Gr.	Pitticite, 453.	$\bar{\mathrm{Fe}}^2\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{As}}{}^2+\bar{\mathrm{Fe}}\,\dddot{\mathrm{S}}^2+30\,\dot{\mathrm{H}}$.
	Diadochite, 454.	$\bar{\mathrm{Fe}}^2\,\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}{}^3+2\,\bar{\mathrm{Fe}}\,\dddot{\mathrm{S}}^2+36\,\dot{\mathrm{H}}$.

VII. SULPHATES—SELENATES.

1. *Anhydrous.*

1. Barytes Gr.—III.	Heavy Spar, 194.	$\dot{\mathrm{Ba}}\,\dddot{\mathrm{S}}$.
	Celestine, 196.	$\dot{\mathrm{Sr}}\,\dddot{\mathrm{S}}$.
	Anglesite, 499.	$\dot{\mathrm{Pb}}\,\dddot{\mathrm{S}}$.
	Anhydrite, 202.	$\dot{\mathrm{Ca}}\,\dddot{\mathrm{S}}$.
	Thenardite, 189.	$\dot{\mathrm{Na}}\,\dddot{\mathrm{S}}$.
	Aphthitalite, 187.	$\dot{\mathrm{K}}\,\dddot{\mathrm{S}}$.
2. Dreelite Gr.—VI.	Dreelite, 195.	$(\dot{\mathrm{Ca}},\dot{\mathrm{Ba}})\dddot{\mathrm{S}}$.
3. Glauberite Gr.—IV.	Glauberite, 189.	$(\dot{\mathrm{Ca}},\dot{\mathrm{Na}})\dddot{\mathrm{S}}$.
4. Selenate of Lead.—504.		

2. *Hydrous.*

a. Salts of protoxyds.

1. Gypsum Group.—IV.	Gypsum, 201.	$\dot{Ca}\dddot{S}+2\dot{H}$.
	[Exanthalose, 188.	$\dot{Na}\dddot{S}+2\dot{H}$.
	[Astrakanite, 188.	$(\dot{Mg},\dot{Na})\dddot{S}+2\dot{H}$.
2. Mascagnine Gr.—III.	Mascagnine, 185.	$(NH^4O)\dddot{S}+\dot{H}$.
3. Polyhalite Gr.—III.	Polyhalite, 187.	$(\dot{K},\dot{Mg},\dot{Ca})\dddot{S}+\frac{1}{3}\dot{H}$.
4. Löweite Gr.	Löweite, Appendix.	$2(\dot{Na},\dot{Mg})S+2\frac{1}{2}\dot{H}$.
	Bloedite, 183.	
5. Vitriol Gr.—V.	Blue Vitriol, 522.	$\dot{Cu}\dddot{S}+5\dot{H}$.
6. Copperas Gr.—IV.	Copperas, 446.	$\dot{Fe}\dddot{S}+7\dot{H}$.
	White Vitriol, 486.	$\dot{Zn}\dddot{S}+7\dot{H}$.
	Cobalt Vitriol, 476.	$\dot{Co}\dddot{S}+7\dot{H}$.
	Nickel Vitriol.	
	Epsomite, 203.	$\dot{Mg}\dddot{S}+7\dot{H}$.
	Johannite, 408.	$\dot{U}$, $\dddot{S}$ and $\dot{H}$.
7. Glauber Salt Gr.—IV.	Glauber Salt, 188.	$\dot{Na}\dddot{S}+10\dot{H}$.
8. Brochantite Gr.—III.	Brochantite, 523.	$\dot{Cu}\dddot{S}+3\dot{Cu}\dot{H}$.
9. Linarite Gr.—IV.	Linarite, 500.	$\dot{Pb}\dddot{S}+\dot{Cu}\dot{H}$.

b. Salts of peroxyds.

1. Websterite Gr.	Websterite, 227.	$\dddot{\bar{Al}}\dddot{S}+9\dot{H}$.
	[Pissophane, 228.	
2. Coquimbite Gr.—VI.	Coquimbite, 447.	$\dddot{\bar{Fe}}\dddot{S}^3+9\dot{H}$.
	[Copiapite, 448.	$\left\{\begin{array}{l}\dddot{\bar{Fe}}^2\dddot{S}^5+18\dot{H}.\\ \dddot{\bar{Fe}}\dddot{S}^2+10\frac{1}{2}\dot{H}.\end{array}\right.$
	[Pittizite, 448.	$\dddot{\bar{Fe}}^2\dddot{S}+6\dot{H}$.
	[Fibroferrite, 448.	$\dddot{\bar{Fe}}^2S^3+18\dot{H}$.
	[Apatelite, 448.	$\dddot{\bar{Fe}}^2\dddot{S}^3+1\frac{1}{2}\dot{H}$.
3. Alunogen Gr.	Alunogen, 224.	$\dddot{\bar{Al}}\dddot{S}^3+18\dot{H}$.

c. Salts of protoxyds and peroxyds.

4. Alunite Gr.	Alunite, 228.	$\dot{K}\dddot{S}+3\dddot{\bar{Al}}\dddot{S}+6\dot{H}$.
5. Alum Gr.—I.	Potash Alum, 225.	$\dot{K}\dddot{S}+\dddot{\bar{Al}}\dddot{S}^3+24\dot{H}$.
	Soda Alum, 226.	$\dot{Na}\dddot{S}+\dddot{\bar{Al}}\dddot{S}^3+24\dot{H}$.
	Magnesia Alum, 226.	$\dot{Mg}\dddot{S}+\dddot{\bar{Al}}\dddot{S}^3+24\dot{H}$.
	Iron Alum, 226.	$\dot{Fe}\dddot{S}+\dddot{\bar{Al}}\dddot{S}^3+24\dot{H}$.
	Manganesian Alum, 226.	$\dot{Mn}\dddot{S}+\dddot{\bar{Al}}\dddot{S}^3+24\dot{H}$.
	Ammonia Alum, 227.	$(NH^4O)\dddot{S}+\dddot{\bar{Al}}\dddot{S}^3+24\dot{H}$.
	Voltaite, 226.	$\dot{R}\dddot{S}+\frac{1}{3}\dddot{\bar{R}}\dddot{S}^3+4\dot{H}$.
6. Potash-copperas Gr.	Potash Copperas, 447.	$\dot{K}\dddot{S}+\dddot{\bar{Fe}}\dddot{S}+9\dot{H}$.
	Soda Copperas, 447.	$\dot{Na}\dddot{S}+\dddot{\bar{Fe}}\dddot{S}+9\dot{H}$.
7. Botryogen Gr.—IV.	Botryogen, 448.	$\dot{Fe}^3\dddot{S}^2+3\dddot{\bar{Fe}}\dddot{S}^2+36\dot{H}$.

8. Lettsomite Gr.	Lettsomite, 522.	$(\dot{Cu}\dddot{S}+3\dot{Cu}\dot{H})+(\dddot{\bar{Al}}\dddot{S}+9\dot{H})$
9. Medjidite Gr.	Medjidite, 410.	$\dot{Ca}\dddot{S}+\dddot{\bar{U}}\dddot{S}+15\dot{H}$

d. Sulphato-carbonates.

1. Lanarkite Gr.—IV.	Lanarkite, 501.	$\dot{Pb}\dddot{S}+\dot{Pb}\ddot{C}$
	Leadhillite, 501.	$\dot{Pb}\dddot{S}+3\dot{Pb}\ddot{C}$
	[Sulphato-carb. Baryta, 197.	$\dot{Ba}\dddot{S}+2\dot{Ba}\ddot{C}$
2. Caledonite Gr.—III.	Caledonite, 500.	$\dot{Pb}\dddot{S}$, and $\dot{Cu}\ddot{C}$

e. Sulphato-chlorids.

1. Connellite Gr.—VI.	Connellite, 523.	Sulphato-chlorid of $\dot{Cu}$?

VIII. CARBONATES.

1. *Anhydrous.*

1. Calcite Gr.—VI.	Calcite, 205.	$\dot{Ca}\ddot{C}$
	Magnesite, 210.	$\dot{Mg}\ddot{C}$
	Dolomite, 210.	$(\dot{Mg},\dot{Ca})\ddot{C}$
		$\dot{Mg}\ddot{C}+\dot{Ca}\ddot{C}$
		$2\dot{Mg}\ddot{C}+3\dot{Ca}\ddot{C}$
		$\dot{Mg}\ddot{C}+2\dot{Ca}\ddot{C}$
		$\dot{Mg}\ddot{C}+3\dot{Ca}\ddot{C}$, (Gurhofian).
		$\dot{Mg}\ddot{C}+5\dot{Ca}\ddot{C}$
		$3\dot{Mg}\ddot{C}+\dot{Ca}\ddot{C}$, (Conite).
		$\dot{Ca}\ddot{C}+(\dot{Mg},\dot{Fe})\ddot{C}$. (Anker-
		$\dot{Ca}\ddot{C}+(\dot{Mg},\dot{Fe},\dot{Co})\ddot{C}$ [ite).
	Breunnerite, 212.	$(\dot{Mg},\dot{Fe},\dot{Mn})\ddot{C}$
		$10\dot{Mg}\ddot{C}+\dot{Fe}\ddot{C}$
		$8\dot{Mg}\ddot{C}+\dot{Fe}\ddot{C}$
		$6\dot{Mg}\ddot{C}+\dot{Fe}\ddot{C}$
		$\dot{Mg}\ddot{C}+\dot{Fe}\ddot{C}$
		$2\dot{Mg}\ddot{C}+\dot{Fe}\ddot{C}$
	Spathic Iron, 444.	$\dot{Fe}\ddot{C}$
		$2\dot{Fe}\ddot{C}+\dot{Mg}\ddot{C}$
		$3\dot{Fe}\ddot{C}+2\dot{Mn}\ddot{C}$, (Oligon)
		$4\dot{Fe}\ddot{C}+\dot{Mn}\ddot{C}$
	Diallogite, 465.	$\dot{Mn}\ddot{C}$
	Calamine, 485.	$\dot{Zn}\ddot{C}$
2. Arragonite Gr.—III.	Arragonite, 208.	$\dot{Ca}\ddot{C}$
	Witherite, 197.	$\dot{Ba}\ddot{C}$
	Strontianite, 197.	$\dot{Sr}\ddot{C}$
	Manganocalcite, 466.	$(\dot{Mn},\dot{Ca},\dot{Mg})\ddot{C}$
	Cerusite, 496.	$\dot{Pb}\ddot{C}$
	Bromlite, 198.	$(\dot{Ba},\dot{Ca})\ddot{C}$

3. Baryto-calcite Gr.—IV.	Baryto-calcite, 198.	$(\dot{Ba}, \dot{Ca})\ddot{C}$
4. Selbite Gr.	Selbite, 545.	$\dot{Ag}\ddot{C}$.
5. Parisite Gr.—VI.	Parisite, 235.	$8(\dot{Ce},\dot{La})\ddot{C}+2CaF+\dot{R}\dot{H}^2$.

2. *Hydrous.*

1. Thermonatrite Gr.—III.	Thermonatrite, 190.	$\dot{Na}\ddot{C}+\dot{H}$.
2. Natron Gr.—IV.	Natron, 190.	$\dot{Na}\ddot{C}+10\dot{H}$.
3. Trona Gr.—IV.	Trona, 191.	$\dot{Na}^2\ddot{C}^3+4\dot{H}$.
4. Gay-Lussite Gr.—IV.	Gay-Lussite, 191.	$(\dot{Na}, \dot{Ca})\ddot{C}+2\frac{1}{2}\dot{H}$.
5. Lancasterite Gr.—IV ?	Lancasterite, 213.	$\dot{Mg}\ddot{C}+\dot{Mg}\dot{H}^2$.
6. Hydrocalcite Gr.	Hydrocalcite, 212.	$\dot{Ca}\ddot{C}+5\dot{H}$.
7. Hydromagnesite Gr.	Hydromagnesite, 213.	$\dot{Mg}^4\ddot{C}^3+4\dot{H}$.
	Hydrodolomite, 213.	$(\dot{Ca}, \dot{Mg})^4\ddot{C}^3+4\dot{H}$.
	[Pennite, 214.	$\dot{R}\ddot{C}+\frac{1}{2}\dot{H}$.
8. Lanthanite Gr.—II.	Lanthanite, 238.	$\dot{La}^2\ddot{C}+3\dot{H}$.
9. Zinc Bloom Gr.	Zinc Bloom, 485.	$\dot{Zn}^3\ddot{C}+3\dot{H}$.
	[Emerald Nickel, 476.	$\dot{Ni}^3\ddot{C}+6\dot{H}$.
10. Malachite Gr.—IV.	Green Malachite, 521.	$\dot{Cu}^2\ddot{C}+\dot{H}$.
	[Aurichalcite, 486.	$\dot{Cu}^2\ddot{C}+\dot{Zn}^3\ddot{C}+3\dot{H}$.
	[Buratite, 486, 522.	
11. Azurite Gr.—IV.	Blue Malachite, 521.	$2\dot{Cu}\ddot{C}+\dot{Cu}\dot{H}$.
12. Bismutite Gr.	Bismutite, 413.	$\dddot{Bi}^4, \ddot{C}^3, \dot{H}^4$.
13. Liebigite Gr.	Liebigite, 410.	$\dot{Ca}\ddot{C}+\dddot{U}\ddot{C}+20\dot{H}$.

3. *Chloro-Carbonates.*

1. Corneous Lead Gr.—II.	Corneous Lead, 497.	$\dot{Pb}\ddot{C}+PbCl$

IX. BORATES.

1. *Anhydrous.*

1. Boracite Gr. —I.	Boracite, 218.	$\dot{Mg}^3\dddot{B}^4$.
	Rhodazite, 219.	

2. *Hydrous.*

1. Hayesine Gr.	Hayesine, 217.	$\dot{Ca}\dddot{B}^2+6\dot{H}$.
2. Ulexite Gr.	Ulexite, 217.	$\dot{Ca}^2\dddot{B}^3+\dot{Na}\dddot{B}^2+10\dot{H}$.
3. Hydroboracite Gr.	Hydroboracite, 218.	$(\dot{Ca}, \dot{Mg})^3\dddot{B}^4+9\dot{H}$.
4. Borax Gr.—IV.	Borax, 193.	$\dot{Na}\dddot{B}^2+10\dot{H}$.

X. SILICATES.

1. *Anhydrous.*

a. Silicates of protoxyds.

		Oxygen ratio. $\dot{R} : \dddot{Si}$.
1. CHRYSOLITE GR.—III.	Chrysolite, 278.	1 : 1, R=Mg, Fe.
	Somma Chrysolite, 278.	1 : 1, R=Ca, Mg.
	Iron Chrysolite, 278.	1 : 1, R=Fe.
	Fayalite, 278.	
	Knebelite, 464.	1 : 1, R=Mn, Fe.
	Tephroite, 464.	1 : 1, R=Mn.
	Forsterite, 277.*	
2. WILLEMITE GR.—VI.	Willemite, 483.	1 : 1, R=Zn.
3. GADOLINITE GR.—IV.	Gadolinite, 382.	1 : 1, R=Ce, Y.
4. BOLTONITE GR.—V ?	Boltonite, 281.	1 : 1½, R=Mg.
5. AUGITE GR.—IV.	Pyroxene, 266.	1 : 2, R=Ca, Mg, Fe.
	Wollastonite, 265.	1 : 2, R=Ca.
	Rhodonite, 462.	1 : 2, R=Mn.
	Acmite, 271. $\dot{R} : \ddot{\bar{R}} : \dddot{Si}=1 : 3 : 9$.	
	Hornblende, 272.	1 : 2¼, R=Ca, Mg, Fe.
	[Babingtonite, 276.	1 : 2¼.
	Nephrite, 277.	
6. EDELFORSITE GR.	Edelforsite, 266.	1 : 3, R=Ca.
	Mancinite, 483.	1 : 3, R=Zn.
7. TALC GR.	Talc, (Steatite), 251.	1 : 3, R=Mg.
	" variety.	1 : 2½.
	" "	1 : 2⅔.
	" "	1 : 2¼.

b. Silicates of peroxyds.

		$\ddot{\bar{R}} : \dddot{Si}$.
1. ANDALUSITE GR.—III.	Andalusite, 317.	3 : 2, R=Al.
	" variety.	4 : 3.
2. KYANITE GR.—V.	Kyanite, 314.	3 : 2.
	" variety.	5 : 4.
	Sillimanite, 315.	3 : 2, R=Al.
	" variety.	6 : 5.
	" "	5 : 4.
	Bucholzite, 315.	1 : 1, R=Al.
	" variety.	4 : 3.
	" "	3 : 2.

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* White Chrysolite, like Monticellite, p. 279, according to Scacchi, Quadri Crist. p. 63.

		$\dddot{\bar{R}} : \dddot{Si}$
3. STAUROTIDE GR.—III.	Staurotide, 319.	2 : 1, R=Al, Fe.
4. BAMLITE GR.—IV ?	Bamlite, 320.	2 : 3, R=Al.
5. ZIRCON GR.—II.	Zircon, 379, $\dddot{\bar{Zr}}\,\dddot{Si}$.	1 : 1.
	" Malacone var. ?	
6. OSTRANITE GR.—III.	Ostranite, 380.	
7. BERYL GR.—VI.	Emerald, 378, $(\frac{1}{2}\dddot{\bar{Be}}+\frac{1}{2}\dddot{\bar{Al}})\,\dddot{Si}^2$.	1 : 2.
	Phenacite, 375, $\dddot{\bar{Be}}\,\dddot{Si}$.	1 : 1.
8. EUCLASE GR.—IV.	Euclase, 375, $(\frac{1}{2}\dddot{\bar{Be}}+\frac{1}{2}\dddot{\bar{Al}})^4\,\dddot{Si}^3$.	4 : 3.

c. Silicates of protoxyds and peroxyds.

		$\dot{R} : \dddot{\bar{R}} : \dddot{Si}$	
1. GARNET GR.—I.	Garnet, 346.	1 : 1 : 2.	A*
	Pyrope, 349, and Appendix.	1 : 1 : 2.	
2. IDOCRASE GR.—II.	Idocrase, 350 and Appendix.	1 : ⅔ : 1⅔.	B
	" variety.	1 : 1 : 2.	AA
3. EPIDOTE GR.—IV.	Epidote, 362 and Appendix.	1 : 2 : 3.	
	Allanite, 354.	1 : 1 : 2.	AAA
	" variety.	1 : ⅔ : 1⅔.	BB
	" Orthite.	1 : 1 : 2+n$\dot{H}$.	
Unarranged.	Bodenite, 383.	1 : ½ : 1.	
	Muromontite, 383.		
4. EUDIALYTE GR.—VI.	Eudialyte, 378, $2\dot{R}^3\dddot{Si}^2+\dddot{\bar{Zr}}\,\dddot{Si}^2$.	1 : ½ : 3.	
5. HEXAG. MICA GR.—VI.	Hexagonal Mica, 360.	1 : 1 : 2.	AAAA
6. RHOMBIC MICA GR.—III.	Rhombic Mica. 359.	1 : ⅔ : 1⅔.	BBB
7. OBLIQUE MICA GR.—IV.	Oblique Mica, 358 and Appen.	1 : 12 : 16.	
	var., Rammelsberg,	1 : 6 : 9.	
	[Lithia Mica, 361.		
8. MARGARITE GR.	Margarite, 362.	1 : 4 : 2⅔ ?	
	Emerylite, 362.	1 : 6 : 4.	
	Euphyllite, 362.	1 : 12 : 12 (or 13).	
9. YENITE GR.—III.	Lievrite, 438.	1 : ⅔ : 1⅓.	
	Wehrlite, 439.	'	
Unarranged Species.	Wichtyne, 345.	1 : 1 : 4.	
	Glaucophane, 345.	1 : ⅔ : 3⅓.	
	Chlorite Spar, 293.	1 : 3 : 2.	
10. SCAPOLITE GR.—II.	Scapolite, 340.	1 : 2 : 4.	
	Meionite, 340.	1 : 2 : 3.	C
	Wernerite, 340.	1 : 3 : 4.	D
	" variety.	1 : 3 : 4½.	E
	Dipyre, 344.	1 : 2½ : 5½.	
	Barsowite, Bytownite, 342.	1 : 3 : 5.	F

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* In the following silicates, the instances of similar composition with different crystallization (or cases of pleomorphism) are indicated by letters of the alphabet.

		$\dot{R} : \bar{\text{Al}} : \dddot{\text{Si}}$	
	Gehlenite, 342.	$1 : 1 : 1\frac{1}{2}$.	
	Humboldtilite, 343.	$1 : \frac{1}{2} : 1\frac{1}{2}$.	
11. NEPHELINE GR.—VI.	Nepheline, 323.	$1 : 3 : 4\frac{1}{2}$.	EE
	Davyne, 324.	$1 : 3 : 4\frac{1}{2}+\frac{1}{3}\dot{R}\ddot{C}$.	
	Iolite, 344.	1 : 3 : 5.	FF
12. FELDSPAR GR.			
1. *Monoclinic.*	Orthoclase, 325.	1 : 3 : 12.	G
	Loxoclase, 330.	1 : 3 : 9.	H
	Ryacolite, 330.	1 : 3 : 6.	K
	Baulite, 330.	1 : 3 : 24.	
	Castor, 339.	1 : 6 : 27.	
	Thiorsauite, 336.	$1 : 2\frac{1}{2} : 4\frac{1}{2}$.	
	Petalite,* 338.	1 : 4 : 20.	
2. *Triclinic.*	Albite, 330.	1 : 3 : 12	GG
	Oligoclase, 332.	1 : 3 : 9.	HH
	Labradorite, 333.	1 : 3 : 6.	KK
	Andesine, 334.	1 : 3 : 8.	L
	Anorthite, 334.	1 : 3 : 4.	DD
	Lepolite, 335.	1 : 3 : 4.	DDD
	Vosgite, 336.	1 : 3 : 5.	FFF
	Hyposclerite, 337.	1 : 2 : 6.	
3. *Unarranged.*	Couzeranite, 336.	1 : 2 : 3.	CC
	Saussurite, 337.	1 : 2 : 3. ?	
	Latrobite, 337.	1 : 4 : 5.	
13. SPODUMENE GR.—III.	Spodumene, 339, Kobell.	1 : 4 : 10.	
	" Berzelius.	1 : 4 : 12. ?	
14. LEUCITE GR.—I.	Leucite, 332.	1 : 3 : 8.	LL

d. Silicates of oxyds of Elements of Group III.

15. BISMUTH BLENDE GR.	Bismuth Blende, 413.	$\dddot{\text{Bi}}^2\dddot{\text{Si}}^3$.

2. *Hydrous.*

a. Silicates of protoxyds.

[As there is no good ground for the grouping of many of the following hydrous silicates according to their strict relations, since most of them are uncrystallised, we have ar-aranged a portion of them according to numerical order in their constitution, nearly as done in a recent table by Rammelsberg.]

			$\dot{R} : \dddot{\text{Si}} : \dot{H}$
1. CERITE GR.—VI.	Cerite, 381.	R=Ce, La.	1 : 1 : 1.
	Thorite, 381.	R=Th.	1 : 1 : 1.
2. ELEC. CALAMINE GR.—III.	Electric Calamine, 482.	R=Zn.	$1 : 1 : \frac{1}{3}$ (or $\frac{1}{2}$).
3. DIOPTASE GR.—VI.	Dioptase, 519.	R=Cu.	1 : 2 : 1.
	Chrysocolla, 519.		1 : 2 : 2 (or 4).

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* This species is placed improperly in the Triclinic division, on page 321.

		$\dot{R}:\dddot{S}i:\dot{H}$
4. OKENITE GR.	Okenite, 447.	1 : 4 : 2.
5. PECTOLITE GR.	Pectolite, 248. $(\dot{C}a,\dot{N}a)^4\dddot{S}i^3+\dot{H}$.	1 : 2¼ : ¼.
6. APOPHYLLITE GR.—II.	Apophyllite, 248. $(\dot{C}a,\dot{K})\dddot{S}i+2\dot{H}$?	
Unarranged Species.	Sideroschisolite, 442.	1 : ⅓ : ⅙.
(*Hydrous silicates of magnesia*	Villarsite, 257.	1 : 1 : ¼.
or other protoxyd bases.)	Retinalite, 257.	
	Deweylite, 257.	
	Serpentine, 254.	1 : 1⅓ : ⅔.
	Metaxite, Kühn's, 256.	1 : 1⅓ : ⅔
	Antigorite, 260.	1 : 1⅓ : ¼ (⅓ ?)
	Bowenite, 265.	1 : 1½ : ⅔.
	Hydrophite, 259.	1 : 1⅓ : 1½ (or 1).
	Gymnite.	1 : 1½ : 1⅓.
	Schiller Spar, 260.	1 : 1⅗ : ⅘.
	Monradite, 259.	1 : 2 : ¼.
	Picrosmine, 258.	1 : 2 : ⅓.
	Aphrodite, 254.	1 : 2 : ½.
	Picrophyll, 259.	1 : 2 : ⅔.
	Kerolite, Kühn's, 257.	1 : 2 : 1⅓.
	Dermatine, 256.	1 : 2 : 2.
	Hydrosteatite, 252.	1 : 2⅖ : ⅖.
	Spadaite, 253.	1 : 2⅖ : ⅘.
	Crocidolite, 441.	1 : 2⅓ : ⅓.
	Meerschaum, 253.	1 : 3 : 1 (or 2).
	Saponite, 253.	1 : 3 : 1 (or 1⅓).*
	Chlorophæite, 442.	1 : 3 : 6.

b. Silicates of peroxyds.

		$\ddot{\bar{R}}:\dddot{S}i:\dot{H}$
Unarranged species.		
(*Hydrous silicates of alumina*	Schrötterite, 288.	1 : ⅙ : 1⅓.
or peroxyd of iron.)	Collyrite, 283.	1 : ⅓ : 1⅔.
	Allophane, 289.	1 : ⅔ : 1⅔.
	Pholerite, 288.	1 : 1 : ⅔.
	Kaolin, (in part), 287.	1 : 1 : ⅔.
	Samoine, 288.	1 : 1 : 1⅔.
	Teratolite, 286.	
	Chloropal, 439.	1 : 2 : 1.
	Nontronite, 440.	1 : 2 : 1.
	Rasoumoffskin, 284.	1 : 2 : 1
	Pyrophyllite, 291.	1 : 3 : ⅓.
	Anthosiderite, 439.	1 : 3 : ⅓.
	Cimolite, 285.	1 : 3 : 1.
	Rhodalite of Thomson.	1 : 4 : 3.
	Polyhydrite, 440.	

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* The formula $2\dot{M}g^3\,\dddot{S}i^2+\ddot{\bar{A}}l\,\dddot{S}i+6\dot{H}$ becomes, if $\ddot{\bar{A}}l$ and $\dddot{S}i$ are mutually replaceable, $\dot{M}g\,(\dddot{S}i,\ddot{\bar{A}}l)+\dot{H}$.

c. Silicates of protoxyds and peroxyds.

Unarranged species.		$\dot{R}:\bar{\bar{R}}:\bar{Si}:\dot{H}$
(*Hydrous silicates of magnesia or protoxyd of iron, and a peroxyd*).	Pyrosclerite, 263.	1 : ⅓ : 1⅓ : ⅘.
	Chonikrite, 263.	"
	Kammererite, 263.	1 : ⅓ : 1⅓ : 1.
	Rhodochrome, 263.	
	Vermiculite, 291.	1 : ⅓ : 1⅔ : ⅘.
	Stilpnomelane, 440.	1 : ⅓ : 3 : 1.
	Thuringite, 440.	1 : ⅔ : 1⅓ : 1.
	Chlorite, 261.	1 : ⅔ : 1⅓ : 1.
	Epichlorite, 263.	1 : ⅔ : 2 : 1.
	Cronstedtite, 441.	1 : 1 : 1 : 1.
	Ripidolite, 261.	1 : 1 : 1⅔ : 1.
	Clintonite,* 264, Clemson's,	1 : 1⅓ : ⅔ : $\frac{2}{9}$.
	" Meitzendorf,	1 : 1⅓ : ⅘ : ⅓.
	Groppite, 290, Rammelsberg,	1 : 1⅓ : 3 : 1. (?)
	Chloritoid, 292, Bonsdorff.	1 : 2 : 2 : 1 (or ⅔).
	" Rammelsberg,	1 : 2 : 1⅔ : ⅔.
	Ottrelite, 292.	1 : 2 : 4 : 1.
	Groppite, 290, Svanberg,	1 : 2 : 4 : 1. (?)
	Palagonite, 288.	1 : 2 : 4 : 3.
	Hisingerite, 441.	1 : 3 : 2 : 2 (or 3).
	Xylite, 259.	1 : 3 : 6 : 1.
	Rosite, 290.	1 : 6 : 8 : 2.
	Damourite, 290.	1 : 9 : 12 : 2.

(*Zeolite tribe: Silicates of alumina and an alkali or alkaline earth.*)

1. HEULANDITE GR.—IV.	Heulandite, 296, Rammelsberg,	1 : 4 : 15 : 6.
	" Damour,	1 : 3 : 12 : 5.
	Brewsterite, 298.	1 : 3 : 12 : 5.
	Laumonite, 303.	1 : 4 : 10 : 6 (? 5).
	" Gerhardt,	1 : 3 : 8 : 4.
	Leonhardite, 304.	(?) 1 : 4 : 9 : 5.
2. STILBITE GR.—III.	Stilbite, 298.	1 : 3 : 12 : 6.
	Epistilbite, 299.	1 : 3 : 12 : 5.
	Retzite, 300.	1 : 3 : 12 : 4.
	Natrolite, 300.	1 : 3 : 6 : 2.
	Scolecite, 300.	1 : 3 : 6 : 3.
	Thomsonite, 306.	1 : 3 : 4 : 2⅓ (? 2⅔).
	[Chlorastrolite, 307.	1 : 2 : 3 : 1.
	[Carpholite, 313.	1 : 3 : 4 : 2.

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* Rammelsberg makes $\bar{\bar{A}}l$ and $\bar{Si}$ replace one another, and writes for the formula 3 $\dot{R}$ ($\bar{Si}$, $\bar{\bar{A}}l$)+$\dot{H}$, which gives the oxygen ratio 1 : 3 : ⅓.

		$\dot{R}$ $\overline{\overline{R}}$ $\dddot{S}i$ $\dot{H}$.
3. HARMOTOME GR.—III.	Harmotome, 304.	1 : 4 : 10 : 6.
	"	1 : 3 : 9 : 5.
	" Damour,	1 : 3 : 12 : 6.
	Phillipsite, 305.	1 : 4 : 10 : 6.
	"	1 : 3 : 8 : 5.
	"	1 : 3 : 6 : 3½.
4. FAUJASITE GR.—II.	Faujasite, 306.	1 : 3 : 10 : 8.
	[Edingtonite, 307.	
5. ZEAGONITE GR.—II?	Zeagonite, 311.	1 : 3 : 4½ : 4½.
6. CHABAZITE GR.—VI.	Chabazite, 308.	1 : 3 : 8 : 6 (or 5).
	"	1 : 3 : 9 : 6.
	Ledererite, 308.	1 : 3 : 8 : 2.
	Levyne, 308, Damour,	1 : 3 : 6 : 4.
7. ANALCIME GR.—I.	Analcime, 311.	1 : 3 : 8 : 2.
	Cluthalite, 312.	1 : 3 : 8 : 3. (?)
	Ittnerite, 370.	1 : 3 : 4 : 2.
8. PREHNITE GR.—III.	Prehnite, 312.	1 : 1½ : 3 : ½.
9. ALGERITE GR.—IV.	Algerite, 314, and Appendix.	
10. LIEBNERITE GR.—VI.	Liebnerite, 314.	1 : 6 : 8 : 1½ (or 1⅔).

3. *Silicates with Sulphate, or Chlorid.*

1. SODALITE GR.—I.	Sodalite, 367.	1 : 3 : 4 (+⅓Na Cl).
2. HAUYNE GR.—I.	Hauyne, 369.	1 : 3 : 4 (+⅓ $\dot{C}a\dddot{S}$).
	Nosean, 369.	1 : 3 : 4 (+⅓ $\dot{N}a\dddot{S}$).
	Skolopsite, 369.	1 : 1 : 3 (+½ $\dot{N}a\dddot{S}$).
	Lapis Lazuli, 368.	
3. PYROSMALITE GR.—VI.	Pyrosmalite, 454.	$4(\dot{F}e+\dot{M}n)^3\dddot{S}i^2+Fe\,Cl^3+\overline{\overline{F}}e\dot{H}^6$.

4. *Silicates containing Fluorine.*

1. TOPAZ GR.—III.	Topaz, 366.	$3\,Al^2(O,F)^3+2\,Si(O,F)^3$.
	Pycnite, 366.	$Al^2(O,F)^3+Si,(O,F)^3$.
2. LEUCOPHANE GR.—V?	Leucophane, 377. ($\overline{\overline{B}}e$, 474·24)	$\overline{\overline{B}}e\,\dddot{S}i^2+\dot{C}a^3\dddot{S}i+Na\,F$.
3. CHONDRODITE GR.—IV.	Chondrodite, 280.	$2\,\dot{M}g^3\dddot{S}i+Mg\,F$.

5. *Silicate and Sulphuret.*

1. HELVIN GR.—I.	Helvin, 377.	$(\overline{\overline{B}}e,\overline{\overline{F}}e)\dddot{S}i+\dot{M}n^3\dddot{S}i+Mn\,S$.

6. *Silicate with Borate.*

1. DANBURITE GR.—V.	Danburite, 281.	$\dot{R}\dddot{B}+4\dot{R}\dddot{S}i$.
2. TOURMALINE GR.—VI.	Tourmaline, 363.	
3. AXINITE GR.—V.	Axinite, 365.	
4. DATHOLITE GR.—IV.	Datholite, 249.	$2\,\dot{C}a^3\dddot{S}i+\dddot{B}^3\dddot{S}i^2+3\dot{H}$.
	Botryolite, 250.	" " $+6\dot{H}$.

PART VII.

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 his best guide.

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.

The following are the subdivisions adopted in Table I.

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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*.

TABLE I.

I. SOLUBLE MINERALS: MINERALS SOLUBLE IN WATER AND HAVING TASTE.

I. CARBONATES: effervescing with muriatic acid; fumes inodorous, 590.

II. NITRATES: deflagrating more or less on burning coals; effervescing with sulphuric acid and not with nitric or muriatic, 591.

III. CHLORIDS: effervescing and giving off suffocating fumes with sulphuric acid, and not with muriatic, 591.

IV. SULPHATES AND PHOSPHATES: no effervescence with either of the acids; B.B. a sulphur or phosphorus reaction.

1. Little or no metallic reaction, 591.
2. Reaction of iron, manganese, cobalt, zinc, or copper, 592.

V. BORATES OR BORACIC ACID: not effervescing with the acids; B.B. boracic acid reaction, 592.

VI. ARSENOUS ACID: B.B. on charcoal alliaceous fumes, 592.

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 NOT MALLEABLE.

1. *When pulverized, wholly soluble to a liquid state in one or more of the acids, (cold or hot).*

* B.B. infusible.

† *Carbonates:* when pulverized, effervescing more or less in acids; fumes inodorous, reddening litmus paper, 593.

†† *Sulphates, Fluorids, Oxyds:* no effervescence with acids, 594.

** B.B. fusible.

† *Carbonates:* when pulverized, effervescing as above, 594.

†† *Phosphates, Sulphates:* no effervescence with acids; B.B. a sulphur or phosphorus reaction, 595.

††† *Fluorids:* B.B. or with acids, a fluorine reaction, 596.

†††† *Borates:* no effervescence; B.B. reaction of boracic acid, 596.

2. *Soluble in acids; the silica gelatinizing: Silicates.*

* B.B. infusible, 596.

** B.B. fusible.

† Hydrous, 597.

†† Anhydrous, 598.

3. *Insoluble in acids, or partly soluble without gelatinizing.*

* B.B. infusible.

† B.B. reaction of phosphorus or fluorine, 600.

†† Hydrous: B.B. no phosphorus reaction; *Hydrous silicates of magnesia, alumina, or oxyd of iron*, 600.

††† Anhydrous, 602.

** B.B. fusible; specific gravity under 4·8.

† *Sulphates, Phosphates:* B.B. sulphur or phosphorus reaction, 604.

†† Hydrous: B.B. no sulphur or phosphorus reaction; G below 3·8, 604.

††† Anhydrous: B.B. no sulphur or phosphorus reaction, 608.

*** B.B. fusible; specific gravity above 4·8, 611.

b. B.B. EITHER FUMES OR A MALLEABLE GLOBULE; G. above 4·8.

* 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, 612.

** B.B. inodorous fumes of Zinc, Bismuth, Antimony, Tellurium, 612.

*** B.B. odorous fumes of Arsenic or Selenium, 613.

**** B.B. wholly vaporizable, with fumes of Quicksilver and Chlorine, 614.

B. STREAK COLORED.

a. B.B. NO FUMES WITHOUT OR WITH THE FLUXES; GLOBULE NOT MALLEABLE.

* B.B. infusible.

† Gelatinize with acids, 614.

†† Not gelatinizing with acids, 614.

** B.B. fusible.

† Gelatinize with acids, 616.

†† Not gelatinizing with acids; B.B. phosphorus reaction, 617.

††† Not gelatinizing with acids; B.B. no phosphorus reaction, 617.

b. B.B. FUMES, OR A MALLEABLE METALLIC GLOBULE.

* B.B. a globule of lead, copper, or silver; no fumes of Arsenic, Sulphur, Selenium, or Antimony.

† Gravity below 4·5; *Ores of Copper*, 618.

†† Gravity above 4·5; *Ores of Lead, or Lead and Copper, or Silver*, 619.

** B.B. globule (when not wholly vaporizable) malleable; fumes of Arsenic, Sulphur, Selenium, Antimony, Bismuth, Quicksilver, Iodine or Chlorine.

† B.B. wholly and easily vaporizable, leaving no metallic globule, 620.

†† B.B. partly vaporizing, leaving a malleable globule of silver or copper; arsenical, sulphur, or antimony fumes, 621.

††† B.B. partly vaporizing, leaving a malleable globule of silver or copper; fumes of iodine, bromine or chlorine, 622.

*** B.B. globule not malleable; fumes of Arsenic, Sulphur, Antimony, or Chlorine.

† B.B. fumes arsenical, 623.

†† B.B. fumes *not* arsenical, 628.

II. LUSTRE METALLIC.

A. STREAK UNMETALLIC.

a. B.B. NO FUMES.

* B.B. infusible, 624.

** B.B. fusible, 625.

b. B.B. GIVING OFF FUMES.

* B.B. fumes of Arsenic; globule brittle, 625.

** B.B. fumes not arsenical; globule brittle, 626.

*** B.B. a malleable globule, or mineral wholly vaporizable, 627.

B. STREAK METALLIC.

a. NOT MALLEABLE.

* B.B. no fumes; infusible, 628.

** B.B. fumes; globule not malleable, 628.

*** B.B. fumes; a malleable globule, or mineral wholly vaporizable, 628.

† B.B. wholly and easily vaporizable, (ores of lead not included), 628.

†† B.B. a malleable globule; fumes odorous, 629.

††† B.B. a malleable globule; fumes inodorous, 629.

b. MALLEABLE, 630.

The following are the abbreviations used in the following pages:

Ad.	Adamantine.	Bk, bkh.	Black, blackish.
Antim.	Antimony.	*Bor*.	Borax.
Arsen.	Arsenical.	Bot.	Botryoidal.
B, bh.	Blue, bluish.	*Cl.*, cleav.	Cleavage, Cleavable.
BB.	Before the Blowpipe.	*Char*.	On charcoal.
Bn, bnh.	Brown, brownish.	Col.	Columnar.

Cryst.	Crystals, crystalline.	Op.	Opaque.
Decrep.	Decrepitate.	*Phos.*	Salt of phosphorus.
Dif.	Difficult, difficultly.	P'ly.	Pearly.
Efflor.	Effloresce.	Pms.	Prisms.
Exfol.	Exfoliate.	Pulv.	Pulverized.
Fib.	Fibrous.	R, rdh.	Red, reddish.
Flex.	Flexible.	Rad.	Radiated.
Fol.	Foliated.	Ren.	Reniform.
Fus.	Fusible.	Res.	Resinous.
Gelat.	Gelatinise.	*Soda,*	Carbonate of soda.
Glob.	Globule.	Sol.	Soluble, solution.
Gn, gnh.	Green, greenish.	*St.*	Streak.
Gran.	Granular.	Stalact.	Stalactitic.
Gy, gyh.	Gray, grayish.	Stel.	Stellate.
Infus.	Infusible.	Strl.	Translucent on edges only.
Insol.	Insoluble.	Strp.	Semitransparent.
Intum.	Intumesce.	Sulph.	Sulphureous.
Lam.	Laminæ.	Submet.	Submetallic.
Mag.	Magnetic.	*Sul.*	Sulphuric acid.
Mam.	Mammillary.	Trl.	Translucent.
Mas.	Massive.	Trp.	Transparent.
Met.	Metallic.	Vit.	Vitreous.
Mur.	Muriatic acid.	W, wh.	White, whitish.
Nit.	Nitric acid.	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.

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 Table of the species arranged according to their specific gravities.

I. SOLUBLE MINERALS, HAVING TASTE.

I. Carbonates: effervescing with muriatic acid; fumes indorous.

	Hardness.	
Carb. Ammonia,		III; *cl* lat; crusts; ywh, w; trl; taste pungent; odor of ammonia; Am, $\ddot{C}$, 185.
Natron,	1—1·5	IV; 76° 28′; crusts; G 1·423; w, gyh; taste alkaline; efflor; $\dot{N}a$, $\ddot{C}$, Aq, 190.
Thermonatrite,	1—1·5	III; efflor; G 1·5—1·6; w; vit; taste alkaline; $\dot{N}a$, $\ddot{C}$, Aq, 190.
Gay Lussite,	2—3	IV; cryst; G 1·9—2; ywh-w; vit; taste weak; $\dot{N}a$, $\dot{C}a$, $\ddot{C}$, Aq, 191.
Trona,	2·5—3	IV; fib, mas; G 2·11; gyh, ywh; vit; trl; taste alkaline; $\dot{N}a$, $\ddot{C}$, Aq, 191.

II. NITRATES: deflagrating on burning coals; effervescing with sulphuric acid, but not with nitric or muriatic.

	Hardness.	
Nitrocalcite,		Silken tufts, efflor; w, gyh; vit; taste sharp, bitter; very deliq; BB slight detonation, fuses and dries; $\dot{\mathrm{Ca}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$, Aq, 204.
Nitromagnesite,		Efflor; crusts; w; very deliquescent; $\dot{\mathrm{Mg}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$, Aq, 204.
Soda Nitre,	1·5—2	VI; 106° 33′; efflor; mas; G 2—2·3; w, bnh, ywh; vit; trp; taste cooling; BB yw flame; $\dot{\mathrm{Na}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$, 190.
Nitre,	2	III; 120°; crusts; acic; G 1·937; w; vit; strp; taste saline cooling; BB flame not yw; $\dot{\mathrm{K}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{N}}$, 189.

III. CHLORIDS: effervescing with suffocating fumes with sulphuric acid, and not with muriatic.

Sal-Ammoniac,	1·5—2	I; *cl* oct; crusts; G 1·5—1·6; w, ywh, gyh; trl, op; taste saline, pungent; not deliq; BB sublimes, with *soda* odor of ammonia; Am, Cl, 185.
Sylvine,	2	I; cubes; mas; G 1·9—2; w; vit; taste saline; K, Cl, 191.
Common Salt,	2·5	I; cryst; mas; G 2·257; w, ywh, rdh, bh; trp; taste saline; Na, Cl, 191.

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.

Stercorite,		Mas; in nodules; G 1·6—1·62; w, ywh; vit; not efflor; BB intum; yields water; fuses to trp glass; in *Guano*.—Am, $\dot{\mathrm{Na}}$, $\overset{\cdot\cdot\cdot\cdot\cdot}{\mathrm{P}}$, $\dot{\mathrm{H}}$, 186.
Mascagnine,		III; *Cl* diag; crusts; ywh; trl; taste pungent, bitter; with *soda* odor of ammonia; Am, $\dddot{\mathrm{S}}$, $\dot{\mathrm{H}}$, 185.
Glauber Salt,	1·5—2	IV; efflor; crusts; G 1·48; w; vit; trl, op; taste cool saline bitter; BB yields water; fuses yw flame; $\dot{\mathrm{Na}}$, $\dddot{\mathrm{S}}$, Aq, 188.
Alum,	2—2·5	I; oct.; fib; crusts; efflor; G 1·75—2; w, ywh, rdh; taste astringent; very sol; BB intum; spongy; $\dddot{\mathrm{Al}}$, $\dddot{\mathrm{S}}$, Aq, with $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$, $\dot{\mathrm{Mg}}$, $\dot{\mathrm{Fe}}$, $\dot{\mathrm{Mn}}$ or Am, 225.
Epsomite,	2—2·5	III; 90° 38′; mas; cryst; G 1·751; w; vit; taste bitter saline; BB deliq; much water; $\dot{\mathrm{Mg}}$, $\dddot{\mathrm{S}}$, Aq, 203.
Thenardite,	2—2·5	III; 125°; cryst; G 2·73; w; vit; trl; efflor; BB yw flame; $\dot{\mathrm{Na}}$, $\dddot{\mathrm{S}}$, 189.
Glauberite,	2·5—3	IV; cryst; G 2·7—2·9; ywh, gyh; vit; taste weak saline; BB decrep; trp glass; $\dot{\mathrm{Na}}$, $\dot{\mathrm{Ca}}$, $\dddot{\mathrm{S}}$, 189.
Reussin,		prism; acic; efflor; w; taste saline, bitter; $\dot{\mathrm{Mg}}$, $\dot{\mathrm{Na}}$, $\dddot{\mathrm{S}}$, 188.
Astrakanite,		prism; cryst; wh; trl; BB yields water; wh flame; $\dot{\mathrm{Mg}}$, $\dot{\mathrm{Na}}$, $\dddot{\mathrm{S}}$, Aq, 188.
Polyhalite,	2·5—3	III; mas; subfib; G 2·7—2·8; rdh; subres, or subp'ly; trl, op; taste bitter astringent, very weak; BB fus!!; $\dot{\mathrm{K}}$, $\dot{\mathrm{Mg}}$, $\dot{\mathrm{Ca}}$, $\dddot{\mathrm{S}}$, Aq, 187.

	Hardness.	
Alunogen,	2—3	fib; mas; crusts; w, ywh, rdh; vit; silky; strp; strl; taste like alum; BB intum; fus! very sol; $\overline{\mathrm{Al}}$, $\dddot{\mathrm{S}}$, $\dot{\mathrm{H}}$, 224.
Aphthitalite,	2—3	III; 120° 24′; mass; crusts; G 1·7—1·75; w, bh; gnh; trl; taste saline bitter; BB fus; no intum; no water; $\dot{\mathrm{K}}$, $\dddot{\mathrm{S}}$, 187.

2. B.B. reaction of iron, cobalt, zinc, copper, or manganese.

Copperas,	2	IV; mas; pulver; vit; gn, gnh-w; w on exposure; trp, trl; taste sweetish-astringent, met; BB mag; $\dot{\mathrm{Fe}}$, $\dddot{\mathrm{S}}$, Aq, 446.
Copiapite,		VI? pulv, fib; p'ly; yw; trl; taste like copperas; $\overline{\mathrm{Fe}}$, $\dddot{\mathrm{S}}$, Aq, 448.
Coquimbite,	2—2·5	VI; gran; vit; w, ywh, bnh; taste like copperas; $\overline{\mathrm{Fe}}$, $\dddot{\mathrm{S}}$, Aq, 447.
Apatelite,		Like Copiapite; $\overline{\mathrm{Fe}}$, $\dddot{\mathrm{S}}$, Aq, 448.
Iron Alum,	2·5	I; oct, crust; G 2; ywh; taste met-astringent, or chalybeate; BB iron reaction; $\dot{\mathrm{Fe}}$, $\overline{\mathrm{Al}}$, $\dddot{\mathrm{S}}$, Aq, 226.
Manganese Alum,	2·5	I; oct, crusts; fib; G 2; ywh, rdh; taste met-astringent; BB manganese reaction; $\dot{\mathrm{Mn}}$, $\overline{\mathrm{Al}}$, $\dddot{\mathrm{S}}$, Aq, 226.
Voltaite,		I; oct; bn, bk; sol, and decomposes; $\overline{\mathrm{Al}}$, $\dot{\mathrm{Fe}}$, $\dot{\mathrm{K}}$, $\dddot{\mathrm{S}}$, Aq, 226.
White Vitriol,	2—2·5	III; mas, incrust; w; vit; trp, trl; BB intum; taste astringent, met; $\dot{\mathrm{Zn}}$, $\dddot{\mathrm{S}}$, Aq, 486.
Blue Vitriol,	2·5	V; mas, earthy; G 2·218; bright b; strp, trl; taste metallic, nauseous; BB *char* copper; $\dot{\mathrm{Cu}}$, $\dddot{\mathrm{S}}$, Aq, 522.
Cobalt Vitriol,		IV; stalact; crusts; flesh and rose-red; trp, trl; taste astringent; BB *char* sulph; *bor* blue; $\dot{\mathrm{Co}}$, $\dddot{\mathrm{S}}$, Aq, 476.
Johannite,	2—2·5	IV; cryst, mas; G 3·19; vit; emerald gn, gnh; *st* paler; trp, trl, op; taste bitter; solution bn precip with infusion of nutgalls; $\dot{\mathrm{U}}$, $\dddot{\mathrm{S}}$, 408.

