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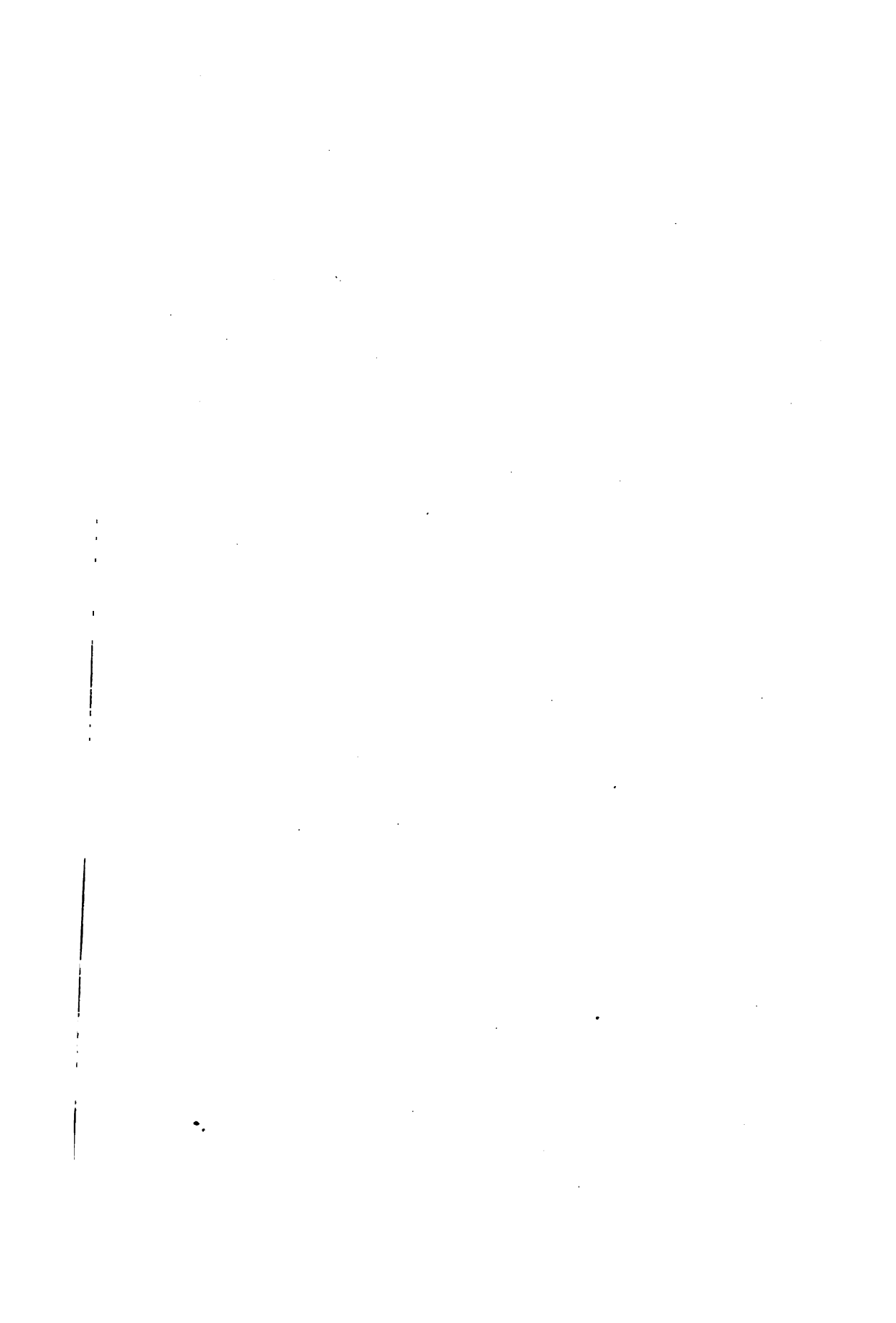
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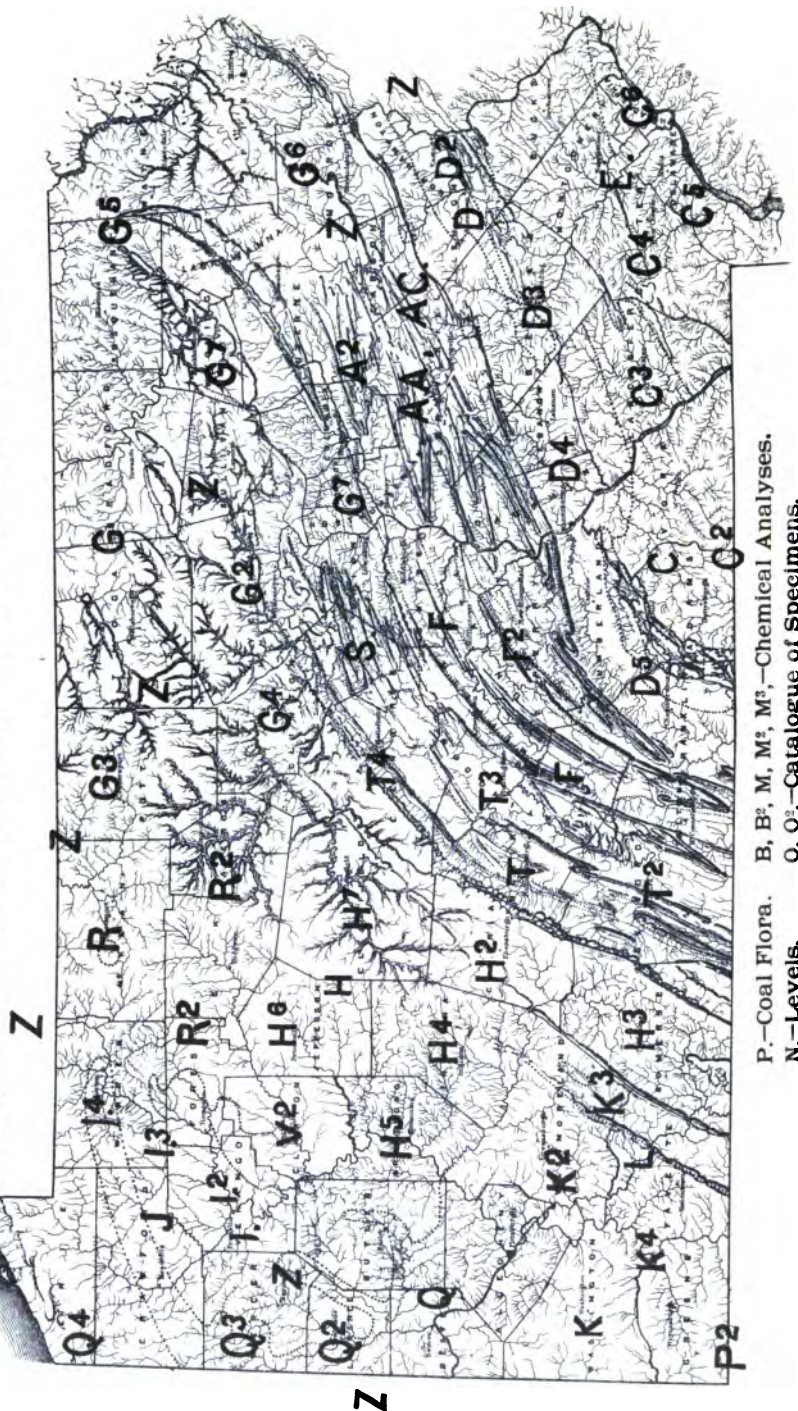








# Geological Reports of Pennsylvania, 1874-1884.



P.—Coal Flora. B, B<sup>2</sup>, M, M<sup>2</sup>, M<sup>3</sup>.—Chemical Analyses.  
N.—Levels. O, O<sup>2</sup>.—Catalogue of Specimens.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA.  
REPORT OF PROGRESS C<sup>s</sup>.  
PART I.  

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FIELD NOTES  
IN  
DELAWARE COUNTY,

BY

C. E. HALL,

WITH

A COLORED GEOLOGICAL MAP OF THE COUNTY,

AND

THIRTY-NINE PHOTOGRAPHIC PICTURES OF THE GRANITE  
QUARRIES, THE KAOLIN MINES, THE SERPENTINE  
OUTCROPS, AND THE CASTLE ROCKS,

PUBLISHED IN ADVANCE OF THE GEOLOGICAL REPORT ON  
DELAWARE COUNTY, PART 2, BY J. P. LESLEY.

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HARRISBURG:  
PUBLISHED BY THE BOARD OF COMMISSIONERS  
FOR THE SECOND GEOLOGICAL SURVEY.

1885.

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## LETTER OF TRANSMITTAL.

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TO HIS EXCELLENCY, GOVERNOR ROBERT E. PATTISON, *ex-officio*  
*Chairman of the Board of Commissioners of the Second*  
*Geological Survey of Pennsylvania:*

SIR: I have the honor to submit the report made to me in 1880 by Mr. Chas. E. Hall on the results of his long continued and careful study of the geology of Delaware county; with a geological map of the county, colored by himself, to show the areas occupied by the older and newer gneiss formations respectively; the belt of quaternary sands and clays stretching along the Delaware river; the most notable patches of Bryn Mawr gravel left upon the upland; and all the outcrops of serpentine which he could find, or clearly distinguish in the county.

This report, which consists wholly and simply of a carefully classified and verified geographical list of the exposures which he studied in all parts of the county, arranged in the order of townships, with lists of all the known species of minerals seen by him in place, or existing in the collections of the Survey, and in the museums of private individuals, I have hitherto withheld, with a view to such further special local geological field work, in various parts of the county, as seem to me to be necessary, in addition to his, data for writing out a complete geological report on Delaware county.

A certain amount of such additional field work has been done, but not enough to enable me to write a report on the county which would be satisfactory to myself or to others.

A survey of the region around Media has been made, for the purpose of discovering the true relationship of the numerous exposures of serpentine to the gneiss country in which they occur. This map in ten foot contour lines remains incomplete, and must be further extended.

(v C<sup>s</sup>.)

A local map of the Castle rocks and vicinity has also been prepared, but requires to be connected with the Media map.

A special local survey map of the extreme north-east corner of Radnor township is requisite for a clear understanding of the geology of the slate belt, and its included serpentine rocks, of which I have a special account kindly furnished by Mr. Theodore D. Rand, with an illustrative line-map of his own ready for use.

A local map of the immediate vicinity of the so-called granite quarries, and a careful study of the exhibitions along the contact of the Delaware gravels, and the escarpment of gneiss facing the river, can hardly be omitted.

A local survey and carefully constructed map in contour lines of the vicinity of the Kaolin quarries, to the extent of several square miles, in the western part of the county is absolutely necessary, as a basis for a practical understanding and clear description of those valuable and curious deposits. Private explorations have just been undertaken, and are being energetically prosecuted, which will probably result in throwing a clear light on the situation and extent of the porcelain clays, and show how they have been formed out of the decomposition of the feldspathic rocks on which they lie, but until these explorations have been carried forward to a successful issue, it would be worse than useless to publish what I have written on the subject.

I therefore withhold my large MS. report on the geology of Delaware county, until I can so revise and supplement it, that it will be reasonably satisfactory to myself and the citizens of the county ; for, an imperfect or erroneous report on any district of the State can only do mischief.

Mr. Hall's descriptions have lost none of their value by the delay of publication, and will be found useful if published as the first part of a report on the county ; especially as I can present to the public the large number of photographic illustrations of the granite quarries, the Kaolin mines and the Castle rocks already printed from the negatives of Mr. E. B. Harden, who photographed the objects from points of view selected by himself, in view of the geological points to be illustrated.

In Mr. Hall's explorations in Delaware county he had no reason to complain of any lack of interest in his work manifested by the citizens of the county, from many of whom he received valuable information. It must be especially noted that Mr. J. H. Smedley not only verified all the serpentine outcrops which Mr. Hall had observed, but indicated several others which Mr. Hall had not encountered; so that there is every reason to believe that the surface indications of serpentine on the county map are complete. And this is of great importance in view of the striking fact that all these exhibitions on the map are included in the areas colored to represent the newer or upper gneiss system; a statement which will be fully developed in the second part of this report, when published.

Respectfully,

J. P. LESLEY.

PHILADELPHIA, *June 15, 1885.*



## LETTER OF Mr. C. E. HALL.

---

Prof. J. P. LESLEY, *State Geologist* :

SIR: I have the honor to submit to you the following report on Delaware county :

There have been a large number of specimens collected throughout the entire belt of crystalline rocks from Trenton in New Jersey to the Brandywine creek, on the western edge of Delaware county. These specimens have been studied and a number of them analyzed by Prof. F. A. Genth and F. A. Genth, Jr.

The collections were begun in Bucks county by Mr. W. A. Fellows in 1877. Mr. Fellows collected specimens along the Delaware river opposite and above Trenton, and also along part of the course of the Neshaminy creek.

In 1878, Mr. M. Carraher, aided by Mr. E. V. d'Invilliers, completed the collections on the Neshaminy creek and finished the work of collecting as far west as the Schuylkill river in Montgomery and Philadelphia counties.

Mr. d'Invilliers was detailed for other work, and in 1879 Mr. Carraher and Mr. N. A. Stockton completed the work west of the Schuylkill river and through Delaware county as far west as the Brandywine creek.

Specimens were obtained in Delaware county along Cobb's, Chester, and Brandywine creeks.

It will be seen from report O<sup>2</sup> that the specimens were collected through part of Chester county.

Great care has been observed in selecting these specimens, and the collections reflect credit on the assistants.

Mr. Smedley was employed in 1881 to locate outcrops of serpentine and the associated minerals. He discovered some localities in Chester, southern Middletown, Easton, the

eastern edge of Concord and the south-eastern edge of Thornbury townships.

I am indebted to Mr. E. B. Harden for the photographic illustrations of quarries accompanying this report. The geological features brought out by these views is very satisfactory and conclusive, as illustrating the fact that the crop lines or bottoms, as they are called by the quarrymen, are true lines of bedding of the measures.

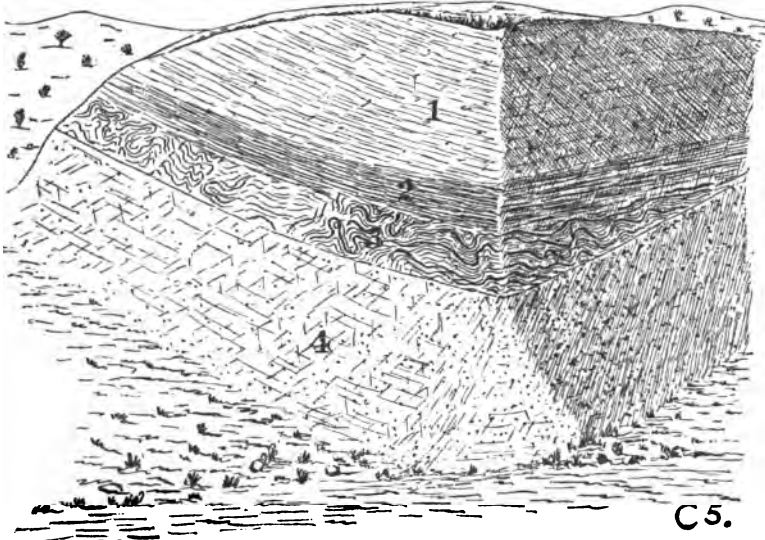
The cleavage, I am satisfied, has been mistaken in many places for the bedding. In report C<sup>6</sup> many of my observations have been made on the cleavage planes and not the bedding.

A fine illustration of cleavage and bedding may be seen at the Fairmount water-works on the Schuylkill river, in Philadelphia. The bedding is undulating and pitches to the northward.

As an explanation of the multiform contortions visible at nearly all the exposures of the micaceous gneiss in this section of the country, I offer an illustration which I find in an old note-book under date of 1874, of an exposure of Champlain clay on the west side of Lake Champlain, in Westport, Essex county, New York. The accompanying figure illustrates an exposure of clay and sand.

The clay is banded with strata which are discolored by carbonaceous matter. Near the base of the clay the dark bands are more prominent, and the strata or bands of the lower portion of the clay mass are contorted as indicated in the figure. There seems to have been a movement in the clay mass, represented in the figure to the left, but this movement would scarcely explain the contortions as seen, unless the movement were at an angle to each of the exposures, which are at right angles to each other. The light lines crossing the contorted beds appear like miniature lines of fault and seem to have had an influence upon the contortions. The whole exposure is not more than ten feet high, and the contortions are confined to a thickness of about two feet.

Similar contorted beds are often met with in the clay deposits in the Hudson river valley, but I never have found



1. *Clay with dark strata discolored by carbonaceous matter.*
2. *Clay with dark strata wider and more distinct.*
3. *Clay with dark strata contorted.*
4. *Yellow sand.*

an explanation for them other than the one here given. I have no doubt that this will serve as a ready explanation for the contorted micaceous gneisses, and where an exposure of these rocks presents a most complex structure it will be found that close at hand a simple horizontal or undulating bedding exists and usually is evident.

C. E. HALL.

PHILADELPHIA, 1880. .





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REPORT OF PROGRESS, C'.

1881.

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REPORT OF A GEOLOGICAL SURVEY  
OF  
DELAWARE COUNTY,

BY  
CHARLES E. HALL.

---

CHAPTER I.

GENERAL REMARKS.

Owing to the complicity of the geological structure and the difficulty of obtaining exposures of the rock in many places and over large areas, the conclusions arrived at have been obtained after long and careful comparison and close study of the rocks.

Not having any definite horizon within the mass of metamorphosed measures in Delaware county, the work has progressed very slowly. It will be seen in report C' that along the southern edge of the older syenites of the Laurentian the Potsdam Sandstone extends in an almost unbroken belt from the Delaware to the vicinity of the Schuylkill river. West of the Schuylkill river, and south of the Chester county limestone valley, the rock of this horizon (Potsdam) has not been identified.

The micaceous and garnetiferous schists which overlie the Potsdam Sandstone and Laurentian syenites east of the Schuylkill, are found throughout Delaware county resting

upon the Laurentian syenites, but I have nowhere detected the Potsdam Sandstone intervening.

At the time when report C' was published it was supposed that the schistose gneissic rocks found along the Schuylkill river south of the Laurentian belt, extended westward to Chester creek, and were there cut off by the Laurentian syenites.\*

Subsequent investigation however has demonstrated the fact that Chester creek has cut through these superficial schistose gneisses in many places, exposing the Laurentian syenites along its course; but a short distance west of the creek the schistose gneisses again occur and extend westward beyond the Brandywine creek and into Chester county.

There are apparently no faults of any consequence within Delaware county to cast a shadow of doubt on the true relations of the schistose rocks to the Laurentian.

The mica schists associated with, or in close proximity to the serpentines, rest unconformably upon the Laurentian syenites, and from the distribution of the rocks they appear to lie in shallow basins, veneering the Laurentian.

Many of the syenitic rocks of the Laurentian are weathered to such an extent that it is, in many cases, impossible to distinguish them from the adjacent and overlying feldspathic schistose gneisses, and it is therefore impossible to draw a definite dividing line between them.

An important fact arrived at is, that throughout a greater portion of the gneissic and schistose belt the cleavage has been, in many cases, mistaken for the bedding of the rock.

The usual strike of the cleavage throughout the schistose gneissic rocks of southern and south-eastern Delaware county is north about ten degrees east; the cleavage dip varies from seventy-five to ninety degrees.

The average or usual strike of the measures east of the Schuylkill river is north seventy degrees east.

The dips indicated in the vicinity of Jenkintown on the map accompanying report C' are undoubtedly erroneous, and are in all probability cleavage planes. The true bed-

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\* See Prof. Lesley's letter of transmittal C<sup>6</sup>, ix.

ding of the measures is nearly horizontal and undulating. (See Report C°, p. ix, b.)

The so-called "bottoms" are more or less distinct lines of separation throughout the gneissic mass, and are the true lines of bedding. These "bottoms" usually maintain their relative distance from each other and cross the cleavage planes at angles, which are usually uniform in each locality.

In many cases, especially where the rock is much weathered, the tranverse lines of bedding or 'bottoms' are obliterated or very indistinct, and the cleavage planes strongly marked. This is especially the case where the rock is very micaceous and schistose.\*

In most of the quarries throughout southern Delaware county the "bottoms" or bedding is sharply defined. The accompanying plates demonstrate this fact.

There have been no deep excavations at any of the quarries in the county, and the most desirable building stone seems to be confined to a limited horizon or vertical thickness. The bedding of the rock being at slight angles readily explains the fact that rock of a similar character is found over a large area.

The fact that the "bottoms" are true lines of bedding may be proven by one instance in particular. At Deshong's quarry, on the east bank of Ridley creek, in Ridley township, a short distance north of the Philadelphia and Wilmington pike, the gray feldspathic granitic gneiss, which is particularly sought after for building purposes, is overlaid by a dark colored micaceous and schistose gneiss with hornblende; as shown in Plate VI.

These facts tend to reduce the hypothetical thickness of the crystalline rock of south-eastern Pennsylvania to a minimum.

I would suggest that the thickness of the measures, excluding the Laurentian, might be one half that suggested by Prof. Lesley in report C°, p. xii. This is of course a mere approximation and may be considered as a guess.

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\* A fine illustration of cleavage and bedding may be seen at the Fairmount Water Works, on the left bank of the Schuylkill river, in Philadelphia. The bedding at this point shows a northward dip, while the cleavage is  $\pm 90^\circ$ .



The serpentines occupy shallow synclinal basins and are the most recent of the metamorphosed rocks in Delaware county. Whether there are any gneissic rocks above the serpentines in the county is still questionable.

The Cambrian measures, with the exception of a small area of South Valley Hill slates, Potsdam sandstone (No. I) and Limestones (No. II) do not appear in Delaware county. The schistose micaceous gneisses rest directly upon the Laurentian syenites.

East of the Schuylkill river, the schists rest upon the up-turned edges of the Potsdam and Limestones, and prove the relative age conclusively.

The serpentine belts which cross the Schuylkill river are a continuation of, and belong to the same horizon as the Delaware county serpentines.

The southern belt of serpentine, which crosses the Schuylkill river at Lafayette, extends to Bryn Mawr, in Montgomery county. In the immediate vicinity of Bryn Mawr, however, in Delaware county, there is no known occurrence of serpentine, though it may exist close to the county line.

Serpentine occurs close to Darby creek, a short distance west of Bryn Mawr, and on the same general line of strike, and associated with the same rocks as the Montgomery county belt, which lies to the east.

The serpentines which occur near the north-east corner of Delaware county, in Radnor township belong to the same horizon as that in the central part of the county, and the associated rocks are also the same.

The probability is, that the two belts which cross the Schuylkill river are not representative of two arms of a sharp synclinal, as suggested in report C<sup>s</sup>, but that they lie in two shallow saucer-shaped basins along synclinal folds which are parallel to each other.

When the geological map accompanying report C<sup>s</sup> was published the rocks in the north-western portion of Delaware county had not been classified, and the serpentines were supposed to rest directly upon the syenites of the Laurentian.

This has been disproved, and the serpentines are found

to be associated with schistose and gneissic rocks, different from any found in the syenite series, and through the entire serpentine range almost identical.

Corrugated micaceous slate and sandstone are prevalent in this series.

The rocks associated with the serpentine extend diagonally across Radnor township, Delaware county, and pass into Chester county, flanking the slates of the South Valley Hill or Hudson River slates on the south. (See report C<sup>s</sup>, p. 14.)

I have seen no locality where the serpentines rest directly upon the syenites of the Laurentian, though in many places they are in close proximity to them.

The group of sandstone, slates and schists with serpentine rests upon the Hudson River group throughout Radnor township, Delaware county; and the same relations between the groups can be traced through Chester county to the vicinity of the Brandywine creek, and probably further westward.

The schistose sandstone and gneisses associated with the serpentines extend east of the Delaware county line into Montgomery county, and occupy a small area between Mechanicsville on the north, and Bryn Mawr on the south. This area is wrongly colored Laurentian syenite on the map accompanying report C<sup>s</sup>.

What has become of the Cambrian measures south of the southern limit of the South Valley Hill is not satisfactorily explained. One fact is established, which is, that the rocks associated with the serpentine, or what may be termed the serpentine group, rests upon and flanks the Hudson River slates southward, and is itself flanked by Laurentian syenites on the south. Unconformity would explain the relations of these three groups which I consider satisfactorily demonstrated by their position.

There is a gradual transition from the Cambrian limestones (No. II.) into the slates of the South Valley Hill or the Hudson River group. The transition may be seen throughout the southern edge of the Chester valley. The

transition measures are considered equivalent to the Trenton limestone. See report C<sup>o</sup> p. 33.

East of the Schuylkill river and south of the Laurentian syenite belt, between Waverly heights and Huntingdon Valley, (Report C<sup>o</sup>, p. 37,) the slates and schists, which are equivalent in horizon to the serpentine group, rest upon the Cambrian limestone No. II, which proves conclusively that there are two distinct groups of slates, and that the serpentine group is more recent than the Hudson River group.

The serpentine group, which may be considered equivalent to the Chestnut Hill group of Report C<sup>o</sup>, is the uppermost or most recent of the mica schists and gneisses of southeastern Pennsylvania.

The series of schistose and gneissic rocks which are called the Manayunk and Philadelphia groups, are below the Chestnut Hill or Serpentine group and not equivalent to the slates of the Hudson River group.

I have in this report no change or alteration to suggest with regard to the relative position of these measures. (See C<sup>o</sup>, p. 14.)

The divisions between the groups are not clearly defined and the fact that one group of rocks gradually fades into the next succeeding group renders a delineation almost impossible.

The outlines of the groups are in reality much more irregular than they appear to be on the map accompanying report C<sup>o</sup>.

The measures in many places pitching at low angles would give irregular lines of outcrop; but, having no definite key rock within the mass, accuracy is impossible.

A carefully prepared contour map would no doubt give prominence to features of erosion which cannot be seen without the aid of such a map.

Could it be directly proven that the hornblendic slates belong to the same horizon at Darby, and along Crum and Ridley creeks, in Delaware county, it would demonstrate the irregularity of outline, and prove a nonconformity between the Serpentine group (or Chestnut Hill group) and the schists and gneisses of the two groups below it.

This unconformity is highly probable, and may in the future be demonstrated.

The recent deposits are noted on the map accompanying this report, though their outline is always indefinite.

The Ferruginous Conglomerate which occurs in a number of localities and over small areas is probably of Tertiary age. Mr. H. C. Lewis has studied this formation in detail and has carried his observations some distance south of Pennsylvania and also north-eastward through New Jersey.

The more recent alluvial deposits are found throughout the southern edge of the county and to a great extent conceal the underlying formations. The alluvial deposits consist of gravel, clay and sand.

The following table (page 8) demonstrates the relations of the formations to each other, as far as I have been able to identify them. A similar table will be found in Report C°, p. 14.

It will be seen from the geological map accompanying this report, that the only known representative of the Cambrian (Siluro-Cambrian) measures in Delaware county is found in the north-east corner of the county, in Radnor township.

All the other schists and gneisses, except those of the Syenite group, belong to a more recent formation than the Hudson river age.

In all probability they belong to a formation which is more recent than the disturbances which mark the close of the Hudson River group. It may be proven that the upper schistose group, or that which was designated as the Chestnut Hill group in Report C°, is the only group which is unconformable upon the Hudson River group; but the facts at present seem to indicate that the entire schistose gneissic belt was deposited upon an exceedingly uneven sea bottom, unconformably upon the Hudson River slates.

Between the Hudson River slates and the Syenite group of rocks which underlie the Potsdam Sandstone there, are no schistose gneissic rocks anywhere to be found which would in any way compare with the Philadelphia and Delaware county rocks.

Recent.	Delaware river gravel, clay.	} Alluvium, gravel, clay.
Tertiary.	Ferruginous conglomerate (Bryn Mawr gravel.)	
Trap.		Dolerite.
Probably metamorphosed Devonian.	Equivalents of the Chestnut Hill, Manayunk and Philadelphia groups.	<div>{ Serpentine, limestone, garnetiferous schist, corrugated ligneous schists and micaceous sandstones, hornblende gneiss, feldspathic micaceous gneiss.</div> <div>{ Mica schists, hornblende gneiss, gray granitic gneiss.</div> <div>{ Coarse mica schists and gneisses, feldspathic and hornblende gneiss.</div>
III.	Hudson River group.	{ Hydromica slates, usually greenish color, with lenticular bodies of milky quartz.
I, II.	Cambrian Limestones and Potsdam Sandstone, not represented in Delaware county.	
Laurentian. Granitic and hornblende syenites.		

## CHAPTER II.

### GENERAL GEOLOGY.

#### *Alluvium.*

The northern limit of the most recent alluvium deposits is not sharply defined.

The accompanying sketch map, Plate I, page 11, is probably as satisfactory an illustration as can be obtained.

The data on which it was constructed were compiled by Dr. George Smith, from records of the settlement of the county. The distribution of the alluvium is difficult to define, as the transition from the more recent deposits to the older ones is not always sharp.

The swampy ground is at present confined to a comparatively limited area.

#### *Gravel and Clay.*

Gravel occurs through the central and southern portion of Upper Darby township. The exposures for the most part are poor.

Throughout Darby township the occurrence of gravel is almost universal. There is an extensive exposure on the Wilmington Post road near Darby P. O. Also exposures along the Philadelphia, Wilmington and Baltimore railroad.

The older gravel underlies the more recent alluvial deposits of Tinicum Island and the region adjoining the Delaware river.

There are indications of gravel along the southern edge of Springfield township near the Philadelphia and West Chester railroad.

Clay occurs at Morton station in close proximity to this railroad.

Ridley township is wholly overlaid by gravel and clay. Throughout the greater portion of the township there are no exposures of the underlying formations whatever, but

extensive deposits of clay are found near the mouth of Crum creek.

Gravel occurs throughout a greater portion of the southern third of Nether Providence township. Its limit is however indefinite.

The probable northern limit of the gravel deposits in Chester township is somewhere in the vicinity of Brook Haven near the northern edge of the township.

Gravel is exposed along the Concord road west of Chester creek.

In South Chester, Chester township, extensive deposits of clay occur.

The southern half of Upper Chichester and the whole of Lower Chichester townships are covered by gravel, clay and loam.

The northern limit of the recent deposits is throughout very indefinite. The general limit however extends through Upper Darby, Nether Providence, Chester and Upper Chichester townships.

*Tertiary.*

*Ferruginous Conglomerate.*

*(Bryn Mawr gravel.)*

This formation is composed of fragments of the metamorphosed crystalline rocks.

The exposures are unsatisfactory as a rule and the areas are small and isolated.

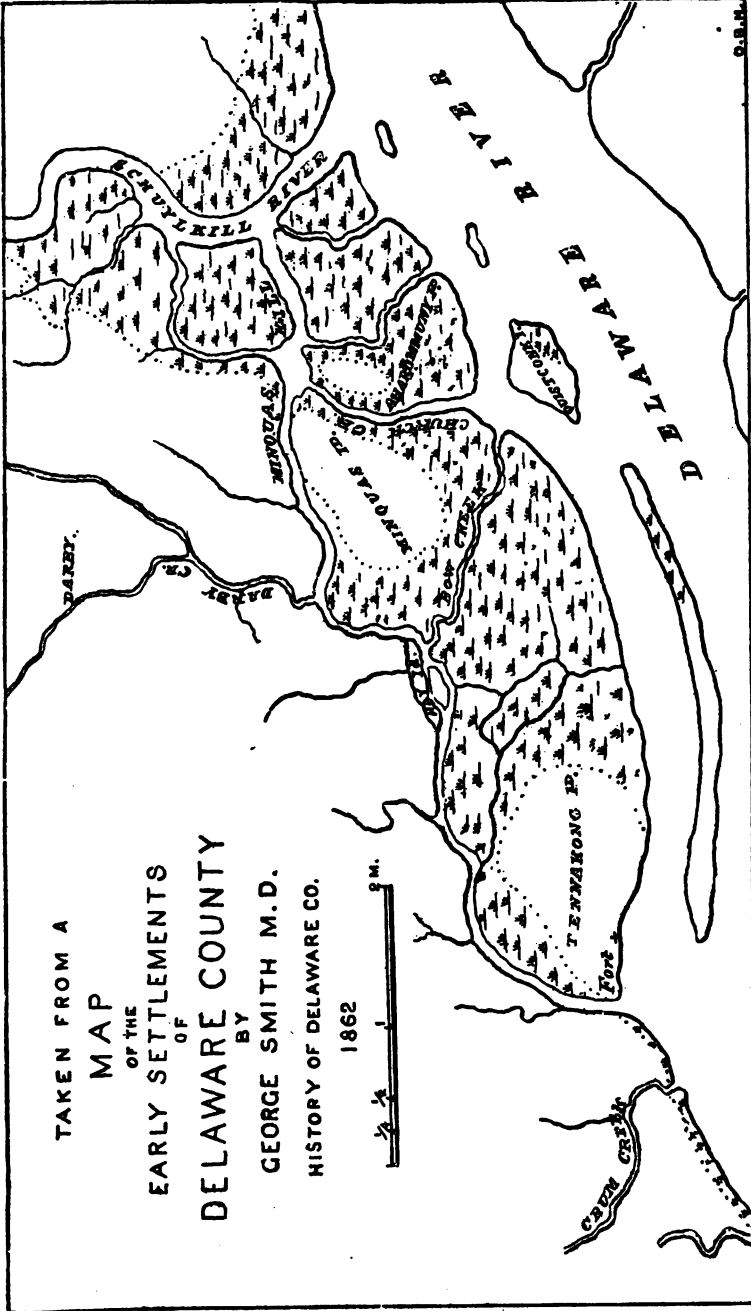
The formation covers a considerable area in the central portion of Haverford and Marple townships.

There are small areas at Media, in Upper Providence, at the Presbyterian church, in Middletown, north-west of Llewellyn in Aston, and an extensive area in the south-west portion of Concord township.

Besides these localities the formation occurs near Clifton, between Upper Darby and Springfield townships on the road leading to Marple; east of Palmer's mill in Upper Providence township a few fragments of the rock were observed, also on the north township line of Middletown and in Edgmont township north of Howellville. The large

TAKEN FROM A  
 MAP  
 OF THE  
 EARLY SETTLEMENTS  
 OF  
 DELAWARE COUNTY  
 BY  
 GEORGE SMITH M.D.  
 HISTORY OF DELAWARE CO.

1862





areas afford no better exposures than the small ones. The formation is composed of conglomerate, coarse sandstone, and probably a clay, which is derived from the decomposition of the underlying feldspathic rocks.

Where the rock occurs, the first indications of it are small fragments of the conglomerate along the road-sides—small rounded milky quartz pebbles occur throughout the red ferruginous soil where the conglomerate is decomposed.

At Media the conglomerate is much coarser than at any locality observed. Some of the pebbles at this locality measured six inches in diameter. The pebbles are usually of milky quartz, the matrix of the pebbles is sand which is cemented with ferruginous matter.

Clay deposits occur at, and south-west of Bryn Mawr, which may owe their origin in part, to the Ferruginous conglomerate.

The schists and gneisses underlying, and in close proximity to this formation, are always much decomposed, and the decomposition has gone on to a considerable depth. This is undoubtedly due to the fact, that the conglomerate was originally deposited upon the more or less decomposed schists, and the decomposition has continued to a greater or less extent since the age of its deposition.

The decomposed material has also been protected from erosion by the overlying conglomerates.

The margin of the conglomerate formation is often marked by a slight and indistinct escarpment. The creeks which cut through the conglomerate areas, as Naylor's run in Haverford township, expose the underlying mica schists and gneisses along their beds.

It is probable that the margin of the Tertiary ocean, at the time when the conglomerate was deposited, was somewhere along a line through the central or northern portion of Delaware county.

No doubt, the Delaware river has been the means of a great portion of the erosion of this formation. The river has been impinging against the formations which rested upon the underlying metamorphic rocks, and has gradually undercut them, one after another, until it has receded to its

present channel. No doubt, the earlier erosion of the river kept pace with the elevation, as the Tertiary and Cretaceous measures which have been swept away were no doubt composed of soft matter, and would readily admit of rapid erosion.

*Serpentine.*

(*Talc, Enstatite, &c.*)

The distribution of the serpentine is exceedingly irregular. There is not the same linear regularity exhibited in Delaware county, which is seen through Lower Merion township, in Montgomery county.

The Delaware county deposits demonstrate the fact, that the serpentine areas are shallow synclinal basins, many of them saucer-shaped.

No doubt, some of the areas may be larger than indicated on the accompanying geological map; but the rock has only been indicated in places and over areas where it has been positively proven to exist. The northernmost deposits of serpentine are near the north-east corner of the county, in Radnor township. These deposits are located northward from Morgan's Corner and south of Gulf creek.

There is a small area of steatite close to Gulf creek and near a limestone deposit.

I think there is no question that the steatite belongs to the same horizon as the serpentine. The belt of serpentine which makes its appearance in Radnor township belongs geologically to the serpentine belt which extends across the Schuylkill river and through Lower Merion township, Montgomery county, and is a direct continuation of the belt which passes through the corner of Tredyffrin township and through the southern townships of Chester county and passes north of West Chester.

The serpentines throughout the central portion of Delaware county belong to the same horizon as those in Lower Merion township, Montgomery county.

From the above facts it will readily be seen that all the serpentines through this region belong to the same geological horizon.

I have not been able to prove that there are any schistose

rocks above the serpentines in the eastern portion of Delaware county.

In the western portion of the county however it is in some cases doubtful whether certain schistose rocks be above or below the serpentines. But it is safe to assume that the serpentines are one of the most recent deposits.

In Report C<sup>s</sup> I suggested a sharp synclinal basin along the northern edge of the Chestnut Hill group of mica schists and serpentines. This structure is probably not quite correct.

I am now inclined to think that the two defined belts of serpentine crossing the Schuylkill river are shallow synclinal basins and that the serpentine does not underlie the schists which intervene between the belts.

The serpentines throughout Delaware county rest upon rocks of the same character as those between the two serpentine belts of Montgomery county.

The schistose rocks and serpentines rest unconformably and at comparatively low angles upon the syenites of the Laurentian group.

In the south-west corner of Radnor there is a belt of serpentine rock which is flanked on the south by enstatite, talcose, steatite and tremolite rocks; this belt extends into Newtown township.

The serpentine area is lenticular in outline and irregular.

The belt may be continuous with the small areas south-east of Newtown Square and along the Philadelphia and West Chester pike.

A small area of serpentine occurs east of Darby creek in Radnor township and east of the eastern extremity of the large serpentine body which extends into Newtown township.

West of Newtown Square a belt or basin of serpentine extends from Newtown township east of Crum creek into Edgemont township.

The serpentine is exposed in one place on the Philadelphia and West Chester pike, east of Crum creek.

South of the pike near Preston's run there is also a considerable area exposed in Newtown township.

The serpentine can be traced west of Crum creek into Edgmont township to a point about half way between Crum and Ridley creeks.

North of this serpentine belt there is a considerable area of enstatite rock in Edgmont township.

The largest and most prominent exposure of this rock is at a locality known as "Castle Rock," which is located on the west bank of Crum creek a short distance south of the Philadelphia and West Chester pike in Edgmont township. (See Report B, p. 62.) The rock forms a prominent and rugged bluff.

The serpentine and associated rocks lie in synclinal basins. This is the rule with regard to all the serpentine areas in Delaware county, and probably with most of the serpentine in this district.

The belt of enstatite, steatite and talcose rocks, which flanks the Radnor and Newtown townships belt on the south, extends south-westward into Marple township, and in this township these rocks are in close proximity to the serpentine.

The serpentine extends across the north-western edge of Marple township, through Upper Providence and Middletown townships. The enstatite rocks are not constant throughout. They do however appear near Ridley creek in Upper Providence township and also are found over a considerable area along the south-eastern margin of the serpentine in Middletown township, near Ridley creek and close to Elwyn Station.

The enstatite and talcose rocks are evidently not constant, but where they do occur they are indicative of the serpentine belt.

In Upper Providence township there are two belts of serpentine. The northern belt crosses the township at the Blue Hill school-house. The southern belt extends across the township from Palmer's mill on the east to the vicinity of Ridley creek, a short distance north-west of Media.

Although the serpentine exists in two distinct belts in this township the belts are not continuous across the township, but exist in patches or small areas.

From the character of the rock adjoining the serpentines there is no question that both the belts belong to the same horizon and are included in synclinal flexures. West of Upper Providence township in Middletown the serpentine is not divisible into separate belts. The areas seem to be merged into each other.

The irregularity of the serpentine areas is no doubt in part due to the unconformity of the rock upon the underlying measures.

Porous quartz, called "honey comb" quartz, is derived from the decomposition of the serpentine and occurs in many localities where the undecomposed serpentine is not visible on the surface.

The porous structure of the quartz is due to the fact that the decomposing serpentine breaks up and becomes cracked, the cracks and fissures become filled with silicious matter and the serpentine decomposing leaves interstices.

There are a number of small isolated localities through the southern edge of Middletown township, located by Mr. Smedley, where steatite, asbestos and hornblende rocks occur. These belong geologically to the serpentine horizon.

There are several small areas of impure serpentine, asbestos and steatite in the southern part of Aston township, west of Chester creek.

The Aston township localities are along the margin of the schistose rocks and close to the junction of the older underlying syenites. Steatite also occurs at a locality a short distance north of Llewellyn in the same township. Close to the northern edge of Bethel township west of Chelsea a steatite quarry was opened at one time. The quarry is located south of Green's creek a tributary of the West Branch of Chester creek.

In the north-west corner of Middletown and also close to the edge of Thornbury township are several small areas of serpentine which are no doubt located along the line of a synclinal flexure which passes diagonally through Concord township in a south-west direction.

Serpentine occurs in Concord township at a locality a short distance north-west of Ivy Mills P. O., on Smith's

Bridge road near the head of Green's creek and near the west township line, a short distance east of Elam P. O.

Anthophyllite or actinolite rock occurs near the south township line north of Green's creek and close to the southern margin of the schistose rocks.

Similar actinolite rock occurs a short distance south of Woodland station, on the P. and B. C. R. R., west of the West Branch of Chester creek.

Chloritic schist occurs at the Kaoline works in Birmingham township, and in close proximity to crystalline limestone. These localities belong undoubtedly to one horizon.

The chlorite schist at the Kaoline works appears to belong to the same geological horizon as the serpentines; and the proximity of the limestone, at this locality, would lead to the conclusion that the serpentines are derived from limestones.

A small steatite area, apparently isolated from the serpentine belt, exists south of Media, and on the east bank of Ridley creek, in Nether Providence township.

There seems to be no geological connection between this locality and the main serpentine areas north of it.

A small area of serpentine exists close to the north county line, west of Ridley creek, in Edgmont township. The area in Delaware county is small. It however, extends into Chester county on the north, and is exposed over a considerable area along, and in proximity to the Philadelphia and West Chester pike.

Limonite is found at nearly all the serpentine localities. Its existence is due to the decomposition of the serpentine, and it is always more or less intimately associated with the porous quartz.

Fine specimens of limonite can be obtained at almost any of the localities, but I have seen no locality within the county where the ore could be mined, without including a large percentage of quartz.

Corundum occurs, associated with the serpentine in Middletown township, near the Black Horse tavern.

A few rods south-west of Morgan's station, in Aston township, corundum occurs, associated with chloritic schists.

There does not seem to be a sufficient amount of the mineral at either of these localities to repay the cost of mining.

Chromic iron is found in many of the serpentine localities. The ore occurs in small lenticular bodies, where I have examined it.

### *Limestone.*

A narrow belt of limestone occurs in the north-eastern edge of Radnor township. The area is small, and can be traced only a short distance. It occurs south of Gulf creek, and flanks the South Valley Hill slates, (Hudson river group) on the south. It is not remote from a deposit of steatite, and may belong to the serpentine horizon.

At the Kaoline works in Birmingham township, coarse crystalline limestone also occurs. There is only one small exposure of the rock at present visible at this place, and its geological position cannot be ascertained. It is in close proximity to the chlorite schists, and decomposed feldspathic beds which form the Kaoline deposit.

The associations seem to indicate that the limestone belongs to the serpentine horizon.

The limestone near the north-east corner of the county, and also that at the Kaoline works, is no doubt the same as the limestone which occurs in the southern portion of Chester county at Copesville, Doe Run, near Kennet, and other places.

This limestone in southern Chester county is no doubt overlaid by schistose gneissic rocks.

The relative position of some sandstones in Chester county to the limestones is not quite clear to me.

The occurrence of decomposed feldspar in proximity to the limestone at the Kaoline works in Birmingham township, in Delaware county, may be coincidence only, as I know of no other locality in this region where limestone and kaoline occur together.

### *Feldspar and Kaoline.*

Kaoline is extensively mined in Birmingham township.

The openings are located on a branch of Beaver creek, and south-west of Brandywine Summit.

The Kaoline is of fine quality and the mining forms a prominent industry of Delaware county.

At one of the newer openings the Kaoline was exhibited in an undisturbed condition and showed the position of the decomposed feldspar bed.

In the workings the top of the bed was clearly defined; the pitch of the bed is to the north-west; the angle is about fifteen degrees where exposed to view.

Feldspar has been mined in Concord township to a limited extent. The locality is a short distance west of Elam P. O.

No doubt this feldspar belongs to the same geological horizon as that which forms the Kaoline deposits.

Much loose feldspar occurs in the soil between the Kaoline Works and Brandywine Summit and east of the latter place.

It is impossible to trace the feldspar bed any distance on the surface, as the feldspathic rock decomposes very rapidly and there are no exposures of the rock.

#### *Sandstone.*

Sandstone and schistose sandstone occur in the north-western part of the county in Edgmont township, close to the Chester county line and also in the vicinity of Dilworthtown:

This sandstone is the same as that associated with the limestones in southern Chester county, and as I have previously stated its relative position to the limestone is not defined.

It has been suggested that this sandstone in certain localities is equivalent to the Potsdam Sandstone, but I see no structural reason for this suggestion.

There are on the contrary structural grounds why the sandstone and sandy slate should be considered more recent than the Hudson River group.

They unquestionably belong to the group of schists which are intimately associated with the serpentines; and this group evidently overlies the slates of the Hudson River group in the north-east corner of Delaware county and also in Chester county.

Very similar to the sandstone and sandy gneiss of the



northern portion of Delaware county are the sandy slates which occur along Darby creek and have been quarried for whetstone in Marple township.

Indications of a very similar rock are also found in the vicinity of Crum creek on the west side of Marple township.

### *Mica Schists.*

The mica schists and gneisses which are stratigraphically uppermost are those which are associated with the serpentine.

This group of schists and gneisses is characterized by silvery, garnetiferous and decomposing feldspathic schists and micaceous sandstones.

A peculiar ligneous fracture is prevalent in many places, but this does not seem to be a constant character, although it may be confined to the group of upper schists.

This group is equivalent to the Chestnut Hill group mentioned in Report C<sup>6</sup>.

The sub-divisions which were provisionally made along the Schuylkill river are not clearly distinguishable through Delaware county.

In the south-eastern portion of the county coarse feldspathic gneisses and mica schists occur.

They are principally confined to the southern portion of Upper Darby, Darby, southern Springfield, Ridley, the lower portion of Nether Providence and Chester townships.

These coarser varieties of gneisses belong to the southernmost belt which was designated the Philadelphia belt in Report C<sup>6</sup>.

Exposures of the rock are found in a number of places, but not usually in a favorable condition for study.

The best exposures are found near Kellyville, on Darby creek; at Avendale, on Crum creek; along the lower portion of Crum and Ridley creeks, and along Chester creek, as far up as Bridgewater.

The exposures at Kellyville are usually coarse feldspathic micaceous gneisses and decomposed mica schist.

The exposures at the other localities named are gray, feldspathic, micaceous and granitic gneiss. The rock is usu-

ally homogeneous and close in texture, and it is especially sought after as a building stone.

The succession of schists above these granitic gneisses is evident. The large area over which they occur is easily explained from the fact that the measures lie at low angles and are undulating. The accompanying plates clearly show the bedding of the rock at some of the larger quarries. The rocks which lie between the underlying gneisses and the schists associated with the serpentines cannot be separated definitely into groups in Delaware county.

The schists and gneisses seem to fade into each other and a definite sub-division is rendered impossible.

Throughout the southern and south-eastern portion of Marple township and a portion of Haverford and Upper Providence townships sandy micaceous gneisses and corrugated schists, with ligneous fractures occur.

These rocks are probably the same as those represented along the northern edge of the county in Edgmont township.

In close proximity to these soft and rapidly decomposing schists we meet with hard and compact feldspathic gneisses.

These harder rocks are usually if not always found not remote from the escarpments of the creeks.

A locality of this sort occurs at Heyville on Darby creek, in Upper Darby township.

I am inclined to think that these harder feldspathic rocks belong to the lower group of gneisses, and the newer schists overlying them have been cut through, exposing them to view along lines of erosion.

If we assume that the hornblendic gneisses which are exposed along Crum creek belong to one horizon, then the question of unconformity would be no longer in doubt.

No facts as yet obtained however tend to disprove this, and on the other hand there is no positive proof that they do belong to the same age.

It is impossible at present to define a line between the lower gneissic rocks of south-eastern Delaware county and the schists of the serpentine group.

In many places it is exceedingly difficult to distinguish

the decomposed feldspathic syenites of the Laurentian from the decomposed feldspathic gneisses which overlie them.

The distribution of the mica schists is exceedingly irregular. The margins indicated on the geological map are in some places not definite.

The detail of distribution can more easily be understood by reference to the map than by explanation.

The most northern area of schistose rocks extends diagonally through Radnor township in a north-west, south-east direction.

When the report and accompanying maps C<sup>o</sup> was published, I supposed that the schistose rocks in the northern portion of Radnor township did not extend into Montgomery county, and that the serpentine of Lafayette and Bryn Mawr were separated from the serpentines north of the Laurentian belt by the Laurentian rocks.

I have since however been able to trace the schistose rocks all the way from Bryn Mawr to the serpentine localities in the vicinity of Wayne in Radnor township, thus connecting the two areas and proving the schistose rocks to extend across the Laurentian belt. North-west of Bryn Mawr the northern belt of schists is partially separated from the main area by the Laurentian rocks which are exposed along Radnor run.

In the western portion of the township, the Laurentian area becomes broader.

The principal exposures of the schistose rocks in Radnor township, are found along the line of the Pennsylvania railroad, along the Lancaster pike near Bryn Mawr, and Bryn Mawr avenue.

There are also some exposures along the west bank of Ithan creek and Darby creek, between Camp run and the south township line.

In Newtown township, there are numerous exposures of the schistose rocks along the Philadelphia and West Chester pike, and in the vicinity of Newtown Square. The escarpments along Crum creek afford few exposures.

In the south-western portion of the township the schistose rocks form a terrace upon the Laurentian syenites. The

junction between the groups is defined by an escarpment which can be traced some distance.

This feature in the topography is visible to a greater or less extent throughout the district, along the line of junction between two groups.

In Edgmont township, Ridley creek marks the western boundary of the schistose gneissic belt which extends through Newtown township.

In Thornbury, Middletown, and Concord townships, the schistose rocks are distributed over irregular areas. Chester creek, and the west branch of the same creek, cut through the superficial rocks, and expose the syenites along nearly their whole length.

Near Cheyney, in Thornbury, and Lenni, in Middletown townships, the schistose rocks are found a short distance back from the bed of the creek on the high ground.

At Glen Mills, a basin of the schistose gneisses with serpentine crosses the creek, and probably extends south-westward into Concord township.

Between Glen Mills and Ivy Mills P. O., the distribution of the schistose rocks is indefinite. The distribution of these rocks north-east of Glen Mills, is also indefinite.

In the north-western portion of Concord, and through Birmingham township, I have not been able to make any sub-division of the schistose gneissic rocks.

Along some of the streams there are harder gneissic rocks exposed, which, in some respects, resemble some of the syenitic rocks which belong to the Laurentian group.

From the data I have been able to collect, however, I have not felt justified in differentiating these rocks.

The exposures of the schistose gneissic rocks are numerous along all the creeks crossing the county.

The principal exposures of the rock on Cobb's creek are near the southern edge of Haverford township. Through Upper Darby and Darby townships there are numerous small exposures.

The most extensive outcrops of gneiss on Darby creek are in Upper Darby township, but small exposures are nu-

merous from Radnor township to the confluence of Cobb's creek with Darby creek.

The quarries at and near Avendale on Crum creek afford the best exposures of the gneissic rocks. Good exposures of hornblendic gneiss occur in Springfield township, on Crum creek. This rock also occurs on Trout run, in Marple township, and on Ridley creek above Todmorden Mills, in Nether Providence township. Along the lower portion of Ridley creek the quarries are numerous.

There are a large number of exposures along Chester creek, between Rockdale and the city of Chester.

Feldspathic garnetiferous gneiss is exposed on the West Branch of Chester creek, close to the confluence of Green's creek. There are few exhibitions of the schistose rocks through Concord township, except along the roads, and the rock is very much weathered.

On Beaver creek, near the Delaware State line, there are numerous ledges and outcrops of schistose gneiss.

The rock in this locality resembles the feldspathic gneisses of Chester township more than the schists through Concord township. In Birmingham township there are a number of exposures of hornblendic gneiss, which seem to differ somewhat from the hornblendic gneisses in the eastern portion of the county.

The probability is, that these hornblendic gneisses of Birmingham township are geologically higher than those east of Chester creek.

The normal dip of the schistose gneissic rocks through southern Birmingham township is to the north-westward. In the northern portion of the same township the dip is apparently to the south and south-eastward.

The angle of the rocks throughout the southern portion of the township probably does not exceed twenty degrees, and the dip is usually to the north-westward.

### CHAPTER III.

#### TOWNSHIP GEOLOGY.

In Delaware county there are twenty-one townships.

The arrangements of the townships is somewhat irregular, although they may be conveniently considered in tiers ranging from north-east to south-west.

The first or most north-western tier of townships are those bordering on Chester county. These are Radnor, Newtown, Edgmont, Thornbury and Birmingham townships; the second tier are Haverford, Marple, Upper Providence, Middletown, Aston, Concord and Bethel townships; the third Upper Darby, Springfield and Nether Providence; the fourth Darby, Tinicum, Ridley, Chester, Upper and Lower Chichester townships.

#### RADNOR TOWNSHIP.

##### *Tertiary.*

##### *Ferruginous Conglomerate.*

This formation is probably represented in the south-east corner of the township.

Flory's brick-yard at Bryn Mawr is located near the edge of a clay deposit which extends southward into the adjoining township. This clay probably owes its origin to the decomposition of the feldspathic rocks underlying the conglomerate.

There are slight indications of the conglomerate on W. G. Thomas' land close to the south township line and near the south-east corner. There is a clay deposit a short distance north-west of Garrettville and near the head of Radnor run. This clay is no doubt similar in age to that close to the south township line.

##### *Serpentine.*

In the south-west corner of the township there is a consid-  
(25 C<sup>s</sup>.)

erable area of serpentine. It is located south of Fawkes run and west of Darby creek on Moro Phillips' land. Steatite and probably enstatite occur on the south side of this serpentine area.

This serpentine is probably continuous to Darby creek, but the exposures of the rock are first noticeable some distance west of the creek.

Chromic iron and limonite are found at this locality.

A small exposure of decomposed serpentine occurs a short distance east of Darby creek and opposite the mouth of Fawkes run. The locality is on J. F. Taylor's land and the rock is exposed on the road which follows the general course of Darby creek.

Serpentine occurs in the north-eastern portion of this township in the vicinity of Morgan's corner.

There is a large area of serpentine a short distance north-east of this place on the road leading to the county line road and west of a branch of Gulf creek. The area is lenticular and extends east and west.

A short distance north-west of Morgan's corner or Radnor station are several small outcrops of serpentine.

These serpentine outcrops are on a line in general parallel to the serpentine which occurs close to Eagle station in Chester county and belong to the same horizon. The areas are isolated, but the associated rocks are the same throughout.

A small area of steatite and hornblende rock occurs a short distance south of Gulf creek close to the east county line and north of the serpentine belt. This rock undoubtedly belongs to the same horizon as the serpentine. The locality is in proximity to a belt of crystalline limestone.

### *Limestone.*

A narrow belt of limestone is found along the south side of Gulf creek and about half way between the east county line and the road leading north-westward from Morgan's corner.

The position of this limestone is geographically between

the slates of the South Valley Hill, the Hudson River group, which lie on the north, and the schistose micaceous gneisses associated with the serpentines on the south.

The limestone is white and gray crystalline, and often granular. It is in many respects similar to limestone which occurs close to the Brandywine creek, and west of the creek in Chester county.

From the position of this limestone, I am led to suspect that it is equivalent to the serpentine in age, and the serpentine is probably in part derived from an alteration of the limestone.

The dip of this limestone on Gulf creek, appears to be to the south-eastward. It can be traced only a short distance along the strike and is only a few yard wide.

#### *Mica Schists.*

The serpentines are associated with a series of mica schists and feldspathic micaceous gneisses.

The mica schists usually have a peculiar ligneous fracture. These gneisses occupy irregular areas within the township.

In the south-eastern portion of the township, these schists extend to Radnor run, and occupy a greater part of the north-eastern portion of the township between Bryn Mawr and Morgan's Corner, or Radnor station.

West of Ithan creek, these rocks extend from the south township line to the vicinity of Radnor P. O., and extend westward to Darby creek, at Camp run. Camp run and a branch of Ithan creek south-west of the Sorrel Horse hotel, form the northern boundary of these rocks in the south-west portion of the township. West of Darby creek, the boundary is not clearly defined.

There are numerous exposures of slaty micaceous and feldspathic gneiss along Darby creek, and south of Camp run. Much of the rock is a silvery mica schist. At Ithan mills mica schist is exposed in the road near the creek. The exposures are not numerous however in the vicinity of Ithan creek. Near the south-east corner of the township



we find numerous exposures of the rock along Bryn Mawr avenue and south of Radnor run.

White quartz and fine grained slaty micaceous sandstone occur a short distance west of Bryn Mawr.

North-west of Bryn Mawr are numerous exposures of schistose and feldspathic gneisses.

The rocks extend north-westward to Gulf creek and are exposed in numerous places along the line of the Pennsylvania railroad and along the Lancaster pike.

These rocks extend into Montgomery county and occupy an area between Gulf creek and Bryn Mawr, and extend to the vicinity of the road leading from Gulf mill to Bryn Mawr. This area of schistose gneiss in Montgomery county was not defined at the time when the geological map accompanying C<sup>s</sup> was published.

The western margin of this schist and gneissic area is defined by the escarpment of Ithan creek.