V. Borates, or Boracic Acid: not effervescing with the acids; B.B. boracic acid reaction.

Sassolin,	1	V?; *cl* basal; scales; G 1·48; w, ywh; p'ly; feel smooth; acidulous; BB fus!! flame gn; $\dddot{\mathrm{B}}$, Aq, 181.
Hydroboracite,	2	Fib and fol like gypsum; G 1·9; w; trl, strl; BB fus! trp, glass, flame gnh; slightly sol in water; *mur* easily sol; $\dot{\mathrm{Ca}}$, $\dot{\mathrm{Mg}}$, $\dddot{\mathrm{B}}$, Aq, 218.
Borax,	2—2·5	IV; G 1·716; w, gyh, bh, gnh; vit; trl, op; taste feebly sweetish-alkaline; BB puffs up, glass; $\dot{\mathrm{Na}}$, $\dddot{\mathrm{B}}$, Aq, 193.

VI. Arsenous Acid: B.B. alliaceous fumes on charcoal.

Arsenous Acid,	1·5	IV; capil; bot, stalact, mas; G 3·698; vit, silky; w, ywh, rdh; trp, op; taste astringent, sweetish, 419.

II. INSOLUBLE MINERALS, OR WITHOUT TASTE.

I. LUSTRE UNMETALLIC.

A. STREAK UNCOLORED.

a. B.B. NO COLORED OR ODOROUS FUMES ON CHARCOAL, WITH OR WITHOUT THE FLUXES; NO MALLEABLE GLOBULE OBTAINED BY REDUCTION.

1. *When pulverized, wholly soluble in one or more acids (cold or hot)*—Carbonates, Sulphates, Phosphates, Fluorids, Borates.

* B.B. Infusible.

† *Carbonates:* when pulverized, effervescing more or less in acids; fumes inodorous.

	Hardness.	
Calc Sinter,		Mas, earthy; w; *mur* efferv. See *Calcite*, 207.
Hydrocalcite,		VI; cryst, crust; w; vit; *mur* efferv; $\dot{Ca}$, $\ddot{C}$, Aq, 212.
Hydromagnesite,	2	Earthy, crust; w; *mur* efferv; $\dot{Mg}$, $\ddot{C}$, Aq, 213.
Hydrodolomite,		Earthy; w, ywh; *mur* efferv; $\dot{Ca}$, $\dot{Mg}$, $\ddot{C}$, Aq.
Lancasterite,	2·5	IV ? cryst; fol! G 2·3—2·35; w, gyh; p'ly; laminæ flex; inelastic; BB exfol, ywh; *mur* slow efferv; $\dot{Mg}$, $\ddot{C}$, Aq, 213.
Bromlite,	2·5	III; 118° 50′, *cl* diff!; G 3·7—3·72; w; trl; $\dot{Ba}$, $\dot{Ca}$, $\ddot{C}$, 198.
Lanthanite,	2·5—3	II; thin plates; earthy; gyh-w, ywh; dull, p'ly; La, $\ddot{C}$, $\dot{H}$, 238.
Calcite,	3—3·5	VI; 105° 5′, *cl* rbdl; cryst, mas, fib; G 2·5—2·78; w, ywh, rdh, bn, bk; vit, subvit, earthy; trp, op; BB intense light, caustic; *mur* efferv; $\dot{Ca}$, $\ddot{C}$, 205.
Emerald Nickel,	3—3·5	Incrust; mas; G 2·5—2·7; vit; emerald-gn; *st* gnh, or nearly w; trp, trl; brittle; *mur* sol efferv; $\dot{Ni}$, $\ddot{C}$, Aq, 476.
Magnesite,	3—4	VI; 107° 22′; *cl* rbdl; cryst, mas, fib; G 2·8—3; w, ywh, gyh, bn; trp, op; *mur* little efferv; $\dot{Mg}$, $\ddot{C}a$, 210.
Pennite,	3·5	Crusts, minute glob; G 2·86; vit, weak; trl, strl; *mur* slow efferv; $\dot{Ca}$, $\dot{Mg}$, $\ddot{C}$, Aq, with little $\dot{Ni}$ at times, 214.
Arragonite,	3·5—4	III; 116° 16′; cryst, mas, fib; G 2·9—3; w, gyh, ywh; trp, trl; BB falls to powder; *mur* efferv; $\dot{Ca}$, $\ddot{C}$, 208.
Dolomite,	3·5—4	VI; 106° 15′; *cl* rbdl; cryst, mas, gran; G 2·85—3·1; w, ywh, rdh, bn, bk; vit; strp, op; *mur* slow efferv; Ca, $\dot{Mg}$, $\ddot{C}$, with sometimes $\dot{Fe}$, and then bn on exposure, 210.
Barytocalcite,	4	IV; 106° 55′; *cl* lat; G 3·6—3·7; w, gyh, gnh, ywh; trp, trl; BB *bor* trp glass; $\dot{Ba}$, $\dot{Ca}$, $\ddot{C}$, 198.
Diallogite,	3·5—4·5	VI; rbdn; cleav, mas, bot, fib; G 3·4—3·6; vit, p'ly; rose-rd; bn on exposure; trl, strl; BB bn, infus, decrep; hot *mur* efferv; $\dot{Mn}$, $\ddot{C}$, 465.

	Hardness.	
Spathic Iron,	3·5—4·5	VI; rbdns; mas, fib, fol; G 3·7—3·85; vit, p'ly; gyh-w, bnh, gnh-gy; bnh-r; trl, op; BB bk, mag; *mur* sol dif; $\dot{\mathrm{F}}\mathrm{e}$, $\ddot{\mathrm{C}}$, often with $\dot{\mathrm{M}}\mathrm{n}$, $\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{C}}\mathrm{a}$, 444.
Manganocalcite,	4—4·5	III; rbc pms; otherwise like Diallogite, 466.
Breunnerite,	4—4·5	VI; 107° 20′; *cl* rbdl; cryst, mas; G 3—3·63; w, ywh, often bn on exposure: vit; trp—strl; BB bk, sometimes magnetic; *mur* slow sol and efferv; $\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{F}}\mathrm{e}$, $\ddot{\mathrm{C}}$, 212.
Parisite,	4·5	VI; *cl* basal!; G 4·35: bnh-yw; *st* ywh-w; vit; BB bnh; *bor* trp glass, *mur* slow sol efferv; $\dot{\mathrm{C}}\mathrm{e}$, $\dot{\mathrm{C}}\mathrm{a}$, $\ddot{\mathrm{C}}$, F, Aq, 235.

a. Very distinctly foliated or fibrous in some varieties.

	Hardness.			Hardness.	
Lancasterite,	2·5	Fol!	Arragonite,	3·5—4	Fib.
Calcite,	3—3·5	Fol (rarely) 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 gravities.

	Sp. gravity.		Sp. gravity.
Calc Sinter.		Arragonite,	2·9—3.
Hydrocalcite.		Breunnerite,	3—3·63.
Hydrodolomite.		Diallogite,	3·5—3·6.
Hydromagnesite.		Manganocalcite,	3·5—3·7.
Lancasterite,	2·3—2·35.	Barytocalcite,	3·6—3·7.
Calcite,	2·5—2·78.	Bromlite,	3·7—3·72.
Emerald Nickel,	2·5—2·7.	Spathic Iron,	3·7—3·82.
Pennite,	2·86.	Lanthanite.	
Magnesite,	2·8—3.	Parisite,	4·35.
Dolomite,	2·85—3·1.		

†† *Sulphates, Fluorids, Oxyds or Hydrated Oxyds:* no effervescence with acids.

Brucite,	1·5	VI; tables; fol! lam flex; fib!; G 2·35; w, gyh; p'ly!; trl, strl; *nit* sol, no efferv; BB op, friable; $\dot{\mathrm{M}}\mathrm{g}$, Aq, 200.
Völknerite,		VI; *cl* basal!; mas; G 2·04; w; p'ly; feel greasy; BB exfol; *bor* intum, trp glass; *acids* sol; $\dot{\mathrm{M}}\mathrm{g}$, $\dddot{\overline{\mathrm{Al}}}$, Aq, 201.
Yttrocerite,	4—5	III!; mas, earthy; G 3·447; violet, gyh, wh, rdh-bn; vit—p'ly; BB *bor* glass yw in outer flame hot; *mur* pulv, sol yw; Ce, Y, Ca, F, 238.
Alunite,	5	VI; rbdl; 92° 50′; *cl* basal; mas, gran; G 2·55—2·75; w, gyh, rdh; vit, p'ly; trp—strl; BB decrep; *sul* pulv, sol; $\dddot{\overline{\mathrm{Al}}}$, $\dot{\mathrm{K}}$, $\dddot{\mathrm{S}}$, Aq, 228.
Periclase,	5—6	I; cubes, oct; *cl* cub; G 3·674; gyh, gn; trp, trl; *hot nit* sol, no efferv; $\dot{\mathrm{M}}\mathrm{g}$, 200.

a. Very distinctly foliated or fibrous in some varieties.

Brucite,	H 1·5	Fol! fib.	Völknerite,	H 2·04	Fol.

** Fusible.

† *Carbonates:* when pulverized, effervescing more or less; fumes inodorous.

Witherite,	3—3·75	III; 118° 30′; cryst; mas; subfib; G 4·29—4·3; w, ywh, gyh; vit—res; strp, trl; BB fus! *mur* efferv; $\dot{\mathrm{B}}\mathrm{a}$ $\ddot{\mathrm{C}}$, 197.

	Hardness.	
Strontianite,	3·5—4	III; 117° 19′; cryst, mas, fib; G 3·6—3·72; gnh; w, gyh, ywh; trp, trl; BB fus dif, rdh flame; Sr $\ddot{\text{C}}$, 197.

†† *Phosphates and Sulphates:* no effervescence with acids; BB sulphur or phosphorus reaction.

Websterite,	1—2	Mas, ren; G 1 66; w; earthy; adheres to tongue; BB fus dif; *acids* sol no efferv; $\overline{\ddot{\text{Al}}}$, $\dddot{\text{S}}$, Aq, 227.
Pissophane,	1—2	Mas, stalact; G 1·9—2; gn, gnh; trp; fragile; BB fus dif; *mur* sol; BB bk; $\overline{\ddot{\text{Al}}}$, $\overline{\ddot{\text{Fe}}}$, $\dddot{\text{S}}$, Aq, 228.
Hopeite,	2·5—3	III; cleav l; ren, mas; G 2·76—2·8; vit, p'ly; gyh-w; bn; trp, trl; sectile; BB fus, flame gn; *soda* fumes of zinc; *mur* sol; $\dot{\text{Z}}\text{n}$, $\overline{\dddot{\text{P}}}$, Aq, 484.
Diadochite,	3	Ren, stalact, lam curved; G 2·035; res, vit; yw, ywh bn; fragile; BB flame gn, intum, fus dif scoria, mag; $\overline{\ddot{\text{Fe}}}$, $\overline{\dddot{\text{P}}}$, $\dddot{\text{S}}$, Aq, 454.
Wavellite,	3—4	III; fib, stel, glob; G 2·3—2·4; w, ywh, gnh, bnh, bk; vit—res; trl; BB w, intum; hot *sul* sol; often fluorine; $\overline{\ddot{\text{Al}}}$, $\overline{\dddot{\text{P}}}$, F, Aq, 231.
Cacoxene,	3—4	III; fib, stel, G 3·38; ywh, bnh; res; trl; like wavellite; $\overline{\ddot{\text{Fe}}}$, $\overline{\ddot{\text{Al}}}$, $\overline{\dddot{\text{P}}}$, Aq, 231.
Pyromorphite,	3·5—4	VI; hexag; ren, bot, fib, gran; G 6 5—7·1; bn, bright gn; orange; strp, strl; brittle; BB *char* fus. glob cryst; *nit* sol; $\dot{\text{P}}\text{b}$, $\overline{\dddot{\text{P}}}$, 502.
Apatite,	4·5—5	VI; hexag pms; mas, fib; G 3—3·3; gn, bh, wh, ywh, gyh, rh, bnh; vit, subres; trp, op; brittle; BB fus dif!! *bor* cryst glass; *nit* sol, no efferv; $\dot{\text{C}}\text{a}$, $\overline{\dddot{\text{P}}}$, F, Cl, 214.
Childrenite,	4·5—5	III; cryst; *cl* oct; yw, ywh, bnh; vit—res; trl; $\overline{\ddot{\text{Al}}}$, $\overline{\ddot{\text{Fe}}}$, $\overline{\dddot{\text{P}}}$?, 233.
Talc-apatite,		VI; hexag pms, like apatite; $\dot{\text{C}}\text{a}$, $\dot{\text{M}}\text{g}$, $\overline{\dddot{\text{P}}}$,. 214.
Triphyline,	5	III; cleav; mas; G 3·5—3·6; subres; bh; *st* gyh; trl, strl; BB fus! mag; *acids* sol, no efferv; $\dot{\text{F}}\text{e}$, $\dot{\text{M}}\text{n}$, $\dot{\text{L}}\text{i}$, $\overline{\dddot{\text{P}}}$, Aq, 448.
Herderite,	5	III; *cl* imperf; G 2·985; ywh, gnh-w; vit, subres; trl; very brittle; BB fus dif w enamel; hot *mur* sol; $\overline{\ddot{\text{Al}}}$, $\dot{\text{C}}\text{a}$, $\overline{\dddot{\text{P}}}$, F ?, 282.
Wagnerite,	5—5·4	IV; 95° 25′; mas; G 3; ywh, gyh; vit; trl; BB fus dif, gnh glass, *bor* trp; heated *nit* sol, no efferv; $\dot{\text{M}}\text{g}$, $\overline{\dddot{\text{P}}}$, F, 216.
Cryptolite,	5—5·5	VI; (II ? phosphocerite); minute acic; G 4·6—4·8; ywh, or colorless; trp—trl; BB fus dif!!; flame gnh; *sul* sol; $\dot{\text{C}}\text{e}$, $\overline{\dddot{\text{P}}}$, 236.
Amblygonite,	6	III ? cryst; *cl* brilliant; G 3—3·11; pale gn; vit, p'ly; strp—trl; BB fus! intum, w; pulv *sul* sol; $\overline{\ddot{\text{Al}}}$, $\overline{\dddot{\text{P}}}$, $\dot{\text{L}}$, F, 232.

a. Species very distinctly foliated or fibrous in some varieties.

Wavellite,	3—4 Fib!	Pyromorphite,	H=3·5—4 Fibrous.
Cacoxene,	3—4 Fib!	Apatite,	H=4·5—5 Fibrous.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Websterite, 227.	1·66.	Amblygonite, 232.	3—3·11.
Pissophane, 228.	1·9—2.	Apatite, 214.	3—3·3.
Diadochite, 454.	2·035.	Talc-apatite, 214.	
Wavellite, 231.	2·3—2·4.	Cacoxene, 231.	3·38.
Hopeite, 483.	2·76—2·8.	Triphyline, 448.	3·5—3·6.
Childrenite, 233.	?	Cryptolite, 236.	4·6—4·8.
Herderite, 232.	2·985	Pyromorphite, 502.	6·5—7·1.
Wagnerite, 216.	3.		

††† *Fluorids:* no effervescence with acids; fluorine reaction.

	Hardness.	
Cryolite,	2—2·5	III; mas, *cl* rectang; G 2·8—2·95; w; vit; subp'ly; strp—trl; brittle; BB fus ! ! !; *sul* sol, fluorine; Na, Al, F, 233.
Fluellite,	3	III; cryst; w; vit; trp; Al, F, 234.
Chodneffite,	3·5—4	III; mas, cleav; G 2·62—3·1; w, gyh, ywh; vit, res; trl; BB fus ! ! !; *sul* sol, fluorine; Na, Al, F, 234.
Chiolite,	4	III; mas, cleav; G 2·7—2·9; w; subres; trl; brittle; BB fus ! ! !; *sul* sol, fluorine; Na, Al, F, 233.
Fluor Spar,	4	I; cryst, *cl* oct !; mas; G 3·1—3·2; w, yw, gn, rdh, bh, purple; vit; trp, trl; brittle; BB phosph; fus dif, enamel; *sul* sol; Ca, F, 216.

†††† *Borates:* no effervescence with acids; B.B. reaction of boracic acid.

Hayesine,		Masses made of interwoven fibres; w; odorous; forms a paste with water; $\dot{\mathrm{C}}\mathrm{a}$, $\dddot{\mathrm{B}}$, Aq, 217.
Ulexite,		Structure like Hayesine; $\dot{\mathrm{C}}\mathrm{a}$, $\dddot{\mathrm{B}}$, $\dot{\mathrm{N}}\mathrm{a}$, Aq, 217.
Boracite,	7	I; small cryst, hemihed; mas; G 2·9—3; w, gyh, ywh, gnh; vit; strp, trl; BB intum, glass; w op cold; *mur* sol $\dot{\mathrm{M}}\mathrm{g}$, $\dddot{\mathrm{B}}$, 216.
Rhodizite,	8	I; like Boracite; gyh, ywh-w; trl; BB fus dif !, flame gnh, then red; *mur* sol dif; a lime-boracite, 219.

2. *Soluble in acids, the silica gelatinizing;* Silicates.

* B.B. infusible.

Nontronite,	2—3	Mas; *feel* unctuous; ywh, gnh; op, strp; fragile; BB infus, bh, bn; *mur* gelat; Fe, Si, Aq, 440.
Chrysolite,	6·5—7	III, 99° 7′, 130° 10′; glassy grains and crystals disseminated; G 3·3—3·5: green; trp—trl; BB *bor* fus, iron bead; *mur* insol; *sul* gelat; Mg, Fe, Si, 278.
Cerite,	5·5	VI; mas, gran; G 4·912; dull adamant, res; clove bn, cherry r, gyh; strl, op; BB infus; pulv *mur* gelat easily; Ce, Fe, Si, Aq, 381.

** B.B. fusible.

† Hydrous.

	Hardness.	
Collyrite,	1—2	Clay-like ; G 2—2·15 ; w ; dull, glimmering ; trl, op ; feel greasy ; adheres to the tongue ; *nit* gelat ; Al, Si, Aq, 288.
Spadaite,	2·5	Mas ; rdh ; p'ly ; BB glassy enamel ; *mur* sol, imperf gelat ; Mg, Si, Aq, 258.
Allophane,	3	Mas, ren ; G 1·85—1·9 ; vit, res ; w, gnh, bnh, bh, ywh ; trl ; brittle ; Al, Si, Aq, 289.
Sphærostilbite,	3·5	Glob, diverg ; G 2·05—2·21 ; p'ly, vit ; w, ywh, gyh ; trl, strl ; brittle ; BB intum, fus ; Al, Ca, Si, Aq ; *Zeolite*, 299.
Laumonite,	3·5—4	IV ; cryst, cl !, columnar diverg ; G 2·29—2·4 ; vit, p'ly ; w, ywh, gyh ; trp, trl ; usually opaque and pulv on exposure ; BB intum, fus ; *nit* or *mur* gelat ; Al,Ca,Si,Aq ; *Zeolite*, 303.
Mesole,	3·5—4	Glob, diverg, flat columnar ; G 2·3—2·4 ; silky, p'ly ; wh, ywh, rdh ; trl ; BB fus, *mur* gelat ! ; Al, Ca, Na, Si, Aq ; *Zeolite*, 302.
Retzite,	4	Fib diverg ; G 2·6 ; r, gy, wh ; BB intum, fus ; Al, Ca, Si, Aq ; *Zeolite*, 300.
Samoine,	4—4·5	Broad stalact ; G 1·65—1·9 ; wh, gyh, bnh ; vit, p'ly, cross fracture, res ; *nit* or *mur* gelat ; Al, Si, Aq ; *lava cavern*, 288.
Phillipsite,	4—4·5	III ; cryst, often cruciform ; cl imperf ; G 2—2·2 ; vit ; w, rdh ; trl, op ; BB intum, fus ; *mur* pulv gelat ! ; Al, Ca, Si, Aq ; *Zeolite*, 305.
Pectolite,	4—5	III ? mas, fib, acic ; G 2—2·74 ; w, gyh ; subvit, p'ly ; strl ; op ; tough ; BB fus ! enamel ; *mur* gelat after heating, Ca, Na, Si, Aq, 248.
Gmelinite,	4·5	VI ; hexag ; G 2·05—2·1 ; w ; trp, trl ; brittle ; BB intum fus ; *mur* gelat ; Al, Ca, Na, Si, Aq ; *Zeolite*, 309.
Brewsterite,	4·5—5	IV ; cryst, cl ! ; G 2·1—2·45 ; vit. p'ly ; w, gyh, ywh ; trp, trl ; BB froths, fus ; Al, Ba, Sr, Si, Aq ; *Zeolite*, 298.
Apophyllite,	4·5—5	II ; oct and prism, mas, *cl* basal ! ; G 2—2·4 ; w, gyh, gnh, ywh, rdh ; trp, op ; brittle ; BB exfol, fus ; *nit* imperf gelat ; Ċa, K̇, S⃛i, 248.
Okenite,	4·5—5	III ; 122° 19′ ; mas, fib ; G 2·28—2·38 ; w, ywh, bh ; subp'ly ; tough ; BB fus ; *soda* efferv, strp glass ; *mur* gelat ; Ċa, S⃛i, Aq, 247.
Elect. Calamine,	4·5—5	III ; mam, bot, stalact, mas ; G 3·35—3·45 ; wh, bh, gnh, ywh, bnh ; trp, trl ; BB fus dif ! ! ; *bor* cleav glass ; *soda* fumes of zinc dif ; *mur* gelat ! ; Żn, S⃛i, Aq, 482.
Thomsonite,	5	III ; cryst, cl ! ; columnar diverg ; G 2·3—2·4 ; vit, p'ly ; w, bnh ; trp, trl ; brittle ; BB intum, fus dif !, *mur* pulv gelat ; Al, Ca, Na, Si, Aq ; *Zeolite*, 306.
Analcime,	5—5·5	I ; often trapezohed ; G 2·05—2·3 ; vit ; w, gyh, gnh, ywh, rdh ; trp, op ; brittle ; BB fus, no intum ; *mur* gelat ; Al, Na, Si, Aq, 311.

[illegible] bend : [illegible]

[illegible] BB fus dif ;

[illegible] trl, strl ;

[illegible] Ca, Na, Si, S,

[illegible] BB decrep,

[illegible] Ca, Na, Si, S, 369.

[illegible] trl, op ;

[illegible] Na, Si, S, 369.

[illegible] BB fus : [illegible]

	Hardness.	
Edelforsite,	5·5	fibrous, feathery, mas; G 2·58; w, gyh; trp; like Wollastonite; Ca, Si, 266.
Willemite,	5·5	VI; hexag pms; mas; G 3·9—4·2; vit, res; wh, gnh-yw; rdh, gyh, bnh; trp, op; brittle; BB decrep, infus, or fus dif ! !; pulv *mur* gelat; Żn, S̈i, 484.
Sodalite,	5·5—6	I; mas; cl dodec; G 2·2—2·4; vit; bn, gy, b, gn; trp, strl; BB fus dif; *nit* gelat; Al, Na, Si, Cl, 368.
Davyne,	5·5—6	VI; hexag, like Nepheline; mas; G 2·42—2·62; subvit, subp'ly; w, gy, yw, gnh, bh, rdh; trl; BB fus ! intum; *mur* efferv, gelat after heating; Al, Na, Ca, Si, C̈, 324.
Nepheline,	5·5—6	VI; hexag; mas; G 2·5—2·65; vit, greasy; w, gyh, gnh, rdh, bnh; trp, strl; BB fus; *acids* gelat !; Al, Na, K, Si, 323.
Barsowite,	5·5—6	Mas, gran; G 2·7—2·76; subp'ly; w; strl; BB fus dif; acids gelat; Al, Ca, Si, 342.
Gehlenite,	5·5—6	II; G 2·9—3·1; res, vit; gyh-gn, bn; strl, op; BB fus dif !; *mur* gelat; Al, Ca, Fe, Si, 342.
Allanite,	5·5—6	IV; cryst, acic; mas; G 3·3—4·2; pitch-black, bn, ywh; strl, op; brittle; *st* gyh; BB intum, fus; *acids* gelat; Al, Fe, Ce, Ca, Si, 354.
Indianite,	6	V; mas, gran; G 2·668; w, gyh; trl, strl; BB fus dif; acids gelat !; Al, Ca, Si, 335.
Eudialyte,	6	VI; rbdl, *cl* basal !; mas; G 2·89—2·91; vit; bnh-r; op, strl; BB fus gyh-gn scoria or op glass; pulv, *acids* gelat; Zr, Fe, Ca, Na, Si, 378.
Tephroite,	6	Mas, gran; G 4—4·12; ash-gy; *st* gyh; bn or bk on exposure; BB fus ! bk scoria; *mur* gelat !, not evolving chlorine; Mn, Si, 464.
Idocrase,	6·5	II; cryst, *cl* indist; mas; G 3·34—4·0; vit, res, often lustrous; bn, gn; yw, b; strp, strl; BB fus ! intum; *acids* after heating, sol and gelat; Al, Ca, Fe, Si, 350.
Epidote,	6·7	IV; cryst; mas, subcolumn; G 3·25—3·5; vit, res; pistachio-gn, bn, gy; strp, op; BB fus; *mur* after strong ignition sol and gelat; Al, Ca, Fe, Si, sometimes with Mg and Ce, 352.
Chrysolite,	6·5—7	III; 99° 7′, 130° 10′; glassy grains and disseminated cryst; G 3·3—3·6; green; Mg, Fe, Si, 278.

α. Species distinctly foliaceous or fibrous in some varieties.

Edelforsite, 266. H=5·5 Fib. Wollastonite, 265. H=4·5—5.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Sodalite, 268.	2·2—2·4.	Nepheline, 323.	2·5—2·65.
Nosean, 369.	2·25—2·3.	Skolopsite, 369.	2·53.
Lapis Lazuli, 268.	2·3—2·5.	Edelforsite, 266.	2·58.
Haüyne, 369.	2·4—2·5	Indianite, 335.	2·668.
Davyne, 324.	2·42—2·62.	Barsowite, 342.	2·7—2·76.

	Sp. gravity.		Sp. gravity.
Wollastonite, 265.	2·75—2·9.	Chrysolite, 278.	3·3—3·6.
Eudialyte, 378.	2·89—2·91.	Allanite, 354.	3·3—4·2.
Gehlenite, 342.	2·9—3·1.	Idocrase, 350.	3·34—4·0.
Humboldtite, 343.	2·9—3·15.	Willemite, 484.	3·9—4·2.
Epidote, 352.	3·25—3·5.	Tephroite, 464.	4—4·12.

3. *Insoluble in acids, or partly soluble without gelatinizing.*

* Infusible.

† B.B. Reaction of phosphorus or fluorine.

	Hardness.	
Xenotime,	4—5	II ; *cl* lateral ! ; G 4·4—4·6 ; ywh-bn ; *st* pale bn ; res ; op ; BB *bor* uncol glob ; *acids* insol ; Y, $\ddot{\mathrm{P}}$, 237.
Fluocerite.	4—5	VI ! hexag ; G 4·7 ; rdh, yw ; *st* w, ywh ; strl, op ; BB darkens ; *bor* sol, red in outer flame, Ce, F, Aq, 237.
Monazite,	5	IV ; small cryst imbedded ; *cl* basal ! ; bn, bnh-red ; vit-res ; strp—strl brittle ; BB *bor* slow ; *mur* slow decomp ; $\dot{\mathrm{C}}\mathrm{e}$, $\dot{\mathrm{L}}\mathrm{a}$, $\dot{\mathrm{T}}\mathrm{h}$, $\ddot{\mathrm{P}}$, 235.
Turquois,	6	Stalact, ren, no *cl* ; G 2·6—2·85 ; bh-gn ; waxy ; strl, op ; BB decrep, bn, gn flame ; *bor* fus ; *mur* insol ; $\bar{\mathrm{A}}\mathrm{l}$, $\ddot{\mathrm{P}}$, Aq, 229.
Lazulite,	5—6	IV ; cryst, mas ; G 3—3·15 ; blue, gnh ; vit ; strl, op ; BB blebby appearance ; *bor* trp glob ; $\dot{\mathrm{M}}\mathrm{g}$, $\bar{\mathrm{A}}\mathrm{l}$, $\ddot{\mathrm{P}}$, Aq, 229.

No species in this subdivision are either fibrous or foliated.

†† Hydrous ; no phosphorus reaction. Hydrous silicates of magnesia, alumina or oxyd of iron.*

Pholerite,	0·5—1	Soft pearly scales, w ; mas ; G 2·3—2·6 ; dilute *nit* not sol ; Al, Si, Aq, 283.
Halloysite,	1	Clay-like, mas ; G 1·6—2·1 ; w, bh ; waxy ; adheres to the tongue ; strl, more trp in water ; *acids* decomp ; BB with cobalt solution blue color ; Al, Si, Aq, 288. (For other hydrous silicates of alumina, see pp. 284, 285, 286).
Pyrophyllite,	1	Fol like talc, rad : G 2·7—2·8 ; p'ly ; gn, gnh, w, ywh ; strp, trl ; lam flex ; BB swells up ! !, *soda* fus ; *sul* partly sol ; Al, Si, Aq, 291.
Talc,	1—1·2	IV or III ; *cl* fol ! ! mas ; G 2·58—2·85 ; gnh, gn, w ; p'ly ; feels greasy ; lam flex, inelastic ; BB *bor* intum, glass ; acids no action ; $\dot{\mathrm{M}}\mathrm{g}$, $\bar{\mathrm{S}}\mathrm{i}$, 251.
Steatite,	1·5	Mas, gran ; G 2·65—2·8 ; w, gyh, gnh ; subp'ly ; feel greasy ; BB *bor* intum, glass ; acids no action ; Mg Si, 251.
Kerolite,	2—2·5	Mas, ren ; lam ; G 2—2·2 ; vit, res ; w, gnh, gn ; trp—trl ; feel greasy ; BB bkns ; Mg, Si, Aq, 257.
Picrosmine,	2·5—3	III ; *cl* mas, fib ; G 2·59—2·68 ; gnh-w, gn, gy ; p'ly, vit ; strl, op ; odor argil if moist ; BB intum ; Mg, Si, Aq, 258.

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* Some of the micas and some feldspars (not here included) are at times hydrous.

	Hardness.	
Aspasiolite,	2·5—3	Hexag, imperf fol ; G 2·764 ; gnh, gyh ; strl, trl ; *mur* heated sol ; Al, Mg, Si, Aq, 293.
Villarsite,	3—3·5	III ; mas ; G 2·975 ; ywh-gn ; strp ; *acids* decomp ; Mg, Si, Aq, 257.
Picrophyll,		Mas, fol ; G 2·75 ; deep gnh-gy ; Mg, Fe, Si, Aq, 259.
Dermatine,		Mas, crusts on *serpentine ;* gnh ; res ; feel greasy ; odor argil when moistened ; BB blackens ; Mg, Si, Aq, 256.
Pyrargillite,	3·5	Mas ; rarely in prisms, not *cl ;* G 2·5 ; bk, bh, rd ; shining or dull ; res ; trl, op ; argil odor ; BB slightly glazed ; *bor* fus slowly ; *mur* sol ; Al, Fe, Si, Aq, 289.
Hydrophite,	3·5	Mas ; fib ; G 2·65 ; mountain-gn ; Mg, Fe, Si, Aq, 259.
Gibbsite,	3—4	VI ; hexag tables ; *cl* basal ; mas, stalact, crust ; G 2·3—2·4 ; gyh, gnh, w ; p'ly, waxy ; trl ; tough ; $\bar{A}l$, Aq, 224.
Retinalite,	3·5—4	Mas ; G 2·493 ; bnh-yw ; resinous ! ; BB whitens ; Mg, Si, Na, Aq, 257.
Clintonite,	4—5	Fol ! mas ; G 3·098 ; rdh-bn ; copper-r ; submet-p'ly ; strl ; lam brittle ; BB wtns ; *bor* sol ; *acids* some action ; Al, Mg, Ca, Fe, Si, Aq, 264.
Œrstedite,	4·5	II ; like zircon ; G 3·629 ; adamantine ; rdh-bn ; op, strl ; BB *bor* or *phos* sol dif, colorless glass ; *soda* not sol ; Zr, Ca, Mg, Si, Ti, Aq, 393.
Monradite,	5—6	Mas, fol ; G 3·2673 ; ywh, w ; vit ; Mg, Fe, Si, Aq, 259.
Chloritoid,	5·5—6	Coarse fol ; G 3·4—3·56 ; gy, gyh-gn, gnh-bk ; weak p'ly ; BB darkens, mag ; *bor* fus iron glass ; *acids* not sol ; Al, Fe, Si, Aq, 292.—Chlorite spar is a similar mineral without water.
Opal,	5·5—6	Mas ; G 2—2·21 ; w, yw, r, b, gn, gy, bn ; vit, res, p'ly ; BB yields water, sometimes rdns when impure ; *soda* fus ! $\ddot{S}i$, Aq, 245.
Bowenite,	6	Mas, fine gran ; G 2·59—2·8 ; apple-gn ; faint vit ; trl ; splintery, tough ; BB unalt ; hot *mur* decomp, 265.
Diaspore,	6—6·5	III ; 129° 54′ ; fol mas ; G 3·4—3·5 ; gnh, gyh, bnh ; p'ly, vit ; trl, strl ; brittle ; BB decrep ; *soda* unalt ; *sul* no action ; $\bar{A}l$, Aq, 223.
Malacone,	6·5	II ; cryst ; G 4·047 ; vit-subres ; bn, rdh, bluish-w within ; BB yields water ; *bor* sol dif ; pulv, *sul* boiling attack ; Zr, Si, H, 380. Resembles zircon.

α. Species distinctly foliated or fibrous.

Pyrophyllite, 291.	H=1	Fol !	Hydrophite, 259.	H=3·5	Fib.
Talc, 251.	1—1·5	Fol !	Gibbsite, 224.	3—4	Fol.
Kerolite, 257.	2—2·5	Fol.	Clintonite, 264.	4—5	Fol.
Picrosmine, 258.	2·5—3	Fib.	Monradite, 259.	5—6	Subfol.
Aspasiolite, 293.	2·5—3	Subfol.	Chloritoid, 292.	5·5—6	Subfol.
Picrophyll, 259.		Fol.	Diaspore, 223.	6—6·5	Fol.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Halloysite, 283.	1·6—2·1.	Opal, 245.	2—2·2.
Kerolite, 257.	2·0—2·2.	Gibbsite, 224.	2·3—2·4.

	Sp. gravity.		Sp. gravity.
Pholerite, 288.	2·3—2·6.	Aspasiolite, 292.	2·764.
Retinalite, 257.	2·493.	Dermatine, 256.	
Pyrargillite, 289.	2·5.	Villarsite, 257.	2·975.
Talc, 251.	2·58—2·65.	Clintonite, 264.	3·098.
Picrosmine, 258.	2·59—2·68.	Mouradite, 259.	3·2673.
Bowenite, 265.	2·59—2·8.	Diaspore, 228.	3·4—3·5.
Hydrophite, 256.	2·65.	Chloritoid, 292.	3·5—3·6.
Steatite, 251.	2·65—2·8.	Œstedite, 292.	3·629.
Picrophyll, 259.	2·75.	Malacone, 380.	4·047.
Pyrophyllite, 291.	2·7—2·8.		

††† Anhydrous.*

	Hardness.	
Chiastolite,	3—6·5	III; pms bnh or bkh, tesselated with gyh-w; dull, subvit; G 2·8—3·3; BB infus; Al, Fe, Si, 318.
Blende,	3·5—4	I; *cl* dodec!; mas; G 4—4·2; resin yw, bn, bk, r, gn; *st* w, bnh; trp, trl; brittle; BB infus, or fus dif!!; *mur* sol; Zn, S, 479.
Azorite,	4·5	II, like zircon; minute cryst; vit; colorless, ywh, gnh; trl, op; BB *bor* sol dif!, more *bor* op on flaming; *phos* slow sol; Ca, Ta (?), 396.
Yttro-columbite,	4·5—5	Mas, thin plates, grains; G 5·5—5·9; res, vit; ywh, bn, bnh-bk; op; BB *bor* sol; *acids* insol; Y, Ca, Ta, U, 399.
Knebelite,	5—6 ?	Mas; G 3·71; glistening; gy, r, bn, gn; BB *bor* fus dark olive-gn; Mn, Si, 464.
Boltonite,	5·5	Dissem cryst, *cl* distinct; G 2·8—3; dark gyh-bn, ywh-gy; ywh on exposure; vit; trl; BB bleached; *bor* trp glass; Mg, Fe, Al, Si, 281.
Perovskite,	5·5	I; cubes, hemihed; G 4·017; met-ad; gyh, iron-bk; strl, op; BB *bor* glass, titan reaction; Ca, Ti, 390.
Leucite,	5·5—6	I; trapezohed; *cl* imperf; G 2·45—2·5; vit, not lustrous; w, gyh-w; trl, op; BB *bor* fus dif; *acids* decomp, silica pulv; Al, K, Si, 322.
Brookite,	5·5—6	III; cryst; G 3·8—4·18; met-ad, submet; bn, ywh, rdh, bk; rest like Rutile, 388.
Anatase,	5·5—6	II; cryst acute oct, or tab; G 3·85—3·95; met-ad; bn, bh, gnh; rest like rutile, 389.
Chondrodite,	6—6·5	IV; dissem in *gran limest;* G 3·1—3·2; subvit, res; yw, wh, bnh; gnh, bkh; trp—sbtrl; very brittle; BB *bor* ywh-gn; reaction of fluorine, Mg, Fe, F, Si, 280.
Rutile,	6—6·5	II; cryst, often acic; mas; G 4·18—4·25; met-ad, subvit; rdh-bn, rd, ywh, bk; strp—op; BB unalt, *bor* rd in outer fl; Ti, 387.
Ostranite,	6—6·5	III; cryst; G 4·3—4·4; vit; clove-bn, gyh; brittle; BB *bor* fus dif; *nit* insol; Zr, Si ?, 380.
Stannite,	6·5	Mas, compact; G 3·545; nearly dull; pale ywh-w; strl, op; Sn, Al, Si, 386.

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* Chondrodite and Topaz in this section give a *fluorine* reaction.

	Hardness.	
Bamlite,	6·5	Columnar, prism; diverg; G 2·984; silky; gyh-w, gnh; trl; BB infus; Al, Si, 320.
Tin Ore,	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; $\ddot{\mathrm{S}}$n, 385.
Kyanite	6—7·25	V; slender bladed cryst, common; bh, wh; rbc pms, bnh, gyh; fib mas; G 3·1—3·7; vit, sbp'ly; bkh; trp—sbtrl; BB unalt; *bor* fus dif; Al, Si, 314.
Andalusite,	6—7·5	III; 91° 20′; prisms stout; mas; G 3·1—3·35; vit; gyh, rdh, gnh; strl—op; tough; BB unalt, *bor* fus dif!; Al, Si, 317.
Quartz,	7	VI; cryst, mas; G 2·6—2·7; w, yw, r, bn, gn, b, bk; trp—op; vit, subres; BB *soda* fus! $\ddot{\mathrm{S}}$i, 239.
Staurotide,	7—7·5	III; 129° 20′; pms stout, often cruciform; G 3·5—3·75; subvit, vit; bnh, rdh-bn, bk, gy; trl, op; BB darkens, *bor* fus dif gn glass; Al, Fe, Si, 319.
Chrome Garnet,	7·5	I; dodec; G 3·4184; vit; emerald-green; BB infus; *bor* chrome-gn glass; Cr, Al, Ca, Si, 348.
Zircon,	7·5	II; cryst; G 4·5—4·75; vit-adamant; bn, r, yw, gy, w, often bright; trp, strl; BB loses color; *phos* and *soda* infus; *acids* no action, or dif! Zr, Si, 379.
Sapphirine,	7—8	Small fol grains; G 3·473; vit; b, gn; trp, trl; BB infus, *bor* infus, unalt; Mg, Al, Si, 320.
Beryl,	7·5—8	VI; hexag pms; G 2·65—2·75; vit, subres; gn, emerald-gn; ywh, bh, bnh; trp, strl; BB *bor* clear glass; Be, Al, Si, 378.
Phenacite,	8	VI; cryst, *cleav* rbdl; G 2·969; vit; colorless, wine-yw; rdh; trp, op; BB *bor* fus dif; trp glass; *soda* w enamel; cobalt solution not blue; Be, Si, 375.
Topaz,	8	III; cryst; *cl* basal!; mas, sub-fib; G 3·4—3·65; vit; yw, w, gnh, bh; trp, trl; BB *bor* clear glass; Al, Si, F, 366.
Spinel,	8	I; oct, dodec, &c.; G 3·5—4·9; vit; r, gn, b, gy, bk, sometimes bright; trp, op; BB *bor* fus dif; Mg, Al; Zn, Al, Mg, Fe, Al; Zn, Mn, Al, Fe; Zn, Fe, 370.
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, 376.
Sapphire,	9	VI; hexag, rbdl; mas; G 3·9—4·2; vit, p'ly; blue, r, yw, bn, gy, wh; trp, op; tough; BB *soda* unaltered; *acids* no action; $\dddot{\bar{\mathrm{A}}}$l, 222.
Diamond,	10	I; rarely mas; G 3·4—3·6; w, b, r, w, gn, bn, gy, bk; adamantine; trp, strl; op, 175.

a. Species distinctly foliated or fibrous in some varieties.

Bamlite, 320.	H=6·5	Subfib.	Bucholzite, 317.	H=7—7·5	Fib.
Kyanite, 316.	6—7·5	Fib.	Sillimanite, 317.	7—7·5	Fib.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Leucite, 322.	2·5—3.	Spinel, 370.	3·5—4·9.
Quartz, 239.	2·6—2·7.	Topaz, 366.	3·4—3·65.
Beryl, 373.	2·65—2·75.	Knebelite, 464.	3·71.
Boltonite, 281.	2·8—3.	Brookite, 388.	3·8—4·18.
Andalusite, 317.	2·8—3·2.	Anatase, 389.	3·85—3·95.
Phenacite, 375.	2·969.	Sapphire, 222.	3·9—4·2.
Bamlite, 320.	2·984.	Blende, 479.	4—4·2.
Chondrodite, 280.	3·1—3·2.	Perovskite, 390.	4·017.
Kyanite, 314.	3·1—3·7.	Rutile, 387.	4·18—4·25.
Chrome Garnet, 348.	3·4184.	Azorite, 396.	
Sapphirine, 320.	3·473.	Ostranite, 380.	4·3—4·4.
Diamond, 175.	3·4—3·6.	Zircon, 379.	4·5—4·75.
Stannite, 386.	3·545.	Yttrocolumbite, 399.	5·5—5·9.
Staurotide, 319.	3·5—3·75.	Tin Ore, 385.	6·3—7·1.

** Fusible. Specific gravity under 4·8.

† *Sulphates, Phosphates:* BB Sulphur or Phosphorus reaction.

	Hardness.	
Gypsum,	1·5—2	IV; 111° 14′; cryst; *cl* fol!!, mas, fib; G 2·26—2·36; w, gy; ywh, bn, bh, bk; trp, op; BB exfol, crumbles; fus dif!; $\dot{\text{Ca}}$, $\dddot{\text{S}}$, Aq, 201.
Heavy Spar,	2·5—3·5	III; cryst; mas, tab, fib; G 4·3—4·9; w, ywh, gyh, bnh; rdh; trp, trl, op; BB fus dif; $\dot{\text{Ba}}$, $\dddot{\text{S}}$, 194.
Anhydrite,	3—3·5	III; *cl* rectang; lam, fib, mas; G 2·85—3; w, gyh, bh, rdh; vit-p'ly; trp, trl; BB not exfol, fus dif! $\dot{\text{Ca}}$, $\dddot{\text{S}}$, 202.
Celestine,	3—3·5	III; 104°; cryst prism; mas, rad; G 3·9—4; w, bh; vit, p'ly; trp, strl; brittle; BB decrep, fus; phosph; $\dot{\text{Sr}}$, $\dddot{\text{S}}$, 196.
Dreelite,	3·5	VI; 94°; G 3·2—3·4; w; p'ly, splendent; $\dot{\text{Ca}}$, $\dot{\text{Ba}}$, $\dddot{\text{S}}$, 195.
Lazulite,	5—6	IV; cryst; *cl* imperf; mas; G 3·0—3·15; fine blue, gnh; vit; strl, op; BB fus dif!!! blebby appearance, *bor* trp glob; $\dot{\text{Mg}}$, $\overline{\text{Al}}$, $\ddddot{\text{P}}$, Aq, 229.

α. Species distinctly foliated or fibrous in some varieties.

Gypsum, 201.	H=1·5—2	Fol! fib!	Anhydrite, 202.	H=3—3·5	Fol, fib.
Heavy Spar, 194.	2·5—3·5	Subfol, fib.	Celestine, 196.	3—3·5	Fib.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Gypsum, 201.	2·2—2·4.	Dreelite, 195.	3·2—3·4.
Anhydrite, 202.	2·85—3.	Celestine, 196.	3·9—4.
Lazulite, 229.	3·0—3·15.	Heavy Spar, 194.	4·3—4·7.

†† Hydrous; BB no sulphur or phosphorus reaction; G below 3·8.

Halloysite,	1	Mas; earthy; G 1·6—2·1; w, bh; adheres to the tongue; waxy; strl, more trp in water, and increases in weight; *acids* decomp; Al, Si, Aq, 283. [For other allied hydrous silicates of alumina, see pp. 284, 285, 286].

	Hardness.	
Vermiculite,	1—1·5	Fol! scaly mas; G 2·756; olive-gn, gyh; p'ly; strl; BB fus dif, swells up!!; *mur* decomp; Mg, Al, Fe, Si, Aq, 291.
Saponite,	1—2	Mas; soft; G 2·26; w, ywh, bh, rdh; greasy; BB bkns, fus dif!!; *Sul* sol; Mg, Al, Si, Aq, 253.
Neolite,	1—2	Fib, stel, mas; G 2·77; gn; silky or earthy; Mg, Fe, Al, Si, Aq, 260.
Ripidolite,	1—2	VI; hexag; fol!; mas gran; G 2·78—2·96; gn, olive-gn; p'ly; trl, strp; lam flex, inelast; BB fus often dif; Mg, Fe, Al, Si, Aq, 261.
Chlorite,	1·5—2	VI; fol!; gran mas; G 2·65—2·85; gn, olive-gn, wh; p'ly, vit-p'ly; trp, strl; lam inelast; BB fus, often dif; *sul* decomp; Mg, Al, Fe, Si, Aq, 261.
Kirwanite,	2	Fib, diverg; G 2·94; dark olive-gn; op; BB bkns, fus dif!; Fe, Ca, Al, Si, Aq, 264.
Metaxite,	2—2·5	Fib, mas; G 2·52; gnh-w, gn; weak p'ly; BB fus dif!!; *mur* sol; Mg, Si, Al, Aq, 256.
Meerschaum,	2—2·5	Mas, earthy; wh, gyh, ywh, rdh; feel smooth; op; BB fus dif!!; *bor* trp glass; *mur* sol, flocky; Mg, Si, Aq, 253. *Aphrodite* is closely allied, p. 254. So also Quincite, rdh, 254.
Epichlorite,	2—2·5	Fib; G 2·76; dull leek-gn; greasy; strl; BB fus dif!!; Mg, Al, Fe, Si, Aq, 263.
Anauxite,	2—3	Mas, gran, cleav; G 2·26; gnh-w; p'ly; trl; BB fus dif!; Al, Fe, Si, Aq, 288.
Fahlunite,	2—3	Somewhat fol, hexag; G 2·7—2·8; gyh-gn, gnh; subp'ly; sbtrl; BB fus dif!; *bor* iron glass; *soda* insol; *acids* insol; Al, Fe, Si, Aq, 293.
Gigantolite,	2—3	Coarse fol, hexag; G 2·8—2·9; bnh, gnh-bn; submet; BB fus, intum, but does not form a globule; Al, Fe, Si, Aq, 293.
Spadaite,	2·5	Mas; rdh; p'ly; BB glassy enamel; *mur* sol; imperf gelat; Mg, Si, Aq, 258.
Antigorite,	2·5	III; mas, fol!; G 2·622; bnh-gn, leek-gn; trp, trl; feel smooth, not greasy; BB fus dif!!; *mur* decomp dif; Mg, Fe, Si, Aq, 260.
Groppite,	2·5	Mas, cleav; G 2·73; rose rd; trl; BB wns, fus dif!!; *bor* sol, intum; Al, Fe, Mg, Si, Aq, 290.
Iberite,	2·5	Hexag, large pms, *cl* basal; G 2·89; dull gnh, gyh; vit, p'ly; op; BB fus dark pearl; Al, Fe, Si, Aq, 295.
Damourite,	2·5—3	Mas, scaly, pulv; G 2·792; yw, ywh; p'ly; trl, scales trp; BB wns, fus dif!, *bor* sol; *mur* insol, *sul* sol; Al, K, Si, Aq, 290.
Rosite,	2·5—4	Mas, in grains, cleav; G 2·7—2·75; rd, rdh, violet; strp; p'ly; BB fus dif!!, *bor* sol, intum; Al, K, Si, Aq, 290.
Pyrosclerite,	3	III?; fol!; mas, gran; G 2·74—2·76; gn, gyh, wh; weak p'ly; trl; BB fus dif!; *mur* decomp; Mg, Si, Aq, 263.
Xylite,	3	Fib, asbest; G 2·935; nut-bn; op; BB fus dif!!; iron reaction; *acids* slight action; Fe, Mg, Ca, Si, Aq, 269.