The belt crosses the upper end of Radnor run and extends north-westward following the general course of Ithan creek. The best exposures are on the line of the Pennsylvania railroad.

At Garrettville and north of this place feldspathic schistose gneiss and sandstone are exposed in the roads, and the ligneous fracture of the rock is evident at most of these localities. The rock exposed along the line of the railroad is usually much decomposed, but does not differ materially in character from that exposed elsewhere in the belt. Some of the rock is granitic in character, and some of the exposures are of doubtful relative age. There are numerous exposures of rusty granitoid gneiss between Upton and Radnor stations.

From Morgan's corner to Wayne station the rock is a slaty micaceous sandstone and schist; and the ligneous fracture is very marked in many of these localities.

Coarse micaceous gneiss, very similar in appearance to that found along the lower Schuylkill, is found close to Gulf creek and a short distance north-west of Wayne station. It is intimately associated with garnetiferous mica schists.

*Hudson River Group.**South Valley Hill Mica Schists.*

The greenish quartzose hydro-mica schists of the South Valley Hill occupy that portion of the township north of the line or escarpment of Gulf creek.

The rock is usually of a gray or greenish color. Milky quartz veins and lenticular bodies of quartz occur throughout the mass.

A belt of garnetiferous mica schist flanks this group on the south; this belt has also been recognized in Chester county.

The rocks of the South Valley Hill are exposed in a number of places along the roads which cross the area.

The geological position of this belt of schists has been discussed in report C° and I can entertain no doubt that they are of Hudson river age.

This small area of schists is the only one in Delaware county, with the exception of the syenites, which can be used as a key rock.

*Syenites.*

The rocks of this group are exposed over a considerable area in the north-western portion of the township. They are also exposed along Darby creek, Little Darby creek and along the whole course of Ithan creek, from its source, to the vicinity of the south township line.

The area occupied by the syenites east of Ithan creek is small and the eastern limit of the group is somewhat indefinite.

The principal exposures along Ithan creek are near the southern edge of the formation and close to Bryn Mawr avenue and also a short distance below Ithan mills on the east side of the creek.

South of Paxson's mills and near Bryn Mawr avenue, the rock is a quartzite and gray granitic syenite. The dip of the rock is about twenty-five degrees, south-eastward (S. 15° E. 25°). The rock in this vicinity is much decomposed by weathering.

Granitic syenite is quarried on J. Brooke's place, south-east of Paxson's mills and on the road leading to Ithan mills.

The rock at this place is much broken and weathered. The posture of the rocks seems to be S.  $45^{\circ}$  E.  $45^{\circ}$

Between Paxson's mills and Ithan mills there are numerous exposures of boulders and blocks of syenite along the roadside.

Close to Ithan mills a ledge of rock is exposed. The direction and strength of dip is about S.  $50^{\circ}$  E.  $18^{\circ}$

The rock exposed is a gray granitic and dark colored hornblendic syenite.

North of Ithan mills boulders of syenite are numerous and at a few places, feldspathic syenite occurs in ledges exposed in the road. Boulders, blocks and occasional exposures of rock are very numerous from the Sorrel Horse hotel to Radnor P. O., and along the road leading from the latter place to Radnor station.

A dark colored garnetiferous syenite resembling in appearance a trap rock, occurs on this road at Radnor P. O., the rock appearing to dip S.  $30^{\circ}$  W.  $65^{\circ}$ .

Loose boulders are numerous throughout the course of Ithan creek above Radnor P. O.

Gray granitic syenite is quarried close to the old Lancaster pike and south-west of Wayne station.

In the vicinity of Lewis' mills on Darby creek and along the course of Little Darby creek boulders and blocks of syenite are very plentiful, the exposures of ledges are however not numerous.

The rock throughout is a gray granitic and dark colored hornblendic and feldspathic syenite.

*Minerals of Radnor Township.*

*Blue Quartz. B. p. 58.*

This quartz has been obtained at Radnor, probably Radnor P. O.

*Enstatite. B. p. 62.*

Laminated or stratified enstatite occurs in this township. The locality is not designated in report B, but the locality

is no doubt in the south-west corner of the township, west of Darby creek and south of Fawkes' run.

*Asbestos. B. p. 68.*

Small amounts of asbestos occur with the serpentine near Morgan's corner, and also with the serpentine in the south-west corner of the township.

*Garnet. B. p. 73.*

Rounded dodecahedral crystals of garnet are found in the soil on F. Fennimore's farm, on Gulf creek a short distance east of Wayne station.

*Talc. B. p. 111.*

Talc occurs associated with the serpentine. It does not exist in quantity. The principal locality is on Mr. Phillips' land in the south-west corner of the township.

*Serpentine. B. p. 113.*

Serpentine occurs on J. J. Brown's and M. and B. Brooke's lands east of Morgan's Corner and also on J. Stacker's land, a short distance north-west of the same place. A large body of serpentine exists in the south-west corner of the township on Moro Phillips' land, south of Fawkes' run. A small exposure of the same rock exists on J. F. Taylor's land east of Darby creek and near the south township line.

*Marmolite. B. p. 115.*

This mineral has been obtained in Radnor township. It is undoubtedly associated with the serpentine.

*Chrysotile. B. p. 116.*

Chrysotile occurs in the seams in the decomposed serpentine.

*Deweylite. B. p. 117.*

Deweylite is found in this township associated with the serpentine.

*Magnesite. B. p. 158.*

Magnesite has been found in Radnor township.

## NEWTOWN TOWNSHIP.

*Serpentine and associated rocks.*

Serpentine rock occupies a considerable area in the southeastern portion of the township, near the east township line.

Fawkes' run forms the northern boundary of this serpentine area. The belt extends in a south-west direction, and crosses the West Chester and Philadelphia pike south of the south branch of Fawkes' run. The southern boundary of the belt is indefinite.

There are several exposures of porous quartz and decomposed serpentine rock along the West Chester and Philadelphia pike near the old Fox Chase hotel.

Along Fawkes' run and the road near the east township line the exposures are continuous for some distance and the best exposures are close to the township line.

West of Newtown Square and a short distance east of Crum creek a small area of serpentine occurs on and close to the West Chester and Philadelphia pike.

Enstatite and porous quartz are associated with the serpentine at this locality.

A serpentine belt exists a short distance south-west of this locality and south of the pike. It is exposed in a number of places close to Crum creek. The dip appears to be S. 20° E. 80° on the northern side. No satisfactory exposures were found on the southern edge of the belt, but from the position occupied by this rock it seems to lie in a shallow synclinal basin.

Limonite is found with the serpentine in small quantities at this locality, porous quartz, enstatite and asbestos also occur.

Finely fibrous tremolite in talc is found south of Hunter's run and near the south township line. The principal locality is near the cross road south of Newtown Square.

A similar rock is found along the south township line road ;

also south of the serpentine area near the south-east corner of the township.

Enstatite is found on the south township line road close to the West Chester and Philadelphia pike.

The whole area south of Fawkes' run, its south-west branch and Hunter's run, is occupied by serpentine, enstatite and the associated rocks. Silvery mica schists are exposed in many places in this area.

In the bed of Hunter's run the underlying syenites are exposed in places.

#### *Mica Schists.*

The area occupied by the schists is irregular.

The mica schists extend through the central portion of the township, from the south-eastern edge of the township, through Newtown Square to Crum creek.

The area extends north of Central Square. The northern boundary west of Central Square is formed by Reese's run. East of Central Square the margin of this group is irregular. In the south-eastern portion of the township the schists extend beyond the township line. In the south-western portion of the township the margin of the schists is defined by the escarpments of Hunter's run and Crum creek.

The schists are principally confined to the higher portions of the southern half of the township.

There are numerous exposures of decomposed schistose rocks along the West Chester and Philadelphia pike, and along the road between Central Square and Newtown Square.

Compact garnetiferous micaceous gneiss is found near the head of Preston's run, and also north of this run near Crum creek, west of Newtown Square.

The dip of the rock seems to be S. 20° to 35° E. 55° to 80°. This however may be the cleavage.

The rock is of a dark color, weathering rusty and brown and breaks up in thin scales, resembling very much some of the syenites in this peculiarity.

The principal exposures of the rock are on W. P. Thomas' and W. L. Howard's land.

There is also an exposure of similar rock about half way  
3 C.

between Newtown and Central Squares, near the head of Fawkes' run. At this point the dip appears to be S. 18° E. 65°.

Slaty micaceous and hornblendic gneiss is exposed on Reese's run, north of the pike and a short distance east of Crum creek.

Slaty micaceous gneiss and sandstone occur on the Goshen or Boot road west of Central Square and south of Reese's run. A similar rock at Central Square indicates a dip of S. 40° E. 35°-40°.

Although the exposures of the schists are numerous along the roads there are few which are satisfactory. The rock decomposes rapidly, and there are no natural exposures of the rock to be found anywhere.

Micaceous gneiss and schist, with a ligneous fracture occur along the east township line and north of Fawkes' run. Light gray and silvery mica schists are found along the road east of Central Square.

#### *Syenites.*

##### *Laurentian.*

This group is principally confined to the northern portion of the township.

A small triangular area extends eastward from Crum creek to Hunter's run in the south-west corner of the township.

Near the eastern township line the rocks are exposed in numerous places along the Saw-Mill run and south of it to the vicinity of the Goshen road leading from Bryn Mawr to Central Square.

On Thomas' run and along Darby creek the indications of the rock are continuous and extend northward to the county line.

The rock is a dark gray granitic and black hornblendic syenite, some of it is very feldspathic.

There are numerous exposures of the rock and loose boulders north and north-west of Central Square.

In the western portion of the township, the rocks are exposed along the Goshen road from Reese's run to Crum creek.

There are numerous boulders along the course of Lewis' run, north of the Goshen road.

Dark colored compact garnetiferous syenite is found near the mouth of Lewis' run. This rock is very similar to that which is found in Radnor township, near Radnor P. O. This rock has the appearance of a trap or dolerite.

The area in the south-west corner of the township extends from the south township line along Crum creek for a distance of about one mile. Hunter's run and the south township line form the southern boundary. The northern edge of the area is not definite.

The principal exposures of the rock are along Crum creek and on the road leading from Newtown Square to Upper Providence. The schistose rocks overlie the syenites and flank the syenite area on the north.

The principal exposures of the syenite are on J. D. Thornton's land close to Crum creek.

*Minerals of Newtown Township.*

*Chromite, B. p. 39.*

Chromic iron has been found in small quantities associated with serpentine.

Good specimens have been found south of Fawkes' run in the south-west corner of the township.

It is also said to occur near Crum creek.

*Limonite, B. p. 48.*

Limonite is found with the serpentine south of the West Chester and Philadelphia pike, north of Preston run and close to Crum creek, on E. Flounders' land. It also occurs near the south-east corner of the township, south of Fawkes' run, associated with serpentine.

On Flounders land some fine specimens are found but the quantity is limited.

*Quartz, B. p. 55.*

Drusy quartz is found at all the serpentine localities. The finest specimens were observed close to Crum creek and near the West Chester and Philadelphia pike.



Chalcedony is also found with the serpentine.

*Enstatite, B. p. 62.*

Enstatite rock occurs close to the south township line, south of the West Chester and Philadelphia pike. It has also been found south of the same pike near Crum creek.

*Tremolite, B. p. 67.*

A finely fibrous tremolite in talc occurs south of Newtown Square close to Hunter's run and near the south township line on H. Maris' and E. Jackson's lands.

*Asbestus, B. p. 68.*

Asbestus is found in small quantities at all the serpentine localities.

*Steatite, B. p. 111.*

Talc and steatite are found with the serpentine south of Fawkes' run. Talc is also found south of Hunter's run.

*Serpentine, B. p. 113.*

Serpentine occurs south of Fawkes run close to the east township line. Decomposed serpentine is visible along the West Chester and Philadelphia pike near the Fox Chase Hotel. It is exposed on the same pike a short distance east of Crum creek and close to Crum creek south of the pike.

The rock is usually much decomposed.

## EDGMONT TOWNSHIP.

*Tertiary.**Ferruginous Conglomerate.*

There are indications of this formation on the Edgmont road a short distance north-west of Howellville. Fragments of the rock were observed along the roadside on J. Mendenhall's land. On the south township line, a short distance east of the Edgmont road, are also surface indications of this formation.

The fragments of the conglomerate and loose quartz pebbles are few and scattered.

*Trap.*

Trap rock is found a short distance west of Howellville, near the head of Rocky run, and also on the Edgmont road a short distance above Howellville and close to the exposure of Ferruginous conglomerate.

Numerous boulders of trap occur close to the Edgmont School House No. 2, a short distance north of Howellville and on the Valley road.

Loose blocks of trap are found a short distance south of the West Branch of Ridley creek, on the road leading from the Ashbridge road to the Valley road. They occur on E. Stackhouse's land.

*Serpentine.*

A small area of serpentine occurs close to the north township line and a short distance west of Ridley creek.

This serpentine is continuous with a large body of the rock which exists in Chester county, close to the county line.

In Edgmont township the serpentine is found on E. L. Baker's and E. Stackhouse's lands.

A small area of serpentine exists near the eastern side of

the township. It may be seen exposed on the road leading from Edgmont P. O. south-eastward to Upper Providence. The locality is about half way between Edgmont P. O. and the Upper Providence township line. It occurs on J. W. Bishop's and J. Davis' lands.

A small area, probably connected with this, which is exposed in the road, is located close to Crum creek and south of Castle Rock. The serpentine in the road is much decomposed.

The rock lies in a shallow synclinal basin.

#### *Enstatite.*

A large body of enstatite rock occurs at Castle Rock which is located not far from the north east corner of the township, close to Crum creek and a short distance south of the West Chester and Philadelphia pike on W. Taylor's land.

This rock is always in close proximity to the serpentine in Delaware county, and I consider it as indicative of the serpentine horizon. Castle Rock is a prominent bluff. The entire mass is composed of enstatite rock. The locality is generally known throughout the county as a romantic spot.

#### *Mica Schists.*

It is difficult to delineate the area occupied by the mica schists. Ridley creek forms the western limit to that portion of the schists lying in the north-eastern part of the township. This area extends north of the county line and crosses Crum creek into Newtown township on the east.

The southern boundary of the area is marked by an escarpment crossing from Crum to Ridley creeks, north of the Upper Providence line.

The schists in the north-western portion of the township extend into Chester county on the north. The eastern edge of the area is close to Ridley creek and near the north township line. The southern limit is rather indefinite. It extends in a south-west direction to the west township line, and the area is principally within the drainage area of the

West Branch of Ridley creek. The schistose rocks extend into Thornbury township on the west.

I have included in this group a series of thinly bedded or laminated granitic rocks, which occur south and south-east of Edgmont P. O. These rocks are visible along the road leading to Upper Providence P. O. They are probably equivalent to the granitic rocks found in Middletown township which are in proximity to the serpentines of that township.

The principal exposures of the schistose rocks in the north eastern portion of Edgmont township are close to the county line, and between Edgmont P. O. and Plumstock on the West Chester and Philadelphia pike. There are also exposures of mica schist at Edgmont.

The rock exposed close to the county line is usually a slaty micaceous gneiss and micaceous sandstone.

There are numerous indications of feldspathic and quartzose gneiss along the cross road south of Plumstock and east of Ridley creek. Decomposed granitic and slaty gneiss is exposed between Edgmont and Crum creek. In the north western portion of the township the same rock is exposed on the Ashbridge road south of the county line, and also along the road south of the west branch of Ridley creek. The principal exposures are on E. and C. Stackhouses' and W. P. Smedley's lands. The rock is much decomposed throughout, and its area is not sharply defined.

In the south-western corner of this township is a small area which probably belongs to this group. It is in close proximity to serpentine rocks.

### *Syenites.*

The syenites occupy a greater part of the central and southern portion of the township.

The rock extends from Crum creek on the east to the west township line. Ridley creek forms the north-eastern boundary of the area. The northern edge of the area runs a short distance south of the West Branch of Ridley creek with a direction in general parallel to it.

There are numerous exposures of the rock along the Edg-

mont road between the south township line and the Ash bridge road. The rock is usually a granitic and hornblendic syenite; at Howellville and a short distance north-west of that place there are many exposures of granitic and hornblendic rocks.

In many places the rock is thoroughly decomposed and forms a sort of impure kaoline.

The syenitic rocks are exposed along the line of Ridley creek and its tributaries, near the south township line the rock exposures along the creek are continuous for some distance.

In the south-western portion of the township there are numerous outcrops of granitic syenite. The most prominent ledges are close to the west township line road, and the road leading from Howellville to Chester creek. The rock exposures are principally on H. Eachus' land. The rock also occurs along the Ashbridge road north of the Edgmont road, and in an escarpment formed by a tributary of the West Branch of Ridley creek.

It has been impossible to obtain a sufficient number of dips to draw any conclusion as to the geological structure of this mass, or to construct cross sections. The difficulty of distinguishing true lines of bedding from cleavage planes is very great.

*Minerals of Edgmont township.*

*Rutile. B. p. 44.*

Rutile occurs in crystals and massive in quartz in this township.

I believe one locality where it has been found is on G. Green's land, east of Ridley creek, and a short distance north-west of the Upper Providence line.

*Enstatite. B. p. 62.*

This rock forms the greater part of Castle Rock which is located close to Crum creek and south of the West Chester and Philadelphia pike, and near the north-east corner of the township.

*Chrysolite. B. p. 71.*

Grains of chrysolite imbedded in bronzite rock are found at Castle Rock.

*Orthoclase. B. p. 92.*

Salmon-colored crystals of orthoclase occur in this township.

*Serpentine. B. p. 113.*

Serpentine occurs close to Crum creek and south of Castle Rock, and also a short distance west of Crum creek and the road leading from Edgmont to Upper Providence.

There is a small area of serpentine north of the West Branch of Ridley creek and close to the county line.

THORNBURY TOWNSHIP.

*Trap.*

Trap rock occurs along the road leading from Cheyney shops to Dilworthtown. The locality is close to the county line south-west of Chester creek.

Trap also occurs on the road between Cheyney station and Thorntonville. It has been observed on H. Brinton's land.

East of Cheyney shops a diabase trap is visible along the road leading to Glen Mills station. It occurs on the north side of the creek near an angle in the road, on J. M. Willcox's land.

Numerous boulders of a similar rock were observed north-east of Cheyney shops on G. Proctor's land.

At Glen Mills station a trap dyke is exposed in the railroad cut a short distance below the station.

*Serpentine.*

Serpentine is found at Glen Mills, close to the Chester creek bridge. It is visible in the road opposite and near the paper-mill. The rock seems to be confined to a small area.

A short distance south-west of Glen mills, serpentine has been found on J. Sharpless' land, close to the road leading to Ivy Mills P. O.

North-east of Glen mills and east of Glen Mills station a narrow belt of serpentine exists close to the corner of the township.

*Mica-schists and Gneisses.*

The mica schists and gneisses occupy the higher portions of the township. Their distribution is somewhat indefinite.

The rocks are exposed in the western portion of the township north-west of Thorntonville, and along the road leading from Brinton's mill to the county line.

There are numerous exposures on the road leading to Dil-

worhtown. The rock is usually much decomposed, in places it is very feldspathic.

Gray slaty micaceous gneiss occurs near the west branch of Chester creek.

North and east of Thorntonville slaty schists are exposed in a number of places.

North and north-east of Cheyney station, slaty micaceous and hornblendic gneisses extend to the north-east corner of the township.

Gray micaceous sandstone, much decomposed, is exposed near Cheyney run close to the north township line.

Near the north-east corner of the township micaceous schistose gneiss and quartz is exposed. The principal exposures are on the Edgmont road and close to T. J. Baker's house. Cleavage dip, E.  $70^{\circ}$ .

### *Syenites.*

The exposures of syenite are principally confined to the escarpments along Chester creek and its tributaries.

South of Glen Mills gray granitic syenite is exposed on the road leading to Ivy Mills P. O.

In the vicinity of Glen Mills station the exposures of hornblendic and granitic syenite are numerous. Dip, S.  $30^{\circ}$  E.  $\pm 20^{\circ}$ .

Close to the corner of Middletown township found an extensive exposure of hornblendic and granitic syenite on the east side of Chester creek. The dip appears to be S.  $20^{\circ}$  W.  $30^{\circ}$   $50'$ .

Loose boulders and blocks of syenite are numerous along Chester creek above Glen Mills station.

Gray granitic syenite with occasional beds of micaceous and garnetiferous gneiss occur near the first bridge above Glen Mills station. Here an extensive ledge of this rock occurs on J. Baker's land.

Close to the second bridge above the station a similar rock is found on D. James' land.

Close to the Edgmont township line there are extensive outcrops of the syenitic rocks. The dip is apparently



N. 70° E. 20°. The exposures are along the escarpment of a tributary of Chester creek.

West of Glen Mills station the syenitic rocks are exposed in an escarpment of a brook which flows into Chester creek. Much of the rock exposed is a compact granitic syenite.

South of Cheyney station gray granitic syenite and slaty feldspathic gneiss is exposed in the escarpment of Chester creek.

Similar rocks are exposed west of Cheyney station.

South of Thorntonville and close to Brinton's mill, on the West Branch of Chester creek, syenite boulders are exposed. The rock is a mottled feldspathic and hornblendic syenite.

The area exposed in this portion of the township is small and confined to the escarpment of the creek.

*Minerals of Thornbury Township.*

*Amethyst. B. p. 57.*

Amethyst has been found in this township, probably in the vicinity of Chester creek.

*Albite. B. p. 91.*

Greenish gray and granular albite is found in the serpentine near Glen Mills.

*Serpentine. B. p. 113.*

Serpentine occurs opposite the Chester creek bridge at Glen Mills, and also near the road leading to Ivy Mills P. O., a short distance south of Glen Mills.

A narrow belt of serpentine is found in the south-east corner of the township, east of Glen Mills station, south of the road leading to Edgmont township, and on A. C. Hemp-hill's land.

## BIRMINGHAM TOWNSHIP.

*Mica Schists and Gneisses.*

Mica schists, gneisses and hornblendic gneiss are found in nearly all parts of the township.

In the southern portion of the township, gray feldspathic schistose micaceous gneiss is exposed along Beaver creek, and close to the Delaware State line near Smith's bridge.

There are extensive exposures north-east of Tempest's mills near Smith's bridge, on W. Twaddell's land.

The rock exposed along the Delaware State line has a vertical cleavage and an undulating north-west dip, probably not exceeding  $10^{\circ}$ .

Garnetiferous mica schist and hornblendic gneiss is exposed on J. and C. Twaddell's land near the Brandywine creek, and on the road leading northward from Smith's bridge.

South of Brandywine Summit slaty feldspathic and hornblendic gneiss is exposed. There are also exposures of decomposed schistose rocks between Brandywine Summit and Painter's Cross Roads. The dip of the rock is S.  $10^{\circ}$  E.  $45^{\circ}$ .

A short distance west of Painter's Cross Roads feldspathic and hornblendic gneiss is exposed in the road near a branch of Harvey's run, on J. H. Painter's land. Some of the rock is conglomeritic in appearance. This is due to the crystals or segregations of light colored feldspar in a dark matrix.

A quarry about one third way between Painter's Cross Roads and Chadd's Ford, on J. C. Turner's land, exhibits thinly laminated feldspathic gneiss. This rock also has the appearance of a conglomerate; the segregations of feldspar are arranged parallel to the lines of bedding or cleavage.

Similar micaceous and feldspathic gneiss is exposed on the cross roads south of the Baltimore Central railroad. Hornblendic gneiss also occurs in some localities in this part of the township.

Hornblendic and slaty micaceous gneiss is found south of the Brandywine Baptist church.

On the cross road, near the railroad about one mile south of Chadd's Ford, dark grey hornblendic gneiss occurs. It is exposed near the Brandywine creek, and also on the road leading east and north from the Double Bridge. The principal exposures of this rock are on J. Garthrope's land.

The geological horizon of the rock is questionable, as it is somewhat different in character from the gneisses usually met with in this section. It occupies an escarpment and is similar in appearance to the older syenites in the vicinity of Chester creek.

Corrugated micaceous gneiss is found in a quarry a short distance north of Chadd's Ford, on G. Brinton's land, close to Brandywine creek and near the county line. The dip of the rock is S. 40° E. 45°.

Sandy micaceous gneiss occurs along the first road east of Chadd's Ford. The principal outcrops of rock along this road are on A. W. House's and J. Hoop's lands. Some of the rock is very sandy.

Feldspathic conglomeritic gneiss and compact hornblendic rocks occur near the county line.

At Dilworthtown slaty micaceous sandstone is exposed. It is probably equivalent to the sandstone which occurs a short distance north of Dilworthtown, in Chester county. The dip of the sandstone at this place is S. 30°-40° E. 15°-20°. In Chester county, it has the peculiarities of itacolumite, and has been considered equivalent to the Potsdam sandstone; but I am not inclined to take this view of the case, as there seems to have been contradictory structural grounds advanced.

A short distance south-east of Dilworthtown, gray flaggy and banded feldspathic micaceous gneiss is exposed near the township line. This rock is in part similar to that found at Turner's quarry, west of Painter's Cross Roads.

Kaoline is extensively mined in Birmingham township. The kaoline works are south-west of Brandywine Summit, and not far from the Concord township line, on a branch of the Beaver creek.

The kaoline deposit has been traced a distance of about half a mile and new openings are being made on the bed. At one of the newest openings the dip of the bed was visible. It is N.  $10^{\circ}$  W.  $15^{\circ}$ . The thickness of the deposits is not known. It is very evident that the deposit has been formed from the decomposition of a feldspar bed in place. The course of the branch of Beaver creek no doubt indicates the general strike of the measures.

At the kaoline works a rock was observed which resembles serpentine.

Granular limestone is found close to the kaoline deposit, but there is only one small exposure of the rock visible.

Dark colored and decomposed mica schist are also found near the kaoline.

The limestone and feldspar may not belong to the same geological horizon.

A short distance south of T. Speakman's house, south of Brandywine Summit there are indications of feldspar and limestone. There is much loose feldspar along the road leading from Brandywine Summit to the kaoline works, and also south south-east of the former place.

*Minerals of Birmingham Township.*

*Rutile. B. p. 44.*

Crystals of rutile and massive rutile in quartz have been found in this township.

*Quartz. B. p. 55.*

Yellow crystalized quartz is found in this township.

*Orthoclase. B. p. 92.*

Salmon-colored crystals of orthoclase are found in the vicinity of the kaoline works and probably south and east of Brandywine Summit.

*Fibrolite. B. p. 99.*

Fibrolite occurs in fine fibrous masses at Bullock's quarry, north-east of the kaoline works. It is also found in quartz at the kaoline works.

*Kaolinite.    B. p. 119.*

Kaoline of a white and yellowish white color is found in large quantities along a branch of Beaver creek, south-west of Brandywine Summit and near the Concord township line.

*Calcite.    B. p. 152.*

Calcite occurs at the kaoline works in this township.

## HAVERFORD TOWNSHIP.

*Clay.*

A small area of clay is found in the north-east corner of the township near Bryn Mawr. It is probable the result of the decomposition of the underlying feldspathic rocks.

*Tertiary.**Ferruginous conglomerate.*

There are indications of ferruginous conglomerate over a considerable area in the central and southern portion of the township.

There are numerous indications of the formation visible in the vicinity of Haverford P. O.

The indications of the conglomerate are continuous from Coopertown to the vicinity of Haverford P. O. Coopertown is probably the northern limit of the main body of the formation, which occupies the higher portions of the central and southern part of the township.

The escarpments of Cobb's creek, Naylor's run and Darby creek expose the underlying gneisses.

East of Cobb's creek ferruginous conglomerate was observed close to the county line, on the church road, and a short distance north of Castle Hill mills.

The conglomerate is everywhere much decomposed, and indications of the existence of the formation are fragments of conglomerate and rounded milky quartz pebbles in the soil. These pebbles are usually small and often ironstained. The soil is usually colored by the decomposed ferruginous matrix of the conglomerate.

An indistinct terrace and escarpment is noticeable in some places along the edge of the areas.

The underlying gneisses are always much decomposed when the conglomerate overlies them.

Gravel, apparently the same as that derived from the

breaking up of the conglomerate, has been observed close to the north township line and west of Cobb's creek.

*Serpentine.*

There are some indications of decomposed serpentine in the extreme north-east corner of the township, and on the Lancaster pike.

A short distance east of the county line decomposed serpentine is exposed in a cut of the Pennsylvania railroad. In all probability this belt extends into Haverford township.

*Mica Schists.*

Garnetiferous mica schists, micaceous sandstones and corrugated mica schists, with ligneous fracture, are found throughout a greater portion of the township.

The exposures along Cobb's and Darby creeks are numerous. Slaty garnetiferous mica schist has been quarried near Cobb's creek, a short distance west of Haverford college, on H. Garrigues' land.

Silvery garnetiferous schists are exposed on the Church road and along Cobb's creek to the township line. Near Castle mills the rock is less decomposed than on church road.

Corrugated mica schist and micaceous sandstone are found near Castle Mills. The cleavage strike is N. 40° W.  $\pm 90^\circ$ , and the bedding or dip of the measures is apparently N. 30°-40° W. 5°-10°.

South of Echo Mills, and near Nitre Hall mills, the observed dips are N. 40° W. 20° and N. 25° W. 30°. A short distance below Castle Hill mills the rock exposed is somewhat coarser and more feldspathic.

Gray slaty mica schist and micaceous sandstone is exposed on the road east of Haverford P. O., near Naylor's run, and opposite Dr. B. S. Anderson's house. The rock is similar in character to the whetstone of Marple township. The dip is N. 10° E. 10°-15°.

Silvery garnetiferous mica schist is exposed west of Haverford P. O. Similar rock also occurs a short distance south of Coopertown gray garnetiferous mica schists, with ligneous

fracture, extend from the vicinity of Coopertown to Darby creek. The exposures along Darby creek are numerous.

Near the north-west corner of the township, and west of Ithan creek, gray slaty mica schist has been quarried on W. Wallace's land. The ligneous fracture is strongly marked.

Some of the rock exposed along Darby creek, between Ithan creek and the West Chester and Philadelphia pike, is very feldspathic and the mica occurs in large crystals. There are numerous exposures of slaty gneiss and micaceous sandstone on T. Cornog's and J. Moore's lands, close to Darby creek and below the confluence of Ithan creek.

In the vicinity of the West Chester and Philadelphia pike veins of feldspathic gneiss and quartz are frequent. They vary in width from one to four feet. Some of the gneiss is quite hard and compact.

The most extensive exposures are on the pike opposite T. Miller's land. The rock exposed along Darby creek south of the pike does not vary from that already mentioned.

The exposures of the rock along the roads throughout the township indicate no change in character in the underlying measures. The rocks are generally concealed by a covering of soil and decomposed matter, and the natural exposures are few.

### *Minerals of Haverford Township.*

#### *Garnet. B. p. 72.*

Garnet occurs in most of the schists and gneisses throughout the township.

#### *Cyanite. B. p. 101.*

Cyanite is found with staurolite on Mrs. Prichett's farm, which is located west of the Spread Eagle hotel and south of the West Chester and Philadelphia pike.

#### *Staurolite. B. p. 103.*

Staurolite occurs with cyanite on Mrs. Prichett's farm, near Darby creek.



## MARPLE TOWNSHIP.

*Tertiary.**Ferruginous conglomerate.*

Fragments of ferruginous conglomerate and small white or rusty rounded quartz pebbles are found on many of the roads through the central portion of the township.

One of the most southerly exposures of this formation is on Dr. S. B. Anderson's land, a short distance west of Whetstone run and north of Marple P. O. Several large boulders of the conglomerate are to be seen on the roadside a short distance west of Mrs. Williamson's house.

Numerous exposures of small rounded pebbles occur along the Springfield road north of Marple P. O. The indications of the formation extend northward along this road to the vicinity of the north township line.

The formation can be traced along the West Chester and Philadelphia pike from the vicinity of the north township line to within a short distance of Darby creek. The formation extends over the high ground on each side of the pike and the Springfield road. The escarpment of Langford run exposes the underlying formations.

West of Trout run, and east of Palmer's mill, fragments of the conglomerate have been observed. The formation probably occupies a small area on the ridge between Trout run and Crum creek.

*Serpentine.*

Serpentine and the associated rocks extend over a considerable area in the north-western corner of the township.

East of Palmer's mill two small exposures are visible in the road.

North of Palmer's mill along the road to Newtown Square and the road to the township line road there are large ex-

posures of serpentine. The principal outcrops are near the forks of the road north of Palmer's Mill and near the Marple school-house and also between Hunter's run and Crum creek on the road leading to Blue Hill.

Enstatite and steatite are found near the north-east corner of the township near Darby creek.

Honey-comb or porous quartz occurs at all the serpentine localities and is found over an area near the north township line where undecomposed serpentine has not been observed. Porous quartz is however always an indication of decomposed serpentine.

Chromic iron has been found near the Marple school-house. It occurs in lenticular masses with mica schists.

#### *Mica Schists.*

In the south-east corner of the township and near Darby creek there are numerous exposures of slaty micaceous gneiss and gray micaceous sandstone.

The principal exposures of this rock are along the south township line road and also near an old saw-mill on Darby creek in the south-east corner of the township.

A short distance north-west of the south-east corner of the township whetstone quarries have been worked.

On G. Garrett's and Dr. B. S. Anderson's lands the rock is a fine-grained sandstone with fine particles of mica. The dip is N. 45° E. 45°.

North of these quarries, and about two thirds way to the West Chester and Philadelphia pike, similar sandstone has been quarried on Dr. George Smith's land. The character of the rock is the same at all the openings.

Feldspathic micaceous gneiss and silvery mica schists are found close to the sandstone.

North of Dr. G. Smith's whetstone quarry slaty mica schist is exposed in the road; and loose feldspar also occurs in the soil.

Close to Langford run and near Darby creek fine grained micaceous and feldspathic gneiss is exposed. The weathered portions of the rock are dark colored, probably because of the decomposition of iron pyrite.

There is an extensive exposure of micaceous gneiss on the West Chester and Philadelphia pike west of Darby creek. Occasional beds of sandy schist are seen in the cut. The whole mass is much contorted and twisted and some of the weathered surfaces show a peculiar corrugation.

Decomposed mica schist and sandstone are exposed near the top of the hill on the pike. The decomposed condition of the rock here may be in part due to the proximity of the overlying ferruginous conglomerate.

The cleavage strike of these exposures is nearly north and south  $\pm 90^\circ$ .

Silvery mica schist is exposed on the pike near the north township line.

There are a few exposures of sandy gneiss on the Springfield road west of Langford run. The ligneous fracture is noticeable at these exposures.

Throughout the southern and south-western portion of the township the rock is of a slaty and whetstone character. Slaty gneiss and flaggy micaceous sandstone are exposed on the road leading from Marple P. O. to Crum creek. The principal outcrops are on G. B. Allen's land and near Holland's run. The ligneous fracture of the weathered rock is very characteristic.

Compact quartzose micaceous gneiss is exposed in a ledge on the north side of Holland's run west of Marple P. O. and a short distance east of Crum creek. The composition of the rock does not materially vary from that exposed elsewhere in the vicinity.

Close to Crum creek there is an extensive exposure on the roadside of micaceous and sandy gneiss. The rock is much weathered. The laminations, which are probably cleavage, dip S.  $80^\circ$  E.  $60^\circ$ .

Mica schist and gneiss is exposed along the bank of Crum creek above the confluence of Holland's run.

Schistose micaceous gneiss and silvery mica schists are exposed in the road which crosses Trout run near Crum creek.

Sandy micaceous rock is visible in some places. There are a few exposures of schistose gneiss along Crum creek between Trout run and Palmer's Mills.

Hornblendic gneiss and micaceous gneiss and schist are exposed on the roads leading from Palmer's mills to the Springfield road. The principal outcrops are near Trout run. Boulders of white milky quartz are numerous west of Trout run.

The rock is usually much decomposed. The general features of the country indicate an unconformity of the corrugated and ligneous schists upon the gneissic rocks with which I am inclined to class the hornblendic gneisses.

The corrugated and ligneous schists belong to the serpentine series or Chestnut Hill group, and the hornblendic gneisses to the Manayunk or Philadelphia series of schists and gneisses.

*Minerals of Marple Township.*

*Menaccanite. B. p. 35.*

Fine crystals of menaccanite have been obtained in this township.

*Magnetite. B. p. 37.*

Titaniferous magnetic iron occurs with chromic iron north of Palmer's Mills.

*Chromite. B. p. 39.*

Chromic iron ore has been found on H. Thomas' and Dr. Williamson's land in the north-western part of the township and north of Palmer's Mills. It is associated with the serpentine and schists adjoining it.

*Quartz. B. p. 55.*

Drusy quartz occur at all serpentine localities, derived from the decomposition of that rock.

*Amethyst. B. p. 57.*

Amethyst crystals have been found in Marple township.

*Chalcedony. B. p. 59.*

Chalcedony usually occurs with the porous quartz and serpentine.

*Carnelian. B. p. 59.*

Red and brownish red varieties of Chalcedony have been found in Marple.

*Agate. B. p. 59.*

Variagated chalcedony is also found in this township.

*Enstatite. B. p. 62.*

Enstatite is found along the north township line near the West Chester and Philadelphia pike also north of Palmer's Mills near the Marple school-house.

*Actinolite. B. p. 67.*

Pale green actinolite is found in this township associated with the serpentines.

*Antholite. B. p. 68.*

This mineral is found with the serpentines.

*Asbestus. B. p. 68.*

Small quantities of asbestus are found with the serpentines

*Beryl. B. p. 71.*

Beryl is said to occur in this township. Probably it has been found in the north-western portion.

*Tourmaline. B. p. 96.*

Green tourmaline is reported from Marple township. (?)

*Andalusite. B. p. 98.*

Fine crystals of andalusite have been found in this township.

*Talc. B. p. 111.*

Chloritic talcose slate is associated with the serpentine.

*Serpentine. B. p. 113.*

Serpentine is found in the north-western portion of the township east and north of Palmer's mills and near the Marple school-house; also between Hunters' run and Crum creek.

*Damourite. B. p. 125.*

"Pseudomorphous micaceous minerals, after andalusite occur in Marple township."

## UPPER PROVIDENCE TOWNSHIP.

*Tertiary.**Ferruginous conglomerate.*

This formation is exposed in the northern portion of the borough of Media. The principle exposures are in the vicinity of the reservoir.

The area occupied by the formation is not sharply defined. It occupies the high ground between Crum and Ridley creeks, and extends northward from Media, indications of the formation being visible about half way to the Rose Tree hotel on the Providence Street road.

The conglomerate is composed of rounded pebbles of white and milky quartz which are cemented together by a ferruginous matrix. A piece of micaceous gneiss was observed in one of the fragments of the conglomerate. Some of the pebbles in Media are four to six inches in diameter. Usually however the conglomerate is composed of small pebbles and sand.

Numerous pebbles occur in the soil a short distance south of the Rose Tree hotel.

White and rusty quartz occurs in large blocks along the Providence Street road between Media and the road leading to Palmer's Mills. These quartz blocks or bowlders may have been left by the tertiary erosion or formed a part of the Ferruginous conglomerate.

*Serpentine.*

The serpentine crosses the northern portion of the township, in two belts which indicate shallow synclinal basins, and the erosion between these areas or basins exposes the underlying mica schists.

The serpentine can be traced from Palmer's Mill on Crum creek to a point on Ridley creek and north of the road leading from Rose Tree hotel to Lima P. O.

The deposits are small. The rock is exposed on the road leading to Palmer's Mill and in the Providence Street road north-west of the Palmer's Mill road.

Decomposed serpentine is found on J. Smedley's land near Ridley creek north-west of Media also north of the road leading from the Rose Tree hotel to Lima. A large quantity of asbestus is exposed at this place. Asbestus is also found a short distance north-east of Smedley's land.

Enstatite rock is found near Ridley creek north of the Lima road.

The largest exposures of serpentine are close to the Blue Hill school-house and east of Sycamore Mills. One area extends from the Providence Street road at the Blue Hill school-house to the vicinity of Crum creek.

There is a large area of the rock south-east of Sycamore Mills and close to Ridley creek. The rock can be traced from the creek to the vicinity of the Blue Hill school-house.

Honey-comb or porous quartz is abundant on the road which crosses the township from Sycamore Mills a short distance north-west of Blue Hill.

#### *Mica Schists.*

Mica schists and gneisses occupy the greater portion of the township south of Blue Hill. The exposures of the rock on Crum creek are numerous.

Gray micaceous and quartzose gneiss and micaceous sandstone are exposed close to Crum creek and near the south-east corner of the township. The rock is corrugated and the ligneous fracture is prevalent. The cleavage strike is nearly north and south  $\pm 90^\circ$ . The bedding is apparently N.  $25^\circ$  W.  $15^\circ$ .

Mica schist and gneiss are exposed along the State road near Crum creek.

Hornblendic gneiss occurs at a quarry on this road a short distance west of the creek.

The rock is usually much decomposed. On the north side of the State road and a short distance west of Crum creek the micaceous gneiss forms a prominent ridge and is somewhat more compact than in the southern edge of the

township. The weathered rock usually has a gray silvery luster.

There are exposures along the State road to the vicinity of the Rose Tree hotel.

Throughout the central portion of the township the exposures are comparatively few.

Near the south-west corner of the township in the vicinity of Hillsboro Mills on Ridley creek there are numerous exposures of micaceous gneiss. Schists and gneisses are also exposed on the roads in this vicinity. The ligneous fracture is noticeable at most of the exposures.

There are exposures of gneiss and schists near the railroad bridge over Ridley creek west of Media. At the Media railroad station there is an extensive exposure of micaceous gneiss in the railroad cuts. Here the cleavage dip is  $\pm 90^\circ$  while the bedding of the rock is marked by undulating cross lines which dip gently to the north-westward.

A short distance north-west of the station the rock is much decomposed, and has the appearance of being very much twisted and contorted. The dip of the measures is at a low angle.

There is a quarry of dark colored micaceous gneiss near the south edge of the borough of Media on the north side of a small brook. The cleavage is  $\pm 90^\circ$  and the dip of the measures S.  $20^\circ$  W.  $10^\circ$ – $15^\circ$ .

Exposures of mica schist in Media have a nearly vertical cleavage and undulating dip S.  $35^\circ$  W. The rock is very garnetiferous in places.

There are numerous exposures of slaty mica schist and garnetiferous mica schist in the north-western portion of Media and near the old water-works.

Corrugated schistose gneiss is exposed in a quarry above the water-works dam. The cleavage strike is about north and south. The dip of the rock is apparently N.  $60^\circ$  E.  $15^\circ$ .

There are exposures of similar rock west of Media and near Ridley creek.

Schists are exposed in numerous places along Ridley creek between Media and Sycamore Mills.

On the road between Sycamore Mills and Crum creek



there are numerous indications of hornblendic and micaeous gneiss.

A short distance north of Blue Hill school house and near Crum creek compact garnetiferous feldspathic gneiss is exposed to view.

*Syenites.*

The northern end of the township north of Blue Hill is occupied by the syenitic rocks, and exposures are numerous throughout this section of the township.

Dark colored hornblendic and feldspathic syenites are exposed at Sycamore Mills and along the road leading to Upper Providence P. O.

Large numbers of bowlders occur in the escarpments of the streams. The dips observed are S. 10°-30° E. 30°-50°.

In the vicinity of Upper Providence P. O. the exposures of bowlders are numerous.

The character of the rock is similar throughout the area. The rock which is exposed along the roadside is usually much decomposed.

There are numerous exposures of bowlders along Crum creek within the township limits.

The rock is usually gray granitic syenite.

*Minerals of Upper Providence Township.*

*Spinel. B. p. 37.*

Spinel occurs in minute crystals at Blue Hill.\*

*Chromite. B. p. 42.*

Large crystals of chromite have been found at Blue Hill.

*Green Quartz. B. p. 58.*

Small but fine crystals of green quartz have been found at Blue Hill.

*Orthoclase. B. p. 93.*

Semi-transparent bluish-green cassinite has been found at Blue Hill.

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\* Col. Willcox considers this to be an error.

*Serpentine. B. p. 116.*

So-called chrysotile occurs at Blue Hill in a seam of decomposed serpentine.

Serpentine occurs at Blue Hill and south-east of Sycamore Mills, it is also south and south-west of Palmer's Mills on and near the road leading from that place to the Providence Street road.

Decomposed serpentine is found on J. Smedley's land near Ridley creek and a short distance north-west of Media.

## MIDDLETOWN TOWNSHIP.

*Ferruginous Conglomerate.**Tertiary.*

This formation is found in the township at the Middletown Presbyterian Church a short distance south-east of Elwyn station on the Philadelphia and West Chester railroad, and also north-west of Lima P. O. close to the north township line and near the Edgmont road.

The areas are small but there are numerous indications of the formation along the roads which cross the areas, and numerous fragments of the rock and loose pebbles are visible. The pebbles are usually quite small and rounded.

*Serpentine.*

A large area of serpentine exists through the central portion of the township.

The southern edge of the serpentine is close to the line of the Philadelphia and West Chester railroad.

The area extends from Elwyn station to Lenni.

Indications of serpentine are visible on all the roads in the township as far north as Dismal run.

The western limit of the serpentine is somewhat indefinite but is probably not far west of the road leading from Lima to Lenni.

The exposures of serpentine are numerous. The rock is usually much decomposed.

The Mineral Hill quarry is located a short distance west of Ridley creek and north of Elwyn station on M. A. Smith's land. The rock is considerably broken and fractured and it is impossible to obtain any structural facts from the exposures.

A. M. Martin and Company's quarry is located a short distance west of Elwyn station and north of the railroad.

The serpentine extends over a large area on the east side of Chrome run, and from surface indications it extends to Ridley creek.

A short distance west of the Sorrel Horse hotel and near the head of Chrome run the serpentine is exposed along the road. There are also numerous exposures east of this hotel and not far from the Training school.

There are exposures of the rock along the Philadelphia and West Chester railroad near Elwyn station.

At Lenni a large serpentine quarry is opened on Sellers' land.

Between Chrome run and Lenni the exposures of serpentine are almost continuous along the railroad, the rock in most cases much weathered and disintegrated.

South of the Philadelphia and West Chester railroad there are a few outcrops of decomposed serpentine and the associated rocks on the Pennsgrove road and a short distance south of it.

Between Glen Riddle and Lima decomposed serpentine and porous quartz are everywhere visible.

There are several outcrops and excavations in the serpentine close to Dismal run and north-east of Lima P. O. Serpentine is also exposed south of Dismal run, and near Ridley creek. There is also much porous quartz visible throughout this section of the township.

In the north-western corner of the township serpentine is found close to Chester creek and a short distance above Glen Mills and also at a locality a short distance east of Glen Mills and near the road leading to Lima.

The areas are small and isolated from the main serpentine belt.

#### *Limonite.*

Limonite is found at most of the serpentine localities. It is derived from the decomposition of the serpentines and exists in the largest quantities where the decomposition has been the greatest.

Limonite has been mined near the western edge of the serpentine area at a point about half way between Lima and Lenni, close to the Rockdale road.

An extensive opening was made close to the Lima road and a short distance north-east of Lima; several openings have been made near Dismal run.

The amount of iron is variable and usually quite silicious, as it is always intimately associated with the porous quartz.

The analysis of pitchy limonite from Middletown Delaware county, given in report B. p. 50, merely shows the composition of a single specimen; thus: Ferric oxide, 74.57; Manganic oxide, 2.58; Cobaltic oxide, 0.60; Alumina, 1.54; Phosphoric acid, 0.13; Quartz, 6.90; Water, 13.10; =99.42.

Small quantities of asbestos are found at a number of places with the serpentine.

A fibrous variety of tremolite, disseminated through quartz is found associated with the serpentines in the vicinity of Elwyn station.

Corundum is found with the decomposed serpentine a short distance south of the Black Horse Hotel and west of Elwyn station.

The locality is known as the Black Horse corundum mine. There is no large quantity of the mineral however and the works have not been a financial success.

Corundum is also found on Chrome run and near Ridley creek on Mineral Hill.

### *Granite.*

Light gray feldspathic granite is found in this township associated with the serpentines.

The principal localities are close to the state road west of the Black Horse hotel and near Chrome run and also along the Lima road near Dismal run.

The rock has been quarried near Chrome run on M. Altemus' and J. Hibbard's lands and also on A. N. Martin and Co's land a short distance west of the serpentine quarry.

The rock is usually of a light gray color. The weathering indicates but a small amount of ferruginous matter.

The exposures near the state road west of the Black Horse hotel show the dip to be E. 10°.

In the vicinity of Dismal run the rock is much broken.

and weathered, and there are no ledge exposures visible. The geological position of this granite formation is below the serpentines.

Near the north-west corner of the township a coarse feldspathic and mica rock occurs in proximity to the serpentine on J. Sharpless' land.

This rock may be geologically equivalent to the granitic rock in the northern central portion of the township.

*Mica schists and Gneisses.*

The exposures of schists and gneisses are principally confined to the escarpments of Ridley and Chester creeks.

There are numerous small areas of steatite, anthophyllite, and actinolite, indicative of the serpentine horizon, through the southern and south-western portion of the township; but these rocks seem to be confined to very small areas lying upon the schists and gneisses which are exposed in the escarpments.

Slaty feldspathic mica schist is exposed on Ridley creek from the south township line to the Philadelphia and West Chester railroad.

At Hillsboro Mills there are extensive ledges of schistose gneiss. The cleavage strike is N.  $10^{\circ}$  W.  $\pm 90^{\circ}$ . On Chester creek and along the Chester creek railroad the exposures of micaceous gneiss extend from the south township line to the vicinity of Rockdale. There are numerous outcrops of decomposed schists and gneisses on Crum and Chrome runs, and also on the roads in the southern portion of the township.

Near the south-west corner of the township and a short distance south of Knowlton station the cleavage is N.  $20^{\circ}$  E.  $55^{\circ}$ – $90^{\circ}$  and the dip of the measures is S.  $20^{\circ}$  E.  $10^{\circ}$ .

The rock is a gray schistose micaceous gneiss.

The principal exposures are close to Chester creek.

The rock exposed along Chrome run north of Mt. Alverno station are somewhat harder and more compact than those exposed throughout the southern central portion of the township.

South of Chrome run and close to Mt. Alverno station  
5 C°.

some of the rock exposed is a slaty micaceous sandstone and is similar to the whetstone rock.

Much of the rock in this portion of the township is garnetiferous.

Decomposed schists and gneisses are exposed south-west of Lima and east of Pennelton station; there are also indications of similar rock near Dismal run in the north-eastern portion of the township.

It is impossible to delineate the boundary of the schists and gneisses definitely. The facts indicate however that the schists and gneisses are overlaid by the serpentines and associated rocks.

### *Syenites.*

The syenites are principally confined to the northern portion of the townships and to the escarpments along Chester creek from the vicinity of Rockdale north-westward.

The principal exposures on Chester creek are close to Glen Riddle, near Lenni, and above Darlington station.

At Glen Riddle and Lenni the serpentines apparently rest directly upon the syenites. This seems to be the case also in the vicinity of Glen Mills.

The syenites are overlaid unconformably by the schists and gneisses.

The exposures of syenitic rock occur along the escarpments of the tributaries of Chester creek.

The schistose rocks occupy usually the higher portions of the township.

The rock exposed along Chester creek is a hornblendic, quartzose and feldspathic syenite, usually dark colored, with occasional alternations of light gray granitic rock.

In the northern portion of the township and remote from the escarpments of the streams the rock is usually much decomposed and disintegrated. Its composition does not vary materially throughout the belt; but the appearance is variable on account of various stages of decomposition.

A considerable amount of hornblendic syenite is visible near the north-eastern corner of the township and close to Ridley creek.

The exposures along the roads are usually unsatisfactory.

*Minerals of Middletown Township.*

*Corundum. B. p. 32.*

Corundum has been mined on C. W. Gray's land, a short distance south of the Black Horse hotel and north-west of Elwyn station. It occurs in slender bi-pyramidal crystals of grayish color. It is associated with the decomposed serpentine.

Loose crystals of corundum are found in the soil in this vicinity.

At Mineral Hill, a short distance north of Elwyn station and near Ridley creek crystals of corundum are found in feldspathic rock near the serpentine.

*Menaccanite. B. p. 36.*

This mineral is said to be found in this township. It probably occurs at Mineral Hill.

*Magnetite. B. p. 39.*

Magnetite has been found in dendrites in muscovite at Mineral Hill.\*

*Rutile. B. p. 44.*

Rutile is found in crystals and massive in quartz.

*Limonite. B. p. 48.*

Limonite is found at nearly all the serpentine localities. It is derived from the decomposition of the serpentines. It has been mined on L. Palmer's land, west of the Rockdale road and a short distance north of Glen Riddle.

A large amount of ore has been dug on T. and E. G. Smedley's land near the Lima road north-east of Lima post office.

Near Dismal run a number of excavations have been made in search of limonite, and small quantities obtained. The ore is usually very siliceous. Small amounts of very fine ore have been obtained.

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\* Col. Willcox considers this to be an error.



*Quartz. B. p. 56.*

Porous and drusy quartz is found associated with the serpentines. Green quartz is found near Dismal run.

Chalcedony is found in many places associated with the serpentines and porous quartz.

*Tremolite. B. p. 67.*

A variety of this mineral is found in oligoclase on Painter's farm near Dismal run.

Antholite, a grayish and brownish variety, radiated and stellated, is also found in this township.

*Actinolite. B. p. 67.*

Pale green, yellowish and brownish green actinolite is abundant at Mineral Hill. It is also found near Lenni.

*Asbestos. B. p. 68.*

Asbestos is found at Mineral Hill and also near Lenni, associated with serpentine.

*Beryl. B. p. 70.*

Yellowish green crystals of considerable size have been found in this township.

*Garnet. B. p. 72.*

Dark reddish brown crystals of garnet in orthoclase are found near Bishop's Mills.

*Chrysolite. B. p. 71.*

Grains of chrysolite occur in bronzite rock.

*Zircon. B. p. 77.*

Minute brown crystals of zircon are found with oligoclase on Painter's farm near Dismal run.

*Biotite. B. p. 83.*

Biotite occurs in many localities. It enters into the composition of many of the schistose gneisses.

*Muscovite. B. p. 85.*

Hexagonal crystals of muscovite, with bands of reticulated magnetite are found at Joel Sharpless's, E. of Glen mills.

*Oligoclase. B. p. 90.*

Transparent, yellowish oligoclase has been found near Dismal run on Painter's land.

*Albite. B. p. 91.*

Albite has been found at Mineral Hill.

*Orthoclase. B. p. 93.*

Orthoclase occurs at Mineral Hill and also near Dismal run. In the north-western portion of the township it is found close to the serpentine on J. Sharpless' land.

*Tourmaline. B. p. 95.*

Radicated, stellated and fibrous tourmaline is found in this township.

*Fibrolite. B. p. 99.*

Fibrous and radiating crystals occur, in the form of corundum, and resulting from its alteration, near the Black Horse hotel.

*Staurolite. B. p. 103.*

Staurolite is found in mica slate at Glen Riddle station.

*Talc. B. p. 111.*

Talc is found at Mineral Hill, and near Lenni.

*Serpentine. B. p. 115.*

Massive, dark green serpentine occurs in a number of localities throughout the central portion of the township.

The principal localities are Mineral Hill, north of Elwyn station; the quarries of A. N. Martin & Co., west of Elwyn; and the quarries at Lenni.

There are numerous exposures along the Philadelphia and West Chester railroad between Elwyn and Lenni, and on the state road south and south-east of Lima.

A porcellanous variety, resembling lithomarge, is found at Mineral Hill and Lenni.

*Jefferisite.*    *B. p. 129.*

This mineral is found at the serpentine outcrops near Lenni. A number of varieties of exfoliating micas have been observed at this locality.

*Hallite.*    *B. p. 130.*

Hallite is found with the decomposed serpentines close to the railroad at Lenni.

## ASTON TOWNSHIP.

*Tertiary.**Ferruginous conglomerate.*

A small area of this formation is found a short distance north-west of Llewellyn and north of the West branch of Chester creek.

Indications of the formation may be seen on the Logtown road and also on the road leading to Lenni north of the creek.

The boundary of the area occupied by this formation is indefinite.

The underlying gneiss is much decomposed and the ferruginous conglomerate is only seen in fragments along the roadsides.

Loose pebbles derived from the disintegration of the rock are found in the soil.

*Serpentine, Steatite.*

Steatite is found west of the road leading from Village Green to Rockdale (Marcus Hook road) and near the road leading to Mt. Alverno station, much decomposed. Fragments of chloritic slate, asbestos and serpentine are scattered over a small area in this vicinity.

Decomposed steatite and chloritic rock is exposed on the Marcus Hook road about half way between Mt Alverno station and Village Green.

A small area of steatite occurs south-west of Village Green and west of the Marcus Hook road. The locality is about half way between the Marcus Hook road and Hook creek.

Milkey quartz with tourmaline occurs on the Marcus Hook road and about half way between Village Green and the south township line. The soil along the roadside in

this vicinity resembles that derived from the decomposition of steatite.

Chloritic schist and corundum are found a few yards south of Morgan station. Several areas of decomposed serpentine occur a short distance south-west of Crozerville and north of the West branch of Chester creek. The outcrops are unimportant.

#### *Mica Schists and Gneisses.*

There are two areas of schists and gneisses in Aston township. The southern area extends from Chester creek and the south township line to the vicinity of Hock creek on the west. The northern boundary is a short distance north west of Village Green and crosses diagonally from Chester creek near Mt. Alverno station to a branch of Hock creek heading near Village Green.

The northern area of schists and gneisses occupies that portion of the township north of the west branch of Chester creek. It extends to the vicinity of the line of the Baltimore Central railroad and the Logtown church.

There are numerous exposures of the rock along Chester creek between Bridgewater and the vicinity of Mt. Alverno station.

Near the south-east corner of the township the bedding appears to be nearly horizontal, slightly undulating in some places. One exposure indicates a dip N. 80° W. 40°. The rock is a mica schist and micaceous feldspathic gneiss. Some of the beds are quite garnetiferous.

There are exposures of decomposed schist and gneiss on the roads leading to Village Green from Morgan's and Knowlton stations, and also on the Marcus Hook road near Village Green.

Gray micaceous sandstone and schists are exposed near Mt. Alverno station. The rock is contorted and twisted. The cleavage appears to be S. 55° E. 80°. The dip is probably to the northward and about 20°.

Silvery mica schists are exposed near Village Green on the road leading from that place to Llewellyn.