	Hardness.	
Serpentine,	3—4	III ; mas, gran, fol, fib ; G 2·2—2·6 ; gn, dark or light, bnh, ywh, wh ; subres, greasy ; trl, op ; BB fus dif ! !, *bor* sol ! ; *mur* sol ; Mg, Si, Aq, 254.
Deweylite,	3—3·5	Mas ; G 2·246 ; ywh-w, ywh-bn, w ; res ! ; trl ; very brittle ; BB decrep !, wtns, fus dif ! ! ; Mg, Si, Aq, 257.
Algerite,	3—3·5	III or IV ; slender prisms, imbedded in *gran limest ;* G 2·69—3 ; vit, subp'ly ; ywh, bnh ; trl ; brittle ; BB intum, fus dif ; Al, K, Si, Aq, 314.
Liebnerite,	3·5	VI ; hexag pms ; *cl* indistinct ; G 2·814 ; greasy ; gnh-gy ; BB intum, fus dif, no globule ; Al, K, Si, Aq, 314.
Stilbite,	3·5	III ; cryst, cl ! ; diverg, columnar, fol ; G 2·05—2·21 ; p'ly, vit ; w, ywh, gyh, rdh ; strp, strl ; brittle ; BB intum, fus ; *acids* slimy ; Al, Ca, Si, Aq, *Zeolite*, 298.
Heulandite,	3·5—4	IV ; cryst, cl ! ; fol ! ; glob ; G 2·19—2·2 ; p'ly ! ; w, rdh, gyh bnh ; trp, strl ; brittle ; BB intum, fus ; *mur* sol ; Al, Ca, Si, Aq ; *Zeolite*, 296.
Schiller Spar,	3·5—4	III ? IV ? fol mas ; G 2·6—2·8 ; gn, pinchbeck bn ; met p'ly ; strl ; BB fus dif ! ! ; *sul* decomp ; Mg, Fe, Si, Aq, 260.
Pyrallolite,	3·5—4	III ; cl ; mas, gran ; G 2·55—2·6 ; w, gnh ; dull, slightly res ; strl, op ; fract earthy ; BB bk, w, fus dif ! intum ; Mg, Ca, Si, Aq, 259.
Epistilbite,	4	III ; cryst, cl ! ; gran ; G 2·25 ; p'ly, vit ; w ; trp, strl ; BB intum, fus ; *mur* sol ; Al, Ca, Si, Aq ; *Zeolite*, 299.
Chabazite,	4—4·5	VI ; rbdns, hexag ; G 2·05—2·2 ; w, gyh, rdh ; vit ; trp, trl ; brittle ; BB intum, fus ; *mur* pulv sol ; Al, Ca, Si, Aq ; *Zeolite*, 308.
Harmotome,	4—4·5	III ; cryst, often cruciform, *cl* imperf ; G 2·35—2·5 ; w, ywh, rdh, bnh ; trp, trl ; BB fus, no intum ; *acids* not sol without heat ; Al, Ba, Si, Aq ; *Zeolite*, 304.
Edingtonite,	4—4·5	II ; cryst, hemihed ; G 2·7—2·8 ; vit ; w, gyh ; trl ; BB fus dif ; Al, Ca, Na, Si, Aq ; *Zeolite*, 307.
Palagonite,	4—5	Mas ; G 2·43 ; wine-yw, ywh-bn ; trl ; res, subvit ; BB fus ! ; *mur* sol ; Al, Fe, Ca, Mg, Si, Aq, 288, *tufa*.
Apophyllite,	4·5—5	II ; oct and prism, mas, *cl* basal ! ; G 2—2·4 ; w, gyh, gnh, ywh, rdh ; trp, op ; brittle ; BB exfol, fus ; *nit* flaky, imperf gelat ; Ca, K, Si, 248.
Brewsterite,	4·5—5	IV ; cryst, cl ! ; G 2·1—2·44 ; vit, p'ly ; w, ywh, gyh ; trp, trl ; BB froths, fus ; *mur* sol ; Al, Ba, Sr, Si, Aq ; *Zeolite*, 298.
Ottrelite,	5	Scales, dissem, micaceous ; G 4·4 ; bkh-gy, gnh-gy ; BB fus dif ; Al, Fe, Mn, Si, Aq, 292.
Carpholite,	5—5·5	Rad, stell ; G 2·9—2·95 ; straw-yw ; silky ; op ; very brittle ; BB intum, fus dif, bn op ; *acids* hardly attacked ; Al, Mn, Si, Aq, 313.
Diphnaite,	5—5·5	VI ; hexag pms, *cl* basal ! ! ; micaceous ; G 3—3·07 ; vit ; bh, w ; trp, trl ; BB op, fus dif, intum enamel ; Al, Ca, Si, Aq, 292.—Margarite ?

	Hardness.	
Chlorastrolite,	5·5—6	Mas, fib, rad, stel ; G 3·18 ; p'ly ; gn, bh-gn, pale ; BB fus ! intum ; *mur* sol ; Al, Ca, Fe, Si, Aq ; *Zeolite*, 307.
Chloritoid,	5·5—6	Coarse fol ; G 3·45—3·6 ; gy, gyh-gn, gnh-bk ; weak p'ly ; BB mag ; fus dif, dark gn ; Al, Fe, Si, Aq ; (Masonite), 292.
Faujasite,	6	II ; oct ; G 1·923 ; w, bnh ; vit ; trp, trl ; BB intum, fus, *mur* sol ; Al, Ca, Na, Si, Aq ; *Zeolite*, 306.
Prehnite,	6—6·5	III ; glob, mas, thick and hard incrust ; G 2·8—3 ; vit, sbp'ly ; gnh, wh ; strp, trl ; BB *intum*, fus ; *mur* sol slowly ; Al, Ca, Si, Aq, 312.
Anthosiderite,	6·5	Fib, rad, feathery ; G 3·6 ; ochre-bn, gyh ; sbtrl, op ; tough ; BB rdh-bn, then bk ; fus dif, bk mag slag ; *mur* sol ; Fe, Si, Aq, 439.

α. Species foliated or fibrous in some varieties.

	Hardness.			Hardness.	
Vermiculite, 291.	1—1·5	Fol !	Serpentine, 255.	3—4	Fol, fib.
Ripidolite, 261.	1—2	Fol !	Stilbite, 298.	3·5	Fol !
Neolite, 260.	1—2	Fib.	Heulandite, 296.	3·5—4	Fol !
Chlorite, 261.	1·5—2	Fol !	Schiller Spar, 260.	3·5—4	Fol.
Kirwanite, 264.	2	Fib.	Epistilbite, 299.	4	Fol.
Epichlorite, 263.	2—2·5	Fib.	Ottrelite, 292.	5	Fol.
Metaxite, 256.	2—2·5	Fol, fib.	Carpholite, 313.	5—5·5	Fib.
Fahlunite, 293.	2—3	Fol.	Diphanite, 292.	5—5·5	Fol !
Antigorite, 260.	2·5	Fol !	Chlorastrolite, 307.	5·5—6	Fib.
Iberite, 295.	2·5	Subfol.	Chloritoid, 292.	5·5—6	Subfol.
Pyrosclerite, 263.	3	Fol.	Anthosiderite, 439.	6·5	Fib.
Xylite, 259.	3	Fib.			

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Halloysite, 283.	1·6—2.1.	Algerite, 314.	2·69—3.
Meerschaum, 253.		Groppite, 290.	2·73.
Aphrodite, 254.		Epichlorite, 263.	2·76.
Quincite, 254.		Neolite, 260.	2·77.
Faujasite, 306.	1·923.	Chlorite, 261.	2·65—2·85.
Stilbite, 298.	2·0—2·21.	Rosite, 290.	2·7—2·75.
Chabazite, 303.	2·0—2·21.	Edingtonite, 307.	2·7—2·8.
Apophyllite, 248.	2·0—2·4.	Fahlunite, 293.	2·7—2·9.
Heulandite, 296.	2·19—2·2.	Pyrosclerite, 263.	2·74—2·76.
Brewsterite, 298.	2·1—2·44.	Vermiculite, 291.	2·756.
Serpentine, 254.	2·2—2·6.	Ripidolite, 261.	2·78—3.
Deweylite, 257.	2·246.	Prehnite, 312.	2·8—3.
Epistilbite, 299.	2·25.	Liebnerite, 314.	2·814.
Saponite, 253.	2·26.	Iberite, 295.	2·89.
Anauxite, 283.	2·26.	Carpholite, 313.	2·9—2·95.
Harmotome, 304.	2·35—2·5.	Xylite, 259.	2·935.
Palagonite, 288.	2·43.	Kirwanite, 264.	2·94.
Spadaite, 253.		Diphanite, 292.	3—3·1.
Metaxite, 256.	2·52.	Chlorastrolite, 307.	3·18.
Pyrallolite, 259.	2·55—2·6.	Chloritoid, 292.	3·4—3·5.
Schiller Spar, 260.	2·5—2·8.	Anthosiderite, 439.	3·6.
Antigorite, 260.	2·622.	Ottrelite, 292.	4·4.

††† Anhydrous; no Sulphur or Phosphorus reaction.

	Hardness.	
Steatite,	1·5	Mas, gran; G 2·65—2·8; w, gyh, gnh; subp'ly; feel greasy; BB fus dif ! !, *bor* intum glass; acids no reaction; $\dot{M}g$, $\dddot{S}i$, 251. Some varieties afford water; see pages 252, 253.
Asbestus,		Fib, sometimes like cotton, fibres separable or not; BB fus dif; acids imperf sol; same compound as pyroxene or hornblende, 266, 274.
Mica,*	2—2·5	Thin micaceous, lam very thin, flex, usually elastic, easily separable; G 2·75—3·1; w, gy, gnh, ywh, bnh, bk; trp—trl; BB whitens, usually fluorine reaction, fus dif; Al, K, Fe, Si; Al, Mg, Fe, Si; Al, Li, K, Si, F, 358—361.
Margarite,*	3—4	Thin micaceous; G 3·032; pale gyh, wh, ywh; trl, strl; rather brittle; *acids* dissolved; BB intum, fus dif; Al, Ca, Si, 362.
Emerylite,*	3—4·5	Thin micaceous; G 2·9—3; w, wh; trl, strl; rather brittle; *acids* not decomp; BB exfol, fus dif ! !; Al, Ca, Na, Si, 362.
Euphyllite,*	3·5—4·5	Thin micaceous; G 2·9—3; w, wh; gnh, gyh; brittle; *acids* not decomp; BB exfol, fus dif !; Al Ca, Si, 363.
Leucophane,	3·5—4	V ! mas, columnar; G 2·974; vit; dirty gn, wine yw; trp—trl; BB fus, violet glass; *bor* amethystine glass; Be, Ca, Na, Si, F, 377.
Sphene,	5—5·5	IV; cryst often thin; mas; G 3·4—3·6; adamant, res; bn, gy, yw, gn, bk; trp—op; BB fus dif ! intum, enam; *bor* clear glass; *mur* heated sol imperf; Ca, Ti, Si, 391.
Pyrochlore,	5—5·5	I; oct; G 3·8—4·35; vit, res; ywh, bnh, dark bn; strl—op; BB fus dif ! *bor* rdh, yw; trp, on flaming op, more *bor* wh enamel; Ce, Th, Ca, Ta, Ti, 397.
Microlite,	5	I; oct; G 5·405; vit, res; pale yw, bright yw, bn; trl, op; BB fus dif ! *bor* like pyrochlore; Ca, Ta, 398.
Babingtonite,	5·5	V; G 3·4—3·5; vit; gnh-bk; strl, op; BB fus ! bead mag; Ca, Fe, Mn, Si, 276.
Glaucophane,	5·5	Prism, mas; G 3·108; vit, p'ly; b, lavender-b, bh-bk, gyh; *st* gyh-b; trl—op; powder slightly magnetic; BB fus ! gn glass; *acids* partly sol; Al, Fe, Mg, Na, Si, 345.
Scapolite,	5—6	II; mas; subfeldsp; G 2·6—2·75; vit-p'ly, vit; w, gy, bh, gnh, rdh; trl, strl, op; BB fus intum; *acids* decomp; Al, Ca, Na, Si, 340.
Dipyre,	5—6	II; like Scapolite; G 2·646; vit; wh, rdh; trp, trl; BB fus, w blebby glass; *acids* dif attacked; Al, Ca, Na, Si, 344.
Hornblende,	5—6	IV; prisms, 124° 32′; mas, fib, gran; G 2·9—3·4; vit, p'ly; gn, w, bk; BB fus dif or easy; Ca, Si; Mg, Si; Fe, Si; Mn, Si, 272.

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*These micas often contain some water, which at times amounts to 5 or 6 per cent.

	Hardness.	
Pyroxene,	5—6	IV, 87° 6′; cryst, fib, lam, gran, mas; asbest; G 3·23—3·5; gn, light or dark; w, gy, bn, bk; subvit, p'ly; trp—op; BB fus, sometimes dif, often with iron reaction; *acids* imperf sol; Mg, Ca, Fe, Mn, S̄i, (Ⱥl); 266. *Diallage* in thin fol, gn; fus dif ! l.
Chladnite,	5·5—6	V ! cleav mas; G 3·116; w, gyh; p'ly, vit; brittle; BB fus ! w enamel; Mg, Na, Si, 279.
Baulite,	5·5—6	IV; feldspath; G 2·62—2·63: vit; wh; trp, trl; BB fus dif; *mur* insol; Al, Na, K, Si, 330.
Stroganowite,	5·5—6	Mas, cleav; G 2·79; clear green; subvit; BB fus; *mur* sol, 324.
Wichtyne,	5·5—6	Mas; G 3·03; dull; bk; BB fus bk, mag; *acids* not attacked; Al, Fe, Ca, Mg, Na, Si, 345.
Saussurite,	5·5—6	V ! mas, cleav; G 3·2—3·4; p'ly, vit; w, gnh, gyh; strl; tough ! BB fus dif; *acids* insol; Al, Fe, Ca, Na, Si, 337.
Allanite,	5·5—6	IV; cryst, acic; mas; G 3·3—4·2; pitch-black, or bn, ywh; strl, op; brittle; *st* gyh; intum easily, fus; *acids* sol or insol; Al, Fe, Ce, Ca, Si, 354.
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, 337.
Rhodonite,	5·5—6·5	IV; like Augite; mas cleav or gran; G 3·4—3·65; vit; light rd; gnh, ywh when impure; bk on exposure; BB bn, rdh-bn glob; *mur* partly sol; Mn, Si, 462.
Orthoclase,	6	IV; cryst, mas, cleav; G 2·4—2·6; vit, subp'ly; w, rdh, gyh, gnh; trp—sbtrl; BB fus dif ! *acids* insol; Al, K, Si, 325.
Ryacolite,	6	IV; feldspath; G 2·5—2·63; vit, subp'ly; w, gyh-yw; trp; BB fus, flame yellow; *acids* sol slowly; Al, Na,K,Si, 330.
Oligoclase,	6	V; feldsp; G 2·63—2·69; vit, subp'ly; ywh, gyh, gnh, w; trp, strl; BB fus quietly; *acids* insol; Al, Na, Ca, Si, 332.
Andesine,	6	V; feldsp; G 2·65—2·74; w, gy, gnh; subvit, p'ly; trl, strl; BB fus dif; *bor* clear glass; *acids* sol imperf; Al, Na, Ca, Si, 334.
Thiorsauite,	6	V ! mas, feldsp; G 2·688; vit, sbp'ly; w, gyh, trp, trl; BB fus dif; *mur* insol; Al, Ca, Si, 336. Anorthite ?
Labradorite,	6	V; feldsp; G 2·68—2·76; subvit, p'ly; gy, bn, gnh, often a play of colors; trl, strl; BB fus dif; *mur* heated sol ! Al, Ca, Na, Si, 333.
Vosgite,	6	V; mas, feldsp; G 2·7—2·8; w, gnh, bh; greasy, p'ly; trl; BB fus, blebby glass; *mur* sol ! Al, Ca, Na, Si, 336.
Acmite,	6	IV; 86° 56′; cryst, long prism, pointed; G 3·2—3·55; bn, rdh-bn; vit—res; op; brittle; BB fus, bk bead, magn; *acids* unalt, or imperf sol; F̶e, M̶n, Ṅa, S̄i, 271.
Castor,	6—6·5	IV; Mas, cleav; G 2·392; lustre like quartz; trp; BB fus dif, trp; flame red, rdh; *acids* insol; Al, Li, Si, 339.
Petalite,	6—6·5	Mas; cleav; subfeldsp; G 2·4—2·45; vit, glist; p'ly; w, gy, rdh, gnh; trl; BB fus dif ! *acids* insol; Al, Na, Li, Si, 338.

Loxoclase,	6—6·5	IV ; cryst, feldsp ; macrod cleav perf ; G 2·6—2·62 ; vit, subp'ly ; w, gyh, ywh, bh ; BB fus dif, flame yellow ; Al, Na, K, Si, 330.
Couseranite,	6—6·5	IV ; 96° ; subfeldsp ; G 2·69 ; vit ; gy, gnh-gy, bk ; BB fus w enamel ; *acids* insol ; Al, Ca, K, Na, Si, 336.
Pollux,	6—6·5	Mas, like quartz ; G 2·88 ; vit ; colorless ; trp ; BB fus, flame orange ; *bor* glass easily ; *acids* decomp ; Al, K, Li, Na, Si, 338.
Helvin,	6—6·5	I ; tetrahed ; G 3·1—3·3 ; vit ; subres ; wax-yw, bnh, gnh ; strl ; BB fus, intum, yw globule op ; *bor* manganese reaction ; Be, Mn, Si, S, 377.
Bodenite, l	6—6·5	Long prism ; G 3·523 ; greasy—vit ; bn, rdh-bn, bk ; *st* gyh-w ; strl ; BB fus dif !, glows, flame yw ; *soda* manganese ; Al, Fe, Y, Ce, La, Ca, Si, 383.
Albite,	6—7	V ; feldsp ; G 2·59—2·65 ; vit, sbp'ly ; w, bh, gyh, gnh ; trp, strl ; BB fus dif, flame yellow ; hot *acids* attack ; Al, Na, Si, 330.
Hyposclerite,	6—7	V ; feldsp ; mas, cleav ; G 2·6—2·7 ; greasy, vit ; trl ; gnh-gy ; BB fus dif ! ; Al, Ca, Na, Si, 337.
Anorthite,	6—7	V ; feldsp ; G 2·65—2·78 ; w, gyh, rdh ; trp, trl ; BB fus dif ; *soda* an enamel ; *acids* sol ; Al, Ca, Si, 334.
Nephrite,	6—7	Mas, subgran ; G 2·9—3·1 ; subvit ; wh, gnh ; tough ; BB fus dif ! ! ; Mg, Ca, Si, 277.
Idocrase, l	6·5	II ; cryst ; *cl* indist ; mas ; G 3·3—4 ; vit, res, often brilliant ; bn, gn ; yw, b ; strp—strl ; BB fus ! intum ; *acids* hot sol' ; Al, Ca, Fe, Si, 350.
Epidote, l	6—7	IV ; cryst ; mas, subcolumn ; G 3·2—3·5 ; vit—res ; pistachio-gn, bn, gy ; strp—op ; BB fus ; *mur* more or less sol ; Al, Ca, Fe, Si, sometimes with Mn, Ce, 352.
Spodumene,	6·5—7	Mas, cleav, subfeldsp ; G 3·15—3·2 ; subp'ly ; gyh—gyh-gn ; trl, strl ; BB fus, intum ; Al, Li, Si, 339.
Axinite,	6·5—7	V ; cryst, with sharp thin edges ; G 3·2—3·3 ; vit ; bn, bh, gyh ; trp, trl ; BB fus ! ; Ca, Al, Fe, Si, $\bar{\mathrm{B}}$, 365.
Garnet,	6·5—7	I ; dodec, trapezohed ; mas ; in grains ; G 3·5—4·3 ; vit, res ; r, bn, ywh-bn, yw, w, gn, bk ; trp—strl ; BB fus ; acids more or less sol ; Al, Ca, Si ; Al, Fe, Si ; Al, Mn, Si ; Fe, Ca, Si, 346.
		Pyrope G 3·69—3·8 ; in rounded grains ; BB fus dif ; *bor* emerald-green glob, 349.
Muromontite,	7	Grains ; G 4·263 ; bk, gnh-bk ; *st* gyh-w ; strl, op ; BB like Bodenite, 383.
Forsterite,	7—7·5	III ; 128° 54′ ; *cl* basal ; vit ; colorless ; trl ; Mg, Si, 277.
Iolite,	7—7·5	III ; 6 and 12-sided pms ; mas ; G 2·55—2·68 ; vit, glassy ; bh, b, bh-bk ; trp, trl ; BB fus slow ; b glass ; *acids* attack dif ! ; Al, Mg, Fe, Si, 344.
Danburite,	7—7·5	Dissem cryst, cleav ; G 2·8—3 ; pale ywh, wh ; vit ; trl, strl ; very brittle ; BB fus reaction of boracic acid ; Ca, Na, $\bar{\mathrm{B}}$, $\bar{\mathrm{Si}}$, 381.

	Hardness.	
Tourmaline,	7—7·5	VI; pms; mas; G 3—3·3; bk, b, gn, rd, w, bn; vit, res; trp, op; BB fus or infus; Al, Si, B̈ with often Fe, Ca, K, 363.
Euclase,	7·5	IV; cryst, cleav; G 2·9—3·1; vit; pale gn, bh; trp, strp; very brittle; BB intum; fus dif; w enamel; *bor* a clear glass; electric by friction!; Be, Al, Si, 375.

α. Species distinctly foliated or fibrous.

Asbestus, 266, 274.		Fib!	Euphyllite, 363.	H=3—4·5	Fol!
Mica, 358–361.	H=2—2·5	Fol!	Hornblende, 274.	5—6	Fib! fol!
Margarite, 362.	3—3·5	Fol!	Pyroxene, 266.	5—6	Fib! fol!
Emerylite, 362.	3—4	Fol!			

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Castor, 339.	2·392.	Nephrite, 277.	2·9—3·1.
Petalite, 338.	2·4—2·45.	Euclase, 375.	2·9—3·1.
Orthoclase, 325.	2·4—2·6.	Leucophane, 377.	2·974.
Ryacolite, 330.	2·5—2·63.	Hornblende, 272.	2·9—3·4.
Iolite, 344.	2·55—2·7.	Tourmaline, 363.	3—3·3.
Albite, 330.	2·59—2·65.	Wichtyne, 345.	3·03.
Loxoclase, 330.	2·6—2·62.	Glaucophane, 345.	3·108.
Hyposclerite, 337.	2·6—2·7.	Chladnite, 279.	3·116.
Scapolite, 340.	2·6—2·75	Helvin, 377.	3·1—3·3.
Baulite, 330.	2·62—2·63.	Spodumene, 339.	3·15—3·2.
Oligoclase, 332.	2·63—2·69.	Axinite, 365.	3·2—3·3.
Dipyre, 344.	2·646.	Saussurite, 337.	3·2—3·4.
Andesine, 334.	2·65—2·74.	Acmite, 271.	3·2—3·55.
Anorthite, 334.	2·65—2·78.	Pyroxene, 266.	3·23—3·5.
Steatite, 252.	2·65—2·8.	Epidote, 352.	3·25—3·5.
Thiorsauite, 336.	2·688.	Allanite, 354.	3·3—3·42.
Labradorite, 333.	2·68—2·76.	Idocrase, 350.	3·34—4.
Couzeranite, 336.	2·69.	Babingtonite, 276.	3·4—3·5.
Vosgite, 336.	2·7—2·8.	Sphene, 391.	3·4—3·6.
Latrobite, 337.	2·7—2·8.	Rhodonite, 462.	3·4—3·65.
Mica, 358–361.	2·75—3·1.	Bodenite, 383.	3·523.
Stroganowite, 324.	2·79.	Garnet, 346.	3·63—3·8.
Danburite, 281.	2·8—3.	Pyrochlore, 397.	3·8—4·35.
Pollux, 338.	2·88.	Muromontite, 383.	4·263.
Emerylite, 362.	2·9—3·1.	Microlite, 398.	5·4.
Euphyllite, 362.	2·9—3·1.		

*** Fusible: specific gravity over 4·8.

Plumboresinite,	4—4·5	Mas; fib; G 6·3—6·4; gum-like; ywh, rdh-bn, ywh-w; BB fus dif, decrep; *bor* not decomp; Ṗb, Äl, P̈, Aq, 506.
Scheelite,	4·5—5	II; cryst, mas, uncleav; G 6—6·1; vit, ad; w, ywh, bnh; strp, strl; brittle; BB fus dif! *bor* sol; *mur* decomp; Ċa, W⃛, 405.

[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.

* Globule of lead with, if not without, the fluxes, which passes off in fumes, and discolors the charcoal around the assay: no fumes of Arsenic, Selenium or Antimony.

	Hardness.	
Cotunnite,	1—2	Acic; ad, silky; w; BB fus! flame b; *char* w vapors, *soda* lead; Pb, Cl, 496.
Corneous Lead,	2·5—3	II; G 6—6·1; adamant; w, gyh, ywh; trp, trl; BB *char* fumes lead; *nit* efferv; Pb, Cl, $\ddot{C}$, 497.
Leadhillite,	2·5	IV; *cl* basal!; G 6—6·5; p'ly, res, ad; w, ywh, gnh, gyh; trp, trl; BB *char* lead; *nit* efferv; $\dot{Pb}$, $\dddot{S}$, $\ddot{C}$, 501.
Anglesite,	2·5—3	III; cryst; mas; G 6·2—6·3; ad, vit, res; w, ywh, gyh, gnh; trp, op; brittle; BB fus!, *char* with *soda* lead; $\dot{Pb}$, $\dddot{S}$, 499.
Wulfenite,	2·5—3	II; cryst; mas; G 6·3—6·9; res, ad; ywh, orange-yw; strp, strl; brittle; BB decrep, fus dif; *char soda* lead; *mur* or *nit* pulv decomp; Pb, Mo, 406.
Lanarkite,	2—2·5	IV; *cl* basal!; G 6·3—7; p'ly, ad, res; gnh-w, ywh, gyh; trp, trl; BB fus, w cold; *char* lead; *nit* sol little efferv; $\dot{Pb}$, $\dddot{S}$, $\ddot{C}$, 501.
Vanadinite,	2·5—3	VI; hexag; glob incrust; G 6·6—7·3; res; pale bnh-yw, straw-yw, rdh-bn; strl, op; brittle; BB fus; *char* glob lead; *mur* sol gn; $\dot{Pb}$, Cl, $\dddot{V}$, 503.
Mendipite,	2·5—3	III; fib, col, rad; *cleav* !; G 7—7·1; p'ly; w, ywh, rdh; sbtrl, op; BB fus!, *char* w vapors, *soda* lead; Pb, Cl, O, 496.
Scheeletine,	2·5—3	II; cryst; G 7·9—8·15; res, subad; gn, gy, bn, rdh; trl, strl; BB fus; *char* vapors of lead; *nit* sol, yw; Pb, W, 406.
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! *char* lead; *nit* efferv; $\dot{Pb}$, $\ddot{C}$, 498.

α. No foliated species in this division; Mendipite is sometimes fibrous.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Cotunnite, 496.		Lanarkite, 501,	6·3—7.
Corneous Lead, 497.	6—6·1.	Cerusite, 498.	6·4—6·5.
Leadhillite, 501.	6—6·5.	Vanadinite, 503.	6·6—7·3.
Anglesite, 499.	6·2—6·3.	Mendipite, 496.	7—7·1.
Wulfenite, 406.	6·3—6·9.	Scheeletine, 406.	7·9—8·2.

** B.B. Indorous 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, 412.

	Hardness.	
Telluric Ochre,		Earthy mass, radiated; ywh-w, gyh-w; earthy; BB reaction of tellurium on charcoal; Te, O, 411.
Zinc Bloom,	2—2·5	Earthy; G 3·55—3·6; dull; w, gyh, ywh; op; BB *char* fumes of zinc; *mur* sol; $\dot{Z}n$, $\ddot{C}$, Aq, 485.
White Antimony,	2·5—3	III; lam; mas, col, gran; G 5·566; ad, p'ly; w, gyh, rdh; trl, strp; BB fus!!!, volat, w fumes, inod; Sb, O, 416.
Bismuth Blende,		I; hemihed, glob, col, lam, gran; G 5·9—6·1; res, ad; bn, ywh-gy, straw-yw; strp, op; BB fus; fumes inodorous, *char* ywh-bn areola; Bi, Si, 413.
Bleinierite,	4	Mas, 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, Aq, 506.
Bismutite,	4—4·5	Acic, incrust; G 6·8—7·7; vit, earthy; w, gnh, ywh; strl, op; BB decrep, fus! *char* met, fumes; $\dddot{\bar{B}}i$, $\ddot{C}$, Aq, 413.
Calamine,	5	VI; *cl* rbdrl; mas; earthy; G 4—4·5; vit, p'ly; w, gyh, gnh, bnh; strp, trl; BB infus, zinc fumes; nit efferv; $\dot{Z}n$, $\ddot{C}$, 485.

α. No foliated species in this subdivision, excepting white antimony, which may be lamellar; this species and bismuth blende may occur columnar.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Bismuth Ochre, 412.	——— ?	Calamine, 485.	4—4·5.
Telluric Ochre, 411.	——— ?	White Antimony, 416.	5·566.
Zinc Bloom, 485.	3·55—3·6.	Bismuth Blende, 413.	5·9 – 6·1.
Bleinierite, 506.	3·9—4·8.	Bismutite, 413.	6·8—7·7.

*** B.B. odorous fumes of Arsenic or Selenium.

Haidingerite,	1·5—2·5	III; 100°, *cl* diag!!; minute cryst, crust, bot; G 2·848; w; vit; trp, trl; lam flex; BB on *char* arsenic; *nit* sol, 220.
Pharmacolite,	2—2·5	IV; 117° 24′, *cl* diag!!; fib, acic, stellate; mas; G 2·64—2·75; w, gyh; vit, p'ly; trl, op; lam flex; BB fus w; on *char* arsenic; *acids* sol!; $\dot{C}a$, $\dddot{\bar{A}}s$, $\dot{H}$, 219.
Pitticite,	2—3	Ren, mas; G 2·2—2·5; vit, greasy; ywh, rdh-bn, rd, w; trl, op; BB *char* arsen; $\dddot{\bar{F}}e$, $\dddot{\bar{A}}s$, $\dddot{S}$, Aq, 458.
Mimetene,	3·5	VI; hexag; G 5·4—7·3; res; pale-yw, bnh, orange-yw; strp, trl; BB fus, bnh-yw; *char* arsen; *nit* sol; Pb, $\dddot{\bar{A}}s$, 508.
Selenate of Lead,	3—4	Bot, glob; vit, greasy; sulphur yw; brittle; BB fus! bh slag; *char* selen; $\dot{P}b$, $\dddot{S}e$, 504.
Scorodite,	3·5—4	III; cryst; G 3·1—3·3; vit, subad; pale gn, bn; BB alliac, fus scoria, mag; *mur* sol; $\dddot{\bar{F}}e$, $\dddot{\bar{A}}s$, Aq, 451.
Mag. Pharmacolite,	5—6	Mas, one cleavage; G 2·52; wh, ywh; waxy; BB on *char* arsenic; *nit* sol; $\dot{C}a$, $\dot{M}g$, $\dddot{\bar{A}}s$, 220.

α. No foliated species in this group, but Pharmacolite and Haidingerite have a very perfect cleavage; Pharmacolite occurs fibrous.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Pitticite, 453.	2·2—2·5.	Scorodite, 451.	3·1—3·2.
Mag. Pharmacolite, 220.	2·52.	Selenate of Lead, 504.	
Pharmacolite, 219.	2·64—2·75.	Mimetene, 503.	5·4—7·3.
Haidingerite, 220.	2·848.		

**** B.B. wholly vaporizable with fumes of quicksilver and chlorine.

Calomel,	1—2	II; mas, incrust; G 6·482; ad; ywh-gy, gy, wh; trl, strl; sectile; BB volat; Hg, Cl, 533.

B. STREAK COLORED.

a. B.B. NO FUMES WITHOUT OR WITH THE FLUXES; GLOBULE NOT MALLEABLE.

* B.B. infusible.

† Gelatinize with acids.

	Hardness.	
Chrysocolla,	2—3	Mas, compact and in seams; G 2—2·4; bh-gn; trl, op; BB gn flame; *bor* gn glob, copper; Cu, Si, Aq, 519.
Nontronite,	2·5—3	Mas; G 2·1—2·2; nearly dull; gn, gnh, *st* paler; BB fus; *bor* iron; *mur* gelat; Fe, Si, Aq, 440.
Dioptase,	5	VI; *cl* rbdrl; G 3·278; vit; emerald; *st* gn; brittle; BB decrep, gn flame; *bor* gn glob, copper; *mur* gelat; Cu, Si, Aq, 519.
Thorite,	6	Mas, compact; G 4·6—4·8; vit; bk, bnh; *st* dark-bn; BB bnh-r, infus, *bor* fus! glass col by iron; *mur* gelat; Th, Fe, Mn, Si, Aq, 381.
Gadolinite,	6·5—7	V; mas; G 4—4·5; vit, pitchy; bk, gnh-bk; *st* gnh-gy; strl, op; BB decrep, swells up; usually glows; *mur* gelat; Y, Ce, Fe, Si, 382.

a. No foliated or fibrous species in this subdivision.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Nontronite, 440.	2·1—2·2	Gadolinite, 382.	4—4·5.
Chrysocolla, 519.	2·1—2·4.	Thorite, 381.	4·6—4·8.
Dioptase, 519.	3·278.		

†† Not gelatinizing with acids.

Wad,	0·5—2·5	Mas; earthy; G 3—3·7; bkh, dull bh, bnh; soils often; BB infus (or subfus); *mur* chlorine; Mn, O, Aq; often Mn, Co, O, Aq, or Mn, Cu, O, Aq, 461.

	Hardness.	
Cerium Ochre,		Yw powder; *mur* sol, lemon-yw; BB *bor* glass, orange, hot, gnh cold, 284.
Chrome Ochre,		Mas; bh-gn, grass-gn; a chrome reaction with the fluxes, 421, 422.
Uranochre,		Earthy pulv; sulphur yw, bnh, rdh; BB orange; BB in inner flame gn; infus; $\bar{\ddot{U}}$, $\dot{H}$, sometimes $\ddot{C}$, 407.
Tungstic Ochre,		Bright yw pulv, crust; BB infus; $\dddot{W}$, 390.
Liebigite,	2—2·5	Mam, cleav; apple-gn; vit; trp; BB bkns; *bor* yw in outer fl, gn glass in inner; *acids* efferv, yw sol; U, Ca, Aq, 410.
Red Iron Ore,		Mas, lentic, &c.; G 4—5; often earthy, dull or bright red; *st* the same; BB *bor* gn or yw glass; hot *mur* sol; Fe^2, O^3, 431.
Chloropal,	2·5—3	Mas; G 1·7—2·2; nearly dull; gn, gnh; *st* lighter; BB infus, bk, bn; *bor* iron; *mur* partly sol; Fe, Si, Aq, 439.
Emerald Nickel,	3—3·5	Mas, crust; G 2·5—2·7; emerald-gn; *st* gnh; Ni, $\ddot{C}$, Aq, 476.
Blende,	3·5—4	I; *cl* dodec; G 4—4·2; adamant, vit, resin; yw, bn, r, gn, bk; *st* bnh; BB *bor* infus or fus dif ! !; Zn, S, 479.
Xenotime,	4—5	II; *cl* lat !; G 4·4—4·6; ywh-bn, *st* pale; res; BB *bor* uncol glob; acids insol; Y, $\bar{\ddot{P}}$, 287.
Red Zinc Ore,	4—4·5	VI; fol !; G 5·4—5·6; subad; deep-red, ywh; *st* orange; trl, strl; brittle; BB *bor* trp glass; Zn, O, 481.
Fluocerine,	4·5—5	I; usually mas; yw, rdh, bnh; *st* yw, bnh; strl, op; vit, res; BB bkns; *bor* slow sol, red in outer flame; *sul* sol, yw; Ce, F, Aq, 287.
Parisite,	4·5	VI; *cl* basal !; G 4·35; bnh-yw; *st* ywh-w; vit; BB bnh; *bor* trp glass, yw hot; *mur* slow sol, efferv, 285.
Limonite,	3—5	Mas, stalact, incrust; G 3·5—4; earthy, silky; bn, yw, ochreous; *st* ywh-bn; BB bkns, becomes magn; *bor* iron; hot *nitro-mur* sol; Fe, O, Aq, 436.
Yttrocolumbite,	5·5	G 5·395; submet; iron-bk; *st* gy; op; BB *soda* intum, fus; *bor* sol; Y, Ca, Fe, Ta, W, U, 399.
Pitchblende,	5·5	I; mas, in grains; G 6·4—7·1; submet or dull; gyh-bk, bnh-bk, velvet-bk; op; *st* bk; BB flame usually gn; *bor* fus yw glass, gnh in inner fl; *nit* pulv sol dif; U, O, 407.
Brookite,	5·5—6	III; cryst; G 3·8—4·18; met-ad, submet; bn, ywh, rdh, bk; *st* gyh, ywh; BB like Rutile; $\ddot{T}$i, 388.
Fergusonite,	5·5—6	II; hemihed, *cl* traces; G 5·8—5·85; vit, submet; bnh-bk, bn, ywh-bn; *st* pale-bn; strl, op; BB loses color, *bor* fus dif; *soda* a slag; Y, Ce, Zr, Ta, 399.
Rutile,	6—6·5	II; cryst, often acic; mas; G 4·18—4·25; met-ad, subvit; rdh-bn, rd, ywh, bk; *st* pale-bn; strp, op; BB unalt; *bor* red in outer flame; $\ddot{T}$i, 387.
Malacone,	6·5	II; cryst, like Zircon; G 4·047; vit, subres; bnh, rdh; bh-w within; *st* bn; BB yields water; *bor* sol dif; pulv *acids* boiling sol dif; Zr, Si, Aq, 380.

	Hardness.	
Tin Ore,	6—7	II; cryst, mas, grains; G 6·8—7·1; ad, subvit, subres; bn, bk, rdh, gyh, ywh; *st* gy, bn; strp—op; BB *char* reduct dif!; *bor* and *soda* reduced; *acids* insol; S̈n, 385.

α. There are no fibrous species in this subdivision, excepting Limonite, which is 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.
Cerium Ochre, 234.	——— ?	Blende, 479.	4—4·2.
Chrome Ochre, 421.	——— ?	Red Iron Ore, 431.	4—5.
Uranochre, 407.	——— ?	Malacone, 380.	4·047.
Tungstic Ochre, 390.	——— ?	Rutile, 387.	4·18—4·25.
Liebigite, 410.	——— ?	Parisite, 235.	4·35.
Fluocerine, 237.	——— ?	Xenotime, 237.	4·4—4·6.
Chloropal, 439.	2·1—2·2.	Yttrocolumbite, 399.	5·395.
Emerald Nickel, 476.	2·5—2·7.	Red Zinc Ore, 481.	5·4—5·6.
Wad, 461.	3—3·7.	Fergusonite, 399.	5·8—5·9.
Limonite, 436.	3·5—4.	Tin Ore, 385.	6·3—7·1.
Brookite, 388.	3·8—4·3.	Pitchblende, 407.	6·4—7·1.

** Fusible.

† Gelatinize with acids.

Hisingerite,	1·5—2	Mas, cleav; G 3·045; bk; *st* gnh-gy, bnh-yw; fract earthy; sectile; BB fus bk mag slag; *acids* sol subgelat; Fe, Si, Aq, 441.
Thuringite,	2—2·5	Mas, cleav; G 3·1—3·2; p'ly; olive-gn; *st* gnh; BB *bor* iron; *mur* gelat; Fe, Si, Aq, 440.
Sideroschisolite,	2—3	Crystals minute; G 3—3·4; velvet-bk, gnh-gy; *st* leek-gn, gnh-gy; op; BB fus! mag; *mur* sol, gelat; Fe, Si, Aq, 442.
Cronstedtite,	2·5	VI; hexag, ren, mas; *cl* basal!; G 3·348; vit!; bnh-bk; *st* dark leek-gn; thin lam elast; BB intum, froths; *mur* pulv gelat; Fe, Mn, Si, Aq, 441.
Lievrite,	5·5—6	III; prism; mas; G 3·8—4·2; submet, bh, gyh-bk; *st* bk, gnh, bnh; brittle; BB fus, bk glob; *bor* iron glass; *mur* sol, gelat; Fe, Ca, Si, 438. Wehrlite, 439; G 3·9; BB fus dif! *mur* sol imperfect.
Gadolinite,	6·5—7	V; mas; G 4—4·5; vit-pitchy; bk, gnh-bk; *st* gnh-gy; strl, op; BB decrep, swells up, usually glows; *mur* gelat; Y, Ce, Fe, Si, 382.

α. No species in this subdivision are properly foliated or fibrous.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Sideroschisolite, 442.	3—3·4.	Cronstedtite, 441.	3·348.
Hisingerite, 441.	3·045.	Lievrite, 438.	3·8—4·2.
Thuringite, 440.	3·1—3·2.	Gadolinite, 382.	4—4·5.

†† Not gelatinizing with acids; B.B. phosphorus reaction.

	Hardness.	
Vivianite,	1·5—2	IV; cryst, cleav! fib, rad, incrust, earthy; G 2·66; p'ly, vit; b, gn, dirty-gn; *st* bh-w, b, bn; trp, trl; BB bn or bk scoria, mag; acids sol; $\dot{\mathrm{F}}\mathrm{e}$, $\ddot{\bar{\mathrm{P}}}$, Aq, 449.
Uranite,	2—2·5	II; micaceous; G 3—3·2; bright yw; *st* yw; p'ly, ad; lam, brittle; BB fus bkh mas; *nit* yw sol; U, Ca, $\ddot{\bar{\mathrm{P}}}$, 409.
Dufrenite,	2—3	Fib, rad; G 3·2—3·4; weak, silky; dull leek-gn, ywh, bnh on exposure; *st* gn; strl; BB fus! slag mag, *acids* sol; $\ddot{\bar{\mathrm{F}}}\mathrm{e}$, $\ddot{\bar{\mathrm{P}}}$, $\ddot{\bar{\mathrm{M}}}\mathrm{n}$, Aq, 450.
Chalcolite,	2—2·5	II; micaceous; G 3·5—3·6; emerald-gn, apple-gn; *st* gnh; BB fus bk, flame bh gn; nit ywh-gn sol; U, Cu, $\ddot{\bar{\mathrm{P}}}$, 409.
Carphosiderite,	4—4·5	Ren; G 2·5; res; straw-yw; *st* ywh; feel greasy; BB mag bead; $\dot{\mathrm{F}}\mathrm{e}$ or $\ddot{\bar{\mathrm{F}}}\mathrm{e}$, $\ddot{\bar{\mathrm{P}}}$, Aq, 452.
Alluaudite,	4·5?	Mas, cleav; G 3·468; dull clove-bn; *st* ywh; strl, op; BB glob, mag; *mur* sol, bk cold, ywh-bn on heating; $\ddot{\bar{\mathrm{F}}}\mathrm{e}$, $\dot{\mathrm{M}}\mathrm{n}$, $\ddot{\bar{\mathrm{P}}}$, Aq, 453.
Hureaulite,	5	IV; no cleav; G 2·27; vit, res; rdh-yw, trl; BB fus! bk glob, met; *acids* insol; $\dot{\mathrm{M}}\mathrm{n}$, $\dot{\mathrm{F}}\mathrm{e}$, $\ddot{\bar{\mathrm{P}}}$, Aq, 466.
Zwieselite,	5	VI? cryst, mas; G 3·97; greasy; clove-bn; *st* gyh-w; BB decrep, bh-bk glass, mag; $\dot{\mathrm{F}}\mathrm{e}$, $\dot{\mathrm{M}}\mathrm{n}$, $\ddot{\bar{\mathrm{P}}}$, F, 466.
Triplite,	5—5·5	III; cryst, mas; G 3·4—3·8; res, ad; bn, bkh-bn; *st* ywh-gy; strl, op; BB fus! bk scoria; *nit* sol, no efferv; $\dot{\mathrm{M}}\mathrm{n}$, $\dot{\mathrm{F}}\mathrm{e}$, $\ddot{\bar{\mathrm{P}}}$, 466.

α. Species distinctly foliaceous or fibrous in some varieties.

Vivianite, 449.	H=1·5—2 Fib.	Chalcolite, 409.	H=2—2·5 Fol!
Uranite, 409.	2—2·5 Fol!	Dufrenite, 450.	2—3 Fib.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Hureaulite, 466.	2·27.	Alluaudite, 453.	3·468.
Carphosiderite, 452.	2·5.	Triplite, 466.	3·4—3·8.
Vivianite, 449.	2·66.	Chalcolite, 409.	3·5—3·6.
Uranite, 409.	3—3·2.	Zwieselite, 466.	3·97.
Dufrenite, 450.	3·2—3·4.		

††† Not gelatinizing with acids; BB no phosphorus reaction.

Molybdic Ochre,	1	Yw pulv, or crust; BB *char* slag; *mur* sol; $\dddot{\mathrm{M}}\mathrm{o}$; occurs with Molybdenite, 390.
Chlorophæite,	1·5—2	Mas, fol; imbedded; G 2·02; dark-gn, bkh; BB fus; Fe, Si, Mg, Aq, 442.
Lepidomelane,	3	VI; fol; hexag scales; *cl* basal!; G 3; bk, gnh; ad, vit; *st* mountain-gn; op, strl; not flex; BB fus, bk, op, mag; *bor* bottle-gn glass; Fe, Al, K, Si, 364.
Stilpnomelane,	3	Fol, rad, mas; G 3—3·4; vit, p'ly; bk, gnh-bk; *st* gnh; BB fus dif bk glob; *acids* sol imperf; Fe, Si, Al, Aq, 440.

	Hardness.	
Polyhydrite,	2—3	Mas; G 2·1—2·142; liver-bn; res, op; Fe, Si, Aq, 440.
Limonite,	3—5·5	Mas, stalact, incrust, earthy; G 3·6—4; silky, dull; bn, ochreous; *st* ywh-bn; BB bkns, magn; fus dif!; *bor* iron; Fe, O, Aq, 436.
Mosandrite,	4	Prism; mas, fib, cleav; G 2·9—3; vit, greasy; dull rdh-bn; *st* gyh-bn; BB fus! bnh-gn pearl; *soda* manganese; Ti, Ce, Mn, Si, Aq, 383.
Crocidolite,	4	Asbestiform; G 3·2—3·3; silky; bh, gnh; fibres separate easily, subelast; BB fus! mag; Fe, Na, Si, Aq, 441.
Göthite,	5	III; acic, capil, fib, ren, mas: G 4—4·4; bn, blood-red; *st* bnh-yw; BB bkns magn; fus dif!; *bor* iron; Fe, Aq, 437.
Microlite,	5	I; oct; G 5·405; vit, res; yw, bn; *st* ywh, bnh; trl, op; BB like Pyrochlore; Ca, Ta, 398.
Pyrochlore,	5—5·5	I; oct; G 3·8—4·35; vit, res; ywh, bnh, dark-bn; *st* ywh, bnh; strl, op; BB fus dif! *bor* rdh-yw trp, on flaming op more bor w enamel; Ce, Th, Ca, Ta, Ti, 397.
Glaucophane,	5·5	Prism, mas; G 3·108; vit, p'ly; b, lavender-b, bh-bk, gyh; *st* gyh-b; trl, op; powder slightly mag; BB fus! gn glass; *acids* partly sol; Al, Fe, Mg, Na, Si, 345.
Keilhauite,	6·5	Mas, cleav; G 3·69; vit, res; bnh-bk; bnh-r in splinters; *st* gyh-bn; BB fus! intum, slag; *mur* sol; Ca, Y, Si, Ti, 393.

α. Species foliated or fibrous in some of their varieties.

Stilpnomelane, 440.	H=3 Fol.	Limonite, 436.	H=3—3·5 Subfib.
Lepidomelane, 364.	3 Fol.	Crocidolite, 442.	4 Fib!
Mosandrite, 383.	4 Subfol, fib.		

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity
Molybdic Ochre, 390.	———!	Crocidolite, 442.	3·2—3·3.
Chlorophæite, 442.	2·02.	Limonite, 436.	3·6—4.
Polyhydrite, 440.	2·1—2·15.	Keilhauite, 393.	3·69.
Mosandrite, 383.	2·9—3.	Pyrochlore, 397.	3·8—4·35.
Lepidomelane, 364.	3	Göthite, 437.	4—4·4.
Stilpnomelane, 440.	3—3·4.	Microlite, 398.	5·405.
Glaucophane, 345.	3·108.		

b. B.B. FUMES, OR A MALLEABLE GLOBULE.

* B.B. 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.

Aurichalcite,	2	Acic, drusy; gran; lam; p'ly; verdigris-gn; trl; BB darker, slag; *soda* and *bor* copper and zinc; *mur* sol, efferv; Żn, Ċu, C̈, Aq, 486.
Buratite,		Rad, acic; plumose; G 3·32; azure-blue; *mur* efferv; Żn, Ċu, C̈, Aq, 486.

	Hardness.	
Connellite,		VI; vit; fine blue; trl; BB *char* mur fumes; glob copper, 523.
Chalcolite,	2—2·5	II; micaceous; G 3·5—3·6; emerald-gn; apple-gn; *st* gnh; BB fus bk, flame bh-gn; *nit* ywh-gn sol; U, Cu, $\ddot{\bar{P}}$, 409.
Melaconite,	2—6	I; mas; earthy; G 5·1—5·4; bk; *st* bk; BB *char* no fumes; glob copper; Cu, O, 518.
Volborthite,	3—3·5	VI; mas; earthy; G 3·4—3·9; p'ly, vit; gn, gy; *st* ywh, gy; strl; BB fus! no intum, slag; *bor* chrome-gn glass; $\dot{Cu}$, $\dot{Ca}$, and Vanadic Acid, 530.
Thrombolite,	3—4	Amorphous; G 3·38—3·4; vit; emerald, dark-gn; op; BB flame b, gn; char fus! copper; $\dot{Cu}$, $\ddot{\bar{P}}$, Aq, 524.
Malachite,	3·5—4	IV; mas, earthy, tuberose, incrust, compact fib; G 3·7—4·1; ad, silky, dull; gn; *st* paler; trl, op; BB *char* fus! copper, flame gn; acids efferv; $\dot{Cu}$, $\ddot{C}$, Aq, 521.
Azurite,	3·5—4·5	IV; mas; earthy; G 3·5—3·9; vit, ad; bright deep-b; *st* paler; trp, strl; brittle; BB *char* fus, copper, flame gn; acids efferv; $\dot{Cu}$, $\ddot{C}$, Aq, 521.
Libethenite,	4	III; G 3·6—3·8; res; olive-gn, dark; *st* same; strl; BB fus!, *char* copper; $\dot{Cu}$, $\ddot{\bar{P}}$, Aq, 525.
Phosphorochalcite,	4·5—5	IV; mas; G 3·8—4·4; ad, vit; emerald, dark-gn, verdigris; *st* paler; trl, strl; BB fus! *char* copper; *nit* sol; $\dot{Cu}$, $\ddot{\bar{P}}$, Aq. Also Ehlite, Tagilite, p. 524, 525.