North of the west branch of Chester creek there are nu-

merous exposures of decomposed schist and gneiss on the road leading from Chester Heights to Logtown, and also near Peter's Mill on the west branch.

Some of the rock at and near Peters' Mill is very garnetiferous. The rock is usually a gray feldspathic micaceous gneiss. There are numerous ledges exposed near Peters' Mill. The dip of the rock is apparently S. 20° E. 30°.

North-west of Chester Heights decomposed slaty micaceous and feldspathic gneiss is exposed on the roadside. Similar rock is exposed in the railroad cut near Chester Heights.

The gneissic rocks extend to the vicinity of Ivy Mills church and occupy the higher portion of the township between Chester creek and its west branch.

There are very few natural exposures within this area of schists and gneisses, and the artificial exposures along the roads show the rock much decomposed.

### *Syenites*

This formation occupies two areas in Aston township.

The southern area extends from Chester creek at Rockdale south-westward to the township line. The rock extends from the margin of the schists and gneisses near Village Green to the West branch of Chester creek. There are numerous exposures of the rock along Chester creek between Rockdale and Lenni, and also along the West branch as far as Llewellyn.

The northern area of syenites extends northward from the Baltimore Central railroad.

The syenites are exposed more or less along Chester creek from Lenni to the north township line.

Numerous indications of the underlying formation are visible along the roads crossing the areas.

The exposures at Rockdale are probably the best found anywhere in the township.

The rock exposed at the Rockdale quarry is a light gray granitic and hornblendic syenite with occasional bands of sandy rock and feldspathic conglomerate.

The rock exposed near Rockdale station is a dark gray granitic syenite. Its dip appears to be S. 40° E. 60°.

South of Crozerville there are extensive outcrops of similar rock along the face of the escarpment.

Large numbers of loose blocks and bowlders of the rock are visible along the creeks which enter the area. Near Hook creek these bowlders are very numerous.

In the northern portion of the township and west of Pen-nelton station large numbers of gray granitic and hornblen-dic bowlders are visible along the roads and escarpments.

Some of the darker colored varieties of syenite are banded with light gray feldspathic syenite.

*Minerals of Aston Township.*

*Corundum. B. p. 32.*

Large crystals of corundum are found a few rods south of Morgan's station and close to Chester creek.

*Amethyst. B. p. 57.*

Fine crystals of amethyst have been found near Morgan Station.

*Actinolite. B. p. 68.*

Actinolite has been found accompanying steatite.

*Hornblende. B. p. 69.*

Hornblende occurs at and near Rockdale.

*Asbestos. B. p. 68.*

Asbestos is found with the steatite and serpentine south-east of Rockdale and a short distance from Mt. Alverno station on J. H. Sides' and J. F. Worrilow's lands.

*Garnet. B. p. 73.*

Garnet occurs in many localities. Good crystals have been found near Peters' Mill.

*Oligoclase. B. p. 89.*

Sunstone has been found in this township.

*Tourmaline. B. p. 97.*

Good specimens of tourmaline are found in Aston township. Small crystals occur in milky quartz a short distance south of Village Green on the Marcus Hook road.

*Fibrolite. B. p. 99.*

Fibrolite in small fibers in quartz is found near Village Green associated with the steatite.

*Talc. B. p. 111.*

Talc is found north of Village Green on the Marcus Hook road close to E. T. Hall's house and close to the same road west of Mt. Alverno station on J. H. Sides' land.

A small area of steatite is found south of Village Green and about half way between Hook creek and the Marcus Hook road.

*Damourite. B. p. 124.*

Damourite, with nuclei of unaltered corundum, is found near Morgan's station in the south-eastern corner of the township.

*Margarite. B. p. 136.*

Pearly margarite, often with nuclei of corundum, is found near Morgan's station.



CONCORD TOWNSHIP.

*Tertiary.*

*Ferruginous conglomerate.*

This formation covers a large area in the south-western portion of the township, extending from the vicinity of the Smith's Bridge road, east of Elam P. O. to the south township line.

There are exposures of the conglomerate near and on the Naaman's Creek road close to the south township line. The principal exposure is at the Kaoline works and near Concord creek.

The escarpments on the edge of the formation are indistinct and there are no natural exposures of the rock to be found.

The kaoline which is found close to the Naaman's Creek road and Concord creek is probably due to the decomposition of the feldspathic rock underlying the ferruginous conglomerate and protected by it from erosion.

A small area of Ferruginous conglomerate is found a short distance east of Painter's Cross Roads, and numerous fragments of the rock are visible on the road leading to Concordville. No exposures were observed in this area, and the indications of the formation are confined to the excavations along the roadside.

*Serpentine.*

Serpentine is found a short distance east of Elam P. O. and close to the Smith's Bridge road. The locality is on a branch of Concord creek. The rock exposed in the quarry is much broken and seamy. Much porous quartz is found in the vicinity.

Decomposed serpentine and porous quartz is found on the Smith's Bridge road near the head of Green's creek.

The area is apparently quite small, as there are no indications of the rock except close to the road side.

A radiated actinolite is found near the south township line and close to Green's creek. This rock unquestionably belongs to the serpentine horizon. As exposed at this locality it is wholly composed of radiating crystals of actinolite.

*Mica Schists and Gneisses.*

Feldspathic and garnetiferous schists occupy the greater portion of the township south of the line of the west branch of the Chester creek and the line of the Baltimore Central railroad.

Feldspathic and schistose rocks are also found in the north-western corner of the township and in the vicinity of Painter's Cross Roads.

The exposures of this rock are usually unsatisfactory and are confined principally to the road cuts.

Slaty schistose micaceous gneiss is exposed on the Concord and Chester road near the south township line and close to Green's creek.

South of Green's creek the rock is much decomposed.

There are numerous exposures of decomposed slaty feldspathic mica schist on the first road west of the Concord and Chester road.

There are numerous indications of similar rock along the Smith's Bridge road.

In the vicinity of Ivy Mills station schistose gneiss is exposed near the creek.

Garnetiferous micaceous gneiss has been quarried a short distance north of the Smith's Bridge road and about half way between Elam and Concord station. The dip appears to be N. 15°; but the rock is usually so much weathered and disintegrated that it is difficult to obtain any observations which can be relied on.

South-east of Painter's Cross Roads large quantities of loose feldspar are found in the soil, probably due to the feldspathic beds which form the kaoline in the adjoining township on the west.

In the vicinity of Elam P. O. there are numerous expos-

ures of slaty garnetiferous and gneissic schists. Some of the rock is very feldspathic.

Feldspar has been dug near the township line and a short distance west of Elam P. O.

Kaoline is found close to the south township line and near Concord creek on the Naaman's Creek road. It is derived from the decomposition of the feldspar and feldspathic gneiss underlying the ferruginous conglomerate which is found at this locality. And the fact that the kaoline is found in this position is due no doubt to the protection of the overlying conglomerate.

*Syenites.*

The syenites are found along the southern edge of the township south of Green's creek and also north of the line of the Baltimore Central railroad.

There are numerous blocks and boulders of gray granitic and hornblendic syenite between the Naaman's Creek road and Green's creek. The principal localities are along the escarpments of the tributaries of Green's creek. In the vicinity of Concordville exposures of the rock are most numerous.

Dark gray syenite is exposed in broken ledges east of Woodland station. There are many boulders and blocks of the rock along the escarpments.

The dip of the measures is apparently N. 10° W. 30.°

In the northern portion of the township the rock is more decomposed and the exposures few.

*Minerals of Concord Township.*

*Rutile. B. p. 45.*

Crystals of rutile have been found in Concord township.

*Amethyst. B. p. 57.*

Fine crystals occur in this township.

*Actinolite. B. p. 67.*

Pale green and other varieties of actinolite are found with the rocks associated with the serpentine. Antholite of gray or brown color occurs on E. Hannum's land, near the southern edge of the township and close to Green's creek.

*Beryl. B. p. 71.*

Fine specimens of beryl have been obtained in Concord township.

*Garnet. B. p. 73.*

Fine specimens of iron-alumina garnet have been found. Small garnets are very plentiful in the soil near Green's creek. A deep-blood-red colored garnet is found near Peter's Mill dam on Green's creek and near the south-east corner of the township. Also massive manganese garnet.

*Biotite. B. p. 83.*

Biotite is found at Painter's Cross Roads and also at Elam P. O.

*Muscovite. B. p. 85.*

Peculiar crystals of muscovite are found in this township.

*Orthoclase. B. p. 95.*

Large quantities of feldspar are found near the west township line, and south of the Baltimore Central railroad.

*Fibrolite. B. p. 99.*

Fibrolite occurs in fibrous masses in quartz. It is found associated with the serpentine rocks.

*Sepiolite. B. p. 113.*

Sepiolite is found in grayish and yellowish white masses in the serpentine near Elam P. O.

*Serpentine. B. p. 113.*

Serpentine is found near the Smith's bridge road east of Elam P. O.

Decomposed serpentine is found on the same road about half way between Elam P. O. and Concord station.

*Kaolinite. B. p. 119.*

Kaoline is found near the south township line and south-east of Elam P. O., close to the Naaman's Creek road and near a branch of Concord creek.

BETHEL TOWNSHIP.

*Tertiary.*

*Ferruginous conglomerate.*

This formation covers a small area in the north-west corner of the township. Fragments of the rock are visible on the Naaman's Creek road near the township line.

*Steatite.*

Steatite is found close to the north township line and near Green's creek. The area occupied by this rock is quite small. A quarry was once opened, but has been long abandoned. There are at present no exposures of the rock visible.

*Mica Schists and Gneisses.*

The area occupied by this formation is close to Green's creek and extends westward from Chelsea a short distance.

There are a few exposures of gray slaty feldspathic and garnetiferous schists north of the Bethel road and along the cross road south-west of Chelsea.

The garnetiferous schist is mined and the garnet used for commercial purposes. The garnet mine is located a short distance south of Green's creek and near the north township line west of Chelsea.

*Syenites.*

Syenites are found in all parts of the township except the narrow strip of schists bordering Green's creek. The rock is usually close to the surface and a large portion of the soil is formed by the decomposition of the feldspathic rocks.

Ledges of the rock are exposed on some of the roads, and boulders are visible at all the escarpments.

Dark colored syenite rock is exposed on the Bethel road near Chelsea.

Decomposed syenitic rock is visible on the Chichester road a short distance south-east of Chelsea.

Gray granitic and hornblendic syenite is exposed in a number of places on the Bethel road between Chelsea and Booth's Corners.

Gray granitic syenite is exposed on the Naaman's Creek near Booth's Corners.

West of Booth's Corners there are large broken ledges visible near the Naaman's Creek road.

Near the south-east corner of the township there is a terrace of granitic syenite which is cut by Naaman's creek.

The sharp northward curve in the creek is caused by this belt of rock.

There are few places in the township where the rock is undisturbed on the surface, and the principal exposures are in the escarpments along the creeks.

The general trend of the boulder exposures and terraces is N. 10° E. and S. 10° W. and the dip appears to be about N. 80° W. 10°-15°.

#### *Minerals of Bethel Township.*

##### *Wad. B. p. 53.*

Good specimens of wad or bog manganese have been obtained at the garnet mine of Herman, Behr and Co. located near Green's creek and west of Chelsea.

##### *Quartz. B. p. 55.*

Massive smoky, milky and transparent quartz is found on J. Larkin's land south of Chelsea and on the west side of a branch of McCay's run.

The quartz occurs in a vein in the syenitic rock and is associated with feldspar.

##### *Garnet. B. p. 72.*

Beautiful specimens of garnet have been obtained at the garnet mine of Herman, Behr and Co., west of Chelsea.

Good specimens of brownish-red garnets are found in muscovite on J. Larkin's land south of Chelsea and near a branch of McCay's run. They occur in the quartz and feldspar vein.

*Talc. B. p. 111.*

A small area of steatite occurs on Herman, Behr and Co's. land close to the garnet mine which is located near Green's creek and west of Chelsea.

*Orthoclase. B. p. 92.*

Orthoclase feldspar is found on J. Larkin's land south of Chelsea.

*Muscovite. B. p. 84.*

Crystals of muscovite are found with quartz and feldspar on S. Larkin's land south of Chelsea.

## UPPER DARBY TOWNSHIP.

*Gravel.*

Gravel is found through the central and southern portion of the township. There are exposures on the road leading north from Lansdowne station.

At Lansdowne station from one to three feet of gravel is exposed in the railroad cut.

South of Kellyville gravel is exposed in several places near the south township line.

*Tertiary.**Ferruginous conglomerate.*

Close to the west township line and west of Clifton ferruginous conglomerate is exposed on the Marple road.

Ferruginous clay and fragments of the rock are found along the road.

The area occupied by this formation is small and is confined to the high ground between the head of Muckinipalus creek and Darby creek.

*Trap.*

Dark colored dolerite is found on the West Chester and Philadelphia pike a short distance from the north township line. Similar bowlders are found on the first road west of the pike and also near the north-west corner of the township, close to Collen brook. These exhibitions are all about the same distance south of the north township line, and may belong to a continuous dyke.

*Schists and Gneisses.*

Slaty micaceous gneiss with occasional bands of light colored feldspathic gneiss is found on Darby creek near the south township line.

Micaceous gneiss appears at Fernwood and Cardington



near Cobb's creek. It is usually much decomposed and being very feldspathic forms in places an impure kaoline.

Similar rock is exposed at Lansdowne station. Some of the rock is quite sandy and resembles somewhat the whetstone of Marple township.

Feldspathic micaceous gneiss has been quarried at Cardington.

Similar rock is exposed in a number of places along Cobb's creek as far as the north township line.

Quartzose hornblendic gneiss is exposed in a quarry on the east side of Cobb's creek and south of the line of the West Chester and Philadelphia pike (Market St).

This rock is not exposed in Upper Darby township, but probably underlies the feldspathic micaceous gneisses of Cobb's creek.

There are numerous exposures of decomposed schistose feldspathic gneiss along the West Chester and Philadelphia pike above Upper Darby P. O. The rock exposed is usually much broken and appears to be much contorted, though the normal dip is probably undulating.

On the New State road close to Naylor run there is an exposure of quartzose hornblendic gneiss associated with a feldspathic or granitic rock. Some of it is black where fresh fracture has occurred.

Numbers of bowlders of the rock are exposed along Naylor run north of the New State road.

The exposures of rock are almost continuous along Darby creek from Heyville to the vicinity of Kellyville.

Coarse micaceous feldspathic gneiss is exposed in the bed of the creek above the crossing of the Delaware county turnpike at Kellyville.

Gray slaty micaceous gneiss and occasional beds of coarse granitic gneiss are exposed along the road above the confluence of Falls run at Kelleyville.

Compact, dark colored quartzose gneiss is exposed in ledges above Clifton Mills and extend to the vicinity of Heyville.

Dark quartzose hornblendic gneiss is exposed in a quarry

a short distance above Clifton Mills on the east side of the creek.

West of the creek in this vicinity decomposed feldspathic and sandy micaceous gneiss is exposed in a number of places along the roads.

The cleavage strike is nearly north and south  $\pm 90^\circ$ .

The rock between Glenwood Mills and Heyville is somewhat harder and more compact than that towards Kellyville.

Decomposed mica schist is exposed near Garretford.

North-west of Garretford and near the New State road light colored sandy mica schist is exposed. South-east of Collen brook are numerous exposures of mottled feldspathic micaceous gneiss. The rock is dark gray and the segregations of light-colored feldspar give it the appearance of a conglomerate.

Hornblendic and feldspathic rocks are exposed near Collen brook and not far from the north township line.

Boulders of quartz occur east of Garretford and near a branch of Falls run.

Smoky quartz (B. p. 58,) has been found near the Kellyville school-house and also near the Garrett road toll-gate.

SPRINGFIELD TOWNSHIP.

*Gravel.*

There are numerous indications of gravel in the southern portion of the township. The exposures are mainly near Morton and close to the railroad. Clay occurs near Morton station. It extends over a considerable area in the southwestern part of the township. The Philadelphia and West Chester railroad is close to the northern limit of the deposit.

Four to six feet of clay are exposed at S. Morton's brick yards near Morton station.

*Tertiary.*

*Ferruginous conglomerate.*

This formation occupies a small area close to the east township line. It is exposed on the Springfield road near Clifton and occupies the high ground south of Heyville. The exposures consist of fragments of conglomerate and red clay exposed along the roadside.

*Trap.*

A dark feldspathic rock resembling dolerite is exposed on the Springfield road south-east of Marple P. O. and near the head of Levis run. It is associated with garnetiferous feldspathic gneiss.

South of this point similar rock is exposed on the roads which cross the head of Stone creek and also east of Stone creek and a short distance south of the Delaware county pike.

*Mica Schists.*

Along Darby creek in the vicinity of Heyville there are numerous exposures of quartzose feldspathic and micaceous gneiss. The rock is usually very compact.

In the neighborhood of the New State road and Darby creek the rock is a feldspathic gneiss. Some of the rock is mottled and has the appearance of a conglomerate. It is usually much decomposed.

Near the north-east corner of the township the rocks are more sandy, and there are exposures of fine gray micaceous sandstone and schist along the township line road, and near Darby creek. Some of the rock is very feldspathic. A peculiar ligneous fracture is noticeable along the exposures.

Similar gray slaty micaceous sandstone and schist and gray, feldspathic gneiss is exposed on the the Springfield road a short distance south of the New State road.

Decomposed mottled feldspathic gneiss and garnetiferous schist is visible on the same road near the head of Levis run.

Feldspathic gneiss is exposed on the Delaware county pike near the east township line and near a branch of Stone creek. It is much decomposed and loose feldspar is found in the soil.

North of Morton and near the branches of Stone creek are numerous exposures of decomposed mica schist and micaceous gneiss.

North-west of Morton station, on Kedron avenue, decomposed feldspathic micaceous gneiss is exposed. A few boulders are visible along Stone creek.

South of the Delaware county pike and east of Stone creek the dip of the rock appears to be N.  $70^{\circ}$  W.  $60^{\circ}$ .

There are several exposures of decomposed feldspathic gneiss and schist on the roads crossing the head of Stone creek and north of the Delaware county pike. Gray micaceous gneiss is exposed on Little Crum creek south-west of Morton and near the south township line. The dip is to be S.  $30^{\circ}$  W.  $15-20^{\circ}$ .

An old quarry is located near the Chester and Springfield road and about half way between the railroad and the south township line.

The rock is a feldspathic micaceous gneiss; some of it is a sandy micaceous sandstone and resembles the whetstone

rock of Marple township. At Avendale, in the south-west corner of the township, there is a large quarry opened.

The rock is a compact gray feldspathic and micaceous gneisses. The mica varies in color from gray to black and is arranged parallel to the cleavage which is  $\pm 90^\circ$ . The cleavage strike is about N.  $10^\circ$  E. and S.  $10^\circ$  W.

The lines of separation, called bottoms, which dip W.  $5^\circ$ – $20^\circ$  are the planes of bedding. The rock is traversed by reins of quartz and feldspar.

The quarry is known as a mineral locality. The minerals are confined to the veins and vein matter. One of the veins exposed contains quartz and tourmaline, another garnet with feldspar and quartz. Mica often occurs in large crystals in the vein matter.

The same rock as quarried at the Avendale quarry is exposed in the Chester and Springfield road south of the quarries. The rock is more weathered and broken. The cleavage and bedding is well defined.

A short distance north-east of Swarthmore college and near the head of Little Crum creek a quarry is opened.

The rock is very similar to that quarried at Avendale and may belong to the same geological horizon. The cleavage strike is east of north  $\pm 90^\circ$ . The lines of bedding are more or less distinct and the dip is E.  $5^\circ$ – $10^\circ$ .

Throughout the north-western portion of the township the rock is usually much decomposed and more schistose.

Between the Delaware county pike and Marple P. O. along the Chester and Springfield road are numerous exposures.

A short distance south of Whiskey run slaty micaceous gneiss and mica schist is exposed in a ledge. The dip is N.  $20^\circ$  E.  $20^\circ$ .

At Holt's mills on Whiskey run there are exposures of similar rock. Towards Marple P. O. the rock becomes somewhat more sandy and there are numerous indications of micaceous sandstone along the roads. The ligneous fracture is characteristic throughout this portion of the township.

There are numerous exposures of schists and micaceous

sandstones on the road north-east of Beatty's Axe factory, and also near Crum creek above the factory. Much of the rock in this vicinity has a corrugated fracture or cleavage.

Mica schist is exposed in places along Crum creek and on the Delaware county pike, near Wallingford Mills.

Hornblendic gneiss is exposed in a number of places along Crum creek. The rock is visible at and above Wallingford Mills. A quarry has been worked near the confluence of Whiskey run. This rock is probably geologically the same as that exposed in the adjoining township near Avendale.

Its geological portion is apparently above the feldspathic gneisses of the Avendale quarries and appears to be unconformably overlaid by the corrugated and ligneous schists and gneisses of the northern part of the township.

*Minerals of Springfield Township.*

*Beryl. B. p. 71.*

Beryl is found in the granite veins in the gneiss at the Avendale quarries south of Swarthmore station.

*Garnet. B. p. 73.*

Fine specimens of garnet are found at the Avendale quarries, (Leiper and Lewis.) They occur in the vein matter.

*Muscovite. B. p. 84.*

Large crystals of muscovite are found in the granite and feldspar veins at the Avendale quarries.

*Tourmaline. B. p. 95.*

Good specimens of tourmaline are found at the Avendale quarries in the south-east corner of the township.

*Andalusite. B. p. 98.*

Andalusite is found near Crum creek and south of Swarthmore station; also a half mile north of the station and near Swarthmore college. It occurs loose in the soil.

*Apatite. B. p. 138.*

Apatite has been found near Beatty's mill in this township.

NETHER PROVIDENCE TOWNSHIP.

*Gravel.*

Indications of gravel are found throughout the southern third of the township. There are exposures on the road between Avendale and Waterville. Small exposures occur on the Providence street road west of Avendale.

The extent of the deposit is indefinite and the exposures unsatisfactory.

*Steatite.*

A short distance south of Rose Valley mills steatite occurs. The rock can be traced from Ridley creek to the road east of the creek. The area is small and narrow.

*Mica Schists.*

The exposures of rock along Crum and Ridley creeks are numerous. A short distance below Avendale there is an extensive quarry known as the Lower Avendale quarry.

The rock is a gray micaceous feldspathic gneiss. The upper beds exposed in the quarry are much weathered and decomposed. The cleavage strike N.  $10^{\circ}$  E. S.  $10^{\circ}$  W.  $\pm 90^{\circ}$ . The bedding is well defined. The dip is S.  $10^{\circ}$ - $20^{\circ}$ .

Granite veins traverse the rock parallel and at angles to the cleavage. Similar rock, though considerably weathered, is found near the south-east corner of the township, close to Crum creek.

Schistose feldspathic and micaceous gneisses are exposed in the vicinity of Crosbyville and Waterville. At Crosbyville and close to Ridley creek the quarries show the same rock as exposed at the Avendale quarry.

Near Johnson's tool factory and above Waterville the rock is somewhat more micaceous. The cleavage dip is N.  $70^{\circ}$  W.  $70^{\circ}$ . The dip of the rocks appears to be S.  $20^{\circ}$  E.  $10^{\circ}$ .

There are numerous exposures of slaty micaceous gneiss along Chester creek between Johnson's tool factory and Todmorden mills.

At Todmorden mills the rock is somewhat finer grained than that exposed along the creek below the mills.

The dip of the rock at Todmorden mills is S.  $30^{\circ}$  E.  $10^{\circ}$ . The dip observed on the east side of the township at Avendale is S.  $80^{\circ}$  W.  $15-25^{\circ}$  which indicates a synclinal axis between Crum and Ridley creeks.

There are numerous indications of slaty micaceous gneiss through the southern central portion of the township. The rock exposed is usually much decomposed at Wallingford station and in the vicinity of Wallingford mills there are exposures of schistose micaceous gneiss and silvery mica schist. The rock is usually much decomposed.

#### *Hornblendic Gneiss.*

Hornblendic gneiss occurs near Lewis' paper-mill, at Wallingford mills, and at Strath Haven, and Avendale on Crum creek. The principal exposures of the rock are close to Dick's run near Strath Haven and close to Avendale.

On the Providence street road opposite Avendale are slight indications of hornblendic gneiss. Close to Ridley creek on the west side of the township and a short distance above Todmorden mills there are large exposures of hornblendic gneiss. Similar rock is also found close to Ridley creek and about half way between Todmorden and Rose Valley mills.

The dip of the hornblendic rocks at Todmorden mills appears to be N.  $30^{\circ}$  W.  $10^{\circ}-30^{\circ}$ . The hornblendic rocks exposed at Avendale overlie the gray feldspathic gneiss which is quarried in the adjoining township. The same relations appear to exist on the west side of the township.

The silvery mica schists and corrugated and ligneous schists and gneisses through the northern and central portion of the township overlie the hornblendic gneisses.

The cleavage strike of these schistose rocks is north about  $10^{\circ}$  east and south  $10^{\circ}$  west and the angles or dip varying from  $5^{\circ}$  to  $90^{\circ}$  south  $80^{\circ}$  east. The bedding is usually un-



dulating and usually at low angles. It varies from north-east to north-west, and usually not more than  $10^{\circ}$  pitch.

There are large exposures of schistose gneiss near the north-east corner of the township near Beatty's axe factory and also in the vicinity of the Rose Valley mills along Ridley creek.

The only mineral reported from this township is orthoclase feldspar B. p. 93. It occurs in the quarries at Crosbyville in the southern edge of the township.

## DARBY TOWNSHIP.

*Gravel.*

The principal exposures of gravel are along the Wilmington post road and near Darby P. O., and on the road leading to Darby station from the post road.

The gravel consists of bowlders and pebbles of quartzite, conglomerate, gray sandstone and fragments of New Red sandstone.

Small deposits of limonite occur through the gravel mass. The thickness of the gravel varies from ten to fifteen feet. About fifteen feet of the gravel is exposed along the Philadelphia, Wilmington and Baltimore railroad a short distance east of Darby station.

A considerable amount of decomposed feldspar is visible in this exposure.

Gravel is exposed along the same railroad near Academy station. It is also visible on the roads in this vicinity and on the Wilmington post road near Hermsprota run and near the west township line in the neighborhood of Glen Olden station. There are exposures of gravel near Glen Olden mills on the township line road.

Near the north-west corner of the township, at Summit ridge, gravel is visible along the roadside. Gravel is visible in the vicinity of Lansdown station and also close to the head of Pusey's run. West of Mount Moriah cemetery and south of Fernwood station there are unimportant outcrops of gravel.

Surface indications show that the gravel covers the greater part of the township except along the creeks where the escarpments have exposed the underlying formations.

The more recent alluvium deposits extend over Smith's and Hay islands and the lower edge of the township between Darby and Muckinipallus creeks.

The southern edge of the gravel deposits is marked by

an escarpment to which the alluvium extends. The escarpment is not always sharply defined.

*Mica Schists.*

There are exposures of mica schist along Cobb's creek near Blue Bell and a short distance east of Darby P. O. The rock is a coarse micaceous gneiss. The mica is usually in large crystals and light colored, usually muscovite.

There are exposures near the Philadelphia, Wilmington and Baltimore railroad and south of it. The rock is all quite similar.

There are numerous exposures of schistose gneiss along Cobb's creek, north of Blue Bell. The rock is usually much decomposed.

South of the Philadelphia and West Chester railroad and in Mount Moriah cemetery are numerous ledges of micaceous gneiss. It is usually of a light gray color.

Numerous exposures of decomposed schistose gneiss are visible along the road leading to Darby station from Darby and along the line of the P. W. and B. R. R.

Feldspathic schists are exposed on Darby creek near the north township line and also at and in the vicinity of Darby P. O. At Hermsprota run decomposed schist is visible on the Wilmington post road.

At Glen Olden mills, near the south-west corner of the township, micaceous feldspathic gneiss is exposed in the bed of Muckinipallus creek.

Hornblendic gneiss is found at Darby P. O. The principal exposure of the rock is at Andrew's quarry, in the borough of Darby, and south of Pusey's run.

The rock is a quartzose hornblendic gneiss. The lower beds are compact and massive. The upper beds are more or less weathered. The dip is S. 10° W. 25°-35°.

About fifty to sixty feet of the rock is exposed.

Griswold's quarry is located at the east end of the Griswold mills. The lower rock in this quarry is similar to that at Andrew's quarry.

In the upper portion of the quarry, mica schist and gneiss is exposed, which overlies the hornblendic gneiss. The rock

is much contorted and twisted. It appears to pitch to the south-west and towards Darby creek.

There are numerous indications of hornblendic gneiss in the bed of Darby creek between Griswold's and Andrew's quarries. Slight indications of hornblendic gneiss are seen on the Wilmington post road near Andrew's quarry.

A short distance north-west of Griswold's quarry decomposed hornblendic gneiss is exposed along Darby road.

Segregations of limonite and decomposed feldspar are visible in the excavations.

*Minerals of Darby township.*

*Wad. B. p. 53.*

Small deposits of wad occur with the limonite segregations in the decomposed hornblendic gneiss on Darby road in the borough of Darby.

*Rutile. B. p. 45.*

Rutile has been found in crystals and massive in quartz. It is probably associated with the hornblendic gneiss.

*Garnet. B. p. 73.*

Reddish brown garnets occur in some of the mica schists in the township.

*Fibrolite. B. p. 81.*

Small specimens of fibrolite occur near Andrew's quarry at Darby, in the micaceous gneiss.

*Cyanite. B. p. 101.*

Cyanite occurs at Mt. Zion Hill near Darby.

*Staurolite. B. p. 103.*

Staurolite has been found loose in the soil in this township.

TINICUM TOWNSHIP.

*Alluvium.*

The entire island is formed of alluvium deposits. The soil is usually sandy or loamy.

The only exposure of rock on the island is found on the edge of Long Hook creek near Darby creek and north of Lazaretto P. O. The exposures are limited to a small area surrounded by alluvium.

The rock is a coarse feldspathic granetoid micaceous gneiss, somewhat similar in appearance to the rock exposed along Crum creek near Blue Bell in Darby township.

## RIDLEY TOWNSHIP.

*Alluvium.*

The alluvium deposits extend a short distance north of Darby creek and the Delaware river. The limit of the deposit is marked by a more or less distinct escarpment along the edge of the gravel deposits.

*Gravel.*

The gravel deposits extend over the whole of the township. There are numerous exposures on the roads in different parts of the township though they are unsatisfactory.

Clay covers a considerable area in the southern portion of the township.

There are several brick-yards between Stone and Crum creeks and south of the Wilmington post road. There are some indications of clay near Morton station and near Stone creek and near the north township line.\*

*Mica schists and Gneiss.*

Feldspathic micaceous gneiss is exposed near Muckinipallus creek and opposite Glen Olden mills, and also close to the Wilmington post road, on the bank of the same creek.

Near the White Horse hotel and Ridleyville are numerous exposures of schistose micaceous gneiss. Similar rock is also exposed south of Ridleyville and close to the Lazaretto bridge. Some of the rock exposed here is a coarse-grained micaceous gneiss.

Cyanite is very plentiful in the brook at and near the road crossing close to the Lazaretto bridge. About half way between Ridleyville and Stone creek and also on Stone creek are exposures of slaty decomposed micaceous and feldspathic gneiss.

The rock is quarried close to the pike and near Stone creek. The exposures of rock near the mouth of Crum

creek, near Avendale on the same creek and along Ridley creek are the most extensive.

Ward's quarries are located a short distance north of Crum creek station, and between Little Crum and Stone creeks.

The rock is a gray feldspathic gneiss. The cleavage is  $\pm 90^\circ$ , and the bedding of the rock is nearly horizontal or has an undulating dip to the eastward.

A short distance below Leiperville and close to Ridley creek there are exposures of gray corrugated mica schist and sandy garnetiferous gneiss.

The Leiper quarries are north of the Wilmington post road and on the east bank of Ridley creek.

Deshong's quarry adjoins the Leiper quarries on the north-west. Shoemaker's quarries are north-west of Deshong's quarry.

The rock at all these quarries belongs evidently to one geological horizon, and is usually a gray feldspathic micaceous granitic gneiss. Veins of feldspar and quartz traverse the rock at various angles.

The rock appears to dip to the north and north-eastward at the Leiper and Deshong's quarries.

At Deshong's a bed of dark colored mica schist, with some hornblende, overlies a portion of the gray granitic gneiss.

Slaty micaceous gneiss is exposed on the east side of Crum creek a short distance north-west of Leiperville. The rock is considerably decomposed.

In the vicinity of Lapidea there are numerous exposures of decomposed feldspathic gneiss. The rock close to the creek is no doubt the same as that developed in the quarries.

A short distance below Avendale, and close to the north-west corner of the township, compact feldspathic gneiss has been quarried.

This rock is in every respect the same as that found along Ridley and Lower Crum creeks.

Close to an angle in Crum creek, between Avendale and Lapidea, hornblendic gneiss is exposed.

This rock overlies the feldspathic gneiss of the quarries.

A short distance west of Spring Hill station, near the north-east corner of the township, and close to the head of a branch of Muckinipallus creek, are several large blocks of feldspathic gneiss. There is but little mica in the mass, and the feldspar is in large crystals. There is no ledge or exposure of the rock in this part of the township.

*Minerals of Ridley Township.*

*Beryl. B. p. 70.*

Crystals of beryl are found in syenite near the White Horse tavern on the Wilmington post road.

Fine specimens are found at Deshong's quarry in the vein matter. It is also found in the Leiper quarry.

*Garnet. B. p. 74.*

A dark red variety of garnet is found in the bed of Darby creek, near the Lazaretto. It is also found at Deshong's and Leiper's quarries.

*Orthoclase. B. p. 93.*

Orthoclase occurs at Deshong's and Leiper's quarries. Very fine crystals are met with in the granite veins.

*Tourmaline. B. p. 96.*

A pale green and red variety of tourmaline is found in albite at Leiperville. Fine crystals of black tourmaline are also found at the same locality, (Leiper and Deshong's quarries.)

*Fibrolite. B. p. 99.*

Fibrolite is found in fibrous masses at the White Horse tavern, near Ridleyville.

*Cyanite. B. p. 101.*

Blue, radiating bladed masses of cyanite occur in granular quartz at the White Horse tavern near Ridleyville. It is sometimes associated with beryl, pyrite and fibrolite.

Blue cyanite is very plentiful in a small brook near the Lazaretto bridge and south of Ridleyville. It has also been found at Ward's quarry, south-east of Leiperville.



*Stilbite.*    *B. p. 108.*

Stilbite is found on quartz in yellowish-brown radiated columnar masses at Leiperville.

*Damourite.*    *B. p. 124.*

Damourite probably is associated with the cyanite at the Black Horse tavern.

*Apatite.*    *B. p. 133.*

Apatite is found at the Leiperville quarries, and occurs in the feldspathic veins in exceedingly small quantity.

*Zoizite.*    *B. p. 80.*

This mineral has been recently found at Deshong's quarry.

## CHESTER TOWNSHIP.

*Alluvium.*

The alluvial deposits extend across the southern edge of the township.

In South Chester there are numerous exposures of clay at the brick-yards. These brick-yards are between Lamokin and Harwick run and north of the Philadelphia, Wilmington and Baltimore railroad.

The northern limit of the clay and alluvial deposits is in general parallel to the present course of the river, and a short distance north of the line of the railroad.

*Gravel.*

Indications of gravel are found over most of the southern portion of the township. An extensive exposure of gravel is found near the Concord road a short distance above the Upper Chichester road and west of Chester creek. From twelve to eighteen feet is exposed. Small deposits of limonite are visible in the gravel.

*Mica Schists and Gneisses.*

Steatite is said to be found close to the north township line and about half way between Chester and Ridley creeks.

The micaceous rocks in this portion of the township are softer, and appear to be less feldspathic than those elsewhere exposed. On Ridley creek there are a few exposures near the north township line. The rock is a micaceous feldspathic gneiss.

The exposures opposite Todmorden mills are the most extensive in this portion of the township. The rock varies from a micaceous gneiss to a fine-grained micaceous sandstone. The dip is S. 30° E. 10°.

In the vicinity of Waterville and Crosbyville there are numerous exposures of mica schist and micaceous gneiss.

In the vicinity of Waterville the rock has a dip S. 45° E. 30°.

The rock at Crosbyville and south of it is a gray feldspathic and micaceous gneiss.

At Powell's quarry a short distance below Crosbyville the dip of the rock is S. 45° E. 10°-20°. The cleavage strike is a few degrees east of north and west of south, and the dip  $\pm 90^\circ$ . The rock is geologically the same as that found in the quarries in Ridley township.

There are numerous outcrops of micaceous gneiss along Chester creek, in the city of Chester and in Upland.

Luken's quarry is near the mouth of Ship creek in Chester. The rock is a much decomposed and broken micaceous gneiss. Undulating lines of bedding are visible in the quarry.

Mr. S. Crozer's quarry is located on the west side of Ship creek between the Upland road and Chester creek. The rock is a compact gray micaceous gneiss similar to that found on Ridley creek. Granitic veins occur in the rock at this quarry.

There are several quarries close to the Upland road and near Ship creek. The rock, when not weathered, is a compact gray feldspathic micaceous gneiss.

There are several exposures of schistose micaceous gneiss along Chester creek near Upland station.

The Bridgewater quarries are opposite Bridgewater station and on the east bank of Chester creek. The rock resembles that exposed on Ridley creek below Crosbyville. The bedding of the rock is N. 70° E. 10°-25°.

Slaty micaceous gneiss and schist is visible on the Concord road, near Baldwin run, west of Chester creek, and also in a few unimportant localities along the Chester creek railroad, between Upland and Bridgewater stations.

Hornblende gneiss is found above the dam at Bridgewater on Chester creek and also on the road leading to Brook Haven close to Chester creek. Slight indications of hornblende gneiss also occur a short distance north-east of Brook Haven on the same road.

*Syenites.*

There is a small area of syenitic rock close to the west township line and extending from Stony run to Baldwin run. The area is indefinite as the rock is covered usually by alluvial deposits. The only outcrop observed within the township is on the west side of Stony run and close to the corner of Upper Chichester township. The rock is a dark colored micaceous syenite with some garnet. The dip appears to be N. 80° E. 80°.

*Minerals of Chester Township.**Pyrite. B. p. 19.*

Crystals of pyrite are found near Chester.

*Chalcopyrite. B. p. 21.*

Chalcopyrite is found associated with molybdenite in the quarries near Chester.

*Menaccanite. B. p. 36.*

Large crystals are found at Dutton's Mills near Upland.

*Molybdenite. B. p. 54.*

Occurs at Upland on Chester creek. It is found as an incrustation on quartz.

*Amethyst. B. p. 57.*

Amethyst is found at Dutton's Mills and at Shaw and Ezra's quarry.

*Beryl. B. p. 70.*

Large crystals have been found on Wm. Trainer's farm at Upland and also at Shaw and Ezra's quarry.

*Garnet. B. p. 73.*

Crystals of garnet are found at Upland and in Shaw and Ezra's quarry. They also occur in various places in the micaceous gneiss.

*Biotite. B. p. 83.*

Large crystals of biotite are found in the vein matter in the quarries near Chester.

*Muscovite. B. p. 85.*

Semi-transparent crystals of muscovite are found at Dutton's Mills. Crystals are also found at Shaw and Ezra's quarry.

*Albite. B. p. 91.*

Aggregations of imperfect crystals have been found at Shaw and Ezra's quarry. It occurs abundantly in cleavable masses in the gneissic rocks in the vicinity of Chester.

*Orthoclase. B. p. 93.*

Fine crystals have been found at Shaw and Ezra's and S. Crozer's quarries and also in Hudson's quarry near Upland.

*Fibrolite. B. p. 99.*

Fibrous masses of fibrolite are found at Dutton's Mills near Chester.

*Antunite. B. p. 144.*

Specimens have been found at S. Crozer's quarry on Ship creek near Chester.

*Mirabilite. B. p. 148.*

This mineral is said to occur in the quarries near Chester.

*Uraconite. B. p. 152.*

Small quantities of this mineral have been found in the quarries near Chester.

*Bismuthite. B. p. 163.*

This mineral has been found in the gneissic rocks in the vicinity of Chester.

## UPPER CHICHESTER TOWNSHIP.

*Gravel.*

Gravel is exposed on the Marcus Hook road near Chichester creek and in a number of places along the south township line road.

Gravel occurs on the Upper Chichester road south of Baldwin run and close to Baldwin run on the Marcus Hook road. Clay is found east of Chichester creek and south of the Upper Chichester road.

A brick yard is located close to the east township line and near the south-east corner of the township on M. Boyd's land.

*Syenites.*

Decomposed syenitic rock is exposed on the Marcus Hook road near Chichester creek not far from the south township line. It is a gray or dark colored feldspathic syenite. It is much weathered and rusty.

A few boulders of similar rock are found on the same road near the north township line and close to Baldwin run.

There are numerous indications of cyanite along Chichester creek. Decomposed rock is exposed near the creek and a short distance east of Chichester.

East of Upper Chichester cross roads there are numerous blocks and boulders of granitic and hornblendic syenite.

There are numerous exposures of syenite rock at Upper Chichester cross roads. The rock is much broken and weathered.

Along the east branch of Naaman's creek are numerous exposures of granitic, hornblendic and mottled feldspathic syenite. Some of the rock has the appearance of dolerite.

West of Chichester the decomposed feldspathic rock forms an impure kaoline.

Near the north township line and close to this branch of

Naaman's creek large numbers of granitic syenite and hornblendic boulders are visible in the escarpments.

There are large numbers of blocks and exposures of broken ledges on the Naaman's creek road and along the middle branch of Naaman's creek.

Large numbers of gray granitic and hornblendic syenite boulders occur along a brook near the west township line between McCay's run and Naaman's creek.

The lines of outcrop of the broken ledges are in many cases well defined. The escarpments are often abrupt but there are no localities when the rock appears at the surface in place. The prevailing dip appears to be to the north-westward and the contour of the country would indicate a fall of ten to fifteen degrees.

Numerous blocks of rusty quartz with feldspar occur near the west township line. This rock is no doubt vein matter which occurs in the Syenites.

## LOWER CHICHESTER TOWNSHIP.

*Alluvium.*

The alluvial deposits cover the southern edge of the township and extend to a line about half way between the Delaware river and the Philadelphia, Wilmington and Baltimore railroad.

Gravel and clay deposits extend over the whole of the township north of the more recent alluvium. Exposures of gravel are found at Linwood Mills and on the north township line road in a number of places.

Clay is found in the north-east corner of the township.

*Syenites.*

There are a few exposures of syenitic rock on Stony run near the east township line. Along Chichester creek the rock is exposed in a number of places. The principal outcrops are above Linwood Mills.

At and in the vicinity of Linwood station decomposed syenite is visible. On Stony run the rock is a micaceous feldspathic syenite with some garnet. The dip appears to be N. 45° W. 70° though the rock is considerably contorted.

Near the railroad and on the west bank of Chichester creek the rock is a bluish gray quartzose syenite. The dip is N. 10° W. 15°.

Some of the rock is garnetiferous. The rock exposed above Linwood Mills is a light gray quartzose feldspathic syenite with occasional beds of hornblendic rock. Here the dip is about N. 45° W. 20°.

Close to the north-west corner of the township near Hickman's Mills and close to Naaman's creek there are several outcrops of decomposed syenitic rock.

Some of the rock in this section of the township resembles dolerite.



*Metamorphosis of Mica.*

As early as 1876 my attention was called to the variety of forms of mica which are to be found at many of the localities where the gneissic and micaceous rocks are exposed.

In some localities large crystals of transparent and silvery muscovite mica are very abundant in the loose debris overlying the gneissic rocks and in some of the granitic veins.

The predominance of white transparent or silvery translucent mica on the surface of the ground is always apparent. Where the rock is not weathered the mica is found to be in part, if not wholly, black or biotite.

The evidence which I produce in the following illustrations leads me to conclude that the transition or metamorphosis of the black mica is going on under our eyes and through atmospheric influences.

The following plates illustrate two crystals which have been split into sixteen and nine parts respectively.

Fig. 1, Plate I is one side, Fig. 16 Plate II is the opposite side of the same crystal. Following the figures through in order of their numbers we observe the gradual fading away of the black nucleus until in Fig. 16 there is scarcely a trace of it left.

In Plates III, IV and V the same phenomenon is exhibited.

The last trace of the black mica is an iron oxide stain on the white transparent mica. This discoloration also gradually disappears.

The specimens were obtained in the vicinity of Forty-fourth street and Baltimore Avenue in the city of Philadelphia.

A similar transition or metamorphism will undoubtedly be found in the micaceous minerals associated with the decomposing serpentine.

The greatest variety of these minerals have been observed in the railroad cut of the Philadelphia and West Chester railroad, close to Lenni, in Middletown township, Delaware county.

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*Staurolite*—Darby, Haverford, Middletown.

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*Margarite*—Aston.

*Apatite*—Ridley, Springfield.

*Autunite*—Chester.

*Mirabilite*—Chester.

*Magnesite*—Radnor.

*Bismuthite*—Chester.

# ADDITIONAL ANALYSES OF MINERALS AND ROCKS,

FROM  
DELAWARE COUNTY.

BY F. A. GENTH.

1. *Titaniferous Magnetite*.—A peculiar variety of magnetite is found at Mary Worral's farm, Upper Providence township.

It is found in masses, breaking in angular fragments, of an uneven to a subconchoidal fracture, without cleavage, of a brownish-black color, and a luster, between submetallic and resinous. Sp. Gr. = 4.572. Small crystals of actinolite sometimes penetrate it, and minute yellowish or reddish-brown grains of rutile are disseminated through the mass. From the latter a portion of the titanitic acid, found in the analysis, is evidently derived.

An analysis which I have made of the purest material, gave :

Titanic acid, . . . . .	= 44.52
Alumina, . . . . .	= 1.43
Ferric oxide, . . . . .	= 24.77
Ferrous oxide, . . . . .	= 20.84
Cobaltous oxide, { . . . . .	= 0.18
Nickelous oxide, { . . . . .	
Manganous oxide, . . . . .	= 0.25
Magnesia, . . . . .	= 6.68
Actinolite, . . . . .	= 1.53
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	100.20

2. *Enstatite rock* from a locality 3 miles south of Radnor Station, on top of steatite. The specimen was presented to me by Theo. D. Rand, Esq. Dark greenish-grey rock, the enstatite in particles of from 3 to 10<sup>mm</sup> in diameter intimately interwoven with each other; very tough. With the lens no admixture is visible.

It has been examined by F. A. Genth, Jr., who found the spec. gr. = 2.988—and the following composition:

Silicic acid, . . . . .	= 52.76
Titanic acid, . . . . .	= 0.09
Phosphoric acid, . . . . .	= 0.26
Alumina, . . . . .	= 5.27
Chromic oxide, . . . . .	= 1.30
Ferric oxide, . . . . .	= 1.16
Ferrous oxide, . . . . .	= 4.63
Manganous oxide, . . . . .	= 0.23
Magnesia, . . . . .	= 28.66
Lime, . . . . .	= 0.59
Lithia, . . . . .	very distinct trace.
Soda, . . . . .	= 0.13
Potash, . . . . .	= 0.04
Loss by ignition, . . . . .	= 3.99
	<u>99.11</u>

There is evidently some chromite present in this rock.

3. *Pyroxene rock?* from the N. E. corner of Upper Darby township.

Finely granular rock of a greenish-grey color with scales of biotite. It much resembles a fine-grained chrysolite rock, but the chemical examination gave about 75% of an insoluble silicate. The soluble portion contained:

Silicic acid, . . . . .	= 44.53
Alumina, . . . . .	= 19.19
Ferrous oxide, . . . . .	= 19.56
Magnesia, . . . . .	= 8.53
Lime, . . . . .	= 8.19
	<u>100.00</u>

4. *Tremolite* from John Davis' farm, a few hundred yards S. S. W. from Castle Rock, Edgemont Twp.

White and pale greyish, radiating from a nucleus of greyish-green indurated talc, from which it is evidently derived, and forming an incrustation on it, from a few to 15<sup>mm</sup> in thickness. It incloses, like the original mineral, small grains of chromite. The spec. grav. of the purest = 2.983 and the composition, according to my analysis :

Silicic acid, . . . . .	= 56.88
Alumina, . . . . .	= 2.45
Chromic oxide, . . . . .	trace.
Ferrous oxide, . . . . .	= 9.20
Manganous oxide, . . . . .	= 0.28
Nickelous oxide, . . . . .	= 0.17
Magnesia, . . . . .	= 28.50
Soda, . . . . .	= 0.18
Potash, . . . . .	= 0.08
Loss by ignition, . . . . .	= 2.28
	<u>99.97</u>

5. *Garnet*—At Chelsea, Bethel Twp., a granular variety of garnet has been mined to some extent, and sent to market as "Emery." It usually forms aggregations of very small, imperfect, reddish, dodecahedral crystals; sometimes they are larger and up to 10<sup>mm</sup> in diameter; often with admixtures of small quantities of quartz, muscovite, biotite, and chlorite, often almost free from foreign substances. Very friable. Perfectly pure grains were examined by F. A. Genth, Jr., who found the spec. gr. = 4.028, and the composition, as follows :

Silicic acid, . . . . .	= 41.11
Alumina, . . . . .	= 21.60
Ferric oxide, . . . . .	= 2.11
Ferrous oxide, . . . . .	= 25.86
Manganous oxide, . . . . .	= 2.22
Magnesia, . . . . .	= 5.41
Lime, . . . . .	= 1.89
	<u>100.20</u>

6. *Garnet*—Near Darby a dark reddish garnet has been found in a dark mica schist. It occurs in rounded masses and imperfect crystals from one half to two inches in diameter.

ameter. Thin splinters are transparent and of a pale reddish color and show inclosures of a black mineral, which the analysis has shown to be menaccanite. In thin sections this latter appears to be pretty uniformly disseminated in small grains, the largest not being over one millimeter in diameter, throughout the mass. The spec. gr.=4.186. I have analyzed it with the following results:

Silicic acid, . . . . .	= 35.97
Titanic acid, . . . . .	= 5.12
Alumina, . . . . .	= 18.72
Ferric oxide, . . . . .	= 1.39
Ferrous oxide, . . . . .	= 30.42
Manganous oxide, . . . . .	= 0.42
Magnesia, . . . . .	= 5.08
Lime, . . . . .	= 2.79
	<hr/>
	99.91
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7. *Decomposed mica schist from 3 miles south of Radnor Station, south of the steatite.* Presented by Theodore D. Rand, Esq.

Schistose or slaty rock, made up of fine scales of mica of a pale brownish-grey color, with some garnet, quartz, and magnetite.

The micaceous portion, as clean as it could be obtained by levigation and separation of the magnetite by a magnet, but containing much free quartz, showed the following composition:

Silicic acid, . . . . .	= 58.45
Titanic acid, . . . . .	= 0.85
Phosphoric acid, . . . . .	= 0.07
Alumina, . . . . .	= 22.01
Ferric oxide, . . . . .	= 5.27
Ferrous oxide, . . . . .	= 0.77
Manganous oxide, . . . . .	trace.
Magnesia, . . . . .	= 2.25
Lime, . . . . .	= 0.20
Lithia, . . . . .	faint trace.
Soda, . . . . .	= 0.94
Potash, . . . . .	= 5.23
Loss by ignition, . . . . .	= 4.30
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	100.40
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9. *Diabase* ? from Chester Creek road below Cheyney's Shops on James M. Willcox's land in Thornbury Twp.

A crypto-crystalline mixture, consisting, apparently principally of pyroxene, plagioclase and magnetite. I found its composition as follows :

Silicic acid, . . . . .	= 47.65
Titanic acid, . . . . .	= 2.36
Phosphoric acid, . . . . .	= 0.41
Alumina, . . . . .	= 13.76
Ferric oxide, . . . . .	= 4.37
Ferrous oxide, . . . . .	= 11.09
Magnesia, . . . . .	= 5.56
Lime, . . . . .	= 10.82
Soda, . . . . .	= 3.05
Potash, . . . . .	= 0.52
Loss by ignition, . . . . .	= 0.84
	<u>99.93</u>

10. *Dolerite* from below Radnor Station. Presented by Th. D. Rand, Esq.

Crypto-crystalline. Under the lens it can be seen to consist of fine granular, white, feldspathic particles, brownish pyroxene and fine grains of magnetite. It has been analyzed by F. A. Genth, Jr., who found its spec. gr. = 3.549, and its composition, as follows :

Silicic acid, . . . . .	= 52.82
Titanic acid, . . . . .	= 2.89
Phosphoric acid, . . . . .	= 0.76
Alumina, . . . . .	= 12.08
Ferric oxide, . . . . .	= 4.18
Ferrous oxide, . . . . .	= 12.32
Manganous oxide, . . . . .	trace.
Cupric oxide, . . . . .	= 0.19
Magnesia, . . . . .	= 2.80
Lime, . . . . .	= 5.87
Soda, . . . . .	= 4.89
Potash, . . . . .	= 1.51
Loss by ignition, . . . . .	= 0.68
	<u>100.94</u>



11. *Oligoclase* from Black Horse near Media.

At this locality crystals of a brownish-grey corundum, slightly coated with mica, are found imbedded in a fine grained brownish-white feldspar, of which I have made an analysis, which proves it to be oligoclase. Sp. Gr. = 2.611.

It contains:

Silicic acid, . . . . .	= 58.22	— 58.62
Alumina, . . . . .	= 22.92	— 23.55
Ferrie oxide, . . . . .	= 0.17	— 0.17
Magnesia, . . . . .	= 0.25	— 0.46
Lime, . . . . .	= 3.02	— 3.23
Baryta, . . . . .	= 2.57	— 2.54
Soda, . . . . .	= —	— 3.68
Potash, . . . . .	= —	— 7.06
Loss by ignition, . . . . .	= 1.59	— 1.49
		<u>100.80</u>

The ratio between the bases  $R_2O$  (RO) :  $Al_2O_3$  :  $SiO_2$  = 1 : 3.2 : 9.1 or very near that of oligoclase.

12. *Moonstone* from Hiram Schofield's farm,  $\frac{1}{2}$  mile west of Elwyn's Station.

Greyish-white, with beautiful blue reflection and very fine striation. I have analyzed it and found:

Silicic acid, . . . . .	= 66.24
Alumina, . . . . .	= 20.91
Ferrie oxide, . . . . .	trace.
Lime, . . . . .	= 1.61
Soda, . . . . .	= 10.14
Potash, . . . . .	= 1.12
Loss by ignition, . . . . .	= 0.59
	<u>100.61</u>

Ratio of  $R_2O$ (RO) :  $Al_2O_3$  :  $SiO_2$  = 1 : 3 : 9.8.

13. *Albite* from Lenni.

The colorless, white or greyish-white granular feldspar, which is frequently found altered into deweylite, has been analyzed in the Laboratory of the University of Pennsylvania by Mr. George M. Lawrence, who found it to contain as follows:

Silicic acid, . . . . .	= 65.48
Alumina, . . . . .	= 20.70
Magnesia, . . . . .	= 0.68
Lime, . . . . .	= 1.11
Soda, . . . . .	= 9.85
Potash, . . . . .	= 0.70
Loss by ignition, . . . . .	= 1.71
	<u>100.18</u>

14. *Albite*—Beautiful colorless crystals of albite in red orthoclase, and resulting from the decomposition of the latter, have been observed at Upper Avondale by Mr. Lewis Palmer of Media, to whom I am indebted for specimens. The albite crystals, associated with minute, but beautifully modified, colorless and slightly greenish crystals of beryl, crystals of muscovite, black tourmaline and calcite, are lining the cavities in orthoclase; between them and the red orthoclase is often a yellowish and greyish-white, deeply striated plagioclase. I have analyzed the colorless crystals of albite, also cleavage masses of the greyish-white striated plagioclase.

The colorless albite has a spec. gr. of 2.604. It contains:

Silicic acid, . . . . .	= 68.52
Alumina, . . . . .	= 19.44
Soda, . . . . .	= 11.42
Potash, . . . . .	= 0.65
	<u>100.03</u>

15. *Plagioclase* from Upper Avondale (Albite + Oligoclase) has been analyzed by me. Sp. gr. = 2.620. I contains:

Silicic acid, . . . . .	= 65.22
Alumina, . . . . .	= 21.44
Ferric oxide, . . . . .	= 0.20
Manganous oxide, . . . . .	trace.
Lime, . . . . .	= 2.07
Soda, . . . . .	= 9.36
Potash, . . . . .	= 1.16
Loss by ignition, . . . . .	= 0.58
	<u>100.03</u>

Ratio of  $R_2O(RO):Al_2O_3:SiO_2 = 1 : 3.1 : 10.6$ .

16. *Red orthoclase* from Upper Avondale.

In flesh-red cleavage masses, showing incipient alteration. Microscopic sections of the purest show a small admixture of plagioclase. It has been analyzed by F. A. Genth, Jr.—who found the sp. gr. = 2.555, and the composition as follows:

Silicic acid, . . . . .	= 64.53
Alumina, . . . . .	= 19.64
Ferric oxide, . . . . .	trace.
Magnesia, . . . . .	= 0.25
Lime, . . . . .	= 0.16
Soda, . . . . .	= 1.77
Potash, . . . . .	= 13.62
Loss by ignition, . . . . .	= 0.71
	<u>100.68</u>

17 & 18. *Orthoclase (adularia)* from Upper Avondale.