α. *Species foliated or fibrous in some of their varieties.*

Aurichalcite, 486.	H=2	Lam, fib.	Chalcolite, 409.	H=2—2·5	Fol!
Buratite, 486.		Fib.	Malachite, 521.	3·5—4	Fib.

β. *Species arranged according to their specific gravities.*

	Sp. gravity.		Sp. gravity.
Aurichalcite, 486.	——— ?	Azurite, 521.	3·5—3·9.
Connellite, 523.	——— ?	Libethenite, 526.	3·6—3·9.
Buratite, 486.	3·32.	Malachite, 521.	3·7—4·1.
Thrombolite, 524.	3·38—3·4.	Phosphorochalcite, 525.	3·8—4·4.
Volborthite, 330.	3·4—3·9.	Melaconite, 518.	5·1—5·4.
Chalcolite, 409.	3·5—3·6.		

†† Gravity above 4·5; ores of Lead, or Lead and Copper, or Silver.

Minium,		III; mas; pulv; G 4·6; rd; BB fus, *char* lead; Pb, O, 495.
Selbite,		Mas, earthy; ash-gy, bkh; BB fus! silver; *nit* sol, efferv; Ag, $\ddot{C}$, 545.
Plumbic Ochre,	2—3	Mas, scaly cryst; G 8; yw, ywh; BB fus! *char* lead; Pb, O, 496.
Linarite,	2·5—3	IV; cl!; G 5·2—5·5; vit, ad; azure-b; *st* paler; trl; BB fus; $\dot{Pb}$, $\dot{Cu}$, $\dddot{\bar{S}}$, Aq, 500.
Vauquelinite,	2·5—3	IV; ren, bot, gran; G 5·5—5·8; ad, res; dark-gn, bkh-gn; *st* siskin gn, bnh; trl, op; BB fus, *char* gray, submet; some points of lead; *nit* partly sol; $\dot{Pb}$, $\dot{Cu}$, $\dddot{Cr}$, 505.

	Hardness.	
Crocoisite,	2·5—3	IV; mas; G 5·9—6·1; ad, vit; bright hyacinth-r; *st* orange; trl; BB fus, *char*, with *soda* lead; *mur* sol, gn; Ṗb, C⃛r, 504.
Caledonite,	2·5—3	III; G 6·4 (5?); res; verdigris-gn, bh-gn; *st* gnh-w; trl; BB *char* lead; Pb, Cu, S⃛, C̈, 500.
Melanochroite,	3—3·5	III; mas; G 5·75; res, ad; bright r; lemon-yw on exposure; *st* brick-r; strl, op; BB fus!, *char* lead; Ṗb, C⃛r, 505.

α. No species in this subdivision fibrous or foliated.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Minium, 495.	4·6.	Crocoisite, 504.	5·9—6·1.
Linarite, 500.	5·2—5·5.	Caledonite, 500.	6·4.
Vauquelinite, 505.	5·5—5·8.	Plumbic Ochre, 496.	8.
Melanochroite, 505.	5·75.	Selbite, 545.	

** B.B. globule (when not wholly vaporizable) malleable; fumes of Arsenic, Sulphur, Selenium, Antimony, Bismuth, or Quicksilver, Iodine or Chlorine.

† Wholly and easily vaporizable, leaving no metallic globule.

Coccinite,		Earthy particles, rdh-bn; BB volat; Hg, I, 534.
Bismuth Ochre,		Mas; earthy, pulv; G 4·36; ywh, gnh-yw; ad, earthy; BB *char* met, fumes; Bi, O, 412.
Sulphur,	1·5—2·5	III; mas; acic; G 2—2·1; yw; trp, trl; BB sulph fumes, 183.
Selensulphur,	1·5—2·5	Mas; G 2·1—2·5; orange or bnh; on *char* sulph and selen fumes, 184.
Selenium,		Incrust; G 4·3; gyh, bnh; red in splinters: *st* r; selen fumes, 184.
Ammiolite,		Red powder consisting of antimonous acid and quicksilver, 534.
Orpiment,	1·5—2	III; cleav!, micaceous; G 3·4—3·5; p'ly; lemon-yw; *st* ywh; strp, strl; lam flex, inelastic; BB fus, burns b flame, fumes alliac; As, S, 420.
Realgar,	1·5—2	IV; cleav; mas; G 3·4—3·7; res; bright rd; *st* ywh—rdh; trp—trl; sectile; BB fus! burns b flame, fumes alliac; As, S, 420.
Red Antimony,	1—1·4	IV; capil cryst in tufts; 4·4—4·6; ad; cherry-rd; *st* bnh-r; trl, strl; sectile; BB *char* fus, vol, sulph fumes; Sb, O, S, 417.
Cinnabar,	2—2·5	VI; mas; earthy; G 8—8·1; ad, submet, dull earthy; cochineal-r, bnh-r; *st* scarlet; strp, op; BB volat, sulph; in a matrass with soda, quicksilver; Hg, S, 532.
smutite,	4—4·5	Acic, incrust; vit, earthy; w, gnh, ywh; *st* gnh-gy; strl—op; BB decrep, fus! *char* met, fumes; Bi, C̈, Aq, 413.

	Hardness.	
Stiblite,	5·5	Mas; G 5·28; greasy; ywh; *st* ywh, shining; trp; BB *char* fumes inod; Sb, O, H, 417.

a. Species foliated or fibrous in some of their varieties.

Orpiment, 420. Fol !

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Coccinite, 534.	——— ?	Selenium, 134.	4·3.
Ammiolite, 534.	——— ?	Bismuth Ochre, 412.	4·36.
Sulphur, 133.	2—2·1.	Red Antimony, 417.	4·4—4·6.
Selensulphur, 134.	2·1—2·5.	Stiblite, 417.	5·28.
Orpiment, 420.	3·4—3·5.	Bismutite, 413.	6·8—7·7.
Realgar, 450.	3·4—3·6.	Cinnabar, 532.	8—8·1.

†† B.B. partly vaporizing, leaving a malleable globule of silver or copper ; arsenical sulphur or antimony fumes.

Tyrolite,	1·5—2	III ? ; ren, mas ; drusy ; p'ly, vit ; G 3·098 ; pale apple-gn, bh ; *st* paler ; trl, strl ; lam flex ; BB *char* fus, arsen ; $\dot{C}u$, $\ddot{\bar{A}}s$, Aq, 527.
Covelline,	1·5—2	VI ; incrust ; mas ; G 3·7—3·9 ; res, faint ; indigo-b ; *st* lead gray, shining ; BB *char* fus, sulph, copper ; Cu, S, 510.
Lettsomite,		Drusy, velvety crusts ; clear smalt blue ; p'ly ; BB *char* copper, $\dot{C}u$, $\dddot{\bar{A}}l$, $\dddot{S}$, Aq, 523.
Copper Mica,	2	VI ; *cl* basal ! !, fol mas ; G 2·4—2·7 ; p'ly, vit ; emerald, grass gn ; *st* paler ; BB decrep, *char* arsen, fus ; *soda* copper ; *acids* sol ; $\dot{C}u$, $\ddot{\bar{A}}s$, Aq, 529.
Xanthokon,	2	VI ; ren, mas, cryst structure within ; G 5—5·2 ; dull-rd, clove-bn ; *st* yw ; strl, edges orange ; BB *char* sulph, arsen, silver ; Ag, S, As, 543.
Liroconite,	2—2·5	III ; rarely gran ; G 2·8—3 ; vit, res ; sky-b, verdigris ; *st* same ; BB *char* arsen, bk scoria ; *bor* gn, partially re duced ; *nit* sol ; $\dot{C}u$, $\dddot{\bar{A}}l$, $\ddot{\bar{A}}s$, Aq, 529.
Miargyrite,	2—2·5	IV ; *cl* imperf ; G 5·234 ; submet-ad ; iron-bk ; *st* dark cherry-red ; op, thin splinters red ; sectile ; BB *char* antim, sulph, silver ; Ag, S, Sb, 539.
Proustite,	2—2·5	VI ; mas ; 5·4—5·6 ; adamantine ; cochineal-r ; *st* bright-red ; strp, trl ; BB *char* sulph, arsen, silver ; Ag, As, S, 541.
Pyrargyrite,	2—2·5	VI ; mas ; G 5·7—5·9 ; met-ad ; bk, rdh ; *st* cochineal-r ; trl, op ; sectile ; BB *char* sulph, antim, silver ; Ag, S, Sb, 540.
Aphanesite,	2·5—3	IV ; mas, rad, hemispher ; G 4·19—4·36 ; p'ly ; dark verdigris ; *st* same ; strl ; BB *char* fus, deflag, arsen ; $\dot{C}u$, $\ddot{\bar{A}}s$, Aq, 528.
Olivenite,	3	III ; glob, ren, fib ; mas ; G 3·9—4·4 ; ad, vit, p'ly ; olive-gn, leek-gn ; wood-bn ; *st* gn, bn ; strp, op ; BB *char* fus, deflag !, arsen ; *nit* sol ; $\dot{C}u$, $\ddot{\bar{A}}s$, Aq, 526.

	Hardness.	
Brochantite,	3·5—4	III; G 3·7—3·9; vit; emerald, bkh-gn; *st* paler; trp; BB *char* fus, copper; $\dot{C}u$, $\dddot{S}$, Aq, 523.
Euchroite,	3·75	III; G 3·389; vit; bright emerald, leek-gn; *st* paler; trp, trl; BB *char* fus, deflag, copper; arsen; $\dot{C}u$, $\ddot{\bar{A}}s$, Aq, 527.
Erinite,	4·5—5	Mam, mas; G 4·043; dull, res; fine emerald-green, *st* paler; strl, op; BB arsen; copper; $\dot{C}u$, $\ddot{\bar{A}}s$, Aq, 528.

α. Species foliated or fibrous in some of their varieties.

Copper Mica, 529.	H=2	Fol!	Aphanesite, 528.	H=2·5—3	Fib.
Lettsomite, 523.		Drusy fib.	Olivenite, 526.	3	Fib.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Lettsomite, 523.	——— ?	Olivenite, 526.	3·9—4·4.
Copper Mica, 529.	2·4—2·7.	Erinite, 528.	4·043.
Liroconite, 530.	2·8—3.	Aphanesite, 528.	4·19—4·36.
Tyrolite, 527.	3·098.	Xanthokon, 543.	5—5·2.
Euchroite, 527.	3·389.	Miargyrite, 540.	5·234.
Brochantite, 523.	3·7—3·9.	Proustite, 541.	5·4—5·6.
Covelline, 510.	3·8—3·9.	Pyrargyrite, 540.	5·7—5·9.

††† B.B. partly vaporizing, leaving a malleable globule of silver or copper; fumes of iodine, bromine, chlorine.

Iodic Silver,		Thin plates, lam; G 5·504; res; pale citron-yw, ywh-gn; trl; *st* submet; plates flexible; BB fus!!, *char* fumes of iodine, violet flame, silver; Ag, I, 544.
Horn Silver,	1—1·5	I; mas, like wax; G 5—5·6; pearl-gy, gnh; bn on exposure; *st* shining; sectile; BB fumes of muriatic acid; *char* silver; Ag, Cl, 544.
Bromic Silver,	1—2	I; concretions; G 5·8—6; splendent; often gn without, yw within; BB fus; fumes of bromine; silver glob; Ag, Br, 545.
Percylite,	?	I; in cubes; sky-blue; BB emerald-gn easily! b on cooling; flame gn, fus!, *char* fumes; Pb, Cu, Cl, O, 497.
Embolite,	2	I; oct; mas; G 5·7—8·2; yw, gn; adamantine; fracture hackly; BB fus! fumes of bromine and chlorine; silver glob; Ag, Br, Cl, 545.
Atacamite,	3—3·5	III; mas; G 4—4·3; ad, vit; bright gn, olive-gn; *st* paler; trl, strl; BB gn or b flame, fumes of mur; *char* copper; Cu, Cl, O, Aq, 518.

α. None of the species in this subdivision are properly foliated or fibrous.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Percylite, 497.	——— ?	Iodic Silver, 544.	5·504.
Atacamite, 518.	4—4·3.	Embolite, 545.	5·7—8·2.
Horn Silver, 544.	5·0—5·6.	Bromic Silver, 545.	5·8—6.

*** B.B. globule not malleable; fumes of Arsenic, Sulphur, Antimony, or Chlorine.

† B.B. partly vaporizing, leaving a globule NOT malleable; fumes arsenical.

	Hardness.	
Nickel Green,	3	V ? ; capil ; mas ; fine apple-gn ; *st* gnh-w ; BB *char* arsen ; $\dot{N}i$, $\ddot{\bar{A}}s$, Aq, 478.
Pitticite,	2—3	Ren, mas ; G 2·2—2·5 ; vit, greasy ; ywh, rdh-bn, r, w ; *st* yw ; trl, op ; BB *char* arsen ; $\bar{F}e$, $\ddot{\bar{A}}s$, Aq, 453.
Arseniosiderite,		Fib ; diverg ; G 3·5—3·9 ; yw, golden ; *st* ochreous; fibres separable ! ; BB fus bk ; odor arsen on adding soda ; hot *nit* or *mur*, sol ; $\bar{F}e$, $\dot{C}a$, $\ddot{\bar{A}}s$, Aq, 452.
Cobalt Bloom.	2—2·5	IV ; cleav ; pulv ; G 2·948 ; p'ly, earthy ; peach-r, crimson ; gyh ; *st* paler ; trp, strl ; *lam* flex ; BB *char* arsen ; acids sol ; $\dot{C}o$, $\ddot{\bar{A}}s$, Aq, 477.
Symplesite,	2·5	IV, cleav ! ; G 2·957 ; p'ly, vit ; indigo, gn ; *st* bh-w ; strp —trl ; BB *char* arsen ; bk, without melting, mag ; $\bar{F}e$ or $\dot{F}e$, $\ddot{\bar{A}}s$, Aq, 454.
Cube Ore,	2·5	I ; cryst ; G 2·9—3 ; ad ; olive-gn, ywh, bnh, rdh, gn ; *st* gn, bn, yw ; strl ; BB *char* arsen, mag ; $\dot{F}e$, $\ddot{\bar{A}}s$, Aq, 453.
Köttigite,	2·5—3	IV ; cleav ; crusts ; G 3·1 ; silky ; light rd ; *st* rdh-w ; trl ; sbtrl ; BB *char* fus, arsen ; *acids* sol ! ; $\dot{Z}n$, $\dot{C}o$, $\ddot{\bar{A}}s$, Aq, 487.

a. Species foliated or fibrous in some of their varieties.

Arseniosiderite, 552.	Fib.	Cobalt Bloom, 477.	Fol.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Nickel Green, 478.	———?	Cobalt Bloom, 477.	2·948.
Pitticite, 453.	2·2—2·5.	Köttigite, 487.	3·1.
Cube Ore, 453.	2·9—3.	Arseniosiderite, 452.	3·5—3·9.
Symplesite, 454.	2·957.		

†† Partly vaporizing, leaving a globule NOT malleable; fumes not arsenical.

Greenockite,	3—3·5	VI ; hexag ; G 4·8—5 ; adamant ; honey-yw, orange ; *st* yw rdh ; strp, trl ; BB *char* ywh ring ; *mur* sol ; Ca, S, 480.
Blende,	3·5—4	I; *cl* dodec !, mas ; G 4—4·2 ; resin yw, bn, r, bk, gn ; *st* w, bnh ; trp, trl ; brittle ; BB infus, or fus dif ! ! ; on *char* zinc fumes dif ! ; Zn, S, 479.
Hauerite,	4	I ; hemihed ; G 3·463 ; met ad ; rdh-bh, bnh-bk ; *st* bnh-r ; BB *char* sulphur ; Mn, S, 456.
Pyrosmalite,	4—4·5	VI ; hexag ; *cl* basal ; mas ; G 3—3·1 ; p'ly, vit ; pale liver-bn, gy, gnh ; gnh-yw within ; BB *char* fumes, fus slag, mag ; *nit* perfectly sol ; $\bar{F}e$, $\bar{M}n$, Cl, $\ddot{S}i$, Aq, 454.
Voltzite,	4·5	Implanted glob ; G 3·66 ; vit, p'ly ; rdh, ywh, bnh ; op, strl ; BB *char* zinc fumes ; *mur* sulph hyd ; Zn, S, O, 481.
Romeine,	5—6	II ; octahed ; hyacinth or honey-yw ; BB fus bkh slag ; acids insol ; Ca, Sb, O, 416.

α. None of the species of this subdivision are foliated or fibrous.

β. Species arranged according to their specific gravities.

	Sp. gravity.		Sp. gravity.
Romeine, 416.	——— ?	Voltzite, 481.	3·66.
Pyrosmalite, 455.	3—3·1.	Blende, 479.	4—4·2.
Hauerite, 456.	3·463.	Greenockite, 480.	4·8—5.

II. LUSTRE METALLIC.

A. STREAK UNMETALLIC.

a. B.B. NO FUMES.

* Infusible.

	Hardness.	
Wad,	0·5—3·5	Mas; earthy; incrust; G 3—3·7; submet, dull; bk, bh or bnh; BB infus or subfus; *mur* chlorine; Mn, O, H; sometimes Mn, Cu, O, H, or Mn, Co, Ni, O, H, 461.
Pyrolusite,	2—2·5	III; col; mas; G 4·8—5; submet; bk, gyh; *st* bk; brittle; BB infus; *mur* chlorine fumes; Mn, O, 457.
Manganite,	4	III col; gran; G 4·3—4·4; submet; steel-gy, bk; *st* rdh-bn, nearly bk; BB infus, *mur* chlorine; Mn, O, H, 459.
Pitchblende,	5·5	I; mas; in grains; submet or dull; velvet-bk, bnh; *st* bk; BB flame usually gn; bor fus yw glass, gnh in inner fl; *nit* pulv sol slowly; U, O, 407.
Limonite,	5—5·5	Mas, stalact; G 3·6—4; submet, silky; bk, bn; *st* ywh-bn; BB bkns, magn; Fe, O, Aq, 436.
Hausmannite,	5—5·5	II; gran; G 4·722; submet; bnh-bk; *st* bn; BB infus; *mur* chlorine; Mn, O, 457.
Chromic Iron,	5·5	I; oct, mas, gran; G 4·3—4·5; bk, gyh-bk; *st* bn; brittle; sometimes magn; BB infus; bor fus dif, beautiful gn glob; Fe, Cr, O, 435.
Yttrocolumbite,	5·5	Semicryst; G 5·395; submet; iron-bk; *st* gy; op; Y, Ca, Fe, Ta, W, 399.
Martite,	5—6	I; oct; G 3·8—4·9; otherwise like Specular Iron, 432.
Psilomelane,	5—6	Mas, bot; G 4—4·4; submet; iron-bk, gy; *st* bnh-bk, shining; BB infus; *mur* chlorine; Mn, O, H, 459.
Ilmenite,	5—6	VI; cryst, lam, mas; G 4·5—5; iron-bk; *st* sometimes submet; BB infus, *bor* iron reaction; Fe^2, O^3, Ti^2 O^3, 432.
Columbite,	5—6	III; mas, uncleav; G 5·4—6·4; bk; submet; *st* bk when G 6·2, bnh-red when less; brittle; BB infus, *bor* fus slow, bkh-gn glass; Fe, Mn, Ta, 401.
Ferro-tantalite,	5—6	III; cryst, mas; G 7·1—8; bk; *st* rdh-bn; brittle; BB like Columbite; Fe, Mn, Ta, 402.

	Hardness.	
Fergusonite,	5·5—6	II; hemihed, *cl* traces; G 5·8—6; submet, vit; bnh-bk, bnh; *st* bnh; strl, op; BB infus; bor fus dif; Y, Ce, Ta, 399.
Specular Iron,	5·5—6·5	VI; cryst, mas, micaceous, &c.; G 4·5—5·3; steel-gy, often splendent; *st* cherry-red; BB infus; *bor* gn or yw glass; hot *mur* sol; Fe, O, 430.
Franklinite,	5·5—6·5	I; oct, mas, gran; G 5—5·1; bk; *st* dark rdh-bn; slightly magn; BB infus; *char* oxyd zinc at high heat; *bor* manganese reaction; Fe, Mn, Zn, O, 435.
Braunite,	6—6·5	II; mas; G 4·75—4·9; submet; bnh-bk; brittle; BB infus; *mur* chlorine; Mn, O, 458. *Heteroclin* is similar; IV; G 4·652, 458.
Euxenite,	6·5	III; mas without cleav; G 4·6—4·8; met, vit; bnh-bk, rdh-bn; *st* rdh-bn; BB infus; *bor* fus; Y, U, Ce, Ni, Fe, 400. *Polycrase* similar; G 5·10; *sul* sol, 400.

** Fusible.

Tenorite,		VI; scales; dark steel-gy; *st* bk; BB *char* no fumes, copper; Cu, O, 518.
Melaconite,	3—6	I; mas; G 5·1—5·4; earthy; bk; *st* bk; BB *char* no fumes, copper; Cu, O, 518.
Crednerite,	4·5	IV; cleav; G 4·9—5; met; iron-bk, gy; *st* bk, bnh; BB fus dif!; Mn, Cu, O, 460.
Limonite,	5—5·5	Mas; stalact; G 3·6—4; submet, silky; bk, bn; *st* ywh-bn; BB fus dif!! magn; Fe, O, Aq, 436.
Wolfram,	5—5·5	III; cryst; mas, uncleav; G 7·1—7·6; submet; gyh-bk, bnh-bk; *st* dark rdh-bn; BB fus dif, magnet; *bor* gn bead; Fe, Mn, W, 403.
Samarskite,	5·5	III; in grains; G 5·6—5·7; bk; *st* dark rdh-bn; BB burns like Gadolinite, fus dif! *bor* fus!; Fe, Y, U, Ni, 403.
Lievrite,	5·5—6	III; rbc prism; mas; G 3·8—4·2; submet; bk, bnh; brittle; BB fus bk glob; *mur* sol, gelat; Fe, Ca, Si, 438. *Wehrlite* similar; BB fus! *mur* sol imperf, 439.
Magnetite,	5·5—6·5	I; oct, mas, gran; G 4·9—5·2; bk; *st* bk; magnetic; BB fus dif!, loses mag; hot *mur* sol; Fe, O, 434.

b. B.B. GIVING OFF FUMES.

* B.B. fumes of Arsenic; globule brittle.

Tennantite,	3·5—4	I; G 4·3—4·5; bkh lead-gy, iron-bk; *st* dark rdh-gy; BB burns b flame, arsen, bk scoria mag; Cu, Fe, S, As, 515.
Glaucodot,	5	III; *cl* basal; mas; G 5·9—6·1; gyh tin-w; *st* bk; BB *char* arsen, sulph; Co, As, S, 474.
Leucopyrite,	5—5·5	III; 122° 26′; cryst, mas; G 7·2—7·4; tin-w, gyh; *st* gyh-bk; BB *char* fumes of arsenic, glob mag; Fe, As, 428.

	Hardness.	
Copper Nickel,	5—5·5	VI; mas; retic; G 7·3—7·7; copper-r, gyh or bkh tarnish; *st* pale bnh-bk; brittle; BB *char* arsen; fus w glob; *nit* gn coating; Ni, As, 469.
Placodine,	5—5·5	IV; tab; mas; G 7·9—8·1; bronze-yw, pale; *st* bk; BB *char* arsen; Ni, As, 475.
Kaneite,	above 5 !	Mas, bot; fol, gran; gyh-w, bk tarnish; BB b flame, *char* arsen; *nit-mur* sol wholly; Mn, As, 456.
Nickel Glance,	5·5	I; hemihed; lam; mas; G 5·6—6·9; silver-w, gyh; tarnish gy, gyh-bk; *st* gyh-bk; BB *char* arsen; Ni, As, S, Fe, 472.
Smaltine,	5·5	I; cryst; mas; G 6·46—7·2; tin-w, gyh; *st* gyh-bk; brittle; BB *char* arsen, w glob; Co, As, Fe, 470.
Cobaltine,	5·5	I; hemihed; mas; silver-w, rdh; *st* gyh-bk; brittle; BB *char* arsen, bk glob mag; Co, As, S, Fe, 472.
Mispickel,	5·5—6	III; 111° 53′; usually mas; G 6·127; silver w, gyh; *st* dark gyh-bk; BB *char* arsen fumes; glob mag; Fe, As, S, 428.
Rammelsbergite,	5·5—6	I; cryst, mas; G 6·4—6·8; tin-white, tarnishes gy, bk; BB arsen, fus brittle; Ni, As, 471.
Chloanthite,	5·5—6	III; G 7·05—7·2; slightly ductile; otherwise like Rammelsbergite, 471.
Skutterudite,	6	I; *cl* cubic; G 6·7—6·9; gyh tin-w; BB *char* arsen; Co, As, 474.

** Fumes not arsenical ; globule brittle.

Syepoorite,		Mas; G 5·45; steel-gy, ywh; Co, S, 469.
Millerite,	3—3·5	VI; capil; G 5·26—5·65; brass yw, tarnish gy, irid; brittle; BB fus brittle glob, mag; warm *nit* gyh or pale-gn sol; open tube sulph; Ni, S, 469.
Manganblende,	3·5—4	I; *cl* cubic; mas; G 3·9—4·1; submet; iron-bk, bn on exposure; *st* gn; BB *char* fus dif!; *mur* sul hyd; Mn, S, 455.
Magnetic Pyrites,	3·5—4·5	VI; hexag, mas; G 4·4—4·7; bronze yw, rdh; *st* dark gyh-bk; magnetic; BB nearly like Pyrites; Fe, S, 427.
Bismuth Nickel,	4·5	I; *cl* octahed; G 5·13; pale steel-gy, silver-w; tarnish ywh, gyh; brittle; BB *char* sulph, coal ywh; Ni, Bi, S, 475.
Ullmannite,	5—5·5	I; *cl* cubic!; mas; G 6·4—6·55; wh steel-gy; brittle; BB *char* fumes antim, sulph; Ni, Sb, S, (As), 473.
Linnæite,	5·5	I; *cl* cubic; G 6·3—6·4; pale steel-gy, copper-r tarnish; *st* bkh-gy; BB *char* sulph; Co, S, 474.
Breithauptite,	5·5	VI, thin plates; arboresc, dissem; G 7·541; light copper-rd, violet; *st* rdh-bn; brittle; BB *char* antim; Ni, Sb, 470.
Pyrites,	6—6·5	I; cubes, &c., mas; pale brass-yw; *st* dark bnh-bk; BB *char* fumes sulph; glob mag; nit sol; Fe, S, 424.
Marcasite,	6—6·5	III; 106° 2′; cryst; mas, rad, crest; G 4·65—4·85; pale bronze, ywh, gyh; *st* gyh bk; BB like Pyrites; Fe, S, 425.

*** B.B. a malleable globule, or mineral wholly vaporizable.

	Hardness.	
Heteromorphite,	1—3	Col, capil, plumose; mas, gran; G 5·6—5·9; dark lead, gy, steel-gy; BB fus ! !, *char* antim, sulph; Pb, S, Sb, 492. For other *antimonial of ores of lead*, see pp. 491 to 495.
Graphic Tellurium,	1·5—2	III; mas; G 5·7—8·3; steel-gy; *st* same; very sectile; BB fus ! flame gnh-b, w oxyd on charcoal, glob mal; *nit* sol; Au, Ag, Te, 554.
Miargyrite,	2—2·5	IV; *cl* imperf; G 5·234; submet ad; iron-bk; *st* dark cherry-red; op, thin splinters red; sectile; BB *char* antim, sulph, silver; Ag, S, Sb, 539.
Aurotellurite,		III; in lam; silver-w, ywh; rather brittle; BB like Graphic Tellurium, 554.
Pyrargyrite,	2—2·5	VI; mas; G 5·7—5·9; met-ad; bk, rdh; *st* cochineal-red; tri, op; sectile; BB *char* sulph, antim, silver; Ag, S, Sb, 540.
Aciculite,	2—2·5	III; acic, mas; G 6·125; bkh-lead-gy, pale rdh tarnish; BB *char* fumes sulph; Bi, Pb, Cu, S, 414.
Cuproplumbite,	2·5	I; *cl* cubic; mas; G 6·4—6·45; bkh-lead-gy; *st* bk; BB *char* lead, sulph; Pb, Cu, S, 490.
Dufrénoysite,		I; dodec; G 5·55; steel-gy; *st* rdh-bn; brittle; BB *char* arsen, sulph, lead; *acids* sol; Pb, S, As, 492.
Clausthalite,	2·5	I; gran mas; G 5·6—8·8; lead-gy, bh; *st* dark gy; BB *char* selen, lead; Pb, Se, with sometimes Co, Ag, Cu, 490.
Erubescite,	3	I; cryst, mas; G 5—5·1; copper-r, pinchbeck bn, tarnishes; *st* pale gyh-bk; brittle; BB *char* sulph; *nit* partly sol; Cu, S, 510.
Wölchite,	3	III ? mas; G 5·7—5·8; bkh-lead-gy; brittle; BB *char* antim, sulph; Pb, Cu, S, Sb, 515.
Altaite,	3	I; *cl* cubic; mas; G 8·16; tin-w; sectile; BB tellur; Pb, Te, 491.
Domeykite,	3—3·5	Ren, bot, mas; G 4·5; tin-w, ywh; BB fus arsen; *mur* not sol; Cu, As, 513.
Wolfsbergite,	3—4	III; G 4·748; lead-gy, iron-gy; *st* bk; BB decrep, fus !, *char* antim, copper; Cu, S, Sb, 515.
Cupreous Bismuth,	3·5	III; acic, col; G 5; steel-gy, tin-w, tarnish lead-gy; *st* bk; BB fus ! sulph fumes; Bi, Cu, S, 414.
Copper Pyrites,	3·5—4	II; tetrahed; mas; G 4·1—4·3; steel-gy, brass-yw; *st* gnh-bk; BB *char* sulph; fus glob mag; *nit* partly sol; Cu, Fe, S, 511.
Tin Pyrites,	5	I; cubic; mas, gran; G 4·3—4·51; steel-gy, ywh; *st* bk; BB *char* sulph, scor glob bk; *nit-mur* sol, 386.

B. STREAK METALLIC.

a. NOT MALLEABLE.

* B.B. no fumes ; infusible.

	Hardness.	
Graphite,	1·0—2·0	VI ; fol !, mas, gran ; G 2—2·1 ; steel-gy, bkh ; sectile ; soils ; *nit* no action ; *BB*, infus, 180.

B.B. fumes ; globule not malleable.

Molybdenite,	1—1·5	VI ; fol ! G 4·44—4·8 ; lead-gy ; lam flex ; inelast ; sectile ; a trace on paper ; BB *char* sulph ; *nit* sol ; Mo, S, 389.
Irite,		Grains or scales ; G 6·506 ; black ; magnetic ; BB with nitre reaction of osmium ; Ir, Os, Cr, Fe, 548.
Iridosmine,		VI ; also I ; scales ; G 19—22 ; tin-w ; light-steel gy ; BB infusible, with nitre odor of osmium, 547.
Berthierite,	2—3	Prism, mas, cleav ; plumose ; gran ; G 4—4·3 ; dark steel-gy, tarnishes ; BB fus ! fumes antim and sulph ; *mur* sol ; Sb, Fe, S, 418.

*** B.B. fumes ; globule malleable, or wholly vaporizable.

† Easily and wholly vaporizable, (ores of lead not included).

Antimony Glance,	2	III ; cleav, prism, col, fib, mas ; G 4·5—4·65 ; lead-gy ; *st* lead-gy ; tarnish dark ; sectile ; BB fus ! ; *char* fumes, sulph ; *mur* sol ; Sb, S, 417.
Tellurium,	2—2·5	VI ; cleav hexag ; gran ; G 5·7—6·3 ; tin-w ; brittle ; BB *char* fus ! gnh fl ; vol, w vapors, 411.
Tetradymite,	2	VI ; mas, fol, gran ; G 6·1—7·5 ; pale steel-gy ; lam elastic ; soils paper ; G fus ! ! flame b, *char* wh or ywh, fumes odorous ; Bi, Te, S, or Se, 414. Bornite resembles Tetradymite, 415.
Bismuthine,	2—2·5	III ; acic ; cleav ; mas, fol, fib ; G 6·549 ; lead-gy—tin-w, ywh or iridescent tarnish ; sectile ; BB fus ! !, *char* vol, yw areola ; sulph fumes ; hot *nit* sol ; Bi, S, 412.
Bismuth,	2—2·5	VI ; nearly cubes, cleav ! mas ; G 9·737 ; rdh-silver-w, tarnish ; sectile ; brittle ; BB fus ! !, *char* yellow areola, 411.
Antimony,	3—3·5	VI ; cleav ! ; G 6·6—6·72 ; tin-w ; rather brittle ; BB fus ! w fumes, inod ; Sb, 415.
Native Arsenic,	3·5	VI ; retic, ren, mas, gran ; G 5·6—6 ; tin-w, gy ; *st* the same ; BB volat, w fumes, alliac ; As, 419.
Arsen. Antimony,	3·5	VI ; ren ; mas, gran ; G 6·1—6·21 ; tin-w, rdh, gyh ; tarnished bnh-bk ; BB fus, fumes arsen, antim ; Sb, As, 419.

†† B.B. a malleable globule; fumes odorous.

	Hardness.	
Berzelianite,		Dendritic crusts; silver-w; BB selen, fus gy bead; *soda*, copper; Cu, Se, 509.
Bismuth Silver,		Acic; mas; tin-w, gyh, tarnishes; sectile; BB fus! *char*, lead, bismuth, silver; Ag, Bi, Pb, S, 543.
Covelline,	1·5—2	VI; mas, incrust; indigo-blue; *st* lead-gy; BB *char* sulph, copper; Cu, S, 510.
Flex. Silver Ore,	2	IV; cl!!; mas; nearly bk externally; *st* shining; thin lam flexible; BB *char* sulphur; fluxes, silver, 539.
Stephanite,	2—2·5	III; mas; G 6·229; iron-bk; *st* same; sectile; BB *char*, antim, sulph; *soda* silver; Ag, S, Sb; some As, 542.
Eucairite,	2—2·5	Mas; films; silver-w, lead-gy; *st* shining; sectile; BB *char* fus! selen!; Ag, Pb, Se, 537.
Freislebenite,	2—2·5	III; cl; G 6—6·4; steel-gray; wh; dark gyh; BB *char* antim, sulph, lead, silver; Ag, Pb, S, Sb, 541.
Sternbergite,		III; *cl* basal!!; pinchbeck-bn; *st* bk; thin lam flexible like tinfoil; traces on paper; BB *char* sulph, b flame, silver; Ag, Fe, S, 539.
Naumannite,	2·5	I; *cl* cubic; mas; iron-bk, splendent; *st* iron-bk; BB *char* fus!, selen; *soda* silver; Ag, Se, 537.
Polybasite,	2—3	VI; tabular; mas; G 6·214; iron-bk; *st* same; BB fus!, *char* sulph, antim; *soda* arsen; Ag, Cu, Sb, S, As, 542.
Copper Glance,	2·5—3	III; cryst; mas; G 5·5—5·8; bkh lead gy; BB *char* sulph, flame bh; copper; hot *nit* gn sol; Cu, S, 508.
Boulangerite,	2·5—3	Plumose, col; gran; G 5·7—6; bh-lead-gy; BB *char* sulph, antim; Pb, S, Sb, 493.—For other ores of lead containing sulphur and antimony, see pp. 491—495.
Bournonite,	2·5—3	Prism, crucif, and wheel shaped cryst; mas; G 5·766; steel-gy, bkh; *st* same; brittle; BB decrep, fus!, *char* antim, sulph; lead on char; Pb, Cu, S, Sb, 516.
Stromeyerite,	2·5—3	III; mas; G 6·2—6·3; dark steel-gray; *st* shining; sectile; BB fus! glob little malleable, *char* sulph; with lead, silver; Ag, Cu, S, 537.
Galena,	2·5—3	I; cleav! cubic; mas, gran; G 7·3—7·7; lead-gy; brittle; BB *char* sulph, lead; Pb, S, 488.
Zinkenite,	3—3·5	VI; hexag; G 5·3—5·4; steel-gy; BB decrep, fus!!, *char* antim, lead; Pb, S, Sb, 491.
Gray Copper,	3—4	I; hemihed; mas; G 4·5—5·2; steel-gy, iron-bk; *st* same as color, or bnh; BB antim, arsen, *char* copper; pulv sol *nit* bnh-gn; Cu, S, Sb, sometimes with Ag or Hg, 514.

††† B.B. a malleable globule; fumes inodorous.

Nagyagite,	1—1·5	II; fol!; gran, mas, fol; bkh lead-gy; lam flex; BB *char* tellur, flame b; Pb, Au, Te, 491.
Amalgam,	3—3·5	I; dodec; mas; silver-w; brittle; BB quicksilver fumes, glob silver; Ag, Hg, 532.

	Hardness.	
Antimon. Silver,	3·5—4	III; mas; G 9·4—10; silver-w, tin-w; tarnish yw, bkh; BB antim, glob not malleable; *char* silver; Ag, Sb, 538.
Gold Amalgam,		Small grains, easily crumbling; BB fumes of mercury, and a globule of gold left; Hg, Au, 555.

b. MALLEABLE.

	Sp. gravity.	
Tin,	7·285	I and II; gyh-w; BB fus !, 384.
Iron,	7·3—7·8	I; iron-gy; BB fus dif, no fumes, 423.
Lead,	11·445	I; lead-gy; BB fus ! !, fumes, 487.
Copper,	8·5—9	I; copper-red; ductile, malleable; BB fus, flame gn; *nit* sol, 507.
Silver,	10—10·11	I; H 2·5—3; silver-w; BB fus, no fumes; *nit* sol, 534.
Palladium,	11·5—12·5	I, also VI; scales; H 4·5—5; wh steel-gy; ductile; malleable; BB infus, 548.
Gold,	15·6—19·5	I; mas, grains, leaves; H 2·5—3; gold yw, sometimes wh; BB fus; *nit* insol; *nit-mur* sol, 549.
Mercury,	13·568.	Liquid to — 39°; tin-white.
Platinum,	16—19	I; mas; grains; no cleav; H 4—4·5; whitish steel-gy; ductile; BB infus; *nit* insol; hot *nit-mur* sol, 546.
Iridosmine,	19—21·5	I, also VI; scales; H 6—7; tin-w, steel-gy; imperfectly malleable; BB infus; with nitre odor of osmium; *nit* insol; hot *nit-mur* sol, 547.

TABLE II.

MINERALS ARRANGED ACCORDING TO THEIR CRYSTALLIZATION.

I. CRYSTALLIZATION MONOMETRIC.

I. LUSTRE UNMETALLIC.

	Hardness.	
Horn Silver,	1—1·5	*Cl* none; wax-gy, etc; G 5·3—5·6, 544.
Bromic Silver,	1—2	*Cl* none; gn, yw; G 5·8—6, 545.
Arsenous Acid,	1·5	Whitish; G 3·698, 419.
Sal Ammoniac,	1·5—2	*Cl* oct; G 1·528; T saline, pungent, 185.
Sylvine,	2	*Cl* cubic; G 1·9—2; T saline, 191.
Embolite,	2	*Cl* cubic, traces; yw, gnh; G 5·75—5·85, 545.
Blakeite,	2—2·5	Oct; G 2—2·1; taste copperas, 447.
Common Salt,	2·5	*Cl* cubic!; G 2·257; T saline, 191.

	Hardness.	
Cube Ore,	2·5	*Cl* cubic; G 2·9—3; gn, bn, rdh, 458.
Alum,	2—3	Oct; *cl* oct perf; taste alum, 225.
Percylite,		Cubes; sky-blue, 497.
Manganblende,	3·5—4	*Cl* cubic!; bk, bn; submetallic; G 3·9—4·1, 455.
Blende,	3·5—4	Hemihed; *cl* dodec!; yw, bn, bk, etc; G 4—4·2, 479.
Fluor Spar,	4	*Cl* oct perf!; G 3·14—3·18; vit; phosp, 216.
Hauerite,	4	Hemihed; *cl* cubic; G 3·463; bn, rdh, bk, 456.
Bismuth Blende,	4·5	Hemihed; *cl* dodec; bn, ywh, gy, yw; G 5·9—6·1, 413.
Analcime,	5—5·5	Trapezohed; cubic; *cl* indistinct; G 2—2·3, 311.
Haüyne,	5—5·5	Dodec; *cl* usually indist; b, gnh; G 2·4—2·5, 369.
Pyrochlore,	5—5·5	Oct; *cl* imperf; yw, bnh; G 3·8—4·25, 397.
Nosean,	5·5	Dodec; gyh, bh, bnh; G 2·2—2·3, 369.
Sodalite,	5·5—6	*Cl* dodec; gy, bn, b, gn; G 2·2—2·4, 368.
Lapis Lazuli,	5·5	Dodec; b; G 2·3—2·5, 368.
Ittnerite,	5·5	Dodec; *cl* dodec; gy, bh; G 2·35—2·4, 370.
Perovskite,	5·5	Cubes; *cl* cubic; G 4·017; gyh-bk, 390.
Microlite,	5·5	Oct; *cl* sometimes distinct; ywh, bnh; G 4·7—5·4, 398.
Periclase,	6	*Cl* cubic; G 3·674; gyh, gn, 200.
Pyrrhite,	6	Oct; *cl* not observed; color orange-yw, 397.
Helvin,	6—6·5	Tetrahed; *cl* oct traces; G 3·1—3·3, 377.
Garnet,	6·5—7·5	Dodec; trapezohed, etc; *cl* dodec; G 3·5—4·3, 346.
Boracite,	7	Hemihed; *cl* oct dif!; G 2·9—3, 218.
Rhodizite,	8	Hemihed; *cl* oct dif!; G 3·3—3·5, 219.
Spinel,	8	Oct; *cl* indistinct; G 3·5—4·9, 370.
Diamond,	10	*Cl* oct, perf; G 3·5—3·6, 175.

II. LUSTRE METALLIC.

Quicksilver,	0	G 13·568; w, 531.
Lead,	1·5	Lead gray; G 11·5, 487.
Dufréynosite,	2	*Cl* indistinct; G 5·549; gy, 492.
Silver Glance,	2—2·5	*Cl* dodec imperf; gy; G 7·15—7·4, 536.
Hessite,	2—2·5	Cubic; gy; G 8·3—8·9, 536.
Cuproplumbite,	2·5	*Cl* cubic!; bkh gy; G 6·4—6·45, 490.
Steinmannite,	2·5	*Cl* cubic; G 6·833; gy, 495.
Galena,	2·5—3	*Cl* cubic!!; lead-gy; G 7·3—7·7, 488.
Clausthalite,	2·5	*Cl* cubic; gy, bh; G 7·1—8·8, 490.
Naumannite,	2·5	*Cl* cub; bk; G 8·0, 537.
Copper,	2·5—3	Oct; r; G 8—9, 507.
Silver,	2·5—3	*Cl* none; w; G 10—11, 534.
Gold,	2·5—3	*Cl* none; yw; G 19·5—20, 549.
Altaite,	3	*Cl* cubic; w; G 8·159, 491.
Amalgam,	3—3·5	*Cl* dodec, imperf; G 10—14; w, 532.
Gray Copper,	3—4	Tetrahed; *cl* oct imperf; gray; G 4·5, 518.
Tennantite,	3·5—4	*Cl* dodec, imperf; bkh-gy; G 4·3—4·5, 515.
Red Copper,	3·5—4	*Cl* oct; red; G 5·992, 517.
Native Titanium,		Cubes; copper red, 386.

	Hardness.	
Melaconite,	3—4	Cub; bk; G 5·1—5·2, 518.
Tin Pyrites,	4	Cubes; steel-gray, ywh; G 4·3—4·51, 386.
Platinum,	4—4·5	White, gyh; malleable; G 16—19, 546.
Bismuth Nickel,	4·5	*Cl* oct; w, gyh; G 5·13, 475.
Iron,	4·5	Iron-gray; G 7·3—7·8, 422.
Palladium,	4·5—5	Gyh-w; G 11—12·5, 548.
Martite,	5—5·5	Oct; *cl* none; G 3·8—4·7; gyh-bk, 432.
Ullmannite,	5—5·5	*Cl* cubic!; G 6·4—6·51; gyh, w, 473.
Chromic Iron,	5·5	Oct; *cl* oct; gyh-bk; G 4·3—4·5, 435.
Nickel Glance,	5·5	Hemihed; *cl* cubic!; G 5·6—6·9; w, gyh, 472.
Cobaltine,	5·5	Hemihed; *cl* cubic!; G 6—6·3; w, rdh, 472.
Linnæite,	5·5	*Cl* cubic; gyh-w; G 6·3—6·4, 474.
Smaltine,	5·5	*Cl* oct imperf; w, gyh; G 6·4—7·2, 470.
Pitchblende,	5·5	Oct; *cl* none; G 6·4—7·1; submetallic, 407.
Rammelsbergite,	5·5—6	W, gyh; G 6·4—6·8, 471.
Magnetite,	5·5—6·5	Oct, dodec, &c; *cl* oct; gyh-bk; G 4·9—5·2, 434.
Franklinite,	5·5—6·5	Oct, *cl* oct; gyh-bk; G 5—5·1, 435.
Skutterudite,	6	*Cl* cubic; w, gyh; G 6·7—6·9, 474.
Iserine,	6—6·5	Oct; *cl* none; G 4·7—4·9; gyh-bk, 432.
Pyrites,	6—6·5	Hemihed; ywh; G 4·8—5·1, 424.
Iridosmine,	6—7	W, gyh; G 19—22, 547.

II. CRYSTALLIZATION DIMETRIC.*

I. LUSTRE UNMETALLIC.

Native Calomel,	1—2	d 98° 4′, 136° 0′; *cl* lat; G 6·4—6·5, 533.
Uranite,	2—2·5	d 95° 46′, 143° 2′; *cl* basal!!; G 3—3·6; gn, yw, 409.
Cryptolite,		Minute crystals; G 4·6, 236.
Lanthanite,	2·5—3	In 4-sided plates, 238.
Corneous Lead,	2·5—3	d (basal) 113° 48′; *cl* m; G 6—6·1; w, gy, yw, 497.
Wulfenite,	2·5—3	d 99° 40′, 131° 35′; *cl* oct; G 6·3—6·9; yw, gn, wh, 406.
Scheeletine,	2·5—3	d 99° 44′, 131° 25′; d′ 92° 40′, 154° 36′; *cl* basal imperf; gn, gy, bn, r; G 7·9—8·2, 406.
Edingtonite,	4—4·5	Hemihed; pms 50° 52′, 87° 19′; *cl* m perf; G 2·7—2·8, 307.
Yttrocerite,	4—5	According to Haidinger dimetric instead of trimetric; G 3·447, 238.
Xenotime,	4—5	a 124° 44′, 82°; *cl* m; G 4·4—4·6, 237.
Zeagonite,	4·5	a 118° 30′ and 92° 30′; G 2·265, 311.
Azorite,	4·5	d 123° 15′; nearly colorless; *cl* none, 396.

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* In this system, we designate, for the sake of brevity, a face of the fundamental octahedron (that placed on the angles of the primary prism) by a; of the intermediate octahedron (on the terminal edges of the prism) by d; the latter has its faces parallel to a diagonal, (line drawn between the centres of opposite planes M), and to this the letter d may be considered as referring. The prism considered the primary prism is that lettered M in the figures in the preceding part of the volume. The angles following d or a are the pyramidal and basal angles of the octahedron d or a.

	Hardness.	
Apophyllite,	4·5—5	a 104° 2′, 121°; *cl* basal !!; G 2·3—2·4, 248.
Scheelite,	4·5—5	d 100° 40′, 129° 2′; *cl* oct, imperf; G 6—6·1, 405.
Humboldtilite,	5	a 135° 1′, 65° 30; *cl* basal !; G 2·9—3·1, 343.
Gehlenite,	5—5·5	*Cl* basal, hardly distinct; G 2·9—3·1, 342.
Dipyre,	5—5·5	Like Scapolite: G 2·646, 344.
Scapolite,	5—6	a 136° 20′ (28)′, 62° 40′—63° 48′; *cl* m, diag; G 2·6—2·75; 340.
Romeine,	5—6	d (basal) 110° 50′ to 111° 20′; yw, rdh, 416.
Meionite,	5·5	a 136° 22′ and 63° 56′; G 2·8—2·65, 340.
Œrstedite,	5·5	d 123° 16½′; G 3·629, 398.
Anatase,	5·5—6	d 97° 55′, 136° 30′; *cl* d and p perf; G 3·8—4, 389.
Faujasite,	6	a 111° 30′, 105° 30′; G 1·923, 306.
Rutile,	6—6·5	d^{3} 123° 8′, 84° 40′, (Miller); a 134° 58′, 65° 35′; *cl* lat; G 4·1—4·3, 387.
Idocrase,	6·5	a 129° 29′, 74° 14′; *cl* imperf; G 3·3—4, 350.
Cassiterite,	6—7	d^{3} 121° 35′, 87° 17′; a 132° 26′, 67° 59′; *cl* imperf; G 6·5—7, 385.
Zircon,	7·5	d^{3} 123° 19′, 84° 20′; *cl* imperf; G 4·5—4·8, 379.

II. LUSTRE METALLIC.

Nagyagite,	1—1·5	d 96° 48′, 140° 0′; *cl* basal !; bkh-gy; G 6·8—7·2, 491.
Copper Pyrites,	3·5—4	Tetrahed; a 109° 53′, 108° 40′; a′ 101° 49′, 126° 11′; *cl* a imperf; yw; G 4·1—4·3, 511.
Hausmannite,	5—5·5	a 105° 25′, 117° 54′; bnh-bk; G 4·7—4·8, 457.
Fergusonite,	5·5—6	d 100° 28, 128° 27′; d′ 88° 6′, 159° 2′; *cl* basal imperf; G 5·8—5·9, 399.—Submetallic.
Braunite,	6—6·5	a 109° 53′, 108° 39′, Haid. (109° 46′, 108° 58′, Descl.); bnh bk; G 4·7—4·9, 458.

III. CRYSTALLIZATION TRIMETRIC.*

I. LUSTRE UNMETALLIC.

Thermonatrite,	1—1·5	n 107° 50′ t 83° 50; *cl* brachyd imperf; G 1·5—1·6, 190.
Tyrolite,	1—1·5	Gn, bh; G 3—3·1, 527.
Orpiment,	1·5—2	b′ 100° 40′; n 117° 49; d 83° 37′, 420.
Sulphur,	1·5—2·5	*cl* oct; n 101° 59′; a 106° 38, 84° 58′, 143° 17′; G 2·072, 183.

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* In this system, we designate the plane of the fundamental octahedron (P) by a; that of a macrodiagonal ($\bar{P}\infty$) prism (or dome, a term much used for these horizontal prisms) by d, (initial of dome); that of a brachydiagonal prism or dome, ($\breve{P}\infty$), by t, (correlate of d). The macrodiagonal vertical plane $\infty\bar{P}\infty$, (larger lateral plane of the rectangular prism), may be designated by m, (initial of macrodiagonal); the brachydiagonal plane corresponding, by b, (initial of brachydiagonal); and the vertical rhombic prism (∞P) in the same series with the fundamental octahedron, may be lettered n,

	Hardness.	
Haidingerite,	1·5—2·5	n 100°; t 58° 2′; a 138° 35′, 123° 59′, 75° 35′; *cl* brachyd perf!; G 2·8—2·9, 220.
Nitre,	2	n 119°; t^2 71°; *cl* n; G 1·9—2, 189.
Mascagnine,	2—2·5	n 107° 40′; 121° 16′; *cl* brachyd; T pungent, 185.
Epsomite,	2—2·5	n 90° 38′; a 127° 22′, 126° 48′, 78° 7′; hemihed; G 1·75, 203.
White Vitriol,	2—2·5	n 90° 42′; a 127° 27′, 126° 45′, 78° 5′; *cl* brachyd!; w; G 2—2·1, 486.
Thenardite,	2—2·5	n 125°; *cl* P, m; taste alk; G 2·73, 189.
Phlogopite,	2—2·5	n 121° 15; *cl* bas!!!, 359.
Cryolite,	2—2·5	*cl* basal distinct; diagonals less so; G 2·8—3, 233.
Liroconite,	2—2·5	n 119° 45′; d 71° 50′; b, bh-gn; G 2·8—3, 529.
Aphthitalite,	2—3	a 131° 15, 112° 32′, 81° 34′; *cl* macrod; T saline, bitt, 187.
Symplesite,	2·5	Like Cobalt Bloom; b, gn; G 2·957, 454.
Bromlite,	2·5	n 118° 30′; *cl* imperf; G 3·7—3·72, 198.
Polyhalite,	2·5—3	n 115°; *cl* m imperf; T bitter weak, 187.
Picrosmine,	2·5—3	n 126° 52′; t 62° 11′; G 2·55—2·7, 258.
Hopeite,	2·5—3	n 101° 24′; a 86° 49′, 107° 2′, 139° 42′; t 81° 34′; *cl* brachyd!; gyh-w, bnh, 484.
White Antimony,	2·5—3	n 136° 58′; t 70° 32′; w; G 5—5·6, 416.
Anglesite,	2·5—3	n 103° 49′; (104° 55′, H.); w, gyh; G 6·2—6·3, 499.
Mendipite,	2·5—3	n 102° 27′; *cl* n!; w, ywh; G 7—7·1, 496.
Heavy Spar,	2·5—3·5	n 101° 42′; t 105° 30′; G 4·3—4·8, 194.
Fluellite,	3	n 105°, a 109°, 82°, 144°; w; trp, 284.
Olivenite,	3	n 110° 50′; t 87° 30′; d 95° 15′; *cl* m imperf; G 4·1—4·4, 526.
Stilbite,	3·5	a 119° 15′, 114° 36′; n 94° 15′; *cl* brachyd!!; G 2—2·2, 298.
Anhydrite,	3—3·5	n 100° 8′; a 121° 32′, 108° 35′, 99° 7′; *cl* brachyd! macrod! P little less perf; G 2·9—3, 202.
Villarsite,	3—3·5	t 60° 1′; a 106° 52′, 139° 45′, 86° 56′; G 2·975, 257.
Celestine,	3—3·5	n 104°—104½°; t 103° 58′; G 3·9—4, 196.
Witherite,	3—3·75	n 118° 30′; *cl* m, b, imperf; G 4·3, 197.
Melanochroite,	3—3·5	rd; G 5·75, 505.
Cerusite,	3—3·5	n 117° 13′; a 92° 19′, 108° 28′, 130°; t′ 110° 40′; *cl* n; w, gyh; G 6·4—6·5, 498.

(initial of *neuter* or *neither*), as it is intermediate in position between the vertical prisms of the macrodiagonal and brachydiagonal. Indexes in connection with these letters may be used to express other planes; as a^2, (for 2P), d^2, (for 2P∞); m^2, (for $\infty\bar{P}2$, and so on. Or in these cases we may use dashes to distinguish the planes, as a, a′, a″.

The angle n, is the angle of the prism n, (or M : M); the angles a, are the angles of the octahedron a; and so in other cases.

The above mode of notation carried out would require an expression for planes $m\bar{P}n$ and $m\breve{P}n$; and for such might be used the letters o and i, that is, for $3\bar{P}2$ we might write $o^{3:2}$; for $3\breve{P}2$, $i^{3:2}$.

	Hardness.	
Serpentine,	3—4	b′ 97° 33′; t 51° 29′, t′ 87° 56′; a 105° 26′, 139° 39′, 88° 26′; G 2·2—2·6, 254.
Cotunnite,		n 118° 50′; w, 496.
Wavellite,	3—4	n 122° 15, Phil., 126° 25′, Haid.; d 107° 26′, Phil., 106° 40′, Haid.; *cl* n perf; G 2·3—2·4, 231.
Arragonite,	3·5—4	n 116° 16′; t 108° 27′; *cl* n; G 2·9—3·0, 208.
Scorodite,	3·5—4	m^2 120° 10′; n 98° 1′; a 114° 35′, 103° 5′; gn, bn; G 3·1—3·3, 451.
Euchroite,	3·5—4	n 117° 20′; t 92° 8′; *cl* t, n, imperf; gn; G 3·389, 527.
Strontianite,	3·5—4	n 117° 19′; t^2 69° 16′; *cl* n; G 3·6—3·75, 197.
Brochantite,	3·5—4	n 114° 20′; t 117°; d 150° 30′; *cl* n; gn; G 3·7—3·9, 523.
Libethenite,	4	n 109° 30′; t 88°, Rose; *cl* imperf; dark gn; G 3·6—3·8, 525.
Epistilbite,	4	n 135° 10′, (134° 46′, Breit.); d 109° 46′, (111° 55′, Breit.); *cl* brachyd !; G 2·2—2·3, 299.
Phillipsite,	4—4·5	a 121° 20′, 88° 40′, 120° 4′, Marignac; *cl* imperf; G 2—2·22, 305.
Harmotome,	4—4·5	a 121° 30′, 89° 30′, 120° 1′, (119° 06′, Descl.); t 110° 30′; *cl* imperf; G 2·35—2·5, 304.
Manganocalcite,	4—4·5	n near Arragonite, 466.
Okenite,	4·5—5	n 122° 19′; G 2·25—2·42, 247.
Childrenite,	4·5—5	a 102° 30′, 97° 50′, 130° 29′; *cl* a, 233.
Electric Calamine,	4·5—5	n 103° 56′; *cl* n !; w, gyh, gnh; G 3·3—3·5, 482.
Mancinite,		n 92°; *cl* n; bn, 488.
Triphyline,	5	n 132°; *cl* basal !; gnh, gy, bh; G 3·45—3·65, 448.
Göthite,	5	n 96° (95° 14′, Levy, 94° 53′, H.), m′ 130° 27′ (130° 40′, H.); t 116° 44′ (117° 30′, H.); bn; G 4—4·4, 437.
Mesotype,	5—5·5	n 91°—91° 35′; a 143° 20′, 142° 40′, 53° 20′; *cl* n; G 2·1—2·27, 300.
Herderite,	5	n 115° 53′; t 64° 51′; a 141° 16′, 77° 20′, 116° 3′; *cl* imperf; G 2·9—3, 232.
Triplite,	5—5·5	bn, bkh-bn; G 3·4—3·8, 466.
Æschynite,	5—6	n 129° (127° 19′, Rose); a′ 74°; a″ 137° 30′; *cl* imperf; G 4·9—5·2, 395.
Lievrite,	5·5—6	n 111° 12′ (110° 10′); a 138° 26, 117° 34′ (139° 37′, 117° 38′, 77° 16′, H.); d 113° 2′; gyh-bk; G 3·8—4·2, 438.
Brookite,	5·5—6	a 135° 46′, 101° 37′; 94° 44′; m 100° 30′; *cl* indistinct; G 3·8—4·2, 388.
Amblygonite,	6	n 106° 10′; *cl* n perf; 3—3·15, 232.
Ostranite,	6—6·5	n 84, (Haidinger says this angle is that of d in zircon in one position); a 128° 14′, 133° 42′, and 71° 56′; G 4·3—4·4, 380.
Prehnite,	6—6·5	n 99° 56′; *cl* basal; G 2·8—3, 312.
Diaspore,	6—6·5	n 129° 54′, (130°, Marignac); *cl* brachyd !! G 3·4—3·5, 223.
Chrysolite,	6·5—7	n 130° 2′; t 80° 53′; G 3·3—3·5, 278.
Iolite,	7—7·5	n 119° 10′; *cl* indistinct; G 2·5—2·67, 344.
Staurotide,	7—7·5	n 129° 20′; d 110° 24′; *cl* brachyd, imperf; G 3·5—3·75, 319.
Andalusite,	7·5	n 91° 20′ (90° 50′); t 70° 32′ (80?); *cl* m; G 3·1—3·5, 317.

	Hardness.	
Topaz,	8	n 124° 19′; b′ 93° 8′; a 141° 7′, 101° 52′, 90° 55′; *cl* basal!; yw, bnh, bh, gnh; G 3·4, 366.
Chrysoberyl,	8·5	m′ 109° 39′; t 60° 14′; *cl* brachyd, imperf; G 3·5—3·8, 376.

II. LUSTRE METALLIC.

Sternbergite,	1—1·5	n 119° 30′, a 118°; *cl* basal!!; bnh; G 4·2—4·3, 539.
Graphic Tellurium,	1·5—2	n 107° 44′; d 94° 20′; gy; G 5·7—8·5, 554.
Aurotellurite,		n 105° 30′, d 143°, 73° 50′; w, ywh; G 7·9—8·4, 554.
Antimony Glance,	2	m 90° 45′; a 109° 16′, 108° 10′, 110° 59′; *cl* brachyd!; G 4·5—4·7, 417.
Pyrolusite,	2—2·5	n 93° 40′; *cl* n, d, t; G 4·8—5, 457.
Jamesonite,	2—2·5	n 101° 20′; *cl* basal!; gy; G 5·5—5·8, 493.
Freislebenite,	2—2·5	n 100° 8′; t 130° 8′; d′ 122° 15′; gy, wh; G 6—6·4, 541.
Bismuthine,	2—2·5	n 91° 30′; *cl* m!; lead-gy; 6·1—6·6, 412.
Stephanite,	2—2·5	n 115° 39′; t′ 107° 29′; a 104° 19′, 96° 7′, 130° 16′; *cl* n, t′; bk; G 6·2—6·3, 542.
Geŏcronite,	2—3	*Cl* one perf; gy; G 6·4—6·6, 494.
Copper Glance,	2·5—3	n 119° 35′; t′ 125° 40′; a (basal) 125° 42′; a″ 63° 43′; *cl* n; gy; G 5·5—5·8, 508.
Bournonite,	2·5—3	n 96° 31′; d′ 92° 52′, d″ 115° 16′, d‴ 129° 9′; t′ 123° 51′, t″ 50° 15′; gy, dark; G 5·7—5·8, 516.
Stromeyerite,	2·5—3	n 119° 35′; a″ 63° 48′; gy; G 6·2—6·3, 537.
Wölchite,	3	dark-gy; G 5·7—5·8, 515.
Zinkenite,	3—3·5	n 120° 39′, Rose; G 5·3—5·4, 491. Perhaps hexagonal.
Wolfsbergite,	3—4	gy; G 4·748, 515.
Manganite,	3·5—4	n 99° 40′; *cl* brachyd!; gyh-bk; G 4·3—4·4, 459.
Antim. Silver,	3·5—4	n 120° nearly; a 132° 42′, 92°, 106° 40′; w; G 9·4—10·0, 538.
Glaucodot,	5	n 112° 36′; *cl* basal!; G 5·9—6·1; gyh-w, 474.
Mengite,	5—5·5	n 136° 20′; a 150° 52′, 101° 10′, 86° 20′; t 79° 32′; *cl* none; G 5·4—5·5, 396.
Leucopyrite,	5—5·5	m 122° 26′; d 51° 20′; t 86° 10′; *cl* basal; w; G 7·2—7·4, 428.
Placodine,	5—5·5	n 115° 28′; G 7·9—8·1; (monoclinic, according to Breithaupt), 475.
Wolfram,	5—5·5	m 101° 45′; d½ 56° 3′; t 98° 27′, Kerndt; n 101° and t 99° 18½′, Descl. Descloizeaux makes the crystals *monoclinic*, (q. v.) G 7·1—7·6, 403.
Columbite,	5—6	n 134° 58′; b′ 79° 28′; b″ 136° 12′; t^{3} 120° 40′; *cl* m; b less distinct; G 5·4—6·4, 401.
Ferrotantalite,	5—6	n 114° 12′; *cl* imperf; G 7·1—8, 402.
Samarskite,	5·5	n 135° to 136°; *cl* imperf; G 5·3—5·7; *submetallic*, 403.
Mispickel,	5·5—6	n 111° 53′; t½ 145° 26′; *cl* m; G 5·9—6·2, 428.
Chloanthite,	5·5—6	n 123° to 124°; w; G 7—7·2, 471.
Marcasite,	6—6·5	n 106° 2′, (106° 36′); t 98° 13, H.; ywh; G 4·6—4·9, 425.

	Hardness.	
Euxenite,	6·5	n 140°; *cl* none; G 4·6—4·8; *submetallic*, 400.
Polymignite,	6·5	n 109° 46′; a 136° 28′, 116° 22′, 80° 26′; *cl* imperf; G 4·7—4·9, 396.
Ildefonsite,	6·7	n 121° 46′; *cl* n; G 7, 416.*

IV. CRYSTALLIZATION MONOCLINIC.†

I. LUSTRE UNMETALLIC.

Talc,	1·0	Hexag tables; n 120° nearly; angle between the optical axes 7° 24′; *cl* basal!!; G 2·55—2·85, 251.
Natron,	1—1·5	n 76° 28′; p n 71° 17′; G 1·428; T alkaline, 190.
Red Antimony,	1—1·5	*p* 78° 41′; d^2 15° 37′; *d* 34° 6′; *cl* brachyd!; r; G 4·4—4·6, 417.
Glauber Salt,	1·5—2	n 86° 31′; a 93° 12′; *cl* clinod perf, 188.
Sulphurine,	1·5—2·5	n 90° 32′; t 90° 18′; *p* 95° 46′; BB vol, sulph, 183.
Gypsum,	1·5—2	prisms 111° 14′, 143° 28′; *cl* clinod perf!!; G 2·2—2·35, 201.
Vivianite,	1·5—2	n 108° 8′; m′ 150° 50′; *p* 125° 18′; bh; G 2·66, 449.
Realgar,	1·5—2	n 74° 30′; m′ 113° 20′; *p* 76° 44′; r, rdh-yw; G 3·4—3·7, 420.
Copperas,	2	n 82° 21′; a 101° 35′; *p* 75° 40′; pn 80° 37′; gn, w; G 1·8—1·9; taste, 446.
Borax,	2—2·5	n 87°; a′ 122° 23′; *p* 73° 25′; G 1·716, 193.
Botryogen,	2—2·5	n 119° 56′; b^2 99° 16′; *a* 125° 22′; bn; G 2—2·1, 448.
Pharmacolite,	2—2·5	n 117° 24′; a 139° 17′; *p* 114° 56; *cl* clinod perf!!; G 2·6—2·75, 219.
Mica,	2—2·5	n 119°, 121°; pn 95° to 98° 40′; *cl* basal!!; lam elastic; G 2·7—3·1, 358.
Cobalt Vitriol,		Like Copperas; rdh, 476.
Cobalt Bloom,	2—2·5	n 130° 10′; c′ 94° 12′; *p* 124° 51′; *cl* clinod!!; rdh; G 2·9—3·1, 477.
Lanarkite,	2—2·5	One perf cleav; G 6·8—7; gyh-w, ywh, gyh, 501.
Johannite,	2—2·5	n 69°; *p* 85° 40′; *cl* m; G 3·19; gn, 408.
Miargyrite,	2—2·5	n 86° 4′; *p* 78° 54′; a 128° 59′; bk; G 5·2—5·3; *submetallic*, 539.
Vauqelinite,		*p* 112° 45′; bkh-gn, dark gn; G 5·5—5·8, 505.

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* A Columbite from Ildefonso, Spain; lustre vitreo-adamantine, submetallic.

† In this system, the letters m, n, b, are used as in the trimetric system, for vertical planes; n for ∞ P, (*e*, fig. 90, pl. 2); m for ∞ P ∞ (M, fig. 90), or the face parallel to the orthodiagonal; b for ∞ P′ ∞ (P, fig. 90), or the face parallel to the clinodiagonal; d represents the hemiprism (P ∞), parallel with the orthodiagonal (ĕ, fig. 93), and *d* a corresponding plane (—P ∞) below (ĕ, fig. 94); t a clinodiagonal prism (P′ ∞ *a*, fig. 98); a represents the hemipyramid +P (â, fig. 102), and *a* the corresponding hemipyramid —P. The inclination of the terminal plane on the vertical axis is called the angle *p*.

	Hardness.	
Trona,	2·5—3	a 47° 30′; *p* 103° 15′; taste; G 1·9—2, 191.
Glauberite,	2·5—3	n 83° 20′; a 116° 20′; *p* 68° 16′; *cl* P perf, 189.
Köttigite,	2·5—3	Like Cobalt Bloom; G 3·1; rdh, 487.
Crocoisite,	2·5—3	n 93° 40′; a 119°; *a* 107° 40′; *p* 102° 30′; rd; G 5·9—6·1, 504.
Aphanesite,	2·5—3	m 56°; *p* 35°; gn, b; G 4·15—4·4, 528.
Algerite,	3—3·5	n 94°; G 2·6—3, 314.
Warwickite,	3—4	n 93°, 94°; G 3—3·3, 398.
Heulandite,	3·5—4	a 135° 52′; *p* 130° 30′; *cl* clinod!!; G 2·15—2·2, 296.
Laumonite,	3·5—4	n 86° 15′, (84° 30′, Duf.); *p* 80° 42′; pn 114° 54′; *cl* orthod!; G 2·25—2·4, 303. Leonhardite, resembles Laumonite.
Schiller Spar,	3·5—4	*Cl* one perf!, another less so; G 2·5—2·8, 260.
Azurite,	3·5—4	n 98° 50′; t 99° 32′; *p* 92° 21′; b; G 3·5—3·9, 521.
Malachite,	3·5—4	n 103° 42′; *cl* basal!; gn; G 3·7—4·1, 521.
Barytocalcite,	4	n 106° 55′; *a* 95° 15′; G 3·6—3·7, 198.
Turnerite,	above 4	n 96° 10′; pn 99° 40′; *cl* diagonals, one perf, 372.
Brewsterite,	4·5—5	n 136°; *p* 93° 40′; *cl* clinod!; G 2·1—2·5, 298.
Wollastonite,	4·5—5	n 95° 38′; pn 104° 48′; *cl* orthod; n less perf; G 2·75—3, 265.
Phosphorochalcite,	4·5—5	n 38° 56′; gn; G 4—4·4, 524.
Hureaulite,	5	n 52° 30′; a 88°; *p* 68°; *cl* none; rdh, ywh; G 2·27, 466.
Monazite,	5	n 93° 10′; pn 100°—100° 25′; a 119° 22′; *a* 106° 36′; *cl* basal!; G 4·8—5·25, 235.
Mesotype,	5—5·5	Monoclinic, according to Rose; n 91°—91° 35′; *p* 90° 54′; G 2·1—2·25, 300.
Datholite,	5—5·5	n 77° 30′; a 122°; *p* 88° 19′; *cl* n, dif; G 2·9—3, 249.
Wagnerite,	5—5·5	n 95° 25′; pn 109° 26′; *cl* n, orthod; G 3·068, 216.
Sphene,	5—5·5	Angles of dif prisms, 136° 6′, (or 136° 48′); 113° 30′, (or 114° 24′); 110° 54′, (or 111°); 133° 48′, (or 133° 56′); 67° 46′; *cl* imperf; G 3·4—3·6, 391.
Glaucophane,	5·5	Probably monoclinic; G 3·108, 345.
Rhodonite,	5·5—6·5	n 87° 6′, like Augite; *p* 74°; *cl* n; rdh; G 3·4—3·7, 462.
Hornblende,	5—6	n 124° 30′; pn 103° 1′; *p* 104° 58′; cl n, m, b; G 2·8—3·2, 272.
Lazulite,	5—6	n 91° 30′; a 100° 20′; *a* 99° 40′; cl n indist; G 3—3·15, 229.
Pyroxene,	5—6	n 87° 6′; p n 100° 25′; *p* 73° 54′; *cl* n, and diags; G 3·2—3·5, 267.
Baulite,	5·5—6	*cl* as in Orthoclase; G 2·6—2·63, 330.
Allanite,	5·5—6	n 70° 51; *p* 114° 55′; G 3·3—4·2, 354.
Orthoclase,	6	n 118° 48′; *p* 116° 7′; pn 112° 16′; *cl* p perf, b nearly perf; G 2·4—3·6, 325.
Ryacolite,	6	n 119° 21′; *p* 116° 6′; *cl* perf, b nearly perf; G 2·55—2·65, 330.
Castor,	6—6·5	*cl* planes 128½°; G 2·392, 339.
Petalite,	6—6·5	n 96°—100°! G 2·4—2·45, 338.
Couzeranite,	6—6·5	n 96°; perhaps Labradorite, 336.

	Hardness.	
Acmite,	6—6·5	n 86° 56′; *p* 74°; G 3·2—3·6, 271.
Loxoclase,	6—6·5	n 120° 15′; *cl* p perf, m nearly perf; G 2·6—2·62, 330.
Chondrodite,	6—6·5	n 68°; a 89°; *a* 80°; *cl* none; G 3—3·2, 280.
Epidote,	6—7	n 69° 54′ (=e : e, page 358); *p* 114° 25′; *cl* imperf; G 3·2—3·5, 352.
Spodumene,	6·5—7	n 93°; *cl* n, and b; G 3·1—3·2, 339.
Euclase,	7·5	n 114° 50′; *p* 108° 53′; *cl* clinod!; G 2·9—3·1, 375.

II. LUSTRE METALLIC.

Flexible Silver,	1—2	n 90° 78′; *p* 125°; bkh, 539.
Plagionite,	2·5	n 120° 49′; *a* 134° 30′; a 142° 3′; pn 138° 52′; *cl* n perf; gy; G 5·4, 494.
Crednerite,	4·5	*cl* one perf!, two less so; bk, gyh; G 4·9—5, 460.
Placodine,	5—5·5	n 64° 32′ and 115° 28′; G 7·9—8·1, 475.
Wolfram,	5—5·5	n 101° 45;[*] t 98° 27′, Kerndt; who agrees with Rose in making the crystals trimetric. The same angles, according to Descloizeaux, 101°, 99° 18½′; according to Levy's measurements 101°, 99° 32½′; according to Phillips's measurements 101° 5′, 99° 12′; Descloizeaux shows that the prism is oblique, with pn 91° 32′, and *p* 91° 59,[†] 403.
Allanite,	5·5—6	n 70° 51′ (=z : z, page 454); m′ 109° 47′; *p* 114° 55′; G 3·3—4·2; *submetallic*, 354.
Gadolinite,	6·5—7	n 115°; *cl* imperf; G 4—4·5, 382.

V. CRYSTALLIZATION TRICLINIC.[‡]

Blue Vitriol,	2·5	109° 32′, 127° 40′, 123° 10′; cleav imperf; b; G 2·2—2·3, 522.
Schiller Spar,	3·5—4	One angle (*cl* planes) 135°—145°; gnh, bnh; G 2·5—2·7, 260.
Leucophane,	3·5—4	126° 36′ and 143° 34′ from three cleavages; G 2·974, 377.
Babingtonite,	5·5	Different prism. angles 89° 20′, 92° 34′, 112° 30′; 88° between cleavages; one *cl* perfect; G 3·4—3·5, 276.
Latrobite,	5·5—6·5	93° 30′, 91° 9′, 98° 30′; cleav 3 unequal; G 2·7—2·8, 337.
Albite,	6	n *n* 121° 38′; p b 93° 30′; G 2·55—2·65, 331.
Oligoclase,	6	n *n* 120°; p on *cl* plane (b) 93° 15′; oblique in the same direction with Albite; G 2·6—2·7, 332.

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[*] e′ : e′ on p. 403, should be *e*′ : *e*′.

[†] Ann. Ch. Phys., Feb. 1850, [3], xxviii, 168.

[‡] In the Triclinic system the different planes, according to the plan adopted, may be designated as in the monoclinic, except that each letter will be in roman for a plane on an obtuse angle of the fundamental prism, and in italics for a plane on the supplementary acute angle; we also write m and b, for macrodiagonal and brachydiagonal vertical planes. In the brief mention of angles in this place, it is seldom necessary to refer to other planes by any special designation.

	Hardness.	
Labradorite,	6	n *n* 119° 16′; p b 86° 32′; G 2·65—2·8, 333.
Vosgite,	6	Like Labradorite? G 2·7—2·8, 336.
Andesine,	6	Like Albite; but *cl* less perfect; G 2·65—2·74, 334.
Lepolite,	6	n *n* 120° 30′; p b 93°; G 2·75—2·77, 335.
Anorthite,	6—7	n *n* 120° 30′; p b 85° 48′; G 2·65—2·78, 334.
Hyposclerite,	6·5	n *n* 119°; p b 87°; G 2·6—2·66, 337.
Kyanite,	6—7·5	93° 15′, 100° 50′, 106° 15′; n *n* 96° 35′; *cl* macrod; G 3·1 —3·7, 314.
Axinite,	6·5—7	134° 40′, 115° 5′, 135° 10′; bn, gyh, bk; G 3·271, 365.
Sillimanite,	6·5—7·5	n *n* 98° varying to 110°; *cl* macrod!; G 3·2—3·6, 314.
Danburite,	7	110°, 54°, 93°; *cl* dist; G 2·9—3, 281.

VI. CRYSTALLIZATION HEXAGONAL.*

I. LUSTRE UNMETALLIC.

Ripidolite,	1—2	Hexag; pyr 132° 40′, 106° 50′; *cl* basal!!; lam flex; G 2·7—3, 261.
Brucite,	1·5	Hexag tables; *cl* basal!!; G 2·35, 200.
Völknerite,		Hexag tables, *cl* basal!!; G 2·04, 201.
Nitratine,	1·5—2	R 106° 33′; *cl* R perf; G 2—2·3; taste cooling, 190.
Chlorite,	1·5—2	R 104° 15′; tab; *cl* basal!!; lam flex; G 2·6—2·9, 261.
Haidingerite,	1·5—2·5	G 2·848; *cl* diag!! w; BB *char* arsen, 220.
Copper Mica,	2	R 68° 45′; *cl* basal!!; gn; G 2·4—2·7, 529.
Xanthokon,	2	R 110° 30′; rd, bn; G 5—5·2, 548.
Coquimbite,	2—2·5	Hexag; d 128° 8′, 58′; w, bh; taste copperas; G 2—2·1 447.
Proustite,	2—2·5	R 107° 48′; *cl* R; rd; G 5·4—5·6, 541.
Pyrargyrite,	2—2·5	R 108° 18′; *r*½ 137° 39′; *cl* R; bk, rdh; G 5·7—5·9, 540.
Cinnabar,	2—2·5	R 71° 47′; *cl* lat; r; G 8—8·1, 582.
Cronstedtite,	2·5	Hexag, hemihed; *cl* basal!; bnh-bk; G 3·3—3·4, 441.
Pennine,	2—3	R 63° 15′; *cl* basal!!; lam flex; G 2·6—2·7, 262.
Biotite (Mica),	2·5—3	Hexag; *cl* basal!!; G 2·8—3·1, 360.
Hydrocalcite,		Changes on exposure, 213.
Calcite,	3	R 105° 5′; *cl* R perf; G 2·5—2·8, 205.
Volborthite,	3—3·5	Hexag; *cl* one perf; yw, ywh-gn; G 3·4—3·9, 530.
Vanadinite,		Hexag; yw, bn; G 6·6—7·3, 503.
Gibbsite,	3—4	Hexag; *cl* basal; G 2·3—2·4, 224.
Magnesite,	3—4	R 107° 22′; *cl* R perf; G 2·8—3, 210.
Dreelite,	3·5	R 93° to 94°; *cl* R, traces; G 3·2—3·4, 195.
Mimetene,	3·5	Hexag; d 141° 47′, 81° 47′; yw, rdh; G 7·1—7·25, 503.
Dolomite,	3·5—4	R 106° 15′; *cl* R perf; G 2·8—3·1, 210.

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* In the Hexagonal system the faces of the fundamental rhombohedron will be designated R or r, and one in the series intermediate *r*. For the hexagonal prism, the pyramidal planes on the basal edges will be lettered d, and those on the angles a,—corresponding thus to the dimetric system.

	Hardness.	
Pyromorphite,	3·5—4	Hexag; d 142° 12′, 80° 44′; a 131° 5′, 111° 48′; *cl* imperf; gn, yw; G 6·9—7·1, 502.
Diallogite,	3·5—4·5	R 106° 51′, (107° 20′); *cl* R!; rdh, bnh; G 3·4—3·6, 465.
Spathic Iron,	3·5—4·5	R 107°; *cl* R!; gyh, bnh; G 3·7—3·9, 444.
Connellite,		Hexag; b; trl, 523.
Chabazite,	4—4·5	R 94° 46′; *cl* R, also hexag; G 2—2·2, 308.
Pyrosmalite,	4—4·5	Hexag; d 130° 18′, 115° 37′; *cl* basal!; bn, gy, gn; G 3—3·1, 454.
Breunnerite,	4—4·5	R 107° 23′; *cl* R perf; G 3—3·63, 212.
Parisite,	4·5	Hexag; a 120° 34′, 164° 58′; *cl* basal!; G 4·35, 235.
Clintonite,	4—5	Hexag tables; *cl* basal!!; lam brittle; G 3—3·1, 264.
Fluocerite,	4—5	G 4·7; ywh·bn, 237.
Red Zinc Ore,	4—4·5	Hexag; d 144° 54′, 74° 12′; *cl* basal!!; rd; G 5·4—5·6, 481.
Chalcotrichite,		R 99° 15′; capil; G 5·8; rd, 517.
Alunite,	5	Rbdl; R 92° 50′; *cleav* basal; G 2·5—2·8, 228.
Apatite,	5	d 80° 30′; a 111°, 72° 42′; *cl* indistinct; G 3—3·3, 214.
Dioptase,	5	R 126° 17′; R^2 95° 48′; *cl* R!; gn; G 3·2—3·4, 519.
Zwieselite,	5	Hexag?; G 3·97; olive-bn, 466.
Calamine,	5	R 107° 40′; *cl* R; w, gyh, gnh; G 4—4·45, 485.
Willemite,	5·5	R 115°; R′ 128° 30′, (127° 33?); $r\frac{1}{2}$ 147° 30′; *cl* basal and lateral; G 3·9—4·2, 488.
Cerite,	5·5	Hexag; G 4·912, 381.
Eudialyte,	5—6	R 73° 30′; *cl* basal!; G 2·85—3, 378.
Davyne,	5·5—6	Hexag; d′ (basal) 51° 46′; *cl* m perf; G 2·4—2·65, 324.
Nepheline,	5·5—6	Hexag; d (basal) 91° 54′; *cl* m, p; G 2·5—2·65, 323.
Quartz,	7	R 94° 15′; *cl* indistinct; G 2·6—2·7, 239.
Tourmaline,	7—7·5	R 133°; *cl* imperf; bk, bn, b, gn, rd; G 3—3·3, 363.
Schorlomite,	7—7·5	Hexag; G 3·75—3·9, 394; (*submet*).
Beryl,	7·5—8	Hexag; d 138° 41′, 89° 45′; a 151° 9′, 59° 47′; *cl* basal not very distinct; G 2·6—2·8, 373.
Phenacite,	8	R 115° 25′; *cl* R; G 2·9—3, 375.
Sapphire,	9	R 86° 6′; *cl* basal; G 3·9—4·2, 222.

II. LUSTRE METALLIC.

Molybdenite,	1—1·5	Hexag tables; *cl* basal!!; G 4·4—4·8, 389.
Covelline,	1·5—2·0	Hexag; dark b; G 3·8—3·9, 510.
Pilsenite, (*D*)	1·5—2	*Cl* basal!; G 8—8·5; gyh; the Molbydänsilber, 415.
Tetradymite,	2	R 66° 40′; R′ 81° 2′; *cl* basal!; gyh; G 7·5, (6·1?), 414.
Tellurium,	2—2·5	R 86° 57′; G 5·7—6·3; tin-w, 411.
Bismuth,	2—2·5	R 87° 40′; G 9·737; tin-w, rdh, 411.
Tenorite,		Scales; G 5—5·5; gy, 518.
Polybasite,	2—3	R 84° 48′, tabular; *cl* indist; bk; G 6·214, 542.
Greenockite,	3—3·5	Hexag; d 127° 26′; d′ 139° 39′, 87° 13′; d″ 155° 29′; yw, rdh; G 4·8—5, 480.

	Hardness.	
Millerite,	3—3·5	R 144° 8′; *cl* R; yw; G 5·2—5·7, 469.
Zinkenite,	3—3·5	Hexag; d 165° 26′, 25° 24′, (perhaps trimetric with M M 120° 39′); *cl* imperf; G 5·3—5·4, 491.
Allemontite,	3—3·5	R 117° 15′; *cl* basal!; w; G 6·1—6·2; arsenical antimony, 419.
Antimony,	3—3·5	R 87° 35′; R′ 117° 15′; *cl* R!; w; G 6·6—6·8, 415.
Arsenic,	3·5	R 85° 4′, (or 85° 26′); w, gy; G 5·6—6, 419.
Plattnerite,		*Cl* indist; bk; G 9—9·5, 496.
Mag. Pyrites,	4—4·5	Hexag; d 126° 49′, 127° 6′; *cl* basal; bronze; G 4·4—4·7, 427.
Copper Nickel,	5—5·5	Hexag; d 139° 48′, 86° 50′; *cl* imperf; rdh; G 7·3—7·7, 469.
Ilmenite,	5—6	R 85° 59′; *cl* imperf; gyh-bk; G 4·5—5·1, 432. *Crichtonite*, r 61° 29′. *Mohsite*, r 73° 53′, 432.
Breithauptite,	5·5	Hexag; d 130° 58′, 112° 10′; rdh; G 7·541, 470.
Specular Iron,	5·5—6·5	R 85° 58′, (86° 10′, H.); *cl* imperf; gyh-bk; G 4·8—5·3, 430.
Iridosmine,	6—7	R 84° 52′; hexag, d 139° 56′; w, gyh; G 19—22, 547.

NOTE.—In the preceding table, the angles given vary in some instances from those of the Descriptive part of the work; they have been differently determined by different authors, and what appear to be the best results are here presented.

SUPPLEMENT.

I. 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.

The recent appearance of the various Reports by the several State Geologists, have enabled the author to give a completeness to this branch of American Mineralogy, before unattainable. 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 the 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, Prof. Troost and Houghton, and Mr Owen of the Western States, Prof. C. B. Adams of the Vermont survey, and Prof. M Tuomey of the South Carolina: 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. Nuttall, 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. Johnston, 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, and D. Dale Owen and J. G. Norwood, of Indiana. The Pennsylvania list is largely prepared from recent information furnished the author, mostly by Messrs. Williams and Seal; the Minesota and Wisconsin, through contributions by Messers Owen and Norwood; the North Carolina, from a manuscript catalogue received from the Hon. Mr. Clingman, and the Michigan, from the explorations of Dr. C. T. Jackson.

In making out the catalogue, the names of those minerals which are obtained in good specimens at the several localities, are distinguished by italics. When the specimens are remarkably good, an exclamation mark (!) has been 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 description 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*, asbestus, 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.

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.

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).

Franchestown.—*Soapstone*, arsenical pyrites.

Franconia.—*Hornblende*, *staurotide* ! *epidote* ! *zoisite*, *specular iron*, *magnetic iron*, *black* and *red manganesian garnets* : *mispickel* ! (*Danaite*), copper pyrites, molybdenite, prehnite.

Gilford.—(Gunstock Mt.)—Magnetic iron ore, native "lodestone."

Goshen.—*Graphite*, black tourmaline.

Grafton.—*Mica* ! (extensively quarried), *albite* ! asparagus stone, blue, green, and yellow *beryls*, *tourmaline*.

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*, *garnets* black and red, *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.

Orford.—*Brown tourmaline* ! *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, soapstone, iron pyrites.

Saddleback Mt.—Black tourmaline, garnet, spinel.

Shelburne.—*Argentiferous galena*, *crystalline black cupreous blende* ! *copper pyrites*, *iron pyrites*, manganese.

Springfield.—Beryls, (very large, 8 inches diameter,) *manganesian garnets* ! in mica slate, *albite*, *mica*.

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*.

Brandon.—*Braunite*, pyrolusite, psilomelane.

Brattleborough.—Black tourmaline in quartz.

Bridgewater.—*Talc*, *dolomite*, *magnetic iron*, steatite, chlorite.

Bristol.—*Rutile*, brown hematite, manganese ores.

Brookfield —*Mispickel*, *iron pyrites.*

Cabot.—Garnets, staurotide, hornblende, *albite.*

Cavendish.—Garnet, *serpentine.*

Chester.—*Asbestus.*

Chittenden.—Psilomelane, pyrolusite, braunite, brown iron ore, *specular* and *magnetic iron*, galena.

Colchester.—Brown iron ore, iron sand, jasper, alum.

Corinth.—*Copper pyrites*, 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.

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 *asbestiform actinolite*, *steatite*, *green quartz*, (called chrysoprase 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*, oct. in chlorite state.

Roxbury.—*Dolomite*, *talc*, serpentine, asbestus.

Salisbury.—Brown iron ore.

Sharon.—*Quartz*, kyanite.

Shoreham.—*Iron pyrites.*

Shrewsbury.—Magnetic iron and copper pyrites.

Somerset.—Magnetic iron, native gold.

Strafford.—Magnetic iron and copper pyrites, 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.—*Crystalline magnetic iron*, talc, *serpentine*, picrosmine, amianthus, *steatite*, one m. S. E. of village of South Troy, on farm of Mr. Pierce, E. side of Missisco, *chromic iron.*

Warren.—Actinolite, magnetic iron ore, wad.

Waterbury.—Mispickel, copper pyrites.

Waterville.—*Steatite*, actinolite, talc.

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.—Polymignite, 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*, 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*, variegated copper ore, zoisite, uranite.

Conway.—Pyrolusite, fluor spar, zoisite, *rutile!!* native alum, galena.

Cummington.—*Rhodonite! cummingtonite*, 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.

Hatfield.—*Heavy spar*, yellow quartz crystals, galena, blende, yellow 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!*

Montague.—Specular iron.

Newbury.—*Serpentine*, amianthus, *epidote*, *massive garnet*, carbonate of iron.

Newburyport.—*Serpentine*, *nemalite*, uranite.

New Braintree.—*Black tourmaline.*

Norwich.—*Apatite ! black tourmaline*, *beryl*, 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.

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,

South Royalston.—*Beryl ! !* (now obtained with great difficulty), *mica ! ! feldspar ! ilmenite*, allanite.

Sterling.—*Spodumene*, *chiastolite*, *spathic iron*, *mispickel*, *blende*, galena, iron and copper pyrites.

Stoneham.—*Nephrite.*

Sturbridge.—*Graphite*, pyrope, apatite, bog ore.

Turner's Falls, (Conn. R.)—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*, *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).—Laumonite.

Bristol.—*Copper glance!!* copper pyrites, heavy spar, *variegated copper ore*, talc, *allophane*, pyromorphite.

Brookfield.—Galena, calamine, *blende*, spodumene, magnetic pyrites.

Canaan.—*Tremolite* and *augite!* in dolomite.

Chatham.—Mispickel, smaltine, copper nickel, *beryl*.

Cheshire.—*Heavy spar! copper glance*, *cryst. variegated copper! green malachite*, kaolin, natrolite, prehnite, chabazite, datholite.

Chester.—*Sillimanite!* zircon, epidote.

Cornwall, near the Housatonic.—*Graphite*, *pyroxene*.

Danbury.—*Danburite*, *albite*, *moonstone*, brown tourmaline.

Farmington.—*Prehnite*, *chabazite!* agate, native copper.

Granby.—Green malachite.

Greenwich.—*Black tourmaline*.

Haddam.—*Chrysoberyl! beryl!! epidote!! tourmaline! feldspar*, *anthophyllite*, *garnet! iolite! chlorophyllite! automolite*, *magnetic iron*, *adularia*, apatite, *columbite!* (!) *mica*, *white* and yellow iron pyrites, *molybdenite! allanite*, sulphuret of bismuth.

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.

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.

Orange.—Pyrites.

Oxford, near Humphreysville.—Kyanite, copper pyrites.

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*, ochrey iron, *pyrolusite*, triplite.

Saybrook.—*Molybdenite*, stilbite, plumbago.

Simsbury.—*Copper glance*, green malachite.

Southbury.—Rose quartz, laumonite, prehnite, calc spar, heavy spar.

Southington.—Heavy spar, datholite.

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*, euclase, (?) 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.

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.—*Garnet*, *massive feldspar*, *epidote*, epsom salt, apatite, (eupyrchroite of *Emmons*), 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.—*Zircon! calc spar*, apatite, actinolite, (Sanford ore-bed), labradorite, mica, specular iron.

Newcomb.—*Labradorite*, feldspar.

Port Henry.—*Brown tourmaline*, *mica*, *rose quartz*, *serpentine*, *green* and *black pyroxene*, hornblende, *cryst. pyrites*, *magnetic pyrites*, *adularia*.

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, *feldspar*, *tourmaline.*

Antwerp.—Stirling iron mine, *specular iron*, *cacoxene! spathic iron*, *millerite*, (sulph. nickel, in capillary crystals), *quartz crystals*, pyrites; at Oxbow, *calc spar!* porous coralloidal heavy spar; near Vrooman's lake, *calc spar!* idocrase, *phlogopite! pyroxene*, *sphene*, 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.*

Theresa.—*Fluor spar*, specular iron ore, hornblende, quartz crystals, serpentine, (associated with the specular iron), celestine; the Muscolongue lake locality of fluor is exhausted.

Watertown.—*Tremolite*, agaric mineral, calc tufa.

[This county adjoins St. Lawrence Co., and the localities of Rossie, Hammond, and Gouverneur, near Oxbow, are in the latter county.]

LEWIS CO., (Am. J. Sci. [2], ix, 424).—Diana.—*Scapolite ! tabular spar*, *green coccolite*, *feldspar*, apatite, *sphene*, mica, *quartz crystals*, drusy quartz, cryst. pyrites, magnetic pyrites, blue calc spar, serpentine, *rensselaerite*, zircon, specular iron ore, iron sand.
Greig.—*Magnetic iron ore*, pyrites.
Leyden.—*Calc spar.*
Lowville—*Calc spar*, fluor spar, pyrites, galena, blende, calc tufa.
Martinsburgh.—Wad.

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, molybdeuite, 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.*

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.—Arragonite.
At Two Ponds in Monroe.—*Pyroxene ! chondrodite*, *hornblende*, *scapolite ! zircon*, *sphene*, apatite.
At Greenwood Furnace in Monroe.—*Chondrodite*, *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.*
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 coccolite*, hornblende, *scapolite*, stilbite, mica, laumonite, 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, magnesite, 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., (Am. J. Sci. [2], ix, 427).—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.

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! feldspar! loxoclase, tourmaline!* pyroxene, apatite, *rensselaerite,* serpentine, *sphene,* fluor, *heavy spar,* rutile, black and copper colored *mica, tremolite!* asbestus, specular iron, graphite, idocrase, mica (near Somerville in serpentine), quartz, *spinel,* pyrites.

Hammond.—*Apatite!! zircon!* (farm of Mr. Hardy), *feldspar, pargasite,* heavy spar, pyrites, purple fluor.

Hermon.—*Quartz crystals, specular iron, spathic iron,* pargasite, pyroxene, serpentine, tourmaline.

Macomb.—Blende, mica.

Mineral Point, Morristown.—Fluor, blende, galena, *phlogopite,* (Pope's Mills), heavy spar.

Ogdensburgh.—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,* coralloidal arragonite, limonite, *quartz, pyrites.*

Rossie Lead Mine.—*Calc spar, galena,* pyrites, *celestine,* copper pyrites, *spathic iron!* white lead ore, anglesite, (but all are obtained with great difficulty, as the mines are not worked).

Elsewhere in Rossie.—*Calc spar, heavy spar,* quartz crystals, chondrodite, *feldspar! pargasite! apatite, pyroxene, mica,* fluor, serpentine, automolite, pearl spar, graphite, serpentine, zircon.

Russel.—*Pargasite, specular iron, quartz* (dodec.), serpentine, rensselaerite.

SARATOGA CO.—Greenfield.—*Chrysoberyl! garnet, tourmaline! mica, feldspar,* apatite, graphite, arragonite, (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.—Wurtsboro'.—*Galena, blende, pyrites, copper pyrites.*

ULSTER CO.—Ellenville.—Galena, blende, copper pyrites, quartz.

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, magnesite, 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.

Allentown, (Monmouth Co.)—Vivianite.

Belville.—Copper mines.

Bergen.—*Calc spar, datholite, thomsonite, pectolite*, (called stellite), *analcime, epistilbite, apophyllite, prehnite*, sphene, stilbite, natrolite, heulandite, laumonite, chabazite, pyrites, pseudomorphous steatite imitative of apophyllite.

Brunswick.—Copper mines; *native copper, malachite, mountain leather.*

Danville, (Jemmy Jump Ridge).—*Graphite*, chondrodite, augite, mica.

Flemington.—*Copper mines.*

Frankfort.—*Serpentine.*

Franklin and Hamburgh, near the Franklin furnace.—*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, *vauxite.* Also *algerite* in gran. limestone.

Franklin and Warwick Mts.—*Pyrites.*

Greenbrook.—Copper mines.

Griggstown.—Copper mines.

Hoboken.—Serpentine, *brucite! nemalite*, (or fibrous brucite), *magnesite.*

Imleytown.—Vivianite.

Lockwood.—*Graphite, chondrodite, talc, augite, quartz, green spinel.*

Mullica Hill, (Gloucester Co.)—*Vivianite* lining belemnites and other fossils.

Newton.—*Spinel, blue and white corundum, 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.*

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.

BERKS CO.—At Jones's Mines, near Morgantown, *green malchite!* 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; 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 Greggs's farm), brown tourmaline, brown mica, tremolite, scapolite, arragonite; 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, *arragonite, 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 Magnesia Quarry, magnesite, marmolite, leelite, serpentine.

Parkesburg, (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; near Kinsey's mill, *pyromorphite, cerusite*, cryst. quartz, galena, anglesite; at Chrisman's, pyromorphite, cerusite, anglesite, copper pyrites, heavy spar.

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), talc, *green tourmaline* (with flat or pyramidal terminations), ligniform asbestus, *yellow beryl* (rare), *serpentine, chromic iron*, quartz crystals, *green quartz*, actinolite, *chlorite* in cryst., diallage, granular albite (H=7), adularia, *emerylite, euphyllite*, unionite, 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; two miles southwest, at Pusey's saw mill, *zircon* (cryst. small, loose in the soil, rare), rutile; one mile south, on the farm of Bailey and Brothers, bright *yellow* and nearly *white tourmaline!* (rare), *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, lancasterite in serpentine, zircon, two miles west; one and a half mile northwest, a pitch-black mineral resembling allanite, (or tscheffkinite), B.B. intumesces very readily; G 3·5.

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 toumaline; 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*, *damourite*, *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, leelite, 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*, *kammererite*, *baltimorite*, *williamsite*, *chromic iron*, *marmolite*, picrolite, dolomite, cryst. magnesite, calcite, serpentine; at Low's Mine, lancasterite, *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.

Little Britain.—*Anthophyllite*.

LEBANON CO.—Cornwall.—*Pyrites!* in cubo-octahedrons, brilliant steel tarnish.

LEHIGH CO.—Near Bethlehem and equally near Cooperstown, *electric calamine!* cryst. quartz, malachite, pyrolusite, wad; near Allentown, magnetic iron, pipe iron ore.