Colorless crystals and cleavage masses of the orthoclase variety "adularia" have also been observed and presented by Mr. Lewis Palmer. I have analyzed the pure crystals (a) and also the cleavage masses (b). The spec. gr. of the crystals I found to be 2.595, that of the cleavage masses= 2.572. The analyses gave:

	a	b
Silicic acid, . . . . .	= 65.84	= 65.03
Phosphoric acid, . . . . .	= —	= 0.08
Alumina, . . . . .	= 19.50	= 19.22
Manganous oxide, . . . . .	= —	= trace.
Lime, . . . . .	= trace	= 0.32
Baryta, . . . . .	= 0.08	= —
Soda, . . . . .	= 3.93	= 1.71
Potash, . . . . .	= 10.69	= 14.18
Loss by ignition, . . . . .	= 0.22	= 0.13
	<u>100.26</u>	<u>100.67</u>

19. *Granulite* from the "Lennilite vein" at Lenni. The specimen was presented to me by Theo. D. Rand, Esqr., and consisted of a fine grained mixture of quartz and white feldspar, containing cleavage masses of from 6 to 10<sup>mm</sup> of a finely striated plagioclase, small, indistinct particles of a

black mineral, resembling tourmaline and small grains of garnet. It has been examined by F. A. Genth, Jr., who found the spec. grav.=2.635, and the following constituents:

Silicic acid, . . . . .	= 73.55
Titanic acid, . . . . .	trace.
Phosphoric acid, . . . . .	= 0.06
Alumina, . . . . .	= 15.82
Ferric oxide, . . . . .	= 0.74
Manganous oxide, . . . . .	trace.
Magnesia, . . . . .	= 0.31
Lime, . . . . .	= 1.59
Soda, . . . . .	= 5.20
Potash, . . . . .	= 3.16
Loss by ignition, . . . . .	= 0.44
	<u>100.87</u>

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20. *Granulite* from Radnor Station. Presented by Theo. D. Rand, Esqr. Fine granular quartz and feldspar, the latter showing many very small cleavage planes, not over 1<sup>mm</sup> in diameter, which have a pearly luster, but show no striation. F. A. Genth, Jr., has made a determination of the alkalis and water, as follows:

Loss by ignition, . . . . .	= 0.66
Soda, . . . . .	= 1.70
Potash, . . . . .	= 6.58

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21. *Syenitic gneiss*, from the S. W. side of Ridley Creek, above Philadelphia Road. Presented to me by Theo. D. Rand, Esqr. Greenish-black hornblende in fine crystalline masses of a slaty structure, inclosing fine grained quartz, white feldspar and some small grains of magnetite. It has been analyzed by F. A. Genth, Jr. Spec. grav.=3.104:

Silicic acid, . . . . .	= 50.01
Titanic acid, . . . . .	= 2.81
Phosphoric acid, . . . . .	= 0.22
Alumina, . . . . .	= 14.62
Ferric oxide, . . . . .	= 6.01
Ferrous oxide, . . . . .	= 9.16
Manganous oxide, . . . . .	trace.
Magnesia, . . . . .	= 5.12

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Lime, . . . . .	= 10.81
Lithia, . . . . .	very faint trace.
Soda, . . . . .	= 1.25
Potash, . . . . .	= 0.31
Loss by ignition, . . . . .	= 0.63
	<u>100.45</u>

22. *Indurated Talc*, from John Davis' farm, a few hundred yards S. S. W. from Castle Rock, Edgemont Twp.

It is a greenish-grey, compact rock without luster, and a splintery to subconchoidal fracture. Inclosing grains of chromite. Partly altered into tremolite (4). I have examined it, found the sp. gr.=2.789 and the composition, as follows :

Silicic acid, . . . . .	= 62.48
Titanic acid, . . . . .	trace.
Chromite, . . . . .	= 0.20
Chromic oxide, . . . . .	= 0.13
Alumina, . . . . .	= 0.59
Ferrous oxide, . . . . .	= 4.95
Niecolous oxide, . . . . .	= 0.16
Magnesia, . . . . .	= 27.69
Loss by ignition, . . . . .	= 4.81
	<u>100.92</u>

23. *Serpentine* from Mineral Hill.

I have examined a variety which closely resembles sepiolite and has often been mistaken for it. It is white, compact, earthy, strongly adhering to the tongue. It cuts easily with a knife and admits of a good polish. It is found in small angular masses, often dendritic and yellowish on the surface. I have analyzed it with the following results :

Moisture, expelled at 110°, . . . . .	= 2.10
Loss on ignition, . . . . .	= 12.78
Silicic acid, . . . . .	= 44.18
Alumina, . . . . .	trace.
Ferrous oxide, . . . . .	= 1.64
Magnesia, . . . . .	= 39.37
	<u>100.07</u>

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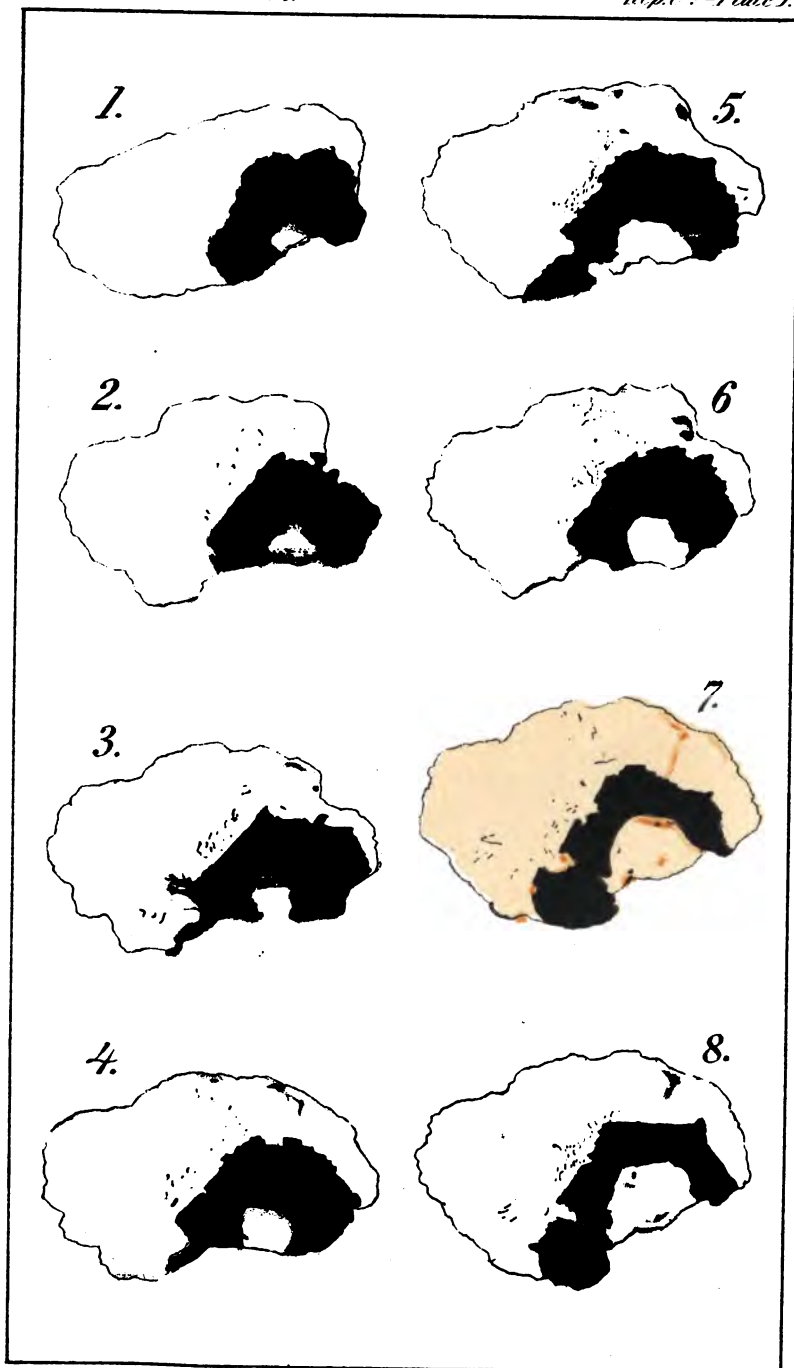
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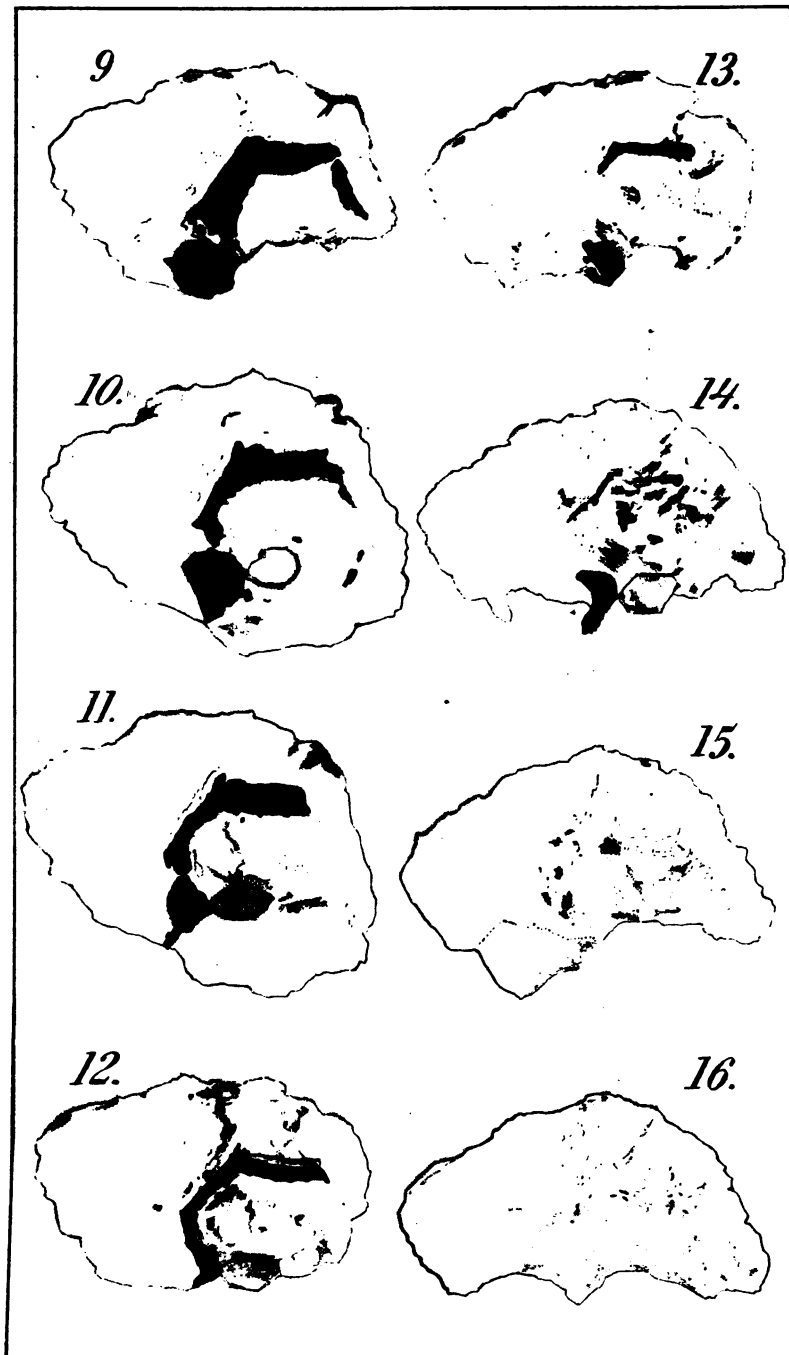
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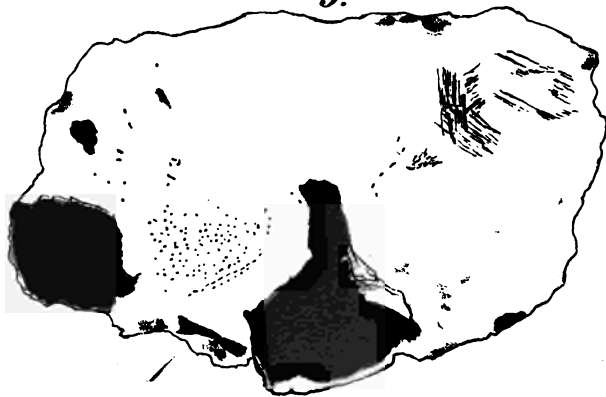




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*Types: Stroudale quarry, Ridley township, Delaware Co., Pa.  
View taken looking north.*







*Upper-Strandale quarry, Ridley township, Delaware Co., Pa.  
View taken looking south-east.*





*Lower Meridale quarry, North Providence township, Delaware Co., Pa.  
View taken looking south south-west.*

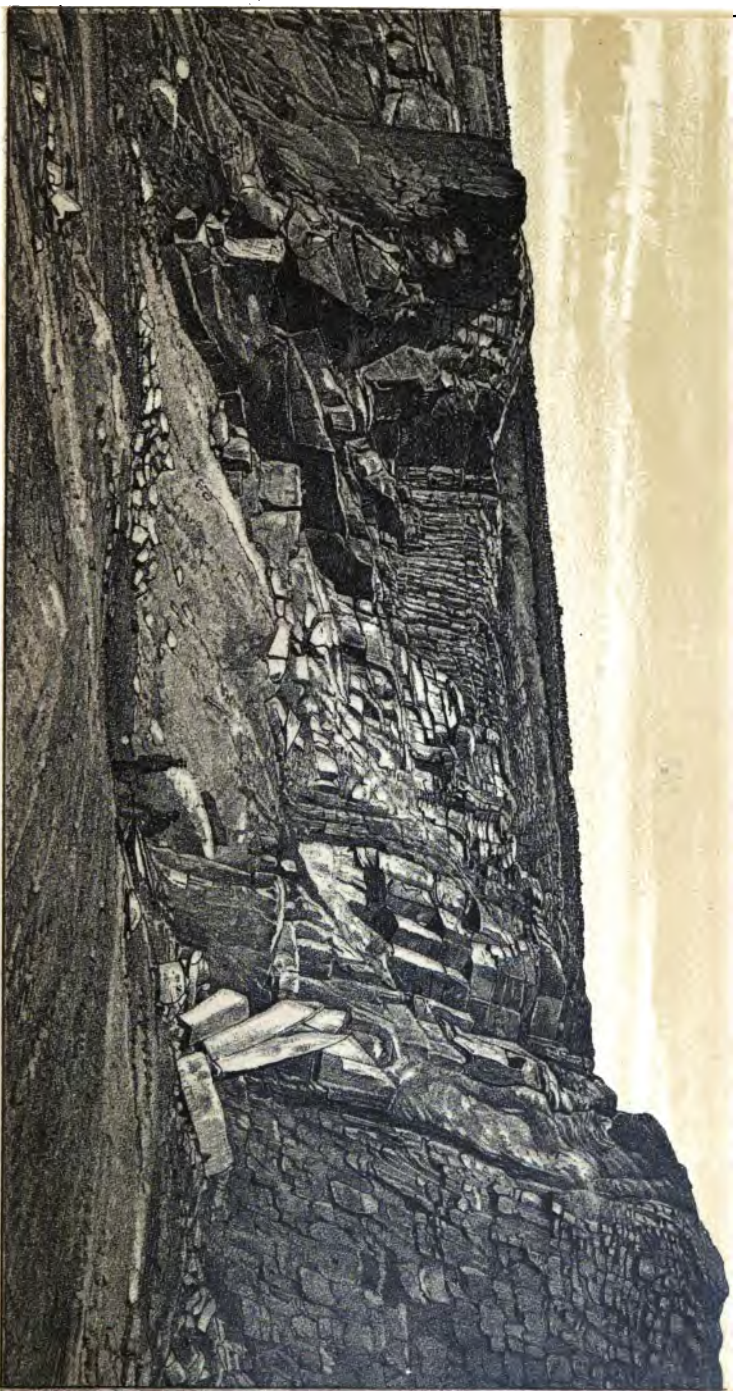






*Deshong's quarry, Vether Providence township, Delaware Co., Pa.  
View taken looking south-east.*

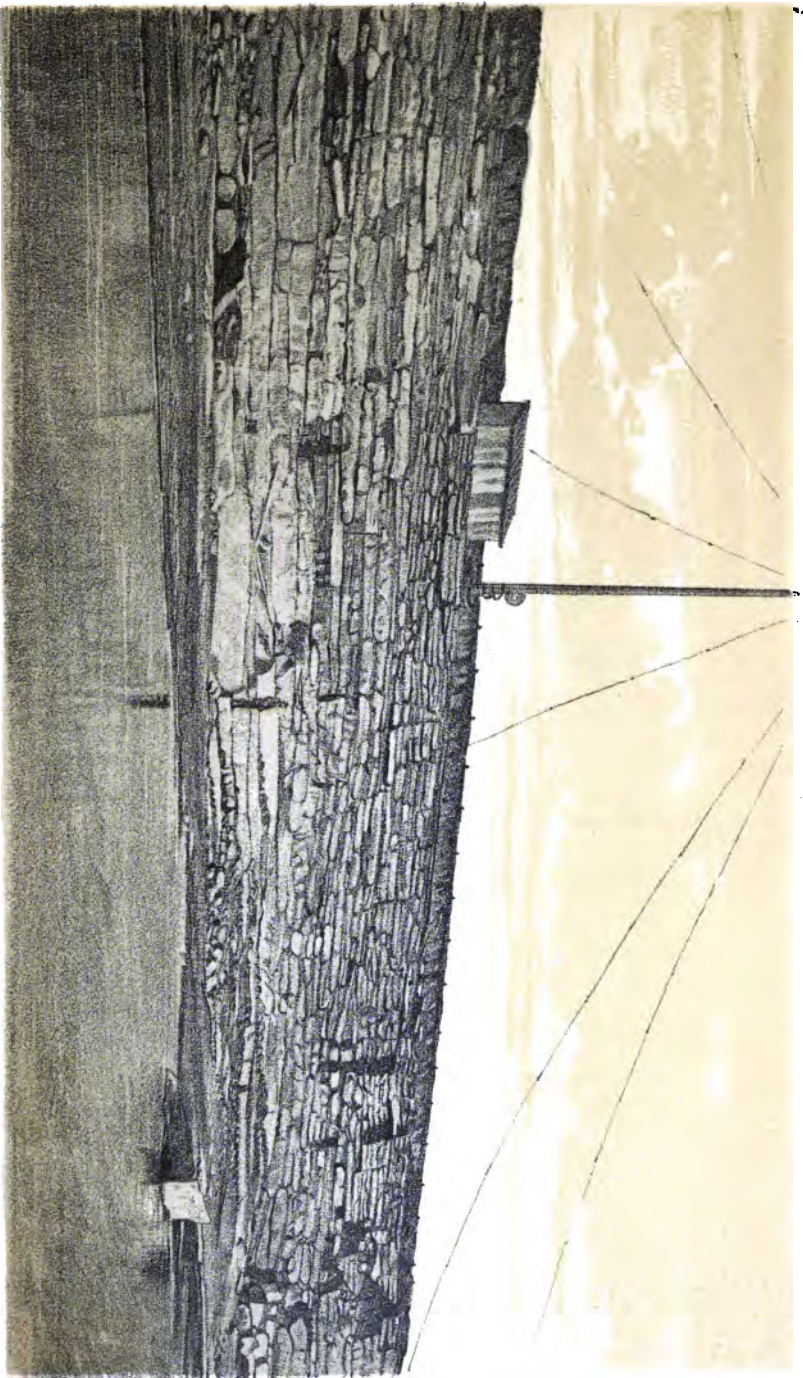




*Deshong's quarry, Nether Providence township, Delaware Co., Pa.  
View taken looking north-east.*







*Ward's quarry, Ridley township, Delaware Co., Pa.  
View taken looking east.*





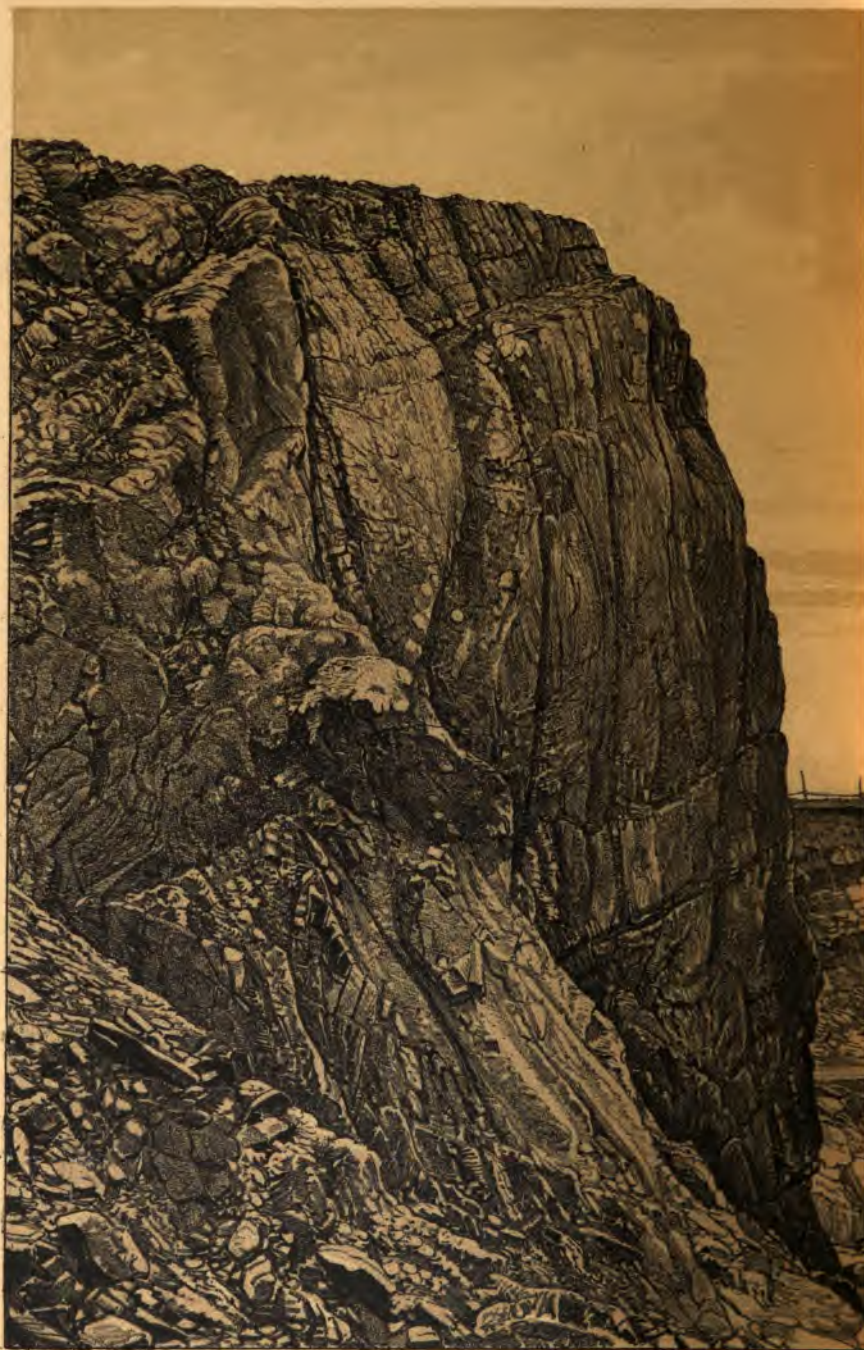
*Griswold's quarry, Darby, Delaware Co., Pa.  
View taken looking east.*







*2nd Geol. Survey of Pa. 1882.*

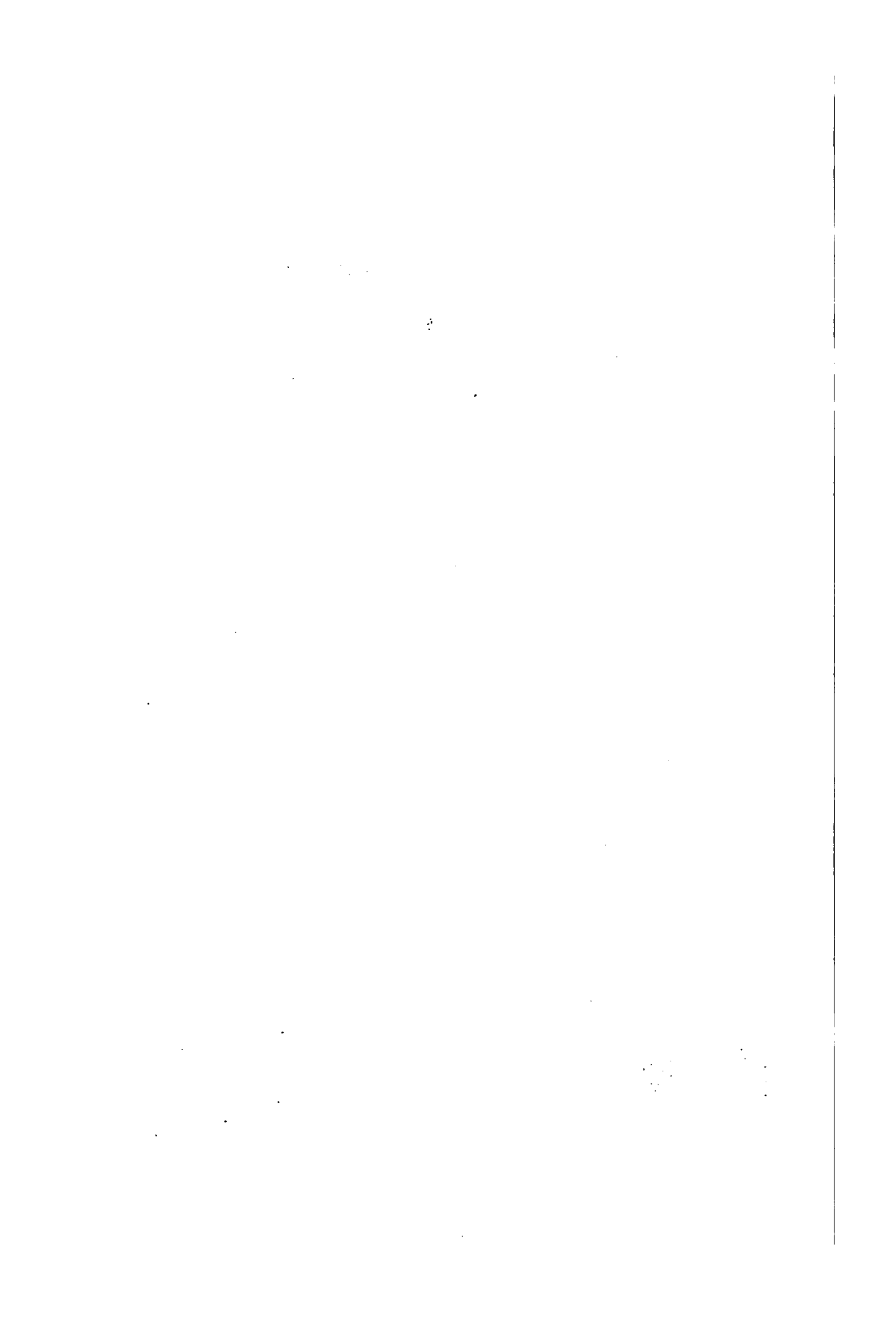


*Serpentine quarry in W. Thornbr*



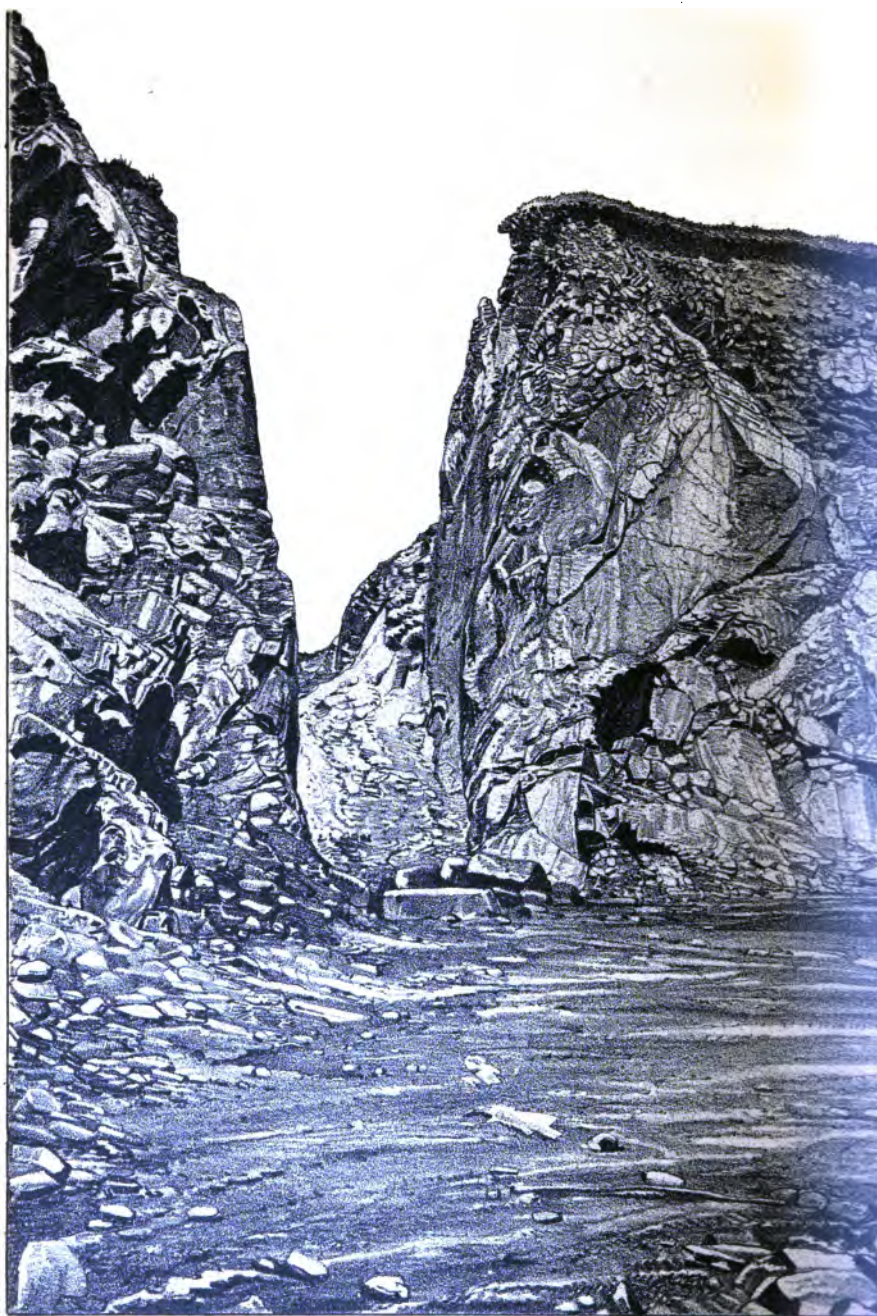
ry township, Chester Co. Pa. 1882.