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 the Lead Mine, cryst. quartz, galena, anglesite, cerusite, molybdate of lead, calamine, blende, green malachite, pyromorphite; at Henderson's Marble Quarry, *calc spar;* about 1 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.

NORTHUMBERLAND CO.—Opposite Selim's grove, electric calamine.

NORTHAMPTON CO.—Near Easton, *zircon!!* (exhausted), nephrite, coccolite, tremolite, calamite, pyroxene, sahlite, limonite, magnetic iron, purple calc spar.

PHILADELPHIA CO.—On the Schuylkill, near foot of inclined plane, *laumonite*, garnet, tourmaline, *mica*.

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.

Conchikocken.—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 not been worked for many years, but a company has lately taken them for the manufactory of porcelain), *adularia*, *albite*, *beryl*, mica, *loelite*, *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, 1¼ 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.

Eight to ten miles north of B.—*Brown hematite*.

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.

Cape Sable, near Magothy R.—Amber, pyrites, alum slate.

Catoctin Mts.—Pyritous copper, carbonate of copper.

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!* chlorite slate.

Liberty.—*Specular iron*.

Meadow Mt.—*Quartz crystals*.

Montgomery Co.—*Oxyd of manganese*.

Six miles north of the Potomac.—Chromic iron, in serpentine, dolomite.

Newmarket, (between Newmarket and Taneytown, east of the Monocacey).—*Copper glance*, *copper pyrites*, *malachite*.

"Soldiers' Delight."—Serpentine (kerolite?), gray antimony.

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*.

Amherst Co., along the west base of Buffalo ridge.—*Copper ores*, etc.

Buckingham Co., Willis's Mt.—*Kyanite*, *tourmaline*, *actinolite*, (Gold region), gold, *heavy spar!* in fine implanted crystallizations, brown, white, or colorless, *auriferous pyrites*.

Culpepper Co., on Rapidan river.—Gold, pyrites.

Franklin Co.—Grayish steatite.

Fauquier Co., Barnet's Mills.—Asbestus; gold mines.

Phenix Copper Mines.—*Copper pyrites*, etc.

Georgetown, D. C.—Rutile,

Goochland Co.—Gold mines, (Moss and Busby's).

Loudon Co.—*Tabular quartz*, *prase*, *pyrites*, *talc*, *chlorite*, *soapstone*, asbestus, *chromic iron*, *actinolite*, *quartz crystals*.

Louisa Co., Walton gold mine.—*Gold*, *pyrites*, copper pyrites, argentiferous galena, spathic iron, blende, anglesite.

Orange Co., western part, Blue Ridge.—Specular iron; gold at the Orange Grove and Greenwood gold mines.

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, tetradymite.

Wythe Co., (Austin's mines).—*White lead ore*, *minium*, *plumbic ochre*, blende, *electric calamine*, *galena*.

Stafford Co., eight or ten miles from Falmouth.—Micaceous iron, gold, silver, galena, vivianite.

Washington Co., eighteen miles from Abingdon.—*Rock salt* with *gypsum*.

Wier's cave and other caves in Virginia.—*Calc spar* and *stalactites*.

Kenawha.—Petroleum, brine springs.

Shepardstown.—Fluor spar.

On the Potomac, twenty-five miles north of Washington City.—*Native sulphur* in gray compact limestone.

Note.—The minerals usually associated with the gold are, arsenical iron, iron and copper pyrites, carbonate of copper, blende, galena, phosphate of lead in crystals, peroxyd of iron, magnetic iron, zircon, and rarely oxyd of tin and bismuth, monazite, platinum.

NORTH CAROLINA.

Ashe Co.—Malachite, copper pyrites abundant.

Buncombe Co.—Nitrogen from a warm spring, *blue corundum!* massive and cryst., *emerylite*, *garnet*, *chromic iron*, *heavy spar*, *fluor spar*, rutile, *iron ores*, oxyd of manganese. The zircon reported from this county, is in what is now Henderson Co.

Burke Co.—*Gold*, monazite, zircon, beryl, *corundum*, *garnet!* sphene, *graphite!* iron ores.

Cabarras Co.—*Gold;* also in Lincoln, Rutherford, and Mecklenburgh Cos.—Phosphate of copper, malachite.

Caldwell Co.—Chromic iron.

Chatham Co.—Mineral coal, pyrites.

Cherokee Co.—*Iron ores*, gold, *galena*, corundum, rutile.

Davidson Co., (King's mine).—*Lamellar native silver*, *carbonate of lead! pyromorphite!* galena, blende, malachite, black copper, oxyd of tin and manganese; at Conrad Hill, five miles from King's mine, gold, copper ores.

Gaston Co.—Iron ores.

Henderson Co.—*Zircon!*

Lincoln Co., near Crowder's mountain.—Gold, *iron ores*, *lazulite*, *kyanite*, *garnet*, graphite.

McDowell Co.—Platinum, brookite, monazite, *corundum* in small crystals, red and white, and some subtransparent, *zircons* in beautiful small crystals, *pyrope*, beryl, sphene, rutile, itacolumite or elastic sandstone, iron ores.

Macon Co.—Chromic iron.

Rutherford Co.—*Gold*, *graphite*, platinum, bismuthic gold, diamond, euclase, *pseudomorphous quartz*, corundum in small crystals, *epidote*, *pyrope*, *quartz crystals*, itacolumite; on the road to Cooper's gap, kyanite.

Stokes and Surrey Cos.—Iron ores, graphite.

Yancey Co.—*Iron ores*, amianthus, *chromic iron*.

SOUTH CAROLINA.

Abbeville Dist.—Gold, galena, phosphate of lead, amethyst, garnet.

Anderson Dist.—Galena.

Charleston.—*Selenite.*

Chewee 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.

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.

Pendleton.—*Actinolite*, galena, kaolin, *tourmaline*.

Picken's Dist.—Gold, manganese ores, kaolin.

Richland.—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.—Limestones, whetstones, witherite, heavy spar.

GEORGIA.

Burke and Scriven Cos.—Hyalite.

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.

Centreville.—*Iron ores,* marble, *heavy spar,* coal, cobalt.
Tuscaloosa Co.—*Coal,* galena.

FLORIDA.

Near Tampa Bay.—Limestone, sulphur springs, chalcedony, carnelian, agate, silicified shells and corals.

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!*

ARKANSAS.

Ouachita Springs.—*Quartz!* whetstones.
Magnet Cove.—*Brookite! schorlomite, elæolite,* magnetic iron, quartz, green coccolite, garnet, apatite.

MICHIGAN.

Kewenaw Point.—(46° 40′ to 47° 29′ N., 87° 55′ to 89° 30′ W.)
Lake Superior Mining Region.—*Native copper! silver!* copper pyrites, horn silver, gray copper, manganese ores, epidote, *prehnite, datholite,* (large vein on W. point of Eagle harbor), heulandite, *stilbite, laumonite, analcime,* chabazite, mesotype, apophyllite, *wollastonite, calc spar,* quartz; at Copper harbor, *black oxyd* of copper, chrysocolla; galena and sulphuret of copper on Chocolate river; copper pyrites and native copper at Presqu' Isle.
Isle Royal, (north side of Lake Superior, 48° N., 89° W.)—*Native copper, epidote,* harmotome, *datholite,* wollastonite, pectolite, chlorastrolite.
Near the Ontonagon, *native copper,* (one mass uncovered measuring by estimate 1200 cubic feet, and 250 tons by weight).

ILLINOIS.

Gallatin Co., on a branch of Grand Pierre Creek, 16 to 30 miles from Shawneetown, down the Ohio, and from 3 to 8 miles from this river.—*Violet fluor spar!* heavy spar, galena, blende, brown iron ore.
In Northern Illinois, townships 27, 28, 29, several important mines of *galena.*
Pope Co.—Pyromorphite.

INDIANA.

Limestone Caverns.—*Epsom salt;* in most of the S. W. counties *pyrites, sulphate of iron,* and *feather alum;* on Sugar Creek, pyrites and *sulphate of iron;* in sandstone of Floyd Co., near the Ohio, *gypsum;* at the top of the blue limestone formation, *brown spar, calc spar.*

WISCONSIN.

At Mineral Point and elsewhere, copper and lead ores abundant, principally silicate and carbonate of copper and galena. Also *pyrites*, *capillary pyrites*, *blende*, *white lead ore*, leadhillite, *calamine*, angleaite, *heavy spar*, and calc spar; often in highly interesting forms.

Sauk 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 Ewings and Sherard's diggings, *calamine!*; at Des Moines, quartz crystals; 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.

Jefferson Co., at Valle's Diggings.—*Calamine*, *galena*, *white lead ore*, anglesite, 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, boracite, caledonite, plumbo-resinite, wolfram.

Perry's Diggings, and elsewhere.—Galena, etc.

Forty miles west of the Mississippi and ninety south of St. Louis, the iron mountains, specular iron, brown hematite.

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 Co., foot of Roan Mt.—*Sahlite*, magnetic iron.

Claiborne Co.—*Calamine*, galena, electric calamine, 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.—Manganesian limestone.

Maury Co.—Wavellite in limestone.

Morgan Co.—Epsom salt, nitrate of lime.

Roan Co., eastern declivity of Cumberlands Mts.—Wavellite in limestone.

Severn Co., in caverns.—Epsom salt, soda alum, saltpeter, nitrate of lime.

Smith Co.—Fluor.

White Co., Sparta, about the Calf Killer's Creek.—A rolled fragment of sulphuret of silver, fluor, liquid bitumen.

Stone Creek, near Mr. Holland's.—Iron ore, black oxyd of manganese.

Smoky Mt., on declivity.—Hornblende, garnet, staurotide.

MINNESOTA.

North shore of Lake 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*, *laumonite*, *heulandite*, *chabazite ?*, *harmotome*, thomsonite, *fluor spar*, *sulphate of barytes*, *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.

Kettle River Trap range.—Epidote, nail-head calc spar, amethystine quartz, calcareous spar, undetermined zeolites.

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 oxide of iron, steatite.

CALIFORNIA.

Along the Sierra Nevada, *gold*, platinum, diamond ? 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*.

CANADA.

CANADA EAST.

Bay St. Paul.—*Ilmenite !*, apatite.

Bolton.—*Chromic iron*, *magnesite*, serpentine, picrolite, steatite, bitter spar, wad.

Brome.—Magnetic iron, copper pyrites, *sphene*, ilmenite, phyllite, sodalite, cancrinite, galena.

Chambly.—Analcime, chabazite and calcite in trachyte.

Inverness.—*Variegated copper.*

Montreal.—*Calcite*, augite, sphene.

Polton.—Chromic iron, steatite, serpentine, *amianthus*.

Sherbrooke.—Jasper, epidote, copper pyrites, gold.

St. Armand.—*Specular iron*, epidote.

St. François Beauce.—*Serpentine*, soapstone, magnetic iron, ilmenite, heavy spar, chromic iron, wad, rutile, *gold !*

Stukley.—Serpentine, *verd antique !* schiller spar.

Sutton.—*Magnetic iron* in fine crystals, specular iron, rutile, dolomite, *magnesite*, chromiferous talc, bitter spar, steatite.

Tring.—Wad, *arragonite*.

Upton.—Copper pyrites, malachite, calcite.

CANADA WEST.

Bathurst.—Heavy spar, *black tourmaline*, *perthite*, *peristerite !* *bytownite*.

Burgess.—*Pyroxene*, albite, *mica*, sapphire, sphene, copper pyrites, *apatite*, *black spinel !* spodumene, (in a boulder).

Bytown.—*Calcite !* bytownite, chondrodite and spinel, in boulders.

Clarendon.—*Idocrase !*

Dalhousie.—Hornblende, dolomite.

Drummond.—*Labradorite.*

Elmsley.—Pyroxene, sphene, feldspar.

Gostineau river, Blasdell's mills.—Calcite, apatite, tourmaline, hornblende, pyroxene.
Grenville.—*Tabular spar! sphene*, idocrase, calcite, pyroxene, albite! *zircon, graphite.*
Hull.—*Magnetic iron*, garnet, graphite.
Lanark.—*Raphillite*, serpentine, asbestus, hydrous anthophyllite!
Madoc.—Magnetic iron.
Marmora.—Magnetic iron, chalcolite, *garnet.*
Lac des Chats.—Island Portage, *brown tourmaline!* in quartz, pyrites, calcite.
Grand Calumet Island.—Apatite, *phlogopite! pyroxene*, sphene, *idocrase!!* serpentine, tremolite, scapolite, brown and black tourmaline, pyrites.

Correction.—Before Carmel, near bottom of page 651, insert PUTNAM CO. The name of the County having been omitted by mistake, this and the following places appear therefore to be in Orange Co.—Add also to the localities in this County:—in Putnam valley, apatite, zircon, sphene; at Carmel, chondrodite; at Phillipstown, vermiculite?

II. ON THE DRAWING OF FIGURES OF CRYSTALS.*

1. The first principle to be kept in mind in drawing a figure of a crystal, is this: *edges which are parallel in the crystal should be represented in the figure as parallel.* Figures projected with this principle in view, though without mathematical accuracy, will be valuable to the science. Yet a knowledge of mathematical crystallography, greatly facilitates the application of this principle.

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.

PROJECTION OF THE PRIMARY FORMS.

2. 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 primaries, which are equal and intersect at right angles. The projection of the axes in the other classes, may be obtained by varying the lengths of the projected monometric axes, and also, when oblique, their inclinations.

1. *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

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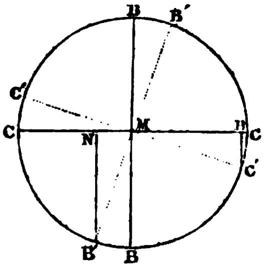
* The following pages are condensed from the "Lehrbuch der reinen und angewandten Krystallographie," of Dr. Carl Freiderich Naumann. (Two vols. 8vo. Leipzig, 1832). For mathematical demonstrations of the principles, see a fuller article by the author, in the American Jour. of Sci., vol. xxxiii, 30, and also Naumann's Treatise, here referred 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. 1 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.

Fig. 1.

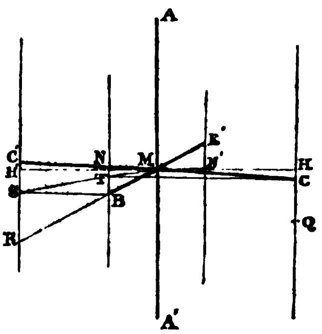


If the eye be elevated, (at any angle, ϵ), the lines B′N, BM and C′H will be projected respectively below N, M and H, and the lengths of these projections (which we may designate b′N, bM and c′H) will be directly proportional to the lengths of the lines B′N, BM and C′H.

It is usual to adopt such a revolution and such a 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:

Draw two lines AA′, H′H (fig. 2) 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.

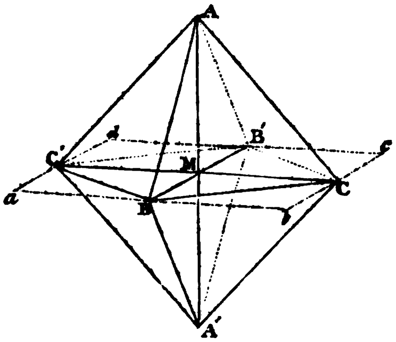
Fig. 2.



2. 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.

3. 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.

Fig. 3.



The values of r and s, commonly taken, are r=3, s=2, in which case, δ= 18° 26′ and ϵ =9° 28′. It is not unusual to give s the value 3, in which case ϵ=6° 20′. This affords a narrower terminal plane. The angle δ is obtained by the equation cot δ=r, and the angle ϵ by the equation cot ϵ=r s.

4. 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 fig. 3. 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.

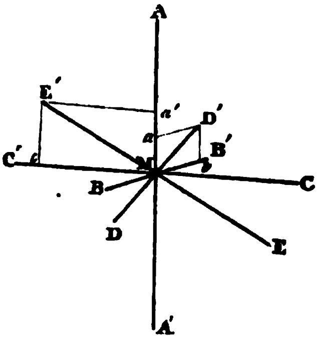
The cube may also be projected by drawing lines from M to the centre of each edge of the octahedron, and then extending these lines to double their length. Their extremities are the vertices of the angles of the cube; and by connecting them a representation of the cube is formed.

5. *Dimetric System.*—In the dimetric system of crystallization, the vertical axis is of varying dimensions, while the horizontal axes are equal, as in the monometric 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 $\frac{a}{b}$; 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 that 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.

6. *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.

7. *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, $Ma = MA \cos \gamma$, and on the axis BB′ (before or behind M, according as the inclination of *b* on *a*, in front, is acute or obtuse) $Mb = MB \times \sin \gamma$. 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.

Fig. 4.



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.

8. *Diclinic System.**—In the diclinic system, the vertical sections 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, (figure 4), $Ma = MA \times \cos \gamma$, and on the axis BB′ (brachydiagonal), $Mb = MB' \times \sin \gamma$. 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, $Ma' = MA \times \cos \beta$, and on MC′, to the left, $Mc = MC' \times \sin \beta$. 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, in which $ME = ME'$ is the

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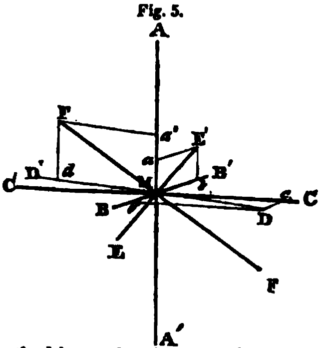
* The Diclinic system differs from the Triclinic in having only two of the axial intersections oblique instead of the three. As no example of it has been observed among minerals, and the forms are as well described in the triclinic system, it was not mentioned in the earlier part of this work.

macrodiagonal. AA′, DD′, EE′ are the axes in a diclinate 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 diclinate form, is sufficiently obvious. The construction of the oblique rectangular prism is analogous to that of the cube.

9. *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 diclinate 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:

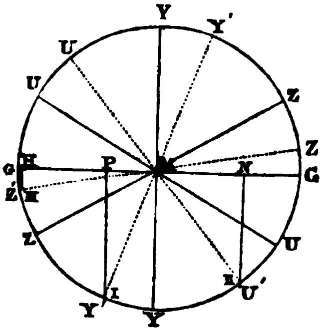
Fig. 5.



Lay off MB, $Mb'=MB\times\cos A$, 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), $Mc=MC\times\sin A$; 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 diclinate 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 triclinate form in which $a=b=c=1$. Different values may be given these axes, according to the method heretofore illustrated.

10. *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 fig. 6. 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 $\delta=YMY'$. 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.

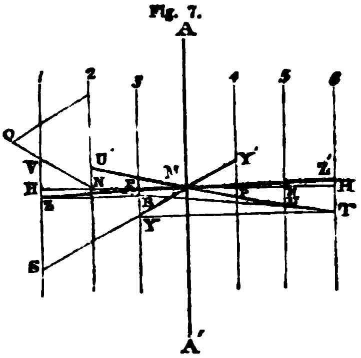
Fig. 6.



11. 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 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.

Fig. 7.



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.

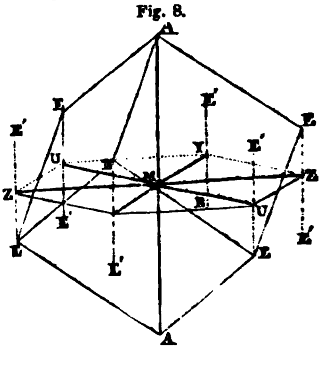
3. From R, where TN intersects the third vertical draw RZ to the first vertical parallel with HH. Then from Z draw a line through M to the sixth vertical: this line ZZ′ is the projection of the axis III.

4. For the vertical axis, lay off from N on the second vertical (fig. 7) 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 fig 6; for in the triangle NHV, the angle HNV is an angle of 30°, and HN=½MH. MV is therefore the radius of the circle, (fig. 6). Make therefore MA=MA′=MV; AA′ is the vertical axis, and YY′, UU′, ZZ′ are the projected horizontal axes.

12. 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.

13. 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, (fig. 8). 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.

Fig. 8.



Delineation of Secondary Planes on the Primary Forms.

14. 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 0P, ∞P∞ 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 0P, $\infty\bar{P}\infty$, $\infty\breve{P}\infty$, 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.

15. Suppose, for example, the right rectangular prism has been projected, (fig 9), and it is required to place on its angles the plane 2P, 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*, ½ the length of *e*, and a point in each ē and ĕ, ¼ 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 4P̄2 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 4P̆2, (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 4P̄2 or 4P̆2 would be delineated. If the plane were 2P̄∞ (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 2P̄∞ 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.

16. The manner of determining the intersections of planes, we may illustrate by an example. Suppose it were required to place the planes P, 2P, 4P̆2, and 2P̄2 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 fig. 9 we may first lay down the plane P, 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 P. By connecting the points *m*, *b*, *n*, the plane 2P is constructed; for the plane *mbn* cuts off 2 parts of *e* to 1 of each ē and ĕ, as the expression 2P requires. To lay off 4P̆2 (4 : 1 : 2), let the whole edge *ab* represent 4; then *an* (½ of ĕ) will equal 2 parts on the edge ĕ, and *ap* (¼ of ē) will equal 1 part on ē, agreeably to the expression 4P̆2; *npb* is therefore the plane 4P̆2. The perimeters of the planes *npb* (4P̆2) and *nmo* (P) 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 P and 4P̆2 is *na*.

Fig. 9.

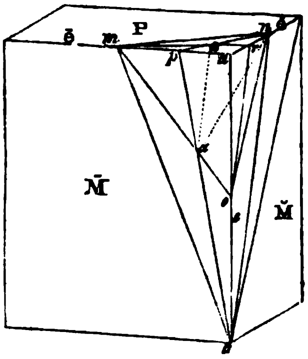
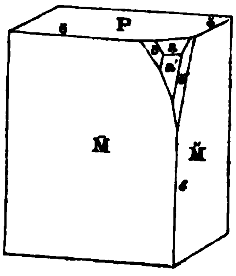


Fig. 10.



The planes *nmb* (2P) and *npb* (4P̆2) intersect in the line *nb*, and therefore the intersection of 2P and 4P̆2 is in the direction of *nb*.

Again, the intersection of P and 2P has the direction *mn*.

We may next lay off the plane $2\bar{P}2$, (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*=$\frac{2}{4}$ē, and *ar*=¼ĕ. Therefore the intersection of *mro* ($2\bar{P}2$) with *mno* (P) has the direction of the common line *mo*.

The perimeters of the planes *mro* ($2\bar{P}2$) and *npb* ($4\breve{P}2$) 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*.

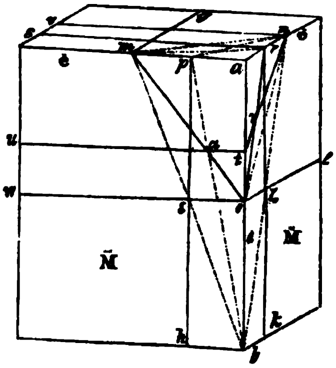
The line *ro* of the plane *mro* ($2\bar{P}2$) is parallel to *nb* of the plane *mnb* (2P); the intersections of $2\bar{P}2$ and 2P would therefore be parallel with these lines. In this manner all the mutual intersections of these and other planes may be obtained.

Fig. 10 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*, (fig. 9). The intersection of P with ō has the direction *mr*, that of P with ŏ′, the direction of *np*. The intersections of a, ō, $\bar{M}$ are parallel with *mo*; those of a′, ŏ, $\breve{M}$, have the direction *bn*, as determined above. The edge a : ŏ′ is drawn in the direction *nα*, explained above as the intersection of *npb* and *nmo*. Finally, the edge $\bar{M}$: a′ is drawn parallel with *mb*, and the edge $\bar{M}$: ō, parallel with *pb*, which in fig. 9 is obviously the intersection of *pbn* with $\bar{M}$. The planes ō and ŏ′ do not meet; were the plane a′ wanting, their intersection would have been drawn parallel with *αβ* or parallel with the edge a′ : ŏ′.

17. 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 $\breve{M}$: 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, which it would be necessary to determine in the above manner.

18. We may now add the planes $\frac{1}{2}\bar{P}\infty$, $2\bar{P}\infty$, $\breve{P}\infty$, and ∞P; 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 $\frac{1}{2}\bar{P}\infty$ meets the planes a and ō; $2\bar{P}\infty$, the plane ō; $\breve{P}\infty$, the planes a′ and ŏ′, and ∞P, the planes a′ and ŏ′. It is therefore necessary to determine the direction of these intersections. For this purpose fig. 9 is redrawn (fig. 11) 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.

Fig. 11.



The plane *ntuv* is so drawn that *an* equals ½ĕ and *at*=½ of ½*e*, which fulfills the conditions for the plane $\frac{1}{2}\bar{P}\infty$ ($\frac{1}{2}$: ∞ : 1). Again, *srow* is the plane $2\bar{P}\infty$ (2 : ∞ : 1); for it cuts off $\frac{2}{4}$ of *e* and ¼ of ĕ, or 2 parts of *e* to 1 of ĕ.

The perimeters of the planes *vntu* ($\frac{1}{2}\bar{P}\infty$) and *mno* (P) intersect in the points *n* and *α*; the intersections of $\frac{1}{2}\bar{P}\infty$ with P has therefore the direction *αn*, and is parallel with the edge a : ŏ′ in figure 10.

The perimeters of the planes *vntu* ($\frac{1}{2}\bar{P}\infty$) and *mro* ($2\bar{P}2$), intersect in the points *α* and *γ*; and a line from *α* to *γ* marks the direction of the edge between the planes $\frac{1}{2}\bar{P}\infty$ and $2\bar{P}2$.

The perimeters of the planes *srow* ($2\bar{P}\infty$ and *mro* ($2\bar{P}2$), coincide in the line *ro*. The intersection of $2\bar{P}\infty$ and $2\bar{P}2$ has therefore the direction *ro*, and is parallel with the edge ō : a′ in fig. 10.

Again, the plane *gmol* represents P̆∞ (1 : 1 : ∞), for it cuts off equal parts of the edges *e* and ĕ. The perimeters of the planes *gmol* and *nmo* (P) coincide in the line *mo*; their intersection is therefore parallel to this line, or to the edges a : ō and ō : M̄, fig. 10.

The perimeters *gmol* and *npb* (4P̆2) intersect in the points ε and ζ; a line from ε to ζ therefore marks the direction of the edge between P̆∞ and 4P̆2 (ŏ′).

Again, the plane *prkh* is the projection ∞ P (∞ : 1 : 1), for it cuts off equal portions of ē and ĕ, and is parallel with the lateral edge. The perimeters *prkh* (∞ P) and *mbn* (2P) 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′, (fig. 10).

The perimeters *prkh* (∞ P), and *pnb* (4P̆2) intersect in the points *p* and ζ. A line drawn from *p* to ζ determines therefore the intersection of ∞ P and 4P̆2 (ŏ′).

Fig. 12.

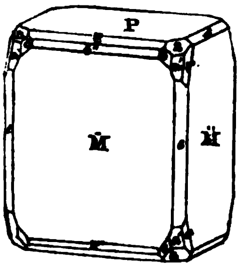


Fig. 13.

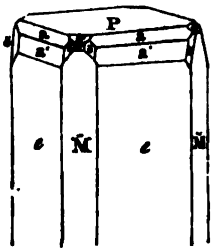


Fig. 12 contains these additional planes laid down according to the above deductions. The edge a : ē′ (⅔P̄∞) is parallel with the edge a : ŏ′; the edge ē′ : ō has the direction εγ; the edge ē″ (2P̄∞) : ō is parallel with the edge ō : a′; the edge a : ĕ (P̆∞) is parallel with edge a : ō or M̄ : ō; the edge ŏ′ : ĕ has the direction of a line from ε to ζ; the edge a′ : *e* (∞ P) is parallel with the edge P : a; and finally the edge *e* : ŏ′ has the direction of a line drawn from to *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. Figure 12 is a completed representation of a crystal which presents the planes above designated, viz.:

0P . ∞P̄∞ . ∞P̆∞ . P . 2P . 2P̄2 . 4P̆2 . P̆∞ . ⅔P̄∞ . 2P̄∞ . ∞P

P M̄ M̆ a a′ ō ŏ′ ĕ ē′ ē″ *e*

This same descriptive expression applies equaliy to fig. 13, which contains the same planes as fig. 12, 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 fig. 12. This figure illustrates a preceding remark, (§ 16), 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 classes, 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 very great degree of accuracy may be attained.

PROJECTION OF SIMPLE SECONDARY FORMS.

19. *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. interaxes.	Rhombic interax.
Trigonal trisoctahedron, (fig. 20, see pl. 1),	2O	$\frac{1}{5}$	O
Dodecahedron, (fig. 7),	∞O	$\frac{1}{2}$	O
Hexoctahedron, (fig. 25),	3O$\frac{3}{2}$	$\frac{1}{2}$	$\frac{1}{5}$
"	4O2	$\frac{5}{7}$	$\frac{1}{3}$
"	5O$\frac{5}{3}$	$\frac{2}{3}$	$\frac{1}{4}$
Tetrahexahedron, (fig. 11),	∞O2	1	$\frac{1}{3}$
"	∞O3	$\frac{5}{4}$	$\frac{1}{2}$
Tetragonal trisoctahedron, (fig. 16),	2O2	$\frac{1}{2}$	$\frac{1}{3}$
"	3O3	$\frac{4}{5}$	$\frac{1}{2}$
Cube,	∞O∞	2	1

To construct the form 4O2, 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 4O2, and by connecting them, the projection of this form is completed.

20. 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

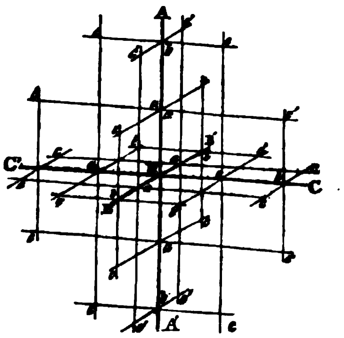
$$\frac{2\,mn-(m-n)}{mn+(m-n)}.$$

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 $\frac{mOn}{2}$ and $-\frac{mOn}{2}$ 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.

		Holohed interax.	Hemihed interax.
Tetrahedron (fig. 30),	$\frac{O}{2}$	0	2
Trigonal hemitrisoctahedron (fig. 34),	$\frac{2O2}{2}$	$\frac{1}{2}$	2
"	$\frac{3O3}{2}$	$\frac{4}{5}$	2
Tetragonal hemitrisoctahedron (fig. 40),	$\frac{\frac{3}{2}O}{2}$	$\frac{1}{8}$	$\frac{5}{4}$
"	$\frac{2O}{2}$	$\frac{1}{5}$	1
Inclined hemihexoctahedron (fig. 41),	$\frac{3O\frac{3}{2}}{2}$	$\frac{1}{2}$	$\frac{5}{4}$
"	$\frac{4O2}{2}$	$\frac{5}{7}$	$\frac{7}{5}$
"	$\frac{5O\frac{5}{3}}{2}$	$\frac{2}{3}$	$\frac{8}{7}$

21. 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 $\frac{[mOn]}{2}$, 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*, (fig. 14), 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 $\frac{[mOn]}{2}$ and those marked *c'*, of the form $-\frac{[mOn]}{2}$.

Fig. 14.



The trigonal interaxes are of the same length as in the holohedral forms. The values of these interaxes, and of the coordinates of the unsymmetrical solid angle for different parallel hemihedrons, are contained in the following table:

		Trigonal interaxis.	Coord. of the unsym. solid angle.	
Parallel hemihexoctahedron (fig. 49),	$\frac{[3O\frac{3}{2}]}{2}$	$\frac{1}{2}$	$\frac{3}{7}$	$\frac{6}{7}$
"	$\frac{[4O2]}{2}$	$\frac{5}{7}$	$\frac{4}{7}$	$\frac{6}{7}$
"	$\frac{[5O\frac{5}{3}]}{2}$	$\frac{2}{3}$	$\frac{5}{11}$	$\frac{10}{11}$
Hemitetrahexahedron (fig. 44),	$\frac{[\infty O\frac{3}{2}]}{2}$	$\frac{4}{5}$	$\frac{1}{3}$	1
"	$\frac{[\infty O2]}{2}$	1	$\frac{1}{2}$	1
"	$\frac{[\infty O3]}{2}$	$\frac{5}{4}$	$\frac{2}{3}$	1

22. *Dimetric System.*—In an octagonal pyramid, mPn (fig. 59), 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 mP 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 mPn. 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.

23. *Hexagonal System.*—The dihexagonal pyramid (fig. 126), 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.

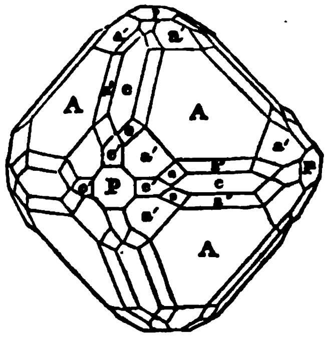
The scalenohedron (fig. 116), mR^n admits of a similar construction with the rhombohedron mR. The only variation required, is to multiply the vertical axis by the number of units in n, after the points E and E′ in the rhombohedron mR have been determined; then connect the points E, or the points E′, with one another and with the extremities of the vertical axis.

III. EXAMPLES OF THE APPLICATION OF MATHEMATICAL CRYSTALLOGRAPHY.

On pages 69, 70, 71, three examples are given of the method of employing mathematics in the study of crystals:—one of the monometric system, one of the triclinic, and one of the monoclinic. The student will gather further aid from the following additional examples.

I. MONOMETRIC SYSTEM.

Red Copper Ore.



This figure represents an octahedron with truncated and beveled edges, and replaced angles.

A is a face of the octahedron, which$=O$.

e truncates the edges, and is therefore the face of a dodecahedron, (fig. 9, pl. 1),$=\infty O$.

p truncates a solid angle, and is therefore a face of a cube, (fig. 3),$=\infty O \infty$.

Of the remaining faces,

a″ is of the general form $m\ O$ (comp. fig. 21).
e′ “ “ $\infty\ O\ n$ (comp. fig. 23).
a′ “ “ $m\ O\ m$ (comp. fig. 17).
o “ “ $m\ O\ n$ (comp. fig. 27).

a′ truncates an edge between two planes e, ($\infty\ O$); its sign is therefore $2\ O\ 2$, (§ 62, *e*, 2, and fig. 18).

To determine a″ ($m\ O$) we measure the inclination of e on a″=160° 32′. Subtracting 90°, 70° 32′ remain, which equal half the interfacial angle a″ : a″$=\frac{1}{2}\ B$, (fig. 20);

using the formula, § 63, 3, $m=\tan.\ \frac{1}{2}B\sqrt{\frac{1}{2}}$, we find that $m=2$. The sign of a″ is therefore $2O$.

The faces o (mOn) bevel the edges of ∞O, and therefore (§ 62, *e*, 1) $n=\frac{m}{m-1}$. 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, (§ 63). But $\tan.\ \varepsilon=\frac{(n-1)\sqrt{3}}{n+1}$, and therefore by transposition $n=\frac{\sqrt{3}+\tan.\ \varepsilon}{\sqrt{3}-\tan.\ \varepsilon}$.

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

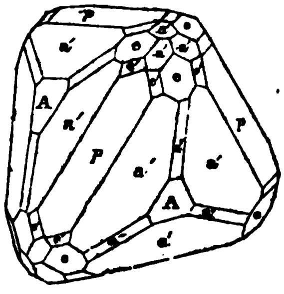
This could have been determined without measurement, if the planes o were so extended as to form an edge with the plane A. Two opposite planes o would then have made parallel intersections with o, and consequently, (§ 62, *a*, 5), we should have had $n=\frac{2m}{m+1}$. Therefore since also $n=\frac{m}{m-1}$, $\frac{m}{m-1}=\frac{2m}{m+1}$, from which we find $m=3$, as before determined.

The signs of the planes collected together form the following description of the crystal:

$O.$	$2O2.$	$\infty O.$	$\infty O\infty.$	$2O.$	$\infty O2.$	$3O\frac{3}{2}.$
A	a′	e	P	a″	e′	o.

2. *Gray Copper Ore.*

This solid has a hemihedral character, being a trigonal hemi-trisoctahedron, with replaced edges and angles. Its planes belong to the following forms:



A, a face of a tetrahedron (fig. 35, pl. 1)$=\frac{O}{2}$;

p, a face of a cube,$=\infty O\infty$;

$a'=\frac{mOm}{2}$, (figs. 33, 34);

$e=\infty O$, (fig. 36);

$e'=\infty On'$, (fig. 38, § 62, *h*, 2);

$-a'=-\frac{m'Om'}{2}$;

$a''=\frac{m''O}{2}$, (fig. 37, § 62, *h*, 1).

The intersections of a′ with two planes e (∞O) are parallel, and therefore, (§ 62, *h*, 3), $m=2$ and $\frac{mOm}{2}=\frac{2O2}{2}$.

For the same reason, $-a'=-\frac{2O2}{2}$.

The planes a″ truncate the shorter edges of $\frac{2O2}{2}$, and, therefore, $a''=\frac{\frac{3}{2}O}{2}$, (§ 62, *h*, 1).

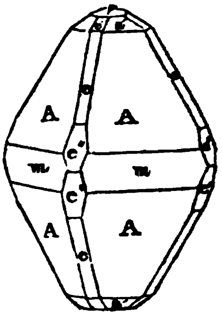
The edges e′ : a′ are parallel to the shorter edges of $\frac{2O2}{2}$, therefore, with respect to the plane e′, (§ 62, *h*, 2), $n'=m+1$, and hence $e'=\infty O3$.

The collected signs are, $\frac{2O2}{2}$. $\infty O\infty$. ∞O. $\frac{O}{2}$. $-\frac{2O2}{2}$. $\infty O3$. $\frac{\frac{3}{2}O}{2}$.

II. DIMETRIC SYSTEM.

1. *Anatase.*

53. This crystal is an octahedron, with truncated edges and replaced angles. The axis a of the fundamental form A $(=P)=$



$\sqrt{\frac{25}{8}}$, cos. $Z=\frac{21}{29}$, tan. $\frac{1}{2}Z=\frac{5}{2}$, and $Z=136°\ 24'$.

$P=0P$, $M=\infty P$, $e=P\infty$, (§ 70, b, 3).*

The intersections of two planes e″ with the same a are parallel, and consequently, $e''=2P\infty$, (§ 70, b, 4)

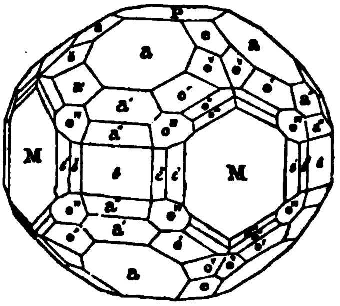
a′ on $A=153°\ 27'$, the supplement of which, $26°\ 33'=\frac{1}{2}Z$. From formula (§ 71, d) $m=\frac{\tan.\frac{1}{2}Z}{\tan.\frac{1}{2}Z'}$, we find $a'=\frac{1}{5}P$.

Consequently, $e'=\frac{1}{5}P\infty$, (§ 70, b, 3).

Description of the crystal: P. ∞P. $2P\infty$. $P\infty$. $\frac{1}{5}P$. $\frac{1}{5}P\infty$. $0P$.

2. *Idocrase.*

54. a, a, are faces of the fundamental octahedron.



Axis $a=\sqrt{\frac{2}{7}}$. Consequently, cos. $Z=-\frac{3}{11}$, cos. $X=-\frac{7}{11}$.

$X=129°\ 31'$, and $Z=74°\ 10\frac{1}{2}'$.

It is obvious, that

$P=0P$, $e=\infty P$, $M=\infty P\infty$, $e=P\infty$, (§ 70, b, 3).*

Measurement gives the angle $a':e=146°\ 30'$, from which, if 90° be subtracted, we obtain $56°\ 30'=\frac{1}{2}Z$, and since (§ 71, d)

$$m=\frac{\tan.\frac{1}{2}Z}{\tan.\frac{1}{2}Z'}=\frac{\tan.56°30'}{\tan.\ 37°\ 5'}=2:\ \text{therefore, } a'=2P.$$

The planes e'', e', are of the general form ∞Pn. By measurement we find, $M:e''=153°\ 30'$, $M:e'=161°\ 34'$. Subtracting 90° there remains the value of $\frac{1}{2}X$ for each form; and since $m=\tan.\frac{1}{2}X$, (§ 71 f), $e''=\infty P2$, $e'=\infty P3$.

Because the planes o′, o^{iv}, and e'', have horizontal intersections, and $e''=\infty P2$, both o′ and o^{iv} are of the form $mP2$, (note below). Because also o^{iv} forms parallel intersections with M and a′, $(2P)$, $o^{iv}=4P2$. o′, o″, o‴, form parallel edges between M and a, and the same are parallel with e, (or x), and they are, therefore, of the general form mPm, (2, in note below). Consequently, from the above, $o'=2P2$. As the mutual intersections of a″, o^{iv}, o‴, are parallel to one another, and also to the normal section, $m'=m$, (note below, 2), and since $o^{iv}=4P2$, $o'''=4P4$, an $a''=4P$.

The planes o^{v} replace the basal angles of the pyramid P, and their edges of intersection with the same a are parallel, or in other words, a truncates edge Y of the form o^{v} (mPn); therefore, (§ 70, a, 1), $m(n+1)=2m'n$; or since $m'=1$,

$$m(n+1)=2n.$$

---

* We add two general principles here, which include this case and others:

1. Forms whose intersections are horizontal and parallel, have $n'=n$, (fig. 57, a′ a, a″).

2. Forms which have their intersections parallel to the edge x, have $m'=m$, (e and a, fig. 55; o, fig. 60).

Again, since o^v replaces the edges between e ($P\infty$) and o′, ($2P2$),

$$m(n-1)=n, \ (\S\ 53,\ c,\ 2).$$

Therefore, $m(n+1)=2m(n-1) \therefore n=3$ and $o^v=\frac{3}{2}P3$.

Since the intersection of o^v and o″ are horizontal, $n'=n$, and consequently, $o''=3P3$.

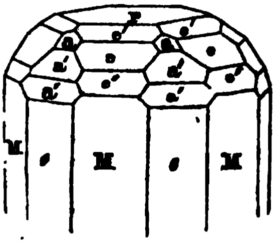
To determine o′ by measurement, we measure the angle o' : M, from which by subtracting 90°, we obtain $\frac{1}{2}T$. Then by formula, (§ 71, b), $m=\tan. \ \frac{1}{2}T \times \cot. \ \frac{1}{2}T'$, we determine m, as before, equal to 2.

The signs of the crystals thus developed are,

$$\infty P\infty.\ P.\ 0P.\ \infty P.\ 2P.\ 4P.\ 2P2.\ 4P2.\ P\infty.\ \tfrac{3}{2}P3.\ \infty P3.\ \infty P2.\ 3P3.\ 4P4.$$

3. HEXAGONAL SYSTEM.

1. *Apatite.*



66. This 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. Then

$$P=0P,\ M=\infty P,\ e=\infty P2,\ (\S\ 91,\ a,\ 3).$$

a truncates a terminal edge of P, and therefore $=P2$, (§ 91, a, 1).

The edge a′ : e is parallel to a *terminal edge* of P, since it is parallel to the edges of the plane a, which truncates this edge; consequently, $a'=2P2$, (§ 91, a 2).

The edge a : e′ is parallel to a terminal edge of e′; therefore, since $a=P2$, $e'=\frac{1}{2}P$, (§ 91, a, 2).

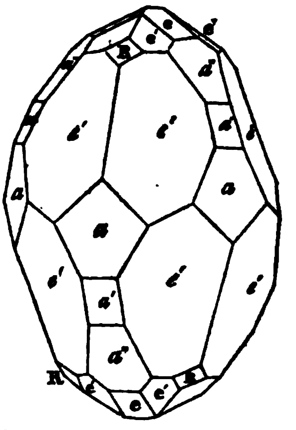
a′ ($2P2$) truncates a lateral edge of the pyramid e″ (mP), and therefore, $e''=2P$, (§ 91, a, 1).

The edge a″ : e″ is parallel to a terminal edge of e″ ($2P$); consequently, $a''=4P2$, (§ 91, a, 2).

Description of the crystals:

$$\infty P.\ \ \infty P2.\ \ 0P.\ \ \tfrac{1}{2}P.\ \ P.\ \ 2P.\ \ P2.\ \ 2P2.\ \ 4P2.$$

2. *Calcareous Spar.*



67. This figure is secondary to a rhombohedron. Its larger faces belong to a scalenohedron. Its primary faces are marked R.

a is a face of a hexagonal prism, and equals ∞R (§ 91, d, 12).

The interfacial angle a' : a, diminished by 90°, equals the inclination of a' on the base, = the angle β; and since $m=\frac{\cot.\ \beta}{\cot.\ \beta'}$, (§ 93, f,) β' being the corresponding angle in the primary $a'=-2R$.

The edges R : e', e' : e', e' : R, are situated one above the other, (the two planes R, being at opposite extremities of the crystal), and are parallel; consequently, e' : e', are faces of a scalenohedron, R^n, (§ 91, e, 1). But also the planes a' ($-2R$) truncate the acute terminal edges of the scalenohedron. It follows, therefore, that $e'=R^3$, (§ 91, d, 9).

The terminal edges of the primary are truncated by $e=-\frac{1}{2}R$, (§ 91, e, 3).

The plane e′ forms a horizontal intersection with e' (R^3) and is, therefore, of the general form mR^3, (§ 91, d, 4). Also, because it bevels the terminal edge of the primary R, $\frac{1}{2}m'(3n'-1)=m$, (§ 91, e, 2). Since $n'=3$, we have $4m'=m=1$ and $m'=\frac{1}{4}$, therefore, $e'=\frac{1}{4}R^3$.

The two adjacent planes e' ($\frac{1}{4}R^3$) form parallel intersections with two faces of the rhombohedron a'', and therefore bevel its terminal edges; consequently, since $\frac{1}{2}m'$ $(3n'+1)=m$, (§ 91, d, 10), $a''=-\frac{5}{4}R$.

To obtain the value of the axis (a) from the angle R : R, use equation § 90, f, $\cos X=\frac{2a^2-3}{4a^2+3}$, m being thrown out as it equals 1.

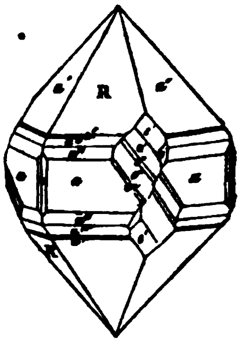
If $x=105°\ 5'$, then since $\cos. 105°\ 5'=-\cos. 74°\ 55°=-0{\cdot}26022$; therefore $-0{\cdot}26022=\frac{2a^2-3}{4a^2+3}$.

Hence $1{\cdot}04088\ a^2-0{\cdot}78066=2\ a^2-3$, or $3{\cdot}04088\ a^2=2{\cdot}21984$. Reducing farther gives the result, $0{\cdot}8548=a$ (the desired axis).

Description of the crystal:

$$R^3.\quad \tfrac{1}{4}R^3.\quad \infty R.\quad -\tfrac{5}{4}R.\quad \tfrac{1}{2}R.\quad -2R.\quad R.$$

3. *Quartz.*



69. In this figure, R, a'', are the planes of the fundamental pyramid. a''', a^{iv}, a^{v}, are other pyramids, and the obliquely situated planes tetatrohedral forms. $a=\infty P$.

The edge $R:e'$ being parallel to a terminal edge of the fundamental pyramid, $e'=2P2$, (§ 91, a, 2).

Because the intersections of the planes o', o'', o''', o^{iv}, are parallel to e' they have the general sign $mP\frac{m}{m-1}$.

The signs of the planes a''', a^{iv}, a^{v}, may be determined by measuring the inclination $a:a'''$, $a:a^{iv}$: $a:a^{v}$, in the manner heretofore described. They are thus found to be

$$a^{v}=\tfrac{5}{3}P,\ aa^{iv}=3P,\ a'''=4P.$$

The tetartohedral forms o', o'', o''', o^{iv}, o^{v}, have the general formula $\frac{mPn}{4}$, and all but the last are $l\frac{mPn}{4}$, the last, $r\frac{mPn}{4}$. The inclinations of these planes on a, diminished by 90°, equal each the semi-angle Z, as in $\frac{mPn}{2}$ (§ 90, e). As the parallel intersections are parallel also to a terminal edge of P, they are of the general form $mP\frac{m}{m-1}$. Then by the formula

$$2m-1=\tan. \tfrac{1}{2}Z\times\frac{\sqrt{3}\sqrt{(a^2+1)}}{a},$$

the value of m is determined. We thus find $2m-1=2{\cdot}34\ \tan. \frac{1}{2}Z$, and obtain,

$$o^{v}=r\frac{3P\frac{3}{2}}{4},\ o'=l\,\frac{4P\frac{4}{3}}{4},\ o''=l\,\frac{5P\frac{5}{4}}{4},\ o'''=l\,\frac{6P\frac{6}{5}}{4},\ o^{iv}=l\,\frac{8P\frac{8}{7}}{4}.$$

Description of the crystals: $P.\quad \infty P.\quad 2P2.\quad \frac{5}{3}P.\quad 3P.\quad 4P.\quad r\frac{3P\frac{3}{2}}{4}.\quad l\frac{4P\frac{4}{3}}{4}.$ $l\frac{5P\frac{5}{4}}{4}.\quad l\frac{6P\frac{6}{5}}{4}.\quad l\frac{8P\frac{8}{7}}{4}.$

APPENDIX.

1. *Polarization.*

The mode of distinguishing uniaxial and biaxial crystals by polarization, is briefly mentioned on p. 133. For this purpose, it is most convenient to have two vertical sections of transparent tourmaline, well polished, and of as pale a shade of color as can be procured; the tourmaline may be one third to half an inch in diameter, and mounted in a thin ring of cork an inch in diameter, and an eighth of an inch thick: this is a common mode of preparing them. By placing one tourmaline against one side of a plate of mica, and the other against or near the opposite, and looking through the two, the character of the mica is readily ascertained. The mica had better be between a fourth and half a line thick, since when too thin the colored rings are very large, or may fail altogether of being distinguished. If the mica is common oblique mica, by looking through the tourmalines in different directions very obliquely, a concentric series of colored ellipses (often nearly circles) will soon be found, and then as obliquely in the opposite direction, another like series of ellipses. In one position of the tourmaline, the rings will on two opposite sides appear dark, and the rest light, and the inner ring will be represented by two dark spots, opposite one another; in another position of the tourmaline, the same spots appear light, and the rest dark.

In the Phlogopite or trimetric mica, in which the divergence of the axes is small, the colored ellipses are seen in a *direct* view, if the mica is not too thin. The axes are so near that there is but a single series of large ellipses surrounding the two, unless a much thicker plate be used than is needed with the common oblique mica. In one position four dark spots are seen within, which are *not equidistant*. The dark cross, if seen in another position of the tourmalines, has one bar lighter and longer than the other.

In the hexagonal or uniaxial mica, a series of concentric circles are seen in a direct view. In one position, four dark spots (inner circle) are seen about the centre, which are *equidistant*. In another, a symmetrical dark cross appears. If the mica is quite thin, the circles may not be seen, and only the dark spots by looking *very* obliquely; their being equidistant will prove the mica to be uniaxial.

To measure the angles between the axes, a Wollaston's goniometer may be very conveniently used. The tourmalines with the mica between may be clamped together and then adjusted in the position of plate *q*, (figure on p. 89), the centre of the tourmalines being placed in the line of the axis of the instrument, and one pole vertically over the other. The mode of measurement will then be the same as when measuring the angle of a crystal. It should be performed in front of a window with a good light, and a bar of the window or some other fixed line will serve as with a crystal. For clamping the tourmalines together, a piece of sheet brass bent like a letter U will answer, if nothing better is at hand; and if a plate like *q* (p. 89) is attached to the bottom of the U, it may be easily adjusted for observation. A goniometer with a horizontal circle is still more convenient for these observations.

Transverse sections of crystals of topaz, nitre, calcite, and many species give similar results. There are various other points connected with the subject, for which we must refer to Treatises on Optics.

For the results of optical examinations of micas, see Mica, beyond, and pp. 356—362.

2. New Species.

[illegible]

[illegible] much wider than [illegible] P : T=110°, [illegible] obtained with [illegible] smoother than [illegible] parallel [illegible] with a faint red- [illegible]

[illegible] soda 2·31, magnesia [illegible]

[illegible]=100·08.

[illegible]

[illegible] The oxygen ratio [illegible] 1 : 3 : 8, giv- [illegible]

[illegible] either in single [illegible] a half an inch [illegible] crystallized in mi- [illegible] and also rutile [illegible]

[illegible] among the ratios [illegible]

[illegible] other feldspars. [illegible] a feldspar and al- [illegible] to give the [illegible]

[illegible] and mixed as the [illegible]

[illegible]

[illegible] or nearly [illegible]

[illegible]

[illegible] in composition [illegible] by Kenngott, (Berichte [illegible]

[illegible]=99·21.

[illegible] magnesia 23·32, soda 30·??, wa- [illegible]

MELANOLITE, *H. Wurtz.* (Private communication).

In thin plates with an uneven subtriated surface incrusting the sides of a fissure in a syenitic rock, successive plates overlying one another, but not separated by true cleavage. Structure columnar. No distinct cleavage.

H.=2. G.=2·69. Lustre resinous. Color black. Streak dark olive-green. Opaque. Very brittle.

Composition.—According to Wurtz,

$$\begin{array}{lllllll} \dddot{\mathrm{Si}} & \bar{\mathrm{Al}} & \bar{\mathrm{Fe}} & \dot{\mathrm{Fe}} & \dot{\mathrm{Na}} & \dot{\mathrm{H}} & \\ 30{\cdot}86 & 3{\cdot}92 & 20{\cdot}25 & 21{\cdot}97 & 1{\cdot}62 & 8{\cdot}94 & \dot{\mathrm{Ca}}\ddot{\mathrm{C}}\,12{\cdot}77=100{\cdot}33. \end{array}$$

As the magnifier exhibits particles of carbonate of lime in the mineral, this ingredient was only an impurity. Thrown out, the analysis becomes

$$\begin{array}{lllllll} & \dddot{\mathrm{Si}} & \bar{\mathrm{Al}} & \bar{\mathrm{Fe}} & \dot{\mathrm{Fe}} & \dot{\mathrm{Na}} & \dot{\mathrm{H}} \\ & 35{\cdot}24 & 4{\cdot}48 & 23{\cdot}18 & 25{\cdot}09 & 1{\cdot}85 & 10{\cdot}21=100. \\ \text{Oxygen} & 18{\cdot}31 & 2{\cdot}09 & 6{\cdot}94 & 5{\cdot}57 & 0{\cdot}48 & 9{\cdot}07, \end{array}$$

giving the oxygen ratio for the protoxyds, peroxyds, silica, and water, 2 : 3 : 6 : 3, and the formula $\dot{\mathrm{R}}^2\dddot{\mathrm{Si}}+\bar{\mathrm{R}}\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$.

This is the composition of Groppite, according to Rammelsberg, excepting 3 instead of 2 $\dot{\mathrm{H}}$. The Groppite is however a rose-red species containing but little iron.

B.B. fuses easily to a dull black opaque globule, which is slightly magnetic. In muriatic acid easily decomposed, with effervescence, the silica separating as a white powder.

From "Milk Row Quarry," near Cambridge, Massachusetts. It has something of a chlorite-like appearance, but is very brittle and nearly coal-black in color, with the columnar structure distinct, but imperfect.

NICKEL VITRIOL, *T. S. Hunt.* (Private communication).

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 only a sulphate of nickel.

Occurs at Wallace mine, Lake Huron, upon a sulphate of nickel and iron, mostly as an efflorescence.

TRITOMITE, *Weibye.* (Ramm. 4th Supp. 249).

In tetrahedral crystals, of a dull brown color. G.=4·16—4·66.

An analysis by N. J. Berlin, not altogether complete on account of the small amount of material, afforded—

$$\begin{array}{lllllllllll} \dddot{\mathrm{Si}} & \bar{\mathrm{Al}} & \bar{\mathrm{Ce}} & \bar{\mathrm{Fe}} & \dot{\mathrm{Y}} & \dot{\mathrm{Ca}} & \dot{\mathrm{Mg}} & \dot{\mathrm{Fe}} & \dot{\mathrm{Na}} & \mathrm{Mn,Ca,Sn,W} & \\ 20{\cdot}13 & 2{\cdot}24 & 40{\cdot}36 & 15{\cdot}11 & 0{\cdot}46 & 5{\cdot}15 & 0{\cdot}22 & 1{\cdot}83 & 1{\cdot}46 & 4{\cdot}62 & \text{ign. } 7{\cdot}86=99{\cdot}44. \end{array}$$

The escape of chlorine on solution in muriatic acid indicated that the mineral contained the cerium as peroxyd. The mineral appears to be a hydrous silicate of oxyd of cerium, oxyd of lanthanum, and lime. In a matrass yields water and a trace of fluorine. From the island Lamö, near Brevig, Norway, associated with Leucophane, and Mosandrite, in Syenite.

B.B. becomes white, intumesces somewhat, decrepitates or breaks to pieces with the heat. With borax in the outer flame affords a yellowish red glass, which on cooling becomes nearly or quite colorless. In powder gelatinizes perfectly in muriatic acid.

UNIONITE, *Silliman, Jr.,* (Am. Jour. Sci. [2], viii, 384).

Massive, with one distinct cleavage, giving it often a sublamellar appearance.

H.=6—6·5. G.=3·298. Lustre vitreous. Color white or slightly yellowish. Translucent. Brittle.

Composition.—$\dot{R}^3\dddot{Si}+6\,\overline{\dddot{Al}}\,\dddot{Si}\,[+3\,\dot{H}]$=Silica 44·9, alumina 42·8, magnesia 8·6, water 3·7. Analysis by Silliman, Jr.:

$\dddot{Si}$	$\overline{\dddot{Al}}$	$\dot{Mg}$	$\dot{Na}$	HF
44·15	42·26	7·36	1·73	3·52=99·04.

The composition is near that of Thomson's Gilbertite; but the Gilbertite has much lower hardness and specific gravity, and has a micaceous appearance. The formula is essentially that of the Altenberg lepidolite, after Turner's analysis, (see p. 688.) B.B. whitens, swells up and fuses to a white enamel, giving a bright light. In the matrass affords water and fluorine.

From Unionville, Pa., occurring among tourmaline with the Euphyllite.

ALTERED SCAPOLITE?—A mineral of a leek-green or yellowish-green color, occurs with quartz and calc spar at Franklin, New Jersey, which is very fusible and affords on analysis a composition distinct from any related species. It has two cleavages, nearly or quite at right angles, one usually appearing most perfect.

H.=3·5. G.=2·78. Lustre subresinous, or subvitreous. Streak uncolored. Subtranslucent. Analysis: 1, 2, Brewer, (private communication); 3, T. H. Garrett, (communicated by J. C. Booth):

	$\dddot{Si}$	$\overline{\dddot{Al}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Fe}$	$\dot{K}$	$\dot{Na}$	$\dot{H}$	$\ddot{C}$
1.	46·39	29·09	11·13	1·97	2·04	*trace*	—	1·80[a]	4·72[a]=97·15, Brewer.
2.	48·32	28·44	12·88	2·07	1·40	*trace*	—	1·80	4·72=99·64, Brewer.
3.	44·75	28·80	8·85[b]	1·50	—	4·14	0·88	—	4·55=93·47, Garrett.

[a] A mean of 3 determinations. [b] Perhaps too low, according to the analyst.

Analysis 1, excluding the carbonate of lime, gives $\dddot{Si}$ 54·83, $\overline{\dddot{Al}}$ 34·38, $\dot{Ca}$ 6·05, $\dot{Fe}$ 2·41, $\dot{Mg}$ 2·33, which corresponds nearly to the formula $2\,\dot{R}\,\dddot{Si}+3\,\overline{\dddot{Al}}\,\dddot{Si}$.

The mineral appears from the crystalline forms it presents to have the crystallization and angles of Scapolite, although unlike this species in hardness and fusibility. It gave for the pyramidal angle 136°, which is the angle a : a of Scapolite. The elements in its composition are in the same proportions as in Scapolite, excepting that a large part of the lime present, instead of belonging to the silicate, is united to carbonic acid. But it seems altogether probable that the mineral has undergone a change, in which *part of the lime of the original Scapolite has become combined with carbonic acid.* The carbonate of lime is disseminated intimately throughout the mineral, sometimes in visible plates in rifts in the specimens, but mostly invisible; and effervescence takes place readily with acids. A pseudomorphous sphene occurs at the same place.

The occurrence of a carbonate in this Scapolite appears thus to explain the mode of existence of carbonic acid in many silicates in which it has been detected, especially of late by Hermann.

3. *Described Species.*

ALGERITE, p. 314.—The following blowpipe characters and analyses of Algerite are by Mr. Richard Crossley, of Boston, (Laboratory of Dr. C. T. Jackson). (Read before the Bost. Soc. Nat. Hist., by Dr. C. T. Jackson, April 17, 1850).

B.B. alone fuses readily with intumescence to a white blebby glass. With soda, a dirty white slag. With borax and salt of phosphorus, a clear bead, faintly tinged by iron, containing a silica skeleton. In a matrass, yields water, which reacts feebly alkaline; and the powder, which is light buff at first, darkens and assumes a brownish tinge. H.=3 to 3·5. G.=2·78. Analysis: *a*, result obtained; *b*, same, carbonate of lime excluded:

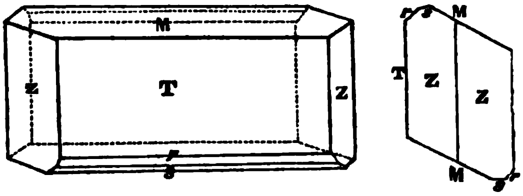
	$\dddot{Si}$	$\overline{\dddot{Al}}$	$\overline{\dddot{Fe}}$	$\dot{Mg}$	$\dot{Ca}\ddot{C}$	$\dot{K}$	$\dot{H}$
a.	49·96	24·41	1·48	5·18	4·21	9·97	5·06=100·27.
b.	52·00	25·42	1·54	5·39	—	10·38	5·27=100.
Oxygen,	27·01	11·38	0·47	2·08	—	1·75	4·68.

From the result, Mr. Crossley deduces the oxygen ratio for the protoxyds, peroxyds, silica, and water, 1 : 3 : 7 : 1, and thence the formula,

$$(\dot{M}g, \dot{K})^3 \dddot{Si} + 3 \bar{Al} \dddot{Si}^2 + 3 \dot{H} [4 \dot{H} ?].$$

The analysis differs from that by Mr. Hunt, mainly in giving more magnesia (5·39 instead of 1·20 per cent.) and less water; also the amount of peroxyds is a little less.

Allanite, p. 354.—The annexed is another figure of the Uralorthite from Kokscharov's Memoir. It shows well the close resemblance between the form of this species and the ordinary crystallizations of epidote.



A massive pitch-black mineral from Orange Co., N. Y., which has been called allanite, proves, according to an analysis by T. H. Garrett in the Laboratory of J. C. Booth, (private communication from Prof. B.) to consist of silica, oxyd of iron, and lime, with a little alumina and no cerium.

Andalusite, p. 317.—Haidinger gives the angle 144° 32′ for the inclination of the face P on a plane situated on the obtuser basal angle, or in other words 109° 4′ for the *macrodiagonal* horizontal prism. Mohs makes the same angle, the angle of a *brachydiagonal* prism. The angle given on page 317, as determined by Teschemacher, (P : a = 144° 50′), is evidently the identical angle referred to by the above authors; and Teschemacher has recently confirmed his former conclusion that the plane $\grave{a}$ is *brachydiagonal.*

Anorthite, p. 534.—The *Thiorsauite* of Genth (p. 336) is the same mineral analyzed by Forchhammer, (analysis 5, p. 335), which is also from Iceland (and not Faroe); and Rammelsberg observes that it is nothing but Anorthite. The small proportion of alumina is attributed to mixture with the gangue.

Apatite, var. **Francolite**, p. 214.—Francolite is an apatite from near Tavistock, Devon. It occurs in small masses of irregular aggregated crystals having a somewhat mammillated surface. Analysis by T. H. Henry, (Phil. Mag. [3], xxxvi, 134, 1850):

$\dot{C}a$	$\dot{F}e$ and $\dot{M}n$	$\dddot{\bar{P}}$	F and loss
53·38	2·96	41·34	2·32
52·81	3·22	41·80	2·17

This gives the formula $3 \dot{C}a^3 \dddot{\bar{P}} + Ca F$, or that of apatite. Part of the lime is replaced by protoxyds of iron and manganese.

Azorite, p. 396.—The hardness of Azorite, according to J. E. Teschemacher, as recently reported to the author, is between 4 and 4·5, it just scratching fluor spar.

Bismuth Nickel, p. 475.—Analysis by Schnabel, (Ramm. 4th Supp. 164),

S	Bi	Ni	Co	Cu	Fe	Pb
31·99	10·49	22·03	11·24	11·59	5·55	7·11=100.
33·10	10·41	22·78	11·73	11·56	6·06	4·36=100.

The result is very different from Kobell's. Rammelsberg observes that if the lead be rejected as sulphuret of lead, there is left for the sulphur and the remaining metals, in analysis 1, the ratio of 14·3 : 15·4; in analysis 2, 14·8 : 16·1, or nearly 1 : 1. But the mineral requires further investigation.

Bismuth Ochre, p. 412.—A Bismuth Ochre, derived from the decomposition of aciculite, afforded Suckow, (in his Die Verwitt. im Min. 14),

$$\bar{\dddot{B}}i\ 96·5, \quad \bar{\dddot{A}}s\ 1·5, \quad \bar{\dddot{F}}e^2 \dot{H}^3\ 2·0 = 100.$$

Dr. C. T. Jackson has observed the yellow oxyd of bismuth (not carbonated) with the Tetradymite of Virginia.

Beraunite, *Breit.*—Supposed from trials by Plattner to be a hydrous phosphate of peroxyd of iron. Occurs foliated and radiated, with one perfect cleavage and one imperfect. Color hyacinth-red, or reddish-brown; streak reddish ochre yellow; lustre vitreous or pearly. B.B. fuses and colors the flame bluish-green. Soluble in muriatic acid. Found in limonite near Beraun in Bohemia. Probably near Cacoxene.

Brookite, p. 333.—The crystals of Arkansite have been measured by Descloizeaux, (Ann. d. Mines, [4], xv, 447), with the following results. We add also the measurements of Shepard, Teschemacher, Breithaupt; also those of Brookite by Levy and Hermann.

	Descl.	Shep.	Tesch.	Breit.	Levy.	Herm.	Calc. by Descl.
M : M	100° 35′	101°	100°	100° 19′	100° 30′	100° 30′	100° 11′
e : e	135° 50′	135°15′	135° 45′	135° 51′	135° 46′	135°	135° 16′
"	101° 30′			101° 19′	101° 37′		101° 37′
a′ : *a′*	128° 40′	128°	124°		123° 36′		128° 40′

In one crystal of the Arkansas variety the pyramidal edge between e and e in front is truncated by a plane, a, and beveled by two planes, o, (⅓P, e being the fundamental octahedron). The angle a : a over the summit is 121° 39′; and o : o (over a) 135° 38′, (136° observed). Brookite sometimes offers a second bevelment of this edge, (planes ⅓P) with o′ : o′=149° 35′. Specific gravity of the Arkansas mineral=4·03 of a crystal; 4·083, of fragments. H.=6·5.

Damour in the same memoir gives the chemical characters of the mineral, and agrees with other chemists in finding it essentially pure titanic acid. He observed in three analyses, in the first decomposing the mineral by means of bisulphate of potash, and in the 2d and 3d by sulphuric acid,

1.	Titanic acid,	99·36	Peroxyd of iron,	1·36	Silica, 0·73=101·45.
2.	Ferriferous titanic acid,	96·72	Matter undissolved,	6·39=103·11.	
3.	" "	101·68	Matter undissolved,	1·39=103·07.	

Damour concludes from the excess obtained in his analyses that part of the titanium is in the state of *peroxyd* in the mineral, instead of titanic acid, and deduces the formula $\ddot{\bar{Ti}}+2\ddot{Ti}$; and he suggests that the crystals may have been subjected for a period to the metamorphic action of heat, and hydrogen or bituminous vapors, and thus have become in part deoxydized and changed to the iron-black color they present. Some experiments on rutile confirmed him in the opinion that titanic acid may be thus deoxydized.

Brucite, p. 200.—The following analyses of Nemalite and Brucite by Mr. Henry Wurtz, of New York, (private communication to the author), confirm Mr. Whitney's results with regard to the identity of these two minerals. His specimens of Nemalite were quite pure, affording no trace of carbonic acid or silica.

	$\dot{Mg}$	$\dot{Fe}$	$\dot{H}$
1. Nemalite,	66·05	5·63	30·13=101·81.
2. "	66·11	5·72	undetermined.
3. Brucite,	69·11	0·47	30·42=100.

The first two analyses give for the oxygen of the magnesia, protoxyd of iron and water 25·64, 1·26, 26·78, corresponding exactly to $(\dot{Mg}, \dot{Fe})\dot{H}$. The last corresponds to $\dot{Mg}\dot{H}$. Specific gravity of the Nemalite (specimen analyzed after drying at 212) 2·38; of the Brucite, in the same manner 2·34.

The species Brucite occurs at Pyschminsk, in the Urals; and according to G. Rose, the Ural variety and that from Hoboken and Swinaness, contain some carbonic acid. This however cannot always be true, as appears from Mr. Wurtz's investigations.

Canaanite, *S. L. Dana.*—A grayish scapolite rock, forming extensive beds with dolomite and mica slate, at Canaan, Ct.

Composition.—According to Dr. S. L. Dana, of Lowell,

$\dddot{Si}$ 53·366, $\ddot{\bar{Fe}}$ 4·099, $\ddot{\bar{Al}}$ 10·380, $\dot{Ca}$ 25·304, $\dot{Mg}$ 1·624, $\ddot{C}$ 4·00=99·673.

The carbonic acid is supposed to proceed from mixture with carbonate of lime.

CHLADNITE, p. 279.—Shepard's analysis of Chladnite is published in the Amer. J. Sci. [2], vi, 414. It seems to make the species a steatite, while it has nothing of the soapy feel of a steatite, and more resembles albite. He obtained

$\dddot{\text{Si}}$ 70·41, Magnesia 28·25, Soda 1·39=100.

It contains but a trace of alumina.

CHLORITE, p. 261.—The Hydrous mica, (or Wasserglimmer of Morin), approaches Chlorite in composition. It contains (Ann. d. Mines, [8], xvii),

$\dddot{\text{Si}}$ 34·8, $\dddot{\bar{\text{Al}}}$ 10·2, $\dot{\text{Ca}}$ 8·4, $\dot{\text{Mg}}$ 8·1, $\dot{\text{Fe}}$ 18·0, $\dot{\text{Mn}}$ 5·0, $\dot{\text{H}}$ 14·4=98·9.

The result affords for the oxygen of the protoxyds, peroxyds, silica, and water, 10·68 : 4·77 : 18·08 : 12·70, which equals 2·24 : 1 : 3·79 : 2·66.

CHLOROPHYLLITE, p. 294.—The formula should read $\dot{\text{R}}^3\dddot{\text{Si}}^2+3\dddot{\bar{\text{R}}}\dddot{\text{Si}}+2\dot{\text{H}}$=Iolite+$2\dot{\text{H}}$.

CHROMIC IRON, p. 435.—Moberg has analyzed the Chromic Iron of Beresof, with the following result, (J. f. pr. Ch. xliii, 119):

$\dot{\text{Fe}}$ 18·42, $\dot{\text{Mg}}$ 6·68, $\dddot{\bar{\text{Cr}}}$ 64·17, $\dddot{\bar{\text{Al}}}$ 10·83 $\dddot{\text{Si}}$ 0·91=101·01.

As there is an excess of chromic oxyd he concludes that part of the chrome is in the condition of protoxyd ($\dot{\text{Cr}}$)—as in the following calculated result:

$\dot{\text{Fe}}$ 18·42, $\dot{\text{Mg}}$ 6·68, $\dot{\text{Cr}}$ 5·17, $\dddot{\bar{\text{Cr}}}$ 58·40, $\dddot{\bar{\text{Al}}}$ 10·83, $\dddot{\text{Si}}$ 0·91=100·41.

Whence we have the formula ($\dot{\text{Fe}}$, $\dot{\text{Mg}}$, $\dot{\text{Cr}}$) ($\dddot{\bar{\text{Cr}}}$, $\dddot{\bar{\text{Al}}}$).

The chromic iron of Texas, Lancaster Co., Pa., which is incrusted with emerald nickel, has been analyzed in the laboratory of J. C. Booth, by Mr. T. H. Garrett, (private communication from J. C. Booth), who obtained

$\dot{\text{Fe}}\dddot{\bar{\text{Cr}}}$ 93·164, $\dot{\text{Fe}}\dddot{\bar{\text{Fe}}}$ 5·298, $\dot{\text{Ni}}$ 2·282=100·744.

It contains 63·384 of oxyd of chrome ($\dddot{\bar{\text{Cr}}}$). The coating of emerald nickel was removed as completely as possible before the analysis.

COBALT VITRIOL, p. 476.—Analyses by Schnabel of a cobalt vitriol, from near Siegen, (Ramm. 4th Supp. 118):

$\dddot{\text{S}}$	$\dot{\text{Co}}$	$\dot{\text{Cu}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	Cl	$\dot{\text{H}}$		
28·81	23·30	0·30	0·43	0·88	0·04	45·22	earthy subst.	1·14=100·12.
20·84	16·50	0·44	*trace*	*trace*	0·05	38·13	"	24·04=100.

With traces of iron and nickel.

COBALTINE, p. 472.—Analyses: 1, Huberdt, (Ramm. 4th Supp. 116); 2, Patera, (ib); 3, Ebbinghaus, (ib.); 4, 5, Schnabel, (ib.):

	S	As	Co	Fe
1. Oratwitza,	19·75	44·13	30·37	5·75=100, Huberdt.
2. " *columnar*,	19·78	43·63	32·08	4·56=100, Patera.
3. Skutterud,	20·25	42·97	32·07	3·42, quartz 1·63=100·34, Ebbinghaus.
4. Siegen, *massive*,	19·35	45·31	33·71	1·62=99·99, Schnabel.
5. " *plumose*,	19·98	42·53	8·67	25·98, Sb 2·84=100, Schnabel.

The last is a cobaltine, in which three-fourths of the cobalt is replaced by iron.

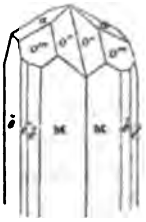
COPPER NICKEL, p. 469.—Analyses: 1, Suckow, (Verwit. im Mineralreiche, 58, Ramm. 4th Supp. 122); 2, Ebelmen, (Ann. d. Mines, [4], xi, 55); 3, Schnabel, (Ramm. 4th Supp. 122):

	As	S	Ni	Fe
1. Riechelsdorf,	53·69	0·15	45·76	2·70=102·30, Suckow.
2. Ayer,	54·05	2·18	43·50	0·45, Co 0·32, Sb 0·05, Gangue 0·2=100·75, E.
3. Westphalia,	52·71	0·48	45·37, Cu 1·44=100, Schnabel.	

The last two were massive, and Ebelmen obtained for the specific gravity of his specimen 7·39.

Delvauxene, p. 451.—A new analysis by Delvaux, (Bull. Acad. Brux. 1838, 147), obtained $\overset{.....}{\mathrm{P}}$ 18·20, $\dddot{\mathrm{\bar{F}e}}$ 40·44, $\dot{\mathrm{H}}$ 41·13=99·77, corresponding to $\dddot{\mathrm{\bar{F}e}}^2\,\overset{.....}{\mathrm{P}}+18\,\dot{\mathrm{H}}$, differing from Dumont's result in containing ⅓ less of water.

Diaspore, p. 223.—The annexed figure of Diaspore from the Dolomite of Campo Longo, St. Gothard, is copied from Marignac, (Bib. Univ. de Genève, vi, Jan. 1848), who gives the following angles:—M : M=129° 54′, ĕ″ : ĕ″=70° 54′, ĕ‴ : ĕ‴=56° 12′, o″ : o″=151° 32′, 116° 38′, (over the summit, opposite), 109° 6′, o‴ : o‴=126° 12′, 122° 12′, (over the summit, opposite), 97° 6′, *a* : *a*=117° 46′, *a* : *e*=121° 7′. Haidinger obtained from the Schemnitz crystals, (see figure on page 223, in which the plane *e*′ is properly M), M : M=129° 54′, ĕ″ : ĕ″=70° 54′; o″ : o″=151° 54′.



The crystals occur imbedded in dolomite in contact with a large crystal of corundum, which they sometimes even penetrate. One of the faces of this crystal of corundum is wholly covered with them, the diaspore crystals being placed transversely, or parallel to a basal edge of the corundum. They are small, colorless, slightly yellowish, longitudinally striated, and have some resemblance to crystals of topaz. Lustre splendent, especially on the terminal planes. Cleavage distinct parallel with the shorter diagonal; and when heated the crystals split in the cleavage direction. Scratches glass easily, but does not scratch quartz. B.B. whitens, but is completely infusible.

Epidote, p. 352.—Rammelsberg renders it probable from his researches that (contrary to Hermann's results) in all varieties of Epidote, including bucklandite, the oxygen ratio for the protoxyds, peroxyds, and silica is 1 : 2 : 3, giving the formula $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}+2\,\dddot{\mathrm{\bar{R}}}\,\dddot{\mathrm{Si}}$. The variation from this ratio obtained by some analyses, he shows is owing to the existence of the iron both as protoxyd and peroxyd, and an incorrect determination of the proportions of the two.

Esmarkite, p. 294.—The formula should read $\dot{\mathrm{R}}^3\,\dddot{\mathrm{Si}}^2+3\,\dddot{\mathrm{\bar{R}}}\,\dddot{\mathrm{Si}}+3\dot{\mathrm{H}}$=Iolite+3 $\dot{\mathrm{H}}$.

Feldspar, p. 325.—Analysis of a bluish-white feldspar (orthoclase) from Mulde, near Freiberg, by Moll, (Ramm. 4th Supp. 69); and of a variety from St. Etienne in Pegmatite by Delesse, (Ann. d. Mines, [4], xvi, 97, 1849):

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{\bar{A}l}}$	$\dddot{\mathrm{\bar{F}e}}$	$\dddot{\mathrm{\bar{M}n}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$
1. Freiberg,	65·75	17·72	—	—	0·82	—	3·66	12·05=100, Moll.
2. St. Etienne,	63·92	20·05		0·30	0·75	0·60	3·10	10·41, ign. 0·41=99·64.

Phosphoric acid has been detected by Fownes in some feldspars, (Chem. Gaz. No. 100, p. 495); and also by Svanberg and Struve, (J. f. pr. Chem. xliv, 300).

Garnet—Pyrope, p. 346, 349.—Analysis of a white garnet from the Schischimakian Mountains, (G.=3·504), by Croft, (G. Rose, Reise nach d. Ural, ii, 132):

$\dddot{\mathrm{Si}}$ 36·86, $\dddot{\mathrm{\bar{A}l}}$ 24·19, $\dot{\mathrm{Ca}}$ 37·15=98·10.

Analysis of a pyrope by Moberg, (J. f. pr. Ch. xliii, 122),

$\dddot{\mathrm{Si}}$ 41·35, $\dddot{\mathrm{\bar{A}l}}$ 22·35, $\dot{\mathrm{Fe}}$ 9·94, $\dot{\mathrm{Cr}}$ 4·18, $\dot{\mathrm{Mg}}$ 15·00, $\dot{\mathrm{Ca}}$ 5·29, $\dot{\mathrm{Mn}}$ 2·59=100·71.

Pyrope is therefore a garnet containing protoxyd of chrome, while Ouvarovite contains peroxyd of chrome. The formula is that of common garnet.

[In the formula of pyrope on p. 349, $\dot{\mathrm{R}}\,\dddot{\mathrm{Si}}$ should read $\dot{\mathrm{R}}^3\,\dddot{\mathrm{Si}}$].

Gilbertite, *Thomson*.—In thin plates, or small folia, lying irregularly together, and in radiating groups. H.=2·75. G.=2·648. Lustre silky. Color white, slightly yellowish. Translucent. Sectile.

Composition.—According to Lehunt, (Thom. Min. i, 235), and Thomson,

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{\bar{A}l}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{H}}$
1. Cornwall,	45·15	40·11	1·90	4·17	2·43	4·25=98·01, Lehunt.
2. Loc. doubtful,	47·80	32·62	1·60	—	5·18	4·00, $\dot{\mathrm{Na}}$ 9·23=100·42, Thom.

The first gives the ratio (excluding the water) 1⅓ : 12 : 16, and the mineral looks like an altered mica. The second is probably margarodite. See pp. 688, 689.

Found at Cornwall in the lode of Stonagwyn, St. Just, mixed with fluor spar.

Gold, p. 549.—F. Alger has described a crystal of gold from California, having an octahedral form, which has the extraordinary size of five-sixteenths of an inch. For analyses of Gold by A. Levol, see Ann. Ch. Ph. [3], xxvii, 310.

Gymnite, *Thomson*, (Phil. Mag. 1843, March, xxii, 191).—A serpentine mineral from Baltimore, Maryland, occurring amorphous and of a pale dirty orange color, subtranslucent, having a resinous lustre, quite tough and nearly as hard as feldspar.

Composition.—According to Thomson,

$\dddot{\text{Si}}$ 40·16, $\bar{\text{Al}}$, $\bar{\text{Fe}}$ 1·16, $\dot{\text{Mg}}$ 36·00, $\dot{\text{Ca}}$ 0·80, $\dot{\text{H}}$ 21·16=99·72.

Formula $\dot{\text{Mg}}\,\dddot{\text{Si}}+\dot{\text{Mg}}\,\dot{\text{H}}^2$, or near Hydrophite and Dermatine.

B.B. becomes dull brown; with soda a white opaque mass; with borax a colorless glass; with cobalt solution a rose-red color.

Harmotome, p. 304.—Rammelsberg, from a review of all the best analyses of Harmotome, deduces the formula $\dot{\text{R}}\,\dddot{\text{Si}}+\bar{\text{Al}}\,\dddot{\text{Si}}^2+5\,\dot{\text{H}}$. Some analyses give $4\frac{1}{2}\dot{\text{H}}$.—4th Supp. p. 89.

Halloysite, p. 288.—Analysis by Monheim of a Halloysite from Altenberg, near Aix la Chapelle, G.=2·221, (Verh. d. nat Ver. d. preuss. Rheinlande, v, 41; Ramm. 4th Supp. 221),

$\dddot{\text{Si}}$ 40·31, $\bar{\text{Al}}$ 33·23, $\dot{\text{Zn}}$ 1·23, $\dot{\text{H}}$ 23·69=98·46.

It is near the halloysite of La Vouth and Thiviers, and gives the formula $\bar{\text{Al}}^3\dddot{\text{Si}}^4+12\,\dot{\text{H}}$. It differs but little from some kaolin.

Heterosite, p. 449.—Rammelsberg has analyzed another mineral from Limoges, (the locality of heterosite, triplite, triphyline, and hureaulite), and obtained the following result:

$\ddot{\bar{\text{P}}}$ 32·18, $\bar{\text{Fe}}$ 31·46, $\bar{\text{Mn}}$ 30·01, $\dot{\text{H}}$ (loss) 6·35,

corresponding to the formula $(\frac{1}{2}\bar{\text{Fe}}+\frac{1}{2}\bar{\text{Mn}})^5\,\ddot{\bar{\text{P}}}^3+5\,\dot{\text{H}}$.

Dufrénoy deduces for the heterosite 3 $(\frac{1}{2}\dot{\text{Fe}}+\frac{1}{2}\dot{\text{Mn}})^5\,\ddot{\bar{\text{P}}}^3+5\,\dot{\text{H}}$. The hureaulite afforded $(\dot{\text{Mn}}, \dot{\text{Fe}})^5\,\ddot{\bar{\text{P}}}^2+8\dot{\text{H}}$. (Ramm. 4th Supp. p. 96). The above hydrous phosphates, together with Pseudotriplite, (p. 451), are considered by Fuchs altered triphyline.

Hydrous Anthophyllite, *Thomson*, Min. i, 209.—Structure consisting of diverging fibrous plates or fibres, producing a scopiform character. Fibres separable, brittle. Lustre silky. Color greenish-yellow, pale-grayish. H.=2·5. G.=2·911.

Composition.—According to Thomson, (loc. cit.),

$\dddot{\text{Si}}$ 54·98, $\bar{\text{Al}}$ 13·38, $\dot{\text{Fe}}$ 9·83, $\dot{\text{Mn}}$ 1·20, $\dot{\text{K}}$ 6·80, $\bar{\text{Al}}$ 1·56, $\dot{\text{H}}$ 11·45=99·20.

The analysis corresponds nearly to $\dot{\text{R}}\,\dddot{\text{Si}}+\dot{\text{H}}$.

From New York Island, in boulders, in the upper part of what now belongs to the city of New York.

A similar mineral in appearance is found at Unionville, Pa.

Hornblende, p. 272.—Analysis of a foliated mineral called hypersthene, from Orange Co., N. Y., by L. C. Beck, (3d Rep. Regents Univ. N. Y. on State Collections, Albany, 1850), Silica 59·50, oxyd of iron 12·00, magnesia 27·75=99·25. Considering the iron in the mineral as protoxyd, the analysis gives for the oxygen of the protoxyds and silica 13·32 : 30·92, which is very near 4 : 9, the ratio in hornblende. The mineral is therefore foliated hornblende, and not true hypersthene, and has the formula $(\dot{\text{Mg}}, \dot{\text{Fe}})^4\,\dddot{\text{Si}}^3$, or more precisely $(\frac{4}{5}\,\dot{\text{Mg}}+\frac{1}{5}\,\dot{\text{Fe}})^4\,\dddot{\text{Si}}^3$.

Ildefonsite.—A columbite from Idelfonso in Spain, is thus named by Haidinger. Its characters are mentioned on page 637.

Isopyre. Isopyric Quartz, *Haid.*, *Turner*. (Ed. New Phil. Jour. 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.—$\dot{Ca}\dddot{Si}+(\ddot{\overline{Al}},\ddot{\overline{Fe}})\dddot{Si}$, Kobell. Analysis by Turner, (loc. cit.):

$\dddot{Si}$ 47·09, $\ddot{\overline{Al}}$ 13·91, $\ddot{\overline{Fe}}$ 20·07, $\dot{Ca}$ 15·43, $\dot{Cu}$ 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 quartz on granite with tourmaline and tin ore, in pieces, two inches in diameter. Also in breccia, on the Calton Hill, Edinburgh, with brown iron ore.

KILLINITE, p. 339.—Rammelsberg deduces from the analyses on p. 339, the formula $\dot{R}\dddot{Si}+\ddot{\overline{Al}}^3\dddot{Si}^2+4\dot{H}$, and suggests a relation to pinite and iolite.

LABRADORITE, p. 333.—A variety of Labradorite in small glassy tabular crystals, colorless and transparent, from an ancient lava, and supposed to be from the island of Maui, Hawaiian group, Pacific islands, afforded M. Adolph Schlieper the following result on analyses:

	$\dddot{Si}$	$\ddot{\overline{Al}}$	$\ddot{\overline{Fe}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Na}$	$\dot{K}$
	53·98	27·56	1·14	8·65	1·35	6·06	0·47=99·21.
Oxygen	28·02	12·87	0·34	2·47	0·52	1·55	0·08,

which corresponds to the constitution of labradorite, and gives the specific formula, $(\frac{3}{4}\dot{Ca}+\frac{1}{4}\dot{Na})\dddot{Si}+\ddot{\overline{Al}}\dddot{Si}$, (private communication from M. Schlieper). The specimen was placed in the hands of M. Schlieper by the author. The locality is somewhat doubtful.

LANCASTERITE, p. 213.—The crystals of this mineral are sometimes acicular, and occasionally it occurs in divergent fibrous forms somewhat like a zeolite. On the same specimen it frequently shows a broad foliated character, pearly like brucite.

LAUMONITE, p. 303.—In Gerhardt's formula, for $\dot{Ca}^3\dddot{Si}$, read $\dot{Ca}^3\dddot{Si}^2$.

LEUCOPYRITE, p. 423.—An analysis by Karsten of the Leucopyrite of Riechenstein, (Eisenhüttenkunde, ii, 19), afforded,

Arsenic 65·88, Iron 32·35, Sulphur 1·77=100.

This result is near Hofmann and Meyer's analysis of the same ore, and as Rammelsberg observes, (4th Supp. 5), gives the formula, Fe^4As^3=Arsenic 66·80, iron 33·20.

LIEBIGITE, p. 410.—Rammelsberg deduces for Liebigite, (4th Supp. 142), from Dr. Smith's analysis, the formula. $2\dot{Ca}\ddot{C}+\ddot{\overline{U}}^2\ddot{C}+36\dot{H}$=Carbonic acid 9·02, oxyd of uranium 39·12, lime 7·67, water 44·19=100

LIEBNERITE, p. 314.—Marignac's Memoir on Liebnerite is in the Bibliothèque Univ. de Genève, vi, 293, Jan. 1848. The hardness is 3·5. In the formula on p. 314, $\dot{H}$ should be 5 $\dot{H}$ (or $4\frac{1}{2}$ $\dot{H}$).

LINDSAYITE, p. 336.—Hermann, in a paper (J. f. pr. Chem. xlviii, 254, Nov. 1849) which has come to hand since the printing of the former notice of Lindsayite, observes that the species differs from Lepolite, in containing no lime. His description is as follows:

Whether monoclinic or triclinic undetermined. T : T′=120°, P on the axis=65°, $\tilde{e}'$: $\tilde{e}'$ (see figure 3, p. 325, which much resembles Hermann's)=59°, á on the axis=64° 30′. Cleavage parallel with P. Crystals often of large size.

H.=4. G.=2·83. Color black externally, probably from iron derived from pyrites; internally gray, bluish gray, and dull reddish. Subtranslucent. Fracture splintery. In a matrass yields water. B.B. fuses with difficulty on the edges. With fluxes the reaction of iron and silica. In the concentrated acids not perfectly decomposed.

Analysis by Hermann,

	$\dddot{Si}$	$\ddot{\overline{Al}}$	$\ddot{\overline{Fe}}$	$\dot{Fe}$	$\dot{Mg}$	$\dot{K}$	$\dot{Na}$	$\dot{H}$	
1.	42·22	27·55	6·98	2·00	8·85	3·00	2·53	7·00	F, $\dddot{P}$ trace=100·13.
2. Oxygen ratio,	21·90	12·84	2·09	0·44	3·49	0·50	0·64	6·22.	

This gives Hermann for the oxygen of protoxyds, peroxyds, silica, and water,

5·07 : 14·98 : 21·90 : 6·22,

whence he deduces the ratio 1 : 3 : 4 : 1, corresponding to $\dot{R}^3\dddot{Si}+3\,\bar{\dddot{Al}}\,\dddot{Si}+3\,\dot{H}$.

But 14·98 is to 21·90 very closely as 2 : 3 instead of 3 : 4; and this gives for the ratio 1 : 3 : 4½ : 1½ (or 1), which, excluding the water, is the proportion in wernerite and nepheline, giving the formula $\dot{R}^3\dddot{Si}+2\,\bar{\dddot{Al}}\,\dddot{Si}+2\tfrac{1}{4}\,\dot{H}$ (or 2 $\dot{H}$).

The large proportion of water, and the presence of the ingredients magnesia and iron to the amount they occur, an amount hitherto unknown in the feldspars, favor Breithaupt's opinion that the crystals have undergone alteration; and if not pseudomorphs after lepolite, they may be after some other species of the feldspar group.

LINNÆITE, p. 474.—SIEGENITE.—Analyses of octahedral crystals from Siegen, by Schnabel, (Ramm. 4th Supp. 117),

S	Ni	Co	Fe	G.
41·98	33·64	22·09	2·29=100.	G.=4·8.
42·30	42·64	11·00	4·69=100·63.	G.=5·0.

Rammelsberg deduces the formula $R\,S+R^2S^3$, or more precisely $(Ni, Co, Fe)S+(Ni, Co, Fe)^2S^3$, confirming Frankenheim's view of this species. The mineral is a nickel linnæite, (*kobaltnickelkies*, Ramm.), and the variety may be named *Siegenite.*

MAGNETIC IRON, p. 434.—A variety of magnetic iron containing titanium, afforded Rhodius, titanic acid 9·63, peroxyd of iron 94·12, or

Titanium 5·89, Iron 65·87, Oxygen 28·24.

This corresponds to a magnetic iron with the composition $(\bar{\dddot{Fe}}, \bar{\dddot{Ti}})\,\dot{Fe}$=Titanic oxyd 8·69, peroxyd of iron 61·27, protoxyd of iron 31·80=101·76, Rammelsberg. G.=5·1.

An earthy *magnetic iron* (Eisenmulm) from near Siegen afforded Genth, (Ann. Chem. u. Pharm. lxvi, 277),

$\bar{\dddot{Fe}}$ 66·20, $\dot{Fe}$ 13·87, $\dot{Mn}$ 17·00, $\dot{Cu}$ 0·09, Sand, &c., 1·75=98·91.

Corresponding to $\bar{\dddot{Fe}}\,(\dot{Fe}, \dot{Mn})$. Specific gravity 3·76.

METEORIC MINERALS.—Apatoid, Sphenomite, Iodolite, and Chantonnite, are the names of substances in meteoric stones, imperfectly described by Prof. C. U. Shepard. See Amer. J. Sci. [2], ii, 379, 380, 381.

MIARGYRITE, p. 539.—This species is isomorphous with Augite. M : M in Miargyrite is 86° 4′, in Augite 87° 6′; P : M in Miargyrite is 101° 6′, in Augite 100° 25.′ The Augite group of isomorphs, includes with this addition, augite, borax, glauber salt, acmite, hornblende, spodumene, and miargyrite, with the several varieties of these species. See Amer. Jour. Sci. [2], ix, 223, 228, 230, 429.

MICA FAMILY, p. 356.—1. *Muscovite.*—Analysis of a variety from Zsidovácz in Hungary, (G=2·817), by Kussin, (Ramm, 4th Supp. p. 75):

$\dddot{Si}$ 48·07, $\bar{\dddot{Al}}$ 38·41, $\bar{\dddot{Fe}}\,\bar{\dddot{Mn}}$ *trace*, $\dot{K}$ 10·10, $\dot{H}$ 3·42=100.

This gives for the oxygen of the protoxyds, peroxyds, silica, and water, 1·71 : 17·93 : 24·97 : 3·04, corresponding very nearly to 1⅓ : 12 : 16.

Rammelsberg in his 4th Supplement has calculated anew the several analyses of muscovite, and lays down the formulas of the varieties. But by some oversight he makes the ratio 1 : 12 : 15 equal to ⅔ : 9 : 12, as if 4 : 5 equals 3 : 4; and the formula deduced is that based on the former ratio. As the point is of some importance, we give here the ratios from his calculations, making the oxygen of the alumina 12, for better comparison with that of the silica, as well as the protoxyds. A slight variation in the protoxyds, whether from impurity or not, varies largely the ratio to the other ingredients; while the ratio between the peroxyds and silica, since it is much nearer equality, is not liable to such fluctuations. The results (corresponding to the analyses on page 357) are as follows:

1. Utö, 1·63 : 18·62[a] : 24·68 = 1·05 : 12 : 15·91.
2. Broddbo, 1·42 : 17·76 : 23·95 = 0·96 : 12 : 16·18.
4. Fahlun, 1·39 : 18·56 : 24·01 = 0·90 : 12 : 15·52.
5. Kimito, 1·56 : 18·54 : 24·09 = 1·01 : 12 : 15·59.
6. Ochotsk, 1·44 : 17·89 : 24·52 = 0·97 : 12 : 16·45.
Zaidovácz, 1·71 : 17·93 : 24·97 = 1·14 : 12 : 16·71.

Mean, excluding the last, 0·98 : 12 : 15·93.
Mean, including the last, 1·005 : 12 : 16·06.

[a] Corrected.

The mean therefore of the five analyses from which Rammelsberg deduces his ratio is very closely 1 : 12 : 16, and if Kussin's analysis be added, it gives still more nearly this ratio; moreover, the separate analyses correspond more nearly with 1 : 12 : 16 than 1 : 12 : 15. Rose's formula $\dot{\mathrm{K}}\,\dddot{\mathrm{Si}}+4\,\overline{\mathrm{Al}}\,\dddot{\mathrm{Si}}$, adopted by this author, is not therefore sustained by the analyses. Neither does Kussin's analysis correspond to the ratio 1⅓ : 12 : 15, whence Rammelsberg derives the formula $\dot{\mathrm{K}}\,\dddot{\mathrm{Si}}+3\,\overline{\mathrm{Al}}\,\dddot{\mathrm{Si}}$, but more nearly to 1⅛ : 12 : 16½, though probably essentially 1 : 12 : 16, like the preceding.

The Unionville and Abborforss mica and Fuchsite, p. 357, afford,

Analysis 10. Unionville, 1·61 : 18·32 : 24·29 = 1·05 : 12 : 15·91 = 1 : 12 : 16.
9. *Fuchsite*, 2·33 : 17·88 : 24·91 = 1·58 : 12 : 16·32 = 1½ : 12 : 16.
8. Abborforss, 3·27 : 15·06 : 20·61 = 2·60 : 12 : 16·42 = 2⅔ : 12 : 16.

The last corresponds to the ratio 2 : 9 : 12. Taking the Fuchsite at 1½ : 12 : 16, it gives the formula on p. 357.

2. *Margarodite*, p. 358.—The oxygen ratios for the analyses of Margarodite are given on p. 359. For comparison with the preceding, we give a tabular view of the results.

1. Delesse, 2·65 : 16·46 : 24·02 = 1·93 : 12 : 17·51 = 0·99 : 6 : 8·76.
2. Rammelsberg, 2·71 : 16·03 : 24·36 = 2·03 : 12 : 18·61 = 1·01 : 6 : 9·30.
3. Schafhäutl, 3·17 : 16·35 : 24·45 = 2·33 : 12 : 17·95 = 1·16 : 6 : 8·97.

Brewer's analyses give an excess of silica, which may be too large. From the above it is altogether probable that the ratio 1 : 6 : 9 will include all, and that they pertain to the species Margarodite. The *gilbertite*, p. 684, appears to be an altered muscovite or a margarodite.

3. *Biotite*, p. 360.—The *chrome mica*, (analysis 11, p. 360), gives the same ratio for the oxygen of the peroxyds and silica, as that characteristic of biotite; but the whole ratio is different, and it is not known that it is uniaxial. For the Rosendal mica, (analysis 7), Rammelsberg supposes part of the iron peroxyd, and deduces the ratio 1 : 1 : 2¼ giving the formula $3\,\dot{\mathrm{R}}^3\,\dddot{\mathrm{Si}}+2\,\overline{\mathrm{R}}\,\dddot{\mathrm{Si}}$.

4. *Lepidolite* or *Lithia mica*, p. 361.—The Lithia micas have been the subject of study by Rammelsberg, and he concludes that in this species, as well as topaz, (p. 366), the fluorine replaces oxygen, or is in the same state of composition as the oxygen. There are several distinct chemical compounds included, and it is not definitely known that they are all biaxial. The ratios given by Rammelsberg are,

a. 1 : 3 : 6 $=\dot{\mathrm{R}}\,\dddot{\mathrm{Si}}+\overline{\mathrm{R}}\,\dddot{\mathrm{Si}}$—mica of Ural, Chursdorf, Utö, Rozena, Altenberg (Stein).
b. 2 : 9 : 15 $=2\,\dot{\mathrm{R}}\,\dddot{\mathrm{Si}}+3\,\overline{\mathrm{R}}\,\dddot{\mathrm{Si}}$—mica of Zinnwald.
c. 1 : 2 : 5 $=3\,\dot{\mathrm{R}}\,\dddot{\mathrm{Si}}+2\,\overline{\mathrm{R}}\,\dddot{\mathrm{Si}}$—mica of Juschakowa.
d. 1 : 6 : 7 $=\dot{\mathrm{R}}^3\,\dddot{\mathrm{Si}}+6\,\overline{\mathrm{R}}\,\dddot{\mathrm{Si}}$—mica of Altenberg according to Turner.

In the Ural, Chursdorf, Utö, and Rozena micas, the fluorine is to the oxygen as 1 : 20; in the Altenberg, (Stein), 1 : 60; in the Zinnwald, 1 : 14, or 1 : 11; in the Juschakowa, 1 : 3; in the Altenberg, (Turner), 1 : 25.

The Ural mica (Turner) affords then the formula,—writing for $\dot{\mathrm{R}}\,\dddot{\mathrm{Si}}+\overline{\mathrm{R}}\,\dddot{\mathrm{Si}}$, $(\mathrm{RO}+\mathrm{SiO}^3)+(\mathrm{R}^2\mathrm{O}^3+\mathrm{SiO}^3)$,

$$20\left[(\mathrm{RO}+\mathrm{SiO}^3)+(\mathrm{R}^2\mathrm{O}^3+\mathrm{SiO}^3)\right]+\left[(\mathrm{RF}+\mathrm{SiF}^3)+(\mathrm{R}^2\mathrm{F}^3+\mathrm{SiF}^3)\right],$$

and in the same way the other formulas may be written out. Making O and F isomorphous, this formula becomes, $[\mathrm{R}(\mathrm{O},\mathrm{F})+\mathrm{Si}(\mathrm{O},\mathrm{F})^3]+[\mathrm{R}^2(\mathrm{O},\mathrm{F})^3+\mathrm{Si}(\mathrm{O},\mathrm{F})^3]$.

5. *Emerylite*, p. 362.—The analyses on p. 362, have the following oxygen ratios for the protoxyds, peroxyds, and silica:

	$\dot{R}$		$\ddot{\bar{R}}$		$\dddot{Si}$						
1.	4·20	:	24·42	:	15·59	=	1·08	:	6·26	:	4
2.	3·87	:	23·01	:	16·79	=	0·99	:	5·48	:	4
3.	3·43	:	23·93	:	16·14	=	0·85	:	5·93	:	4
4.	3·40	:	24·12	:	16·24	=	0·85	:	5·94	:	4
5.	4·03	:	24·02	:	15·68	=	1·03	:	6·13	:	4
6.	4·01	:	23·64	:	15·53	=	1·17	:	6·08	:	4
7.	3·65[a]	:	25·37	:	16·71	=	0·92	:	6·08	:	4
8.	3·99	:	23·92	:	15·84	=	1·03	:	6·04	:	4
						Mean=	1·00	:	5·99	:	4

[a] Supposing the alkalies equivalent to the loss.

The mean result is quite closely 1 : 6 : 4, and the same is afforded by several of the particular results. As Dr. Smith found no water, and Hartshorne only 0·5 per cent., the species is primarily anhydrous. Including the water found by Craw in his specimens, the ratio is 1 : 6 : 4 : 1.

The Emerylite, as observed by Dr. J. L. Smith the discoverer and original describer of the species, occurs with the corundum of Magnesia, Asia Minor, and also that of Naxia and Niconia.

6. *Euphyllite*, p. 362.—The following are the oxygen ratios for the analyses:

1.	1·80	:	20·88	:	22·65	=	0·95	:	11·06	:	12
2.	1·88	:	21·02	:	22·57	=	1·00	:	11·18	:	12
3.	1·96	:	22·82	:	23·87	=	0·98	:	11·47	:	12
4.	—	:	21·72	:	23·55		—	:	11·07	:	12
						Mean,	0·98	:	11·19	:	12

The ratio 1 : 11 : 12 appears therefore to be that authorized by the analyses. As no water was found in the 3d and 4th analyses, the species is essentially anhydrous. Including the water found by Erni, the ratio becomes 1 : 11 : 12 : 3.

It is still possible that 1 : 12 : 12 will prove to be the true ratio; and in that case the ratios for margarite, emerylite, euphyllite, and muscovite, have an obvious simple relation, they being respectively 1 : 12 : 8; 2 : 12 : 8; 1 : 12 : 12; 1 : 12 : 16.

Recapitulation.—The following are the oxygen ratios observed among the micas, and the formulas corresponding:—

1. Micas having atomically as much alumina as silica, or a larger amount. These micas are harder than those of the following division, and brittle or but slightly elastic.

1. *Margarite*,	1	:	12	:	8	=	1 : 12 : 8				$\dot{R}^3\dddot{Si}^2+6\ddot{\bar{Al}}^2\dddot{Si}$.
2. *Emerylite*,	2	:	12	:	8	=	1 : 6 : 4				$\dot{R}^3\dddot{Si}+3\ddot{\bar{Al}}^2\dddot{Si}$.
3. *Euphyllite*,	1	:	12(? 11)	:	12						? $\dot{R}^3\dddot{Si}+11\ddot{\bar{R}}\dddot{Si}$.

2. Micas having atomically less alumina than silica.

1. *Muscovite*, *a.*	1	:	12	:	16	=	1	:	12	: 16	3 $\dot{R}$, 12 $\ddot{\bar{Al}}$, 16 $\dddot{Si}$.
b. Fuchsite,	1½	:	12	:	16	=	1	:	8	: 10⅔	
c. Abborforss,	2⅔	:	12	:	16	=	1	:	4½	: 6	$\dot{R}^3\dddot{Si}+3\ddot{\bar{Al}}\dddot{Si}$.
2. *Margarodite*,	2	:	12	:	18	=	1	:	6	: 9	$\dot{R}\dddot{Si}+2\ddot{\bar{Al}}\dddot{Si}$.
3. *Lepidolite*, *a.*	4	:	12	:	24	=	1	:	3	: 6	$\dot{R}\dddot{Si}+\ddot{\bar{R}}\dddot{Si}$.
b.	2⅔	:	12	:	20	=	1	:	4½	: 7½	$2\dot{R}\dddot{Si}+3\ddot{\bar{R}}\dddot{Si}$.
c.	6	:	12	:	30	=	1	:	2	: 5	$3\dot{R}\dddot{Si}+2\ddot{\bar{R}}\dddot{Si}$.
d.	2	:	12	:	14	=	1	:	6	: 7	$\dot{R}^3\dddot{Si}+6\ddot{\bar{R}}\dddot{Si}$.
4. *Phlogopite*,	18	:	12	:	30	=	1	:	⅔	: 1⅔	$3\dot{R}^3\dddot{Si}+2\ddot{\bar{R}}\dddot{Si}$.
5. *Biotite*, *a.*	12	:	12	:	24	=	1	:	1	: 2	$\dot{R}^3\dddot{Si}+\ddot{\bar{R}}\dddot{Si}$.
b. Pargas,	8	:	12	:	24	=	1	:	1½	: 3	$\dot{R}^3\dddot{Si}+\ddot{\bar{R}}\dddot{Si}$.
c. Chrome,	6	:	12	:	24	=	1	:	2	: 4	$\dot{R}^3\dddot{Si}^2+2\ddot{\bar{Al}}\dddot{Si}$.
d. Rosendal,	(?)12	:	12	:	30	=	1	:	1	: 2½	$3\dot{R}^3\dddot{Si}+2\ddot{\bar{R}}\dddot{Si}$.
6. Chamouni, Delesse,	(?)4⅘	:	12	:	19⅕	=	1	:	2½	: 4	$3\dot{R}^3\dddot{Si}+5\ddot{\bar{R}}\dddot{Si}$.
7. *Lepidomelane*,	4	:	12	:	16	=	1	:	3	: 4	$3\dot{R}^3\dddot{Si}+3\ddot{\bar{R}}\dddot{Si}$.

The mineral *Diphanite*, (p. 292), resembles margarite and euphyllite, and has the ratio 1 : 4½ : 3¾ or 2⅔ : 12 : 10.

We have not written a formula for the muscovite. It is evident from a survey of the compounds, that there must be some more satisfactory mode of exhibiting the relations of substances, than by the formulas often made out. They frequently make diversity instead of showing relationships, and tend to mislead the eye not thoroughly acquainted with the wide variation of formula consequent on a slight change of ratio.

The amount of water which analyses afford varies from 0 to 5 per cent.; and as it exists variously or not at all in micas in which the oxygen ratio is the same, there is reason for believing it the result of a partial alteration of the mica, like that which takes place in iolite. The hydrous varieties are commonly more or less wanting in transparency.

For an article on singular vermiform crystallizations of mica in quartz, by Fr. Alger, see Amer. J. Sci. [2], x.

Polarization of Mica.—The angles between the axes of polarization of some American Micas have been measured by the author, in connection with B. Silliman, Jr., and the following are the results arrived at. For a particular notice of the localities and the variety each affords, see description of the species referred to, and the notes below.

1. *Muscovite, Lithia Mica, and Euphyllite.*

Pennsbury, Pa., (brown, cryst.),	59°	Goshen, Mass., (c)	69½°—70°
Royalston, Mass.,	58°—59°	Pennsbury, Pa., (2d loc.)	69½°—70°
Philadelphia, (near railroad),	60°—61°	Middletown, Ct.,	70½°—70°
" near Fairmount,	62½°	Chester, Mass.,	70°—70½°
Monroe, Ct., (brown),	64½°—65½°	Loc. doubtful, (d)	70°—70½°
Jones's Falls, Md.,	66°—66½°	Leiperville, Pa.,	70°—71°
Greenfield, Ct., (a)	66½°	Haddam, Ct., (columbite loc.),	71°—72°
Unionville, Pa.,	67°—67½°	East Chester, N. Y., (e)	71½°—72°
Acworth, N. H.,	67°—67½°	Paris, Me., (f)	73°—74°
Grafton, N. H.,	67°—69½°	Goshen, Mass., (g)	75°—76°
Dixon's Quarry, Del.,	68°—68½°	Goshen, Mass. (rose),	75°—76°
Willimantic Falls, Ct., (b)	69½—70°	Euphyllite,	71½°

a. A pale somewhat brownish mica in large plates. *b.* Color light brownish-green, very transparent. *c.* A brownish mica associated with spodumene. *d.* Pale greenish mica in distinct large crystals. *e.* Pale greenish mica from East Chester, in Westchester, Co., N. Y. *f.* A pale yellowish mica in large plates. *g.* A pale yellowish mica with a shade of green, occurring with indicolite.

2. *Phlogopite.*

1. Natural Bridge,	16°	3. Pope's Mills, (nearly colorless),	7°
2. Edwards, N. Y.,	16°	4. " (brown),	15°

Of similar optical character, the coppery mica of Franklin, New Jersey; a yellowish coppery mica of Gouverneur, resembling that of Natural Bridge; and a black mica from Moriah, Essex Co., affording a smoky-red color by transmitted light.

There is another mica from Monmouth, N. J., which has the axes slightly divergent as in the Phlogopite, occurring in large tables or plates, of a dark dull green color, nearly black, and often having on the surface cross lines affording triangular and rhombic areas. But the crystals are oblique from an obtuse edge, like common oblique mica, with the angle P : M 112°—115½°, and M : M=122°—125°. This must be a distinct species from the Phlogopite, and also distinct from Muscovite. It requires some care to observe that the optical character is not that of a *uniaxial* crystal. It resembles much the Greenwood Furnace rhombohedral mica, (biotite), externally as well as optically, but the crystals of the latter mineral when in sections, as often seen, are rhombic prisms *oblique from an acute edge.*

Biot, in his investigations on the optical characters of the micas,* obtained the angle

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* In giving the angle for micas on page 182, the half angle for the angles 25° to 47° is given instead of the whole angle. Biot calls this angle the angle of condensation, and his statements are in this form.

60° for a white silvery mica from Philadelphia, and 64° for a St. Gothard mica; but states that 66° to 70° is the most common range. Biot also gives the angle 50° for a silvery mica from Zinnwald, Bohemia, and Brewster mentions having observed the angle 45°.

Molybdenite, p. 389.—Analyses by Svanberg and Struve, (J. f. pr. Ch. xliv, 257):

1.	Lindaos in Smaoland,	S 39·756	Mo 57·368	Gangue 2·876=100.
2.	" " "	40·573	58·627	0·800=100.
3.	" " "	40·409	58·470	1·221=100.
4.	Bohuslän,	39·710	57·154	3·136=100.

The formula $\mathrm{Mo\,S^2}$=(with the new atomic weights) Sulphur 40·99, molybdenum 59·01.

Natrocalcite.—Pseudomorphs after Gay-Lussite, called Natrocalcite, from Sangerhausen, have afforded Marchand on analysis, (J. f. pr. Chem. xlvi, 95),

$\dot{\mathrm{Ca}}\,\ddot{\mathrm{C}}$ 94·37, $\not{\mathrm{A}}\mathrm{l}$, $\not{\mathrm{F}}\mathrm{e}$ 1·15, $\dot{\mathrm{Ca}}\,\dddot{\mathrm{S}}$ 2·02, $\dot{\not{\mathrm{H}}}$ 1·34, Gangue 1·10=99·98.

Nickel.—An earthy ore of nickel, allied to earthy cobalt, occurs at Mine La Motte, Missouri, which affords 10 or 11 per cent. of oxyd of nickel, besides oxyd of cobalt and copper, with iron, lead, and sulphur.

Opal, p. 245.—The Fire Opal from Washington Co., Ga., (p. 247), has been analyzed by G. J. Brush, (private communication), with the following result:

$\dddot{\mathrm{Si}}$ 91·89, $\not{\mathrm{A}}\mathrm{l}$ 1·40, $\dot{\mathrm{Mg}}$ 0·02, $\dot{\not{\mathrm{H}}}$ 5·84=100·15,

giving the formula $\dddot{\mathrm{Si}}^3\,\dot{\not{\mathrm{H}}}$. G.=2·07.

A resin opal from Vourla, near Smyrna, (p. 247), having a grayish-green color, afforded Mr. Brush 5·10 per cent. of water. G.=2·054.

Pectolite, p. 248.—The formula $(\dot{\mathrm{Ca}}, \dot{\mathrm{Na}})^4\,\dddot{\mathrm{Si}}^3+\dot{\not{\mathrm{H}}}$ corresponds well with the composition of Pectolite, it giving the percentage, (making the lime to the soda 4:1), Silica 52·9, lime 34·3, soda 9·4, water 3·4=100. Excluding the water it is the composition of a hornblende, as shown by Frankenheim.

[The formula of Rammelsberg, p. 248, following Kobell's, pertains to the preceding species and should be erased].

Pennite, *Hermann*, p. 214.—Previous to Hermann's description, this species was mentioned by Silliman, Jr., (Am. J. Sci. [2], iii, 409, 1847), as a mixture of carbonate of magnesia, with the hydrous carbonate of nickel, and afterwards by Shepard, under the name *hydro-nickel-magnesite*, as a hydrous carbonate of nickel and magnesite, (Am. J. Sci. [2], vi, 250). The color fades in different specimens from a clear green into white or grayish-white, showing that the nickel is not essential to the species.

Platinum, p. 546.—The author is informed by J. E. Teschemacher that he has detected a large proportion of platinum with the gold of California. In an ounce of the gold in fine grains, he found about fifty granules of pure platinum. A portion of them were boiled in strong nitric acid to test their platinum character. The proportion of platinum in the gold, Mr. Teschemacher observes, is about as large as with that of South America—a fact of great interest to the arts as well as science.

Praseolite, p. 294.—Rammelsberg, by making the iron in Erdmann's analysis peroxyd in place of protoxyd, obtains the formula $(\dot{\mathrm{R}}^3\,\dddot{\mathrm{Si}}+3\,\not{\mathrm{R}}\,\dddot{\mathrm{Si}})+3\dot{\not{\mathrm{H}}}$, making it an iolite which has lost 1 $\dddot{\mathrm{Si}}$ and received 3 $\dot{\not{\mathrm{H}}}$.

Pyrallolite, p. 259.—According to Bischof, pyrallolite is an altered augite, which species it approaches in composition.

Pyrargillite, p. 289.—According to Bischof, Pyrargillite is allied to the Fahlunite series, and is a result of the alteration of iolite. (Lehrb. der phys. u. chem. Geologie, ii, 375; Ramm. 4th Supp. 192).

Pyrosclerite, p. 263.—Analysis by Svanberg of a green mineral from Taberg in Wermland, near chlorite or green mica in appearance, (K. V. Ac. H. 1839, 155),

$\dddot{\mathrm{Si}}$ 35·76, $\not{\mathrm{A}}\mathrm{l}$ 13·03, $\dot{\mathrm{Fe}}$ 6·24, $\dot{\mathrm{Mn}}$ 1·64, $\dot{\mathrm{Mg}}$ 29·27, $\dot{\mathrm{K}}$ 2·07, $\mathrm{Mg\,F}$ 1·10, $\dot{\not{\mathrm{H}}}$ 11·76=100·92.

Rammelsberg thence deduces the formula $2\,\dot{\rm R}^3\,\dddot{\rm Si}+\overline{\rm Al}\,\dddot{\rm Si}+5\,\dot{\rm H}$, (4th Supp. 193). For Vermiculite, which is closely related, see pages 291 and 696.

PYROXENE, p. 266.—Analysis of an asbestus from Staten Island, compact in texture, (rockwood), with a greenish color, by L. C. Beck, (3d Rep. Regent's Univ. on State Collections, Albany, 1850, p. 132),

$\dddot{\rm Si}$ 55·20, $\dot{\rm Mg}$ 30·73, Oxyd of iron 11·82, $\dot{\rm H}$ 2·25=100.

Considering the iron in the mineral as protoxyd it affords for the oxygen of the protoxyds and silica (excluding the water) 14·44 : 28·68, or 1 : 2, the ratio in pyroxene, and giving the formula $(\dot{\rm Mg}, \dot{\rm Fe})^3\,\dddot{\rm Si}^2$.

Pyroxene occurs at Fine, St. Lawrence Co., N. Y., in crystals more than a yard in length, (Emmon's Jour. Agric. iii, 158). The "Idocrase" from Hall's on Muscolunge Lake, is pyroxene, according to Beck, giving the angles 87° and 93°.

SCHORLOMITE, p. 394.—In a recent examination of schorlomite, Mr. Crossley has obtained the following for the composition of this species:

$\dddot{\rm Si}$ 26·36, $\ddot{\rm Ti}$ 21·56, $\overline{\rm Fe}$ 22·00, $\overline{\rm Mn}$ *trace*, $\dot{\rm Ca}$ 30·72, $\dot{\rm Mg}$ 1·25=101·89.

There may be still some titanic acid with the silica. The state of oxydation of the iron was not particularly determined. But considering it protoxyd, as indicated by the excess in the analysis, it affords the formula $\dot{\rm Fe}\,\dddot{\rm Si}+\dot{\rm Ca}^3\,\ddot{\rm Ti}$. (Private communication).

SERPENTINE.—METAXITE.—MARMOLITE, p. 256.—The serpentine localities of Texas, Lancaster Co., Pa., afford many varieties of serpentine, or serpentine-like minerals, which so graduate into one another that it is difficult to distinguish them into species. Shepard's williamsite (p. 256) is from this locality. The following are other analyses of allied varieties: 1, 2, W. H. Brewer, (Silliman, Jr., Proc. Amer. Assoc. in 1849, p. 134); 3, G. J. Brush, (private communication),—to which we add other analyses; 4, from Villa Rota on the Po, Delesse, (Ann. d. Mines, [4], xiv, 78); 5, from near Dillenberg, Schnabel, (Ramm. 4th Supp. 200); 6, from Zoblitz, C. Schmidt, (J. f. pr. Chem. xlv, 14); 7, from Hoboken, New Jersey, T. H. Garrett, in the Lab. of J. C. Booth, Philad., (private communication from Prof. Booth):

	$\dddot{\rm Si}$	$\overline{\rm Al}$	$\overline{\rm Fe}$	$\dot{\rm Fe}$	$\dot{\rm Mg}$	$\dot{\rm H}$
1. "*Green Picrolite,*"	44·25	4·90	—	3·67	34·00	10·32, $\dot{\rm Ni}$ 0·69=99·83, S.
2. "*Slaty Serpentine,*"	44·58	3·03	6·15		34·51	12·38=100·65, Silliman.
3. "*Williamsite,*"	45·02	3·35	—	—	37·75	13·01=99·13, Brush.
4. *Slaty, grayish-green,*	41·34	3·22	—	5·54	37·61	12·06=99·77, Delesse.
5. *Massive, pale orange-green,*	41·70	7·04	—	26·95	10·26	11·58, $\dot{\rm Ca}$ 3·34=100·87, S.
6. "*Asbestus,*"	43·70	2·76	—	10·03	29·96	12·27, $\dot{\rm Na}$ 1·98=100, S.
7. *Marmolite, N. J.,*	42·32	0·66	—	1·28	42·23	13·80=100·29, Garritt.

The *Williamsite* closely resembles the slaty serpentine, and both appear to be impure varieties of the species serpentine.

The *Marmolite* gives for the oxygen of the protoxyds, silica and water 16·68 : 21·09 : 12·27, which does not vary essentially from the ratio in serpentine. Hermann's formula requires the percentage, silica 40·13, magnesia 44·23, water 15·64.

[The formula of serpentine, p. 255, should read $2\,\dot{\rm Mg}^3\,\dddot{\rm Si}^2+3\,\dot{\rm Mg}\,\dot{\rm H}^2$].

SORDAWALITE, *Norkenskiöld's* Bidrag, p. 86.—Massive; no cleavage apparent. H.=2·5—3. 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,

$\dddot{\rm Si}$ 49·4, $\overline{\rm Al}$ 13·8, $\dot{\rm Fe}$ 18·17, $\dot{\rm Mg}$ 10·67, $\dddot{\rm P}$ 2·68, $\dot{\rm H}$ 4·38=99·10.

Supposed by Berzelius to be a mixture of a silicate and phosphate, the silicate corresponding to $(\dot{\rm Mg}, \dot{\rm Fe})^3\,\dddot{\rm Si}^2+\overline{\rm Al}\,\dddot{\rm Si}^2$, which is essentially the formula of Wichtyne, p. 345.

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.

Sodalite, p. 368.—The blue mineral from Litchfield, Me., described as sodalite, p. 366, is described by Dr. C. T. Jackson, (Am. J. Sci. [2], i, 119), under the name cancrinite, a name originally applied by G. Rose to the sodalite from the Ilmen Mts., but subsequently to another species. Dr. Jackson obtained

$\bar{\dddot{\text{Si}}}$	$\dddot{\text{S}}$	$\bar{\dddot{\text{Al}}}$	$\dot{\text{Na}}$	$\dot{\text{Mn}}$	$\dot{\text{Mg}}$	$\dot{\text{Ca}}$	$\dot{\text{H}}$
35·40	6·46	31·75	17·58	6·46	1·80	1·86	0·86

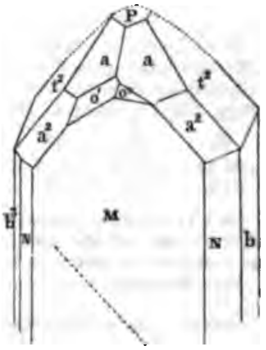
If the sulphur is in the state of sulphuret instead of sulphuric acid, it would give for S 2·59, and a loss in the analysis of 3·75. Dr. Jackson, (in a private communication), says that he is satisfied that part of the sulphur is in the state of sulphuret of sodium, and not as sulphate, since it gave sulphuretted hydrogen with acids.

The analysis corresponds rather nearly with some of the analyses of nosean, p. 369.

The mineral called nepheline in the same place, he now says is cancrinite or davyne, (p. 324).

Spathic Iron, p. 444.—Schnabel has made a series of analyses of spathic iron from different localities, which are published in Rammelsberg's 4th Supplement, p. 209.

Spodumene, p. 339.—The annexed figure of a crystal of Spodumene, from Norwich, Mass., has been made by the author from a specimen belonging to Mr. Charles Hartwell. Mr. Hartwell had measured the angles, and presented a notice of the crystal to the meeting of the American Scientific Association at Cambridge, in 1849. On examination the author finds that the crystal is monoclinic, and further that Spodumene is actually isomorphous with Pyroxene. The annexed figure represents the crystal as it is, with a vertical plane b² on the right and the corresponding one on the left wanting, and also with the two planes o′ and o″ unmated; moreover the back planes of the summit are absent, as the crystal is not entire or is broken on that part. The edge of intersection of o′ and o″ is uncertain, as the surface has been abraded. But the rest of the faces figured are smooth, though not bright. The crystal which Mr. Hartwell's zeal has brought to light is 2¼ inches long, 1⅝ inches wide, and 1 inch thick. The color is grayish, with a tinge of green. Besides the usual cleavages—the orthodiagonal perfect, and the prismatic scarcely less so—there are distinct traces of cleavage parallel to each orthodiagonal edge of the pyramid a—a direction pointed out on the figure by the dotted line on plane M. The surface of plane M moreover is very finely crossed by lines corresponding to this cleavage direction. The crystal is bisected along its orthodiagonal section, and on holding one of the halves up to the light it is seen to be translucent, and marked throughout with the same lines as on the surface.



The following are the angles, as observed by Mr. Hartwell and by the author:

	Hartwell.	Author.
N : N	87°	87°
N : N (lateral angle)	93°	93°
N : M	133°	133° 30′
N : b	137°	136° 30′
N : b²	153°	154°
M : b²		107°
M : t²		106°—107°
M : P		69° 40′
M : a	100° 30′	100° 30′
M : a²	116°	116°
M : o′		127°
M : o″		140°
t² : t² (over P)		79° 30′
t² : b	140°	139° 45′
a² : t²		140° 30′
a : a (front)	117°	117°

The crystallographic expressions for the planes are indicated in the lettering, except for the planes o′, o″, which are not determinable with certainty. In Naumann's system of notation they are:—

0P	3P	∞P∞	∞P′∞	∞P′3	P	2P	2P′∞	3P3	mPn
P	N	M	b	b³	a	a²	t²	o′	o″

There has not been time for calculating the angles, before going to press.

STEATITE, p. 251.—Rammelsberg deduces from the best analyses of steatite the formula $\dot{Mg}^6\,\dddot{Si}^5$ or $\dot{Mg}^3\,\dddot{Si}^2+3\,\dot{Mg}\,\dddot{Si}$.

STEATITIC PSEUDOMORPHS—RENSSELAERITE, (*Emmons*), is a compact steatitic rock occurring abundantly in northern New York, in the towns of Fowler, Dekalb, Edwards, Russel, Gouverneur, Canton, and Hermon, St. Lawrence Co. It has a fine texture and occurs of various colors, gray, whitish, greenish, brownish, and sometimes black. It is soft (H.=3—4), and translucent, and receives a smooth surface by friction. G.=2·874. The mineral has often the cleavage of augite, and its crystalline forms, and appears to be pseudomorphous after that and other mineral species, affording an example of steatitic pseudomorphism on a large scale.

Composition.—Analysis by Beck, (Min. N. York, p. 297); and also of an allied steatitic augite by Beudant:

$\dddot{Si}$	$\ddot{Fe}$	$\dot{Fe}$	$\ddot{C}$	$\dot{Mn}$	$\dot{H}$
59·75	3·40	—	1·00	0·78	2·85=99·90, Beck.
60·65	—	4·18	4·95	—	4·38=100·16, Beudant.

This mineral, on account of its softness, translucency, and fine texture, is worked in a lathe into inkstands and other articles, which have a very neat appearance.

A steatitic Pleonast from Monzoni, has afforded the following results: 1, Städler, (Pogg. lxii); 2, Marignac, (Bib. Univ. vi, 303, Jan. 1848):

$\dddot{Si}$	$\ddot{Al}$	$\ddot{Fe}$	$\dot{Mg}$	$\dot{Ca}$	$\ddot{Mn}$	$\dot{H}$
31·10	17·50	2·76	29·69	5·56	—	13·67=100·28, Städler.
37·5	15·7	4·6	25·8	8·7	1·7	6·0 =100·0, Marignac.

Such pseudomorphs often retain some portion of the original material unaltered, or in different states of alteration, and therefore identity of composition, or a regular chemical compound, is seldom to be expected.

For other analyses of steatitic pseudomorphs, see p. 253.

STRONTIANITE, p. 197.—Analyses: 1, Becks, (Pogg. l, 191); 2, Schnabel, (Ramm. 4th Supp. 215):

		$\dot{Sr}\ddot{C}$	$\dot{Ca}\ddot{C}$	
1.	Hamm in Westphalia,	94·70	5·22	$\dot{H}$ 0·08=100, Becks.
2.	" "	91·71	7·89	$\dddot{Si}$ and loss 0·4=100, Schnabel.

Schnabel's analysis corresponds to 1 of $\dot{Ca}\ddot{C}$ to 8 of $\dot{Sr}\ddot{C}$.

SULPHURIC ACID IN MINERAL SPRINGS, p. 183.—The sulphuric acid waters of Alabama, Genesee Co., N. Y., have been analyzed by H. Erni and W. J. Craw, with the following result, for 1000 parts of the water, (Am. J. Sci. [2], ix, 449):

Free $\dddot{S}$	$\dot{Fe}\dddot{S}$	$\ddot{Al}\dddot{S}^3$	$\dot{Ca}\dddot{S}$	$\dot{Mg}\dddot{S}$	$\dot{K}\dddot{S}$	$\dot{Na}\dddot{S}$	$\dddot{Si}$	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. It tastes sharply acid, affecting the teeth.

TALC, p. 251.—Analysis of a variety from Roschkina, district of Slatoust in the Ural, by Hermann, (J. f. pr. Ch. xlvi, 231):

$\dddot{Si}$ 59·21, $\dot{Mg}$ 34·42, $\dot{Fe}$ 2·14, $\dot{Ni}$ 0·12, $\dot{H}$ 1·00, $\ddot{C}$ 2·50=99·39.

Formula, $\dot{Mg}^4\,\dddot{Si}^3$. Color greenish-white.

TACHYLITE.—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,

$\dddot{\mathrm{Si}}$	$\ddot{\mathrm{Ti}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Na}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{H}}$&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 $\dot{\mathrm{R}}^3\dddot{\mathrm{Si}}^2+\dddot{\bar{\mathrm{Al}}}\dddot{\mathrm{Si}}$. But the species is probably bad. A similar mineral from Säsebühl near Dransfeld, afforded Schnedermann,

$\dddot{\mathrm{Si}}$ 55·74, $\dddot{\bar{\mathrm{Al}}}$ 12·40, $\dot{\mathrm{Fe}}$ 13·06, $\dot{\mathrm{Mg}}$ 6·92, $\dot{\mathrm{Na}}$ 3·88, $\dot{\mathrm{K}}$ 0·60, $\dot{\mathrm{Mn}}$ 0·19, $\dot{\mathrm{H}}$ 2·78=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* 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 Tachylite, (and not Tautolite, as it has been called); also in a trap dyke at Johnsburg, Warren Co., N. Y.

TETRADYMITE, p. 414.—The Virginia tellurium ore, referred to tetradymite, was first made known by C. T. Jackson, in the Am. J. Sci. [2], vi, 188, 1848, where after some blowpipe trials, it was published as essentially a telluret of lead. Two analyses by Jackson, recently made (private communication), have afforded

Te	Bi	Au, $\dddot{\bar{\mathrm{Fe}}}$ earthy matter	S and loss	
31·61	55·26	3·6,	9·53,	Se *trace*.
32·550	56·566	" " 2·7	" 3·65,	Se *trace*=95·466.

The tests and trials gave no weighable quantity of selenium, and in this respect the results differ widely from Fisher's, (p. 415). Dr. Jackson adds the following particulars with regard to the mineral. In foliated scales or lamellar masses, frequently intersecting one another. Lustre splendent and metallic. Streak lead-gray. H.=1. Laminæ or scales flexible like graphite, and sectile.

Occurs in mica slate and in quartz veins in nodules and incrusted with yellow oxyd of bismuth, associated and mixed with native gold, or having gold between its folia, the proportion of gold amounting to 2 to 5 per cent. Also incrusting masses of gold, and sometimes the gold is marked with impressions of the edges of the crystals of the tellurium ore.

TITANIC IRON, p. 482.—Hermann infers that titanic iron contains protoxyd of iron and titanic acid, instead of peroxyds of iron and titanium, as suggested by Rose, (see p. 483), and he makes $\dddot{\bar{\mathrm{Fe}}}$, $\dot{\mathrm{Fe}}\mathrm{Ti}$, $\dot{\mathrm{Fe}}^2\mathrm{Ti}^3$ isomorphous, (J. f. pr. Ch. xliii, 50).

Rammelsberg objects to this view, remarking on the improbability of it, and stating that the hypothesis of isomorphism between compounds of the kind mentioned is altogether an assumption. The argument drawn by Hermann from the magnetism of the mineral is set aside by the observations of Rose and Scheerer, (Ramm. 4th Supp. p. 236).

TOURMALINE, p. 368.—Analyses by Hermann, (J. f. pr. Ch. xxxv, 282),

	$\dddot{\mathrm{Si}}$	$\dddot{\mathrm{B}}$	$\dddot{\bar{\mathrm{Al}}}$	$\dddot{\bar{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Li}}$	$\dot{\mathrm{Na}}$	
1. *Black*,	39·00	10·73	30·65	1·58	6·1	9·44	—	—	—,	$\ddot{\mathrm{C}}$ 2·50=100.
2. *Brown*,	37·80	9·90	30·56	0·50	12·07	1·42	2·50	0·50	2·09,	$\ddot{\mathrm{C}}$ 1·66=100.
3. *Green*,	40·54	11·78	31·77	—	3·65	6·44	0·90	2·09	—,	$\ddot{\mathrm{C}}$ 1·66, $\dddot{\bar{\mathrm{Cr}}}$ 1·17=100.
4. *Red*,	42·89	5·34	44·09	—	—	0·45	0·27	2·19	3·12,	$\ddot{\mathrm{C}}$ 1·66=100.
5. *Red*,	39·70	6·65	40·29	—	—	0·16	2·30	3·02	7·88=100.	

ULEXITE.—The species of borate, (see p. 217), analyzed by Ulex, from Chili, differs so widely from that examined by Hayes, that it seems to require a distinct appellation.

URANITE, p. 409.—Analysis by Werther, (J. f. pr. Ch. xliii, 332),

$\dddot{\bar{\mathrm{P}}}$ 14·00, $\dddot{\bar{\mathrm{U}}}$ 63·28, $\dot{\mathrm{Ca}}$ 5·86, $\dot{\mathrm{Ba}}$ 1·08, $\dot{\mathrm{H}}$ 14·30=98·47,

agreeing with the result obtained by Berzelius. The mineral was from Autun.

VERMICULITE, p. 291.—The investigations of R. Crossley, making this mineral pyrosclerite, are sustained by Svanberg's analysis of a micaceous pyrosclerite, p. 691. It is of some interest to observe that the formula $2\dot{R}^3(\dddot{Si}, \overline{Al})^2+4\frac{1}{2}\dot{H}$, to which the mineral corresponds, (provided $\overline{Al}$ and $\dddot{Si}$ admit of mutual substitution), is the formula of pyroxene, excepting the water, it being equivalent to $\dot{R}^3(\dddot{Si}, \overline{Al})^2+2\frac{1}{4}\dot{H}$.

A locality of a mineral very similar to Vermiculite, exists at Phillipstown, Putnam Co., N. Y. The mineral is grayish-green, and occurs in foliated scales somewhat resembling talc, imbedded in a grayish-white mealy base.

VIOLAN, *Breithaupt*, Jour. f. prakt. Chemie, xv, 321.—Amorphous. Cleavage affording a slightly rhombic prism. H.=5—6. G.=4·233. Lustre waxy. Color dark violet-blue. Opaque. Fracture uneven to imperfectly conchoidal.

Violan is a silicate of alumina, magnesia, lime, much protoxyd of iron, soda, and manganese. 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.

This mineral occurs with magnesian epidote, at St. Marcel in Piedmont.

VOSGITE, p. 336.—The formula given for vosgite was deduced by Delesse for the Corsica mineral. Rammelsberg suggests that the mineral is labradorite, (4th Supp. 126).

WILLEMITE, p. 483—Analyses: 1, 2, Monheim, (Verh. nat. Vereins Rheinl. 1848, 157); 3, 4, Delesse, (Ann. d. Mines, [4], x, 211):

	$\dddot{Si}$	$\dot{Zn}$	$\dot{Fe}$
1. Stolberg,	26·90	72·91	0·35=100·16, Monheim G.=4·18.
2. "	26·53	69·06	4·36, $\dot{Ca}$ 0·41, $\dot{Mg}$ 0·18, $\ddot{C}$ 0·04=100·53, Monheim.
3. "	27·28	72·37	$\dot{Fe}$ 0·35=100, Delesse. [G.=4—4·16.
4. Franklin, N. J.,	27·40	68·83	0·87, $\dot{Mn}$ 2·9=100, Delesse. G.=4·154.

WOLFRAM, p. 403.—This species has been crystallographically examined by Descloiseaux, and shown to be monoclinic, (see p. 639). He gives the following angles, (fig. p. 403); $\bar{M}$ (front): ŏ=91° 10′—91° 30′, $\bar{M}$ (back): ŏ=88° 30′, $\bar{M}$: ŏ (above)=116° 49′, $\bar{M}$: ŏ (below)=115° 41′, e′ : e′=101°, e′ : P=91° 32′, $\bar{M}$: P=91° 59′.—*Ann. Ch. Phys.* [3], xxviii, 163.

WOLLASTONITE, p. 265.—Analyses: 1, J. B. Bunce, (private communication); 2, Rammelsberg, (4th Supp. 266):

	$\dddot{Si}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Fe}$
1. Grenville, U. Canada,	53·05	45·74	——	1·20=99·99, Bunce.
2. Harzburg, Hartz,	53·01	44·91	1·04	—— ign. 1·59=100·55, Rammelsb.

YTTROTANTALITE, p. 399.—The black Yttrotantalite from Ytterby, Sweden, (after its ignition) afforded H. Rose, (Pogg. lxxii, 155):

$\overline{Ta}$	$\dddot{W}$	$\dot{Y}$	$\dot{Fe}$	$\dot{U}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Cu}$
58·65	0·60	21·25	6·29	3·94	7·55	1·40	0·40=100·08

G.=5·67, after heating 6·40. Loss by ignition 3·9, 4·86, 5·54 per cent., and the color changes to yellowish-brown, without any appearance of glowing. The acid present was proved to be true tantalic acid.

ZWIESELITE, p. 466.—The Zwieselite has afforded Rammelsberg, (4th Supp. 247), $\overline{\overline{P}}$ 30·33, $\dot{Fe}$ 41·42, $\dot{Mn}$ 23·25, F 6·00=101. Formula $\dot{Fe}^4\overline{\overline{P}}+$Fe F.

Ratio of oxygen of protoxyds, peroxyds, silica, and water, in some silicates.

	$\dot{R}$	$\overline{R}$	$\dddot{Si}$	$\dot{H}$
Kerolite, *Delesse.*	1 :		2½	1½
Pimelite,	1 :		3	1
Melanolite, p. 679.	1 :	1½ :	3	1½
Algerite, Hunt's anal. 314.	1 :	6 :	12	3
Crossley's, 680.	1 :	3 :	7	1
Killinite, 339, 686.	1 :	6 :	12	4
Tachylite, 695.	1 :	1 :	3	

	$\dot{R}$	$\overline{R}$	$\dddot{Si}$
Chesterlite, p. 678.	1 :	2 :	8
Isopyre, 685.	1 :	1½ :	6
	1 :	3 :	6
Uniounite, 679.	1 :	6 :	7
Chladnite, 279, 688.	?1	:	3(or 3½).

Micas, see p. 687—690.

INDEX.

ERRATA AND ADDENDA.

Page 182, 12th and 13th lines from bottom, opposite Mica, the angles 25°, 30°, 31°, 32°, 34°, 37°, should be doubled, so as to read, 50°, 60°, 62°, 64°, 68°, 74°.

Page 191, 11th line from bottom, for "schwefelsaures," read "salz-saures."

" 219, 24th line from bottom, for "T," read "P."

" 227, 5th line from top, for "$\mathrm{N}\,\dot{\mathrm{H}}^4\,\dddot{\mathrm{S}}$," read "$\mathrm{N\,H^4\,O}\,\dddot{\mathrm{S}}$."

" 248, 12th line from top, dele "($\dot{\mathrm{Ca}}^3\,\dddot{\mathrm{Si}}^4+6\,\dot{\mathrm{H}}$, Ramm.)"

" 253, under Spadaite, for "G.=2·5" read "H.=2·5."

" 255, in formula of Serpentine, for "$2\,\dot{\mathrm{Mg}}^3$," read "$2\,\dddot{\rlap{--}\mathrm{Mg}}^3$."

" 261, 8th line from top, words "highly perfect" transfer to next line after "basal."

" 288, for "Samoite," read "Samoine."

" 294, in formula of Esmarkite, exchange the signs before and after $3\,\dot{\mathrm{H}}$, placing the = after, and the + before it; and in formula of Chlorophyllite, insert $+2\,\dot{\mathrm{H}}$ before the sign of equality.

Page 303, in Gerhardt's formula of Laumonite, for "$\dot{\mathrm{Ca}}^3\,\dddot{\mathrm{Si}}$," read "$\dot{\mathrm{Ca}}^3\,\dddot{\mathrm{Si}}^2$."

" 311, 3d line from bottom, for "Sarcoite," read "Sarcolite."

" 314, in formula of Liebnerite, for "H," read "$5\,\dot{\mathrm{H}}$ (or $4\frac{1}{2}\,\dot{\mathrm{H}}$)."

" 317, 7th line from bottom, last letter, for "a," read "*a*."

" 321, transfer Petalite to subdivision V, its crystallization being doubtful.

" 349, in the formula of Pyrope, for "$\dot{\mathrm{R}}\,\dddot{\mathrm{Si}}$," read "$\dot{\mathrm{R}}^3\,\dddot{\mathrm{Si}}$."

" 374, 21st line from bottom, for "Compton," read "Campton."

" 403, 10th line from bottom, for "*e*′ : e′," read "*e*′ : *e*′."

" 414, 4th line from bottom, transpose 59·6 and 35·9.

" 450, 10th line from bottom, for "$\dot{\mathrm{Fe}}$," read "$\dddot{\rlap{--}\mathrm{Fe}}$."

" 468, last line, for "$\rlap{--}\mathrm{Cu}^3\,\mathrm{As}$," read "$\dot{\rlap{--}\mathrm{Cu}}^3\,\mathrm{As}^2$."

" 523, 8th line from top, for "over P," read "adjacent."

" 539, 9th line from bottom, for "P : M," read "P on axis."

" 549, in line with analysis 6, for "2 : 1," read "3 : 1." The proportions in this and the other cases, are based on the usual atomic weight of gold, which is half that in the table on page 146.

Page 572, 11th line from bottom, for "III," read "II."

" 582, 5th line from top, before Iolite, insert "IOLITE GR. III."

" 637, in line with Ildefonsite, for "G 7,416," read "G 7·416."

" 651, 10th line from bottom, before Carmel, insert PUTNAM CO.

" 695. In place of the Analyses under Tetradymite, by Dr. C. T. Jackson, insert the following corrected result by him, (communicated to the Author since the former page was printed).—Te 35·05, Bi 58·80, S 3·65, Au, $\dddot{\rlap{--}\mathrm{Fe}}$, $\dddot{\mathrm{Si}}$ 2·70=100·20. Formula, as on page 414, $2\,\mathrm{Bi\,Te}^3+\mathrm{Bi\,S}^3$=Tellurium 35·9, sulphur 4·5, bismuth 59·6.

Page 696, in part of the edition, dele part of 4th line from bottom, beginning with Vauxite.

ADD:—

Page 312, after Analcime.—GLOTTALITE, *Thomson*. Monometric; vitreous; colorless or white. Composition.—$\dddot{\mathrm{Si}}$ 37·01, $\dddot{\rlap{--}\mathrm{Al}}$ 16·31, $\dddot{\rlap{--}\mathrm{Fe}}$ 0·50, $\dot{\mathrm{Ca}}$ 23·93, $\dot{\mathrm{H}}$ 21·25=99. Formula, $\dot{\mathrm{Ca}}^3\,\dddot{\mathrm{Si}}^2+\dddot{\rlap{--}\mathrm{Al}}\,\dddot{\mathrm{Si}}+9\,\mathrm{H}$. From greenstone, near Port Glasgow.

Page 408, at bottom.—URANGREEN, *Hartmann*, (Urangrün, Uranchalzit), a basic sulphate of the oxyds of copper and uranium. From Joachimstahl.

Page 440, under CHLOROPAL.—Analysis of PINGUITE, from Wolkenstein, by Kersten, (Schw. J. lxvi. 9), $\dddot{\mathrm{Si}}$ 36·90, $\dddot{\rlap{--}\mathrm{Al}}$ 1·8, $\dddot{\rlap{--}\mathrm{Fe}}$ 29·50, $\dddot{\rlap{--}\mathrm{Mn}}$ 0·15, $\dot{\mathrm{Fe}}$ 6·10, $\dot{\mathrm{Mg}}$ 0·45, $\dot{\mathrm{H}}$ 25·10=100. Formula, $\dot{\mathrm{Fe}}\,\dddot{\mathrm{Si}}+\dddot{\rlap{--}\mathrm{Fe}}^2\,\dddot{\mathrm{Si}}^3+15\,\dot{\mathrm{H}}$. G.=2·3—2·35. Feel greasy.

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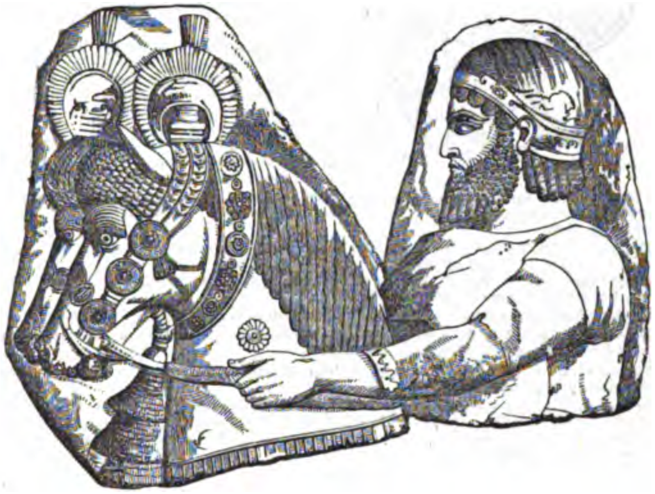

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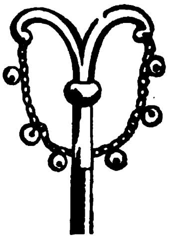

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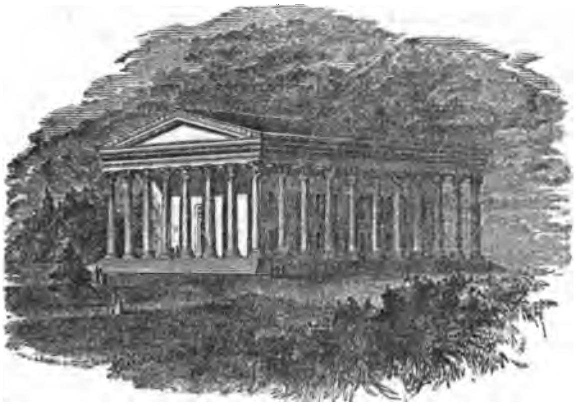

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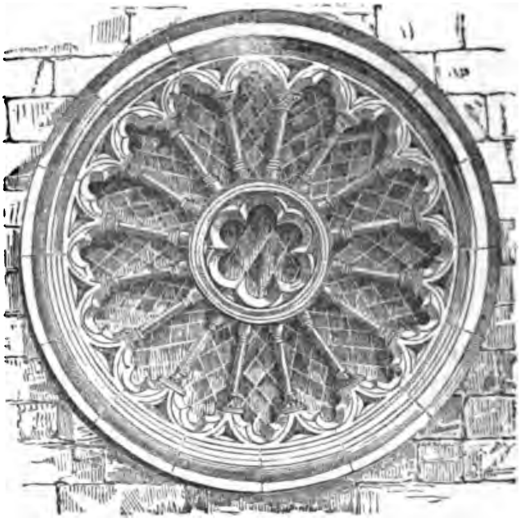

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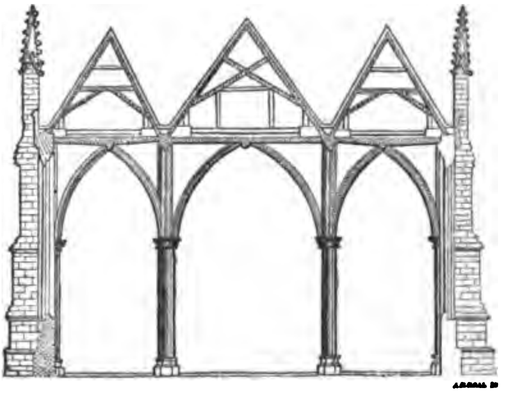

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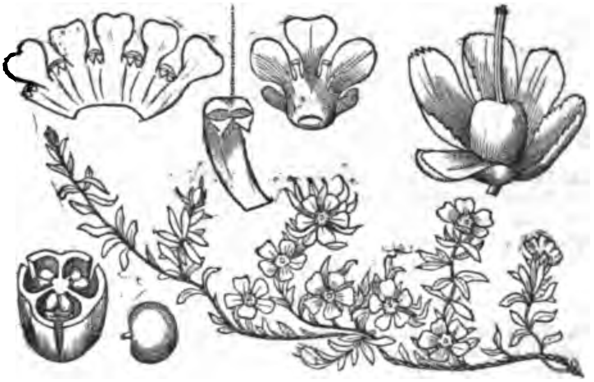

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