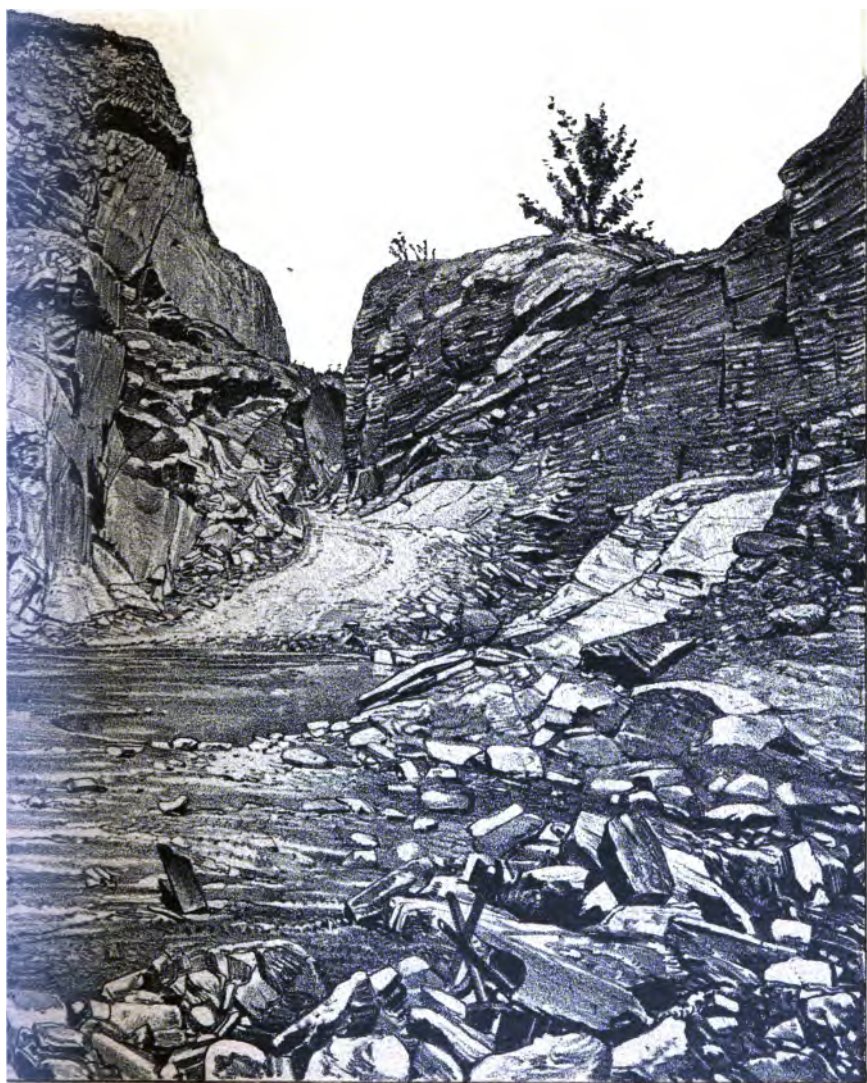




*2nd Geol. Survey of Pa. 1882.*



*Serpentine quarry in W. Thornbury.*



*y township, Chester Co. Pa. 1882.*

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and the role of the accounting department in ensuring the integrity of the financial statements.

2. It also highlights the need for regular audits and the importance of transparency in financial reporting.

3. The second part of the document focuses on the implementation of internal controls to prevent fraud and ensure the accuracy of the data.

4. It provides a detailed overview of the accounting system, including the various accounts and the flow of information between them.

5. The third part of the document discusses the role of the accounting department in providing financial information to management and the importance of timely reporting.

6. It also highlights the need for the accounting department to stay up-to-date on the latest accounting standards and regulations.

7. The fourth part of the document discusses the role of the accounting department in providing financial information to external stakeholders, such as investors and creditors.

8. It also highlights the need for the accounting department to maintain a high level of confidentiality and security when handling financial information.

9. The fifth part of the document discusses the role of the accounting department in providing financial information to the public and the importance of transparency in financial reporting.

10. It also highlights the need for the accounting department to maintain a high level of accuracy and reliability in all financial reporting.



PLATE XV.



HELOIYK PRINTING CO.

BRANDYWINE SUMMIT KAOLIN WORKS, DELAWARE COUNTY, LOOKING S. 50° W.

BOSTON



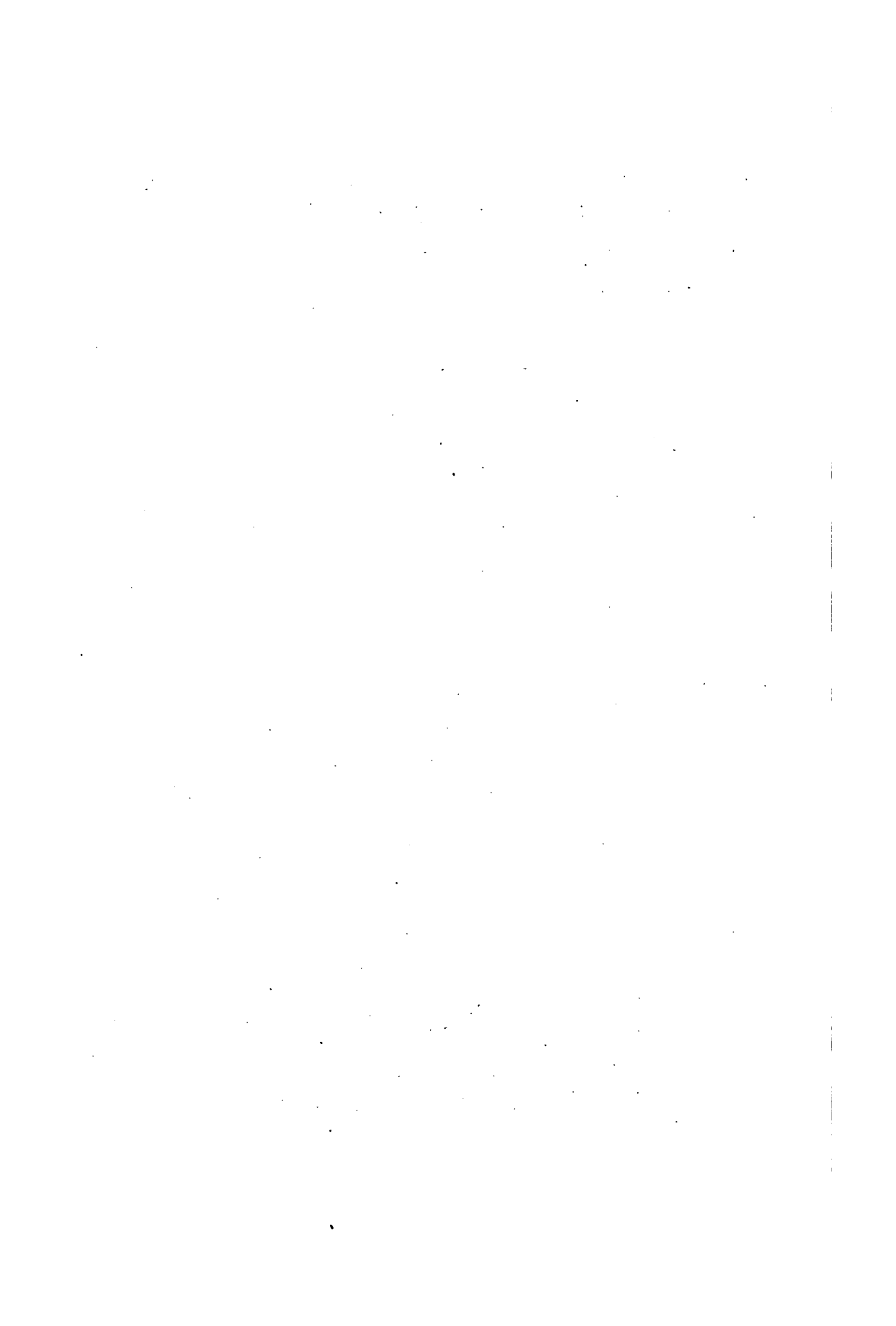


HELOTTIE PRINTING CO.,

BRANDYWINE SUMMIT KAOLIN WORKS, LOOKING WEST.

100708



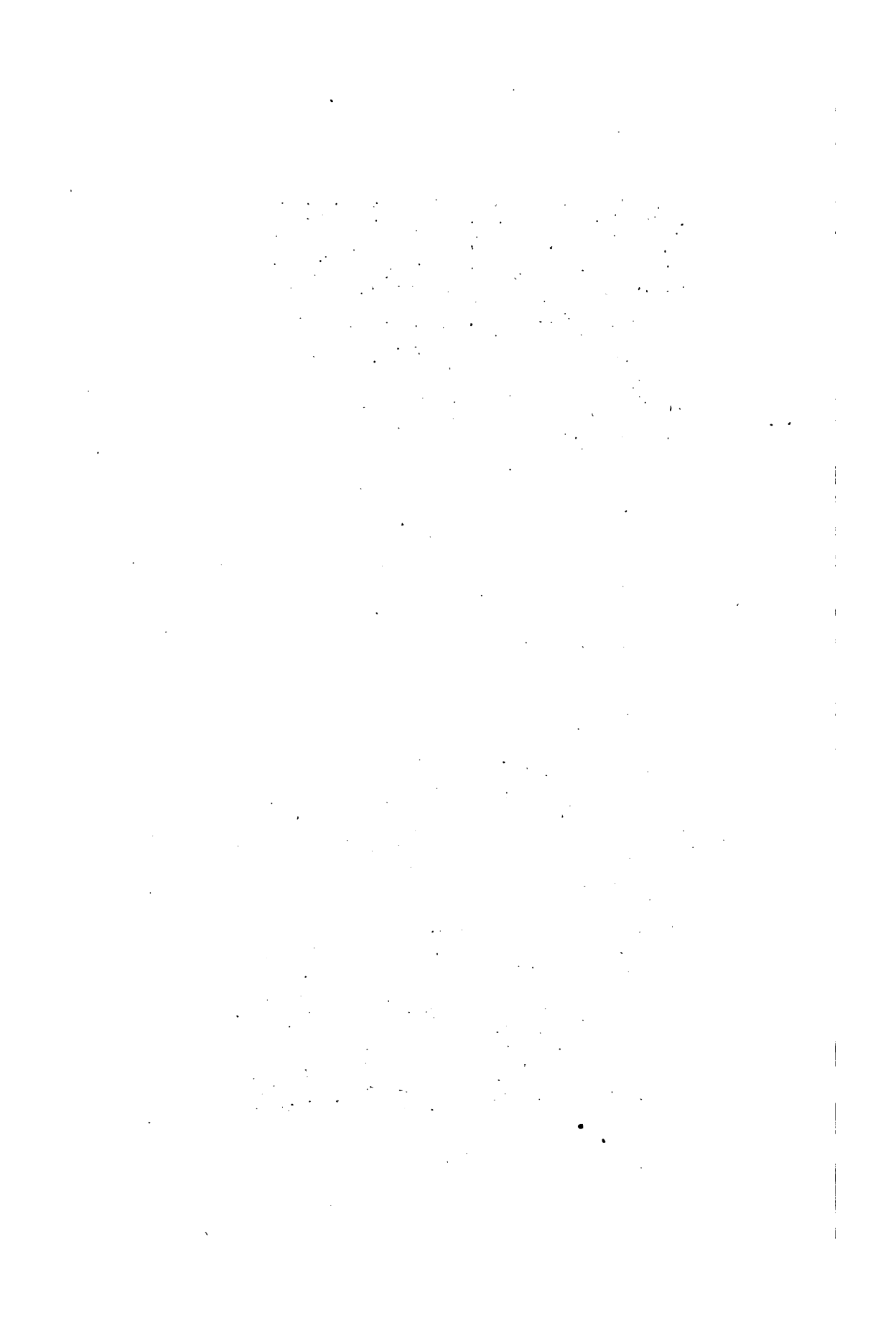


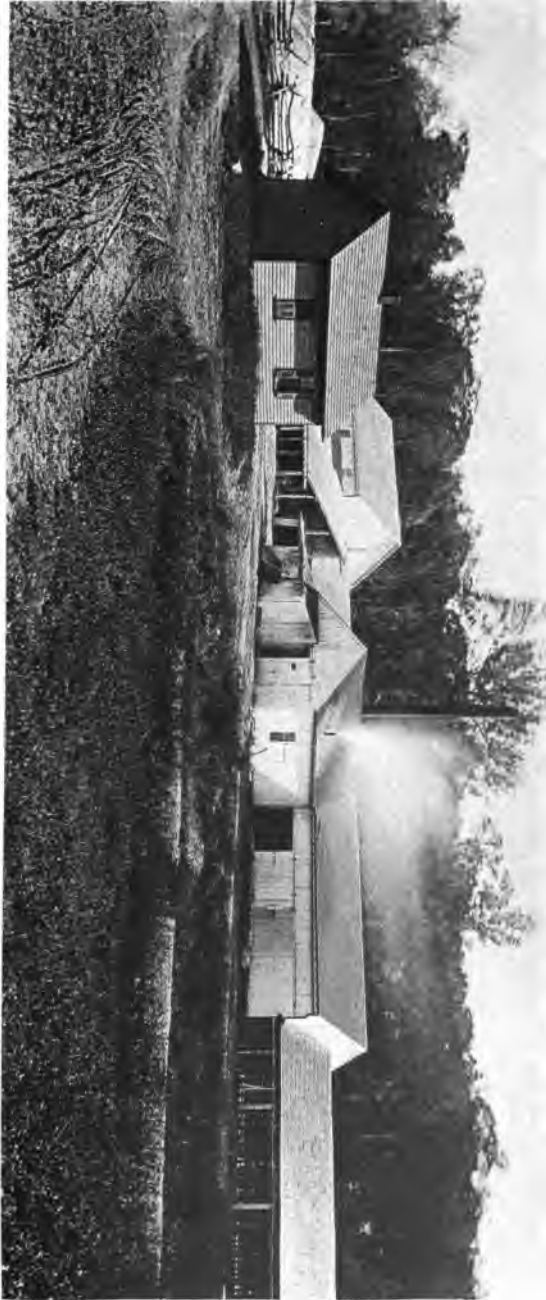


RELATIVE PAINTING CO.,

BRANDYWINE SUMMIT KAOLIN WORKS, DELAWARE COUNTY, LOOKING WEST.

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SECOND GEOL. SURVEY, PA. REPORT C 5. PLATE XVIII

HELIOTYPE PRINTING CO.,

BRANDYWINE SUMMIT KAOLIN WORKS, DELAWARE CO., LOOKING S. 15° W.

BOSTON



PLATE XIX.



ELLIOTT PRINTING CO.,

NATIONAL KAOLIN WORKS, BRANDYWINE SUMMIT, PA., LOOKING N. 42° E.

100104.





GELOTT'S PRINTING CO.,

NATIONAL KAOLIN WORKS, BRANDYWINE SUMMIT, LOOKING WEST.

NOV 1904.







RELIABLE PRINTING CO.,

NATIONAL KAOLIN WORKS, BRANDYWINE SUMMIT, PA.

BOSTON

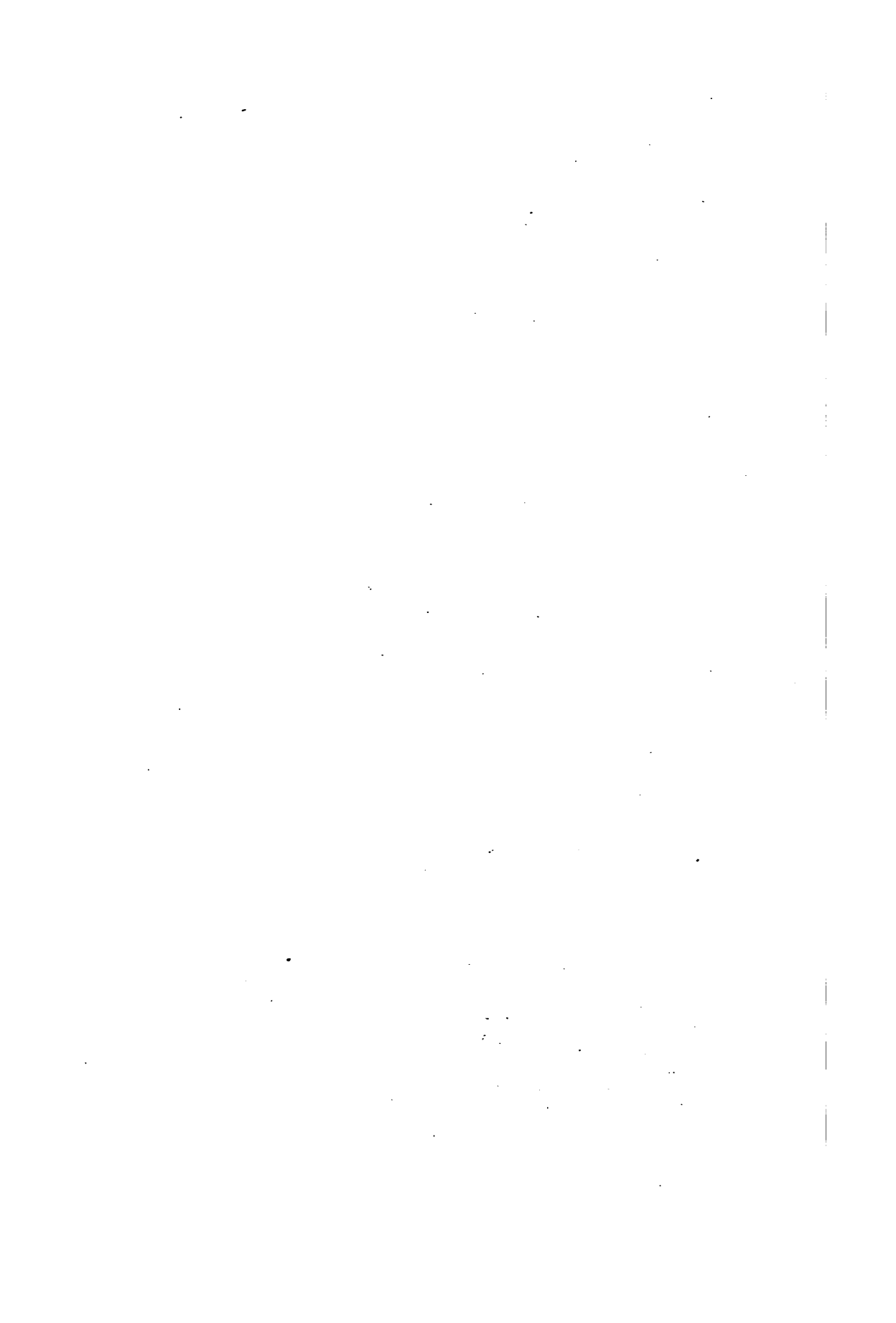


PLATE XXII.



ALLOTT'S PRINTING CO.,  
THE BRYN MAWR GRAVEL AT CRAWFORD'S FIRE CLAY PIT, DELAWARE CO. LOOKING N. 34° W.

BOSTON.



PLATE XXIII.



ELLIOTTE PRINTING CO.,  
FELDSPAR QUARRY, BRANDYWINE SUMMIT KAOLIN WORKS, DELAWARE CO. LOOKING N. 20° E.

BOSTON.





HELIOTYPE PRINTING CO.,

GNEISS PEAK, ON HARVEY THOMAS' FARM, BETHEL TOWNSHIP, LOOKING S. 80° W.

BOSTON





PLATE XXV.



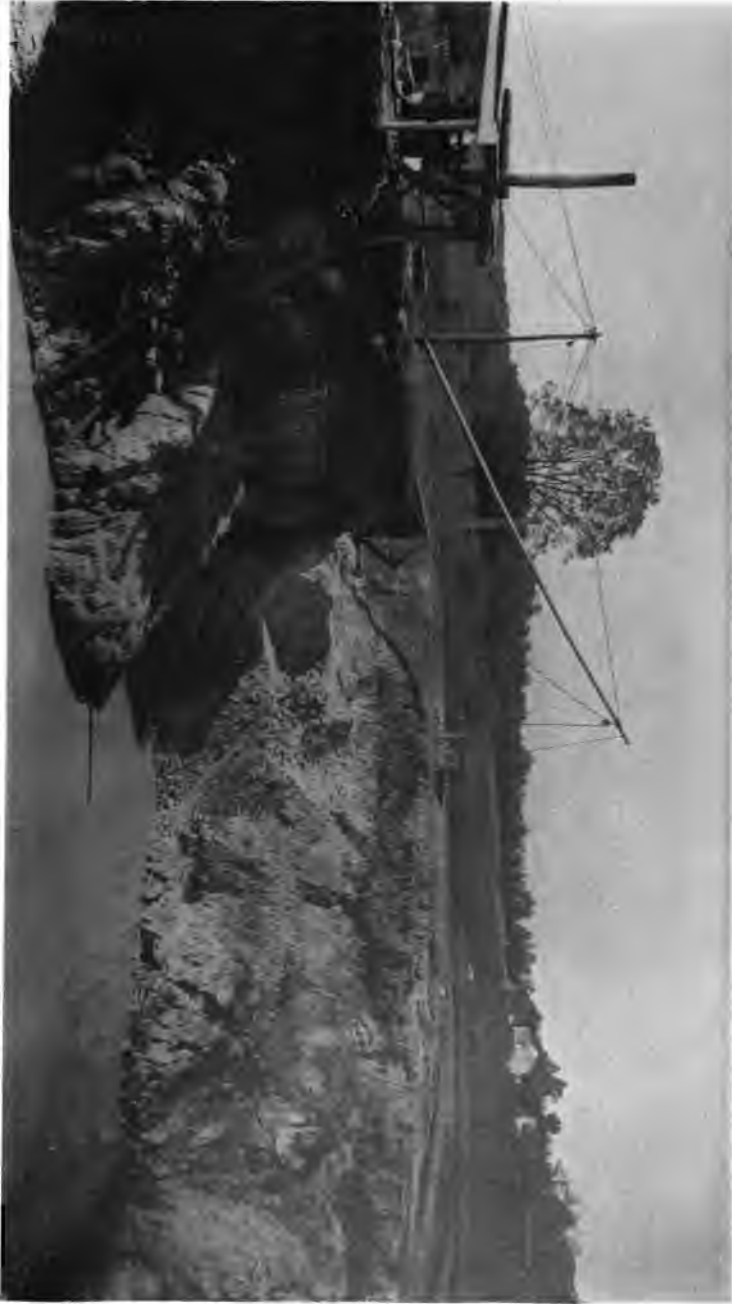
WELCHER PRINTING CO.,

AMERICAN KAOLIN WORKS, NEW GARDEN TOWNSHIP, CHESTER COUNTY.

BOSTON.



PLATE XXVI.



RELIABLE PRINTING CO.,

AMERICAN KAOLIN WORKS, NEW GARDEN, CHESTER CO., LOOKING WEST.

50110A.

SECOND GEOL. SURVEY, PA. REPORT C. 5. PLATE XXVI.



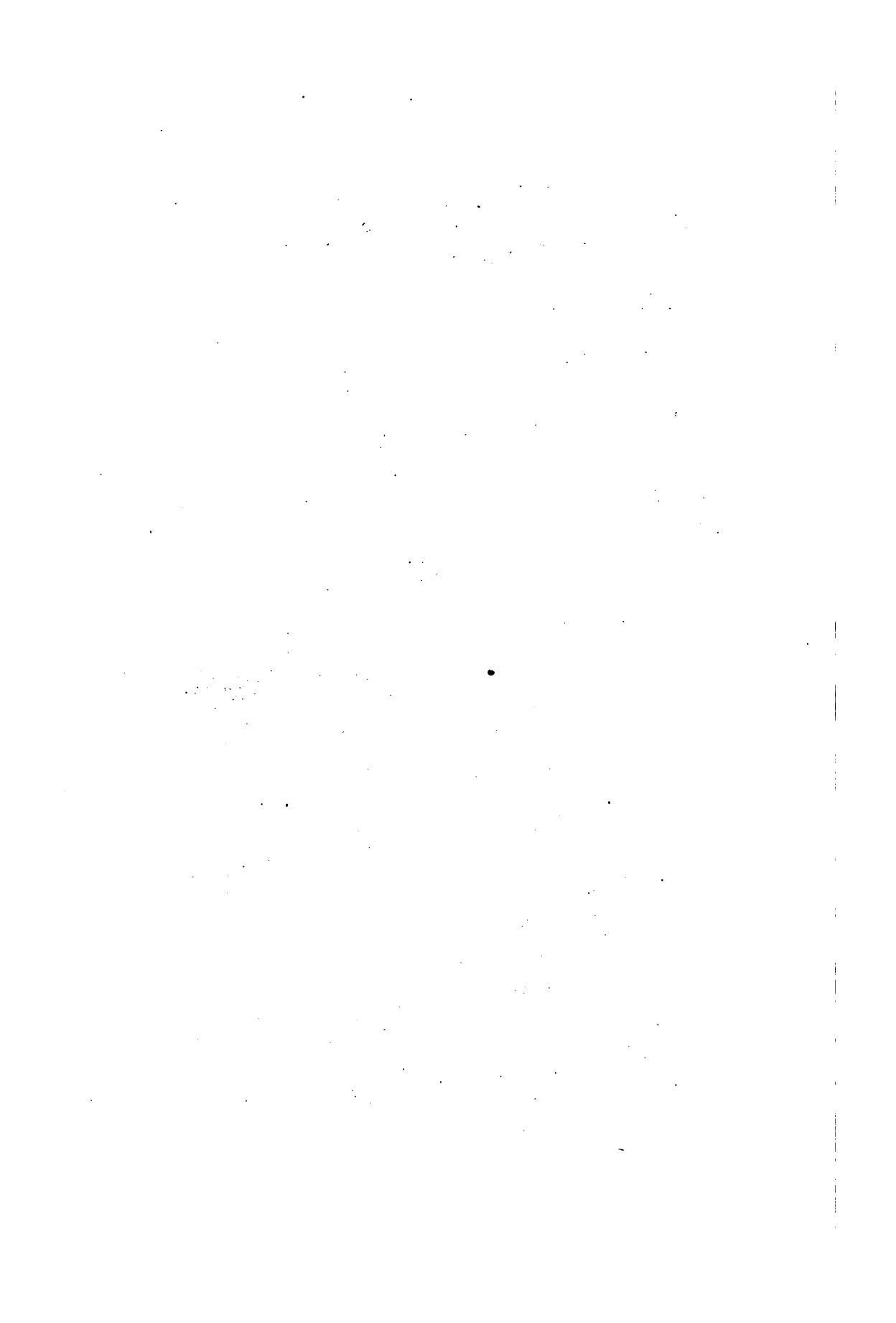


SECOND GEOL. SURVEY, PA. REPORT C 5. PLATE XXVII.

AMERICAN KAOLIN WORKS, NEW GARDEN TOWNSHIP, CHESTER CO., LOOKING N. 5° E.

903704.

HELDTYPE PRINTING CO.,





GELOTTRE MINING CO.,

KAOLIN MINE AT HOCKESSIN, DELAWARE. LOOKING N. 60° E.

80810N.







KEUOTTE PRINTING CO.,

KAOLIN MINE AT HOCKESSIN, DELAWARE, LOOKING N. 70° E.

BOSTON.



PLATE XXX.



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CASTLE ROCK, EDGMONT TOWNSHIP, DELAWARE COUNTY, PA., LOOKING S. 55° E.

HELIOTYPE PRINTING CO.,

80810N.





HELIOTYPE PRINTING CO.,

CASTLE ROCK, EDMONT, DELAWARE CO.—WEST END, LOOKING N. 70° E.

BOSTON.





HELIOTYPE PRINTING CO.,

CASTLE ROCK, WESTERN END, EDMONT TOWNSHIP, LOOKING N. 15° E.

BOSTON







ANASTOYIC PAINTING CO.,

CASTLE ROCK, EASTERN END, EDMONT TOWNSHIP, LOOKING N. 80° E.

WATSON.





PLATE XXXIV.

HELIOTYPE PRINTING CO.,

CASTLE ROCK, EDMONT TOWNSHIP. LOOKING N. 68° W.

BOSTON.





ANSTON PAINTING CO.

"BLACK ROCKS," ONE MILE EAST OF BRYN MAWR STATION, P. R. R. LOOKING N. 25° W.

BOSTON



PLATE XXXVI.



REPLIQUE, HAWKING CO.

"BLACK ROCKS," NEAR BRYN MAWR, MONTGOMERY COUNTY, LOOKING S. 50° W.

BOSTON







ELLIOTT'S QUARRYING CO.,  
I. L. REGISTER'S QUARRY NORTH OF H. EGBERT'S BLACK ROCKS, (PL. XXXVI) LOOKING N. 38° W.

60810A.





ALLOTTE PAINTING CO.,

CASTLE ROCK, EASTERN END, EDMONT TOWNSHIP, LOOKING N. 80° E.

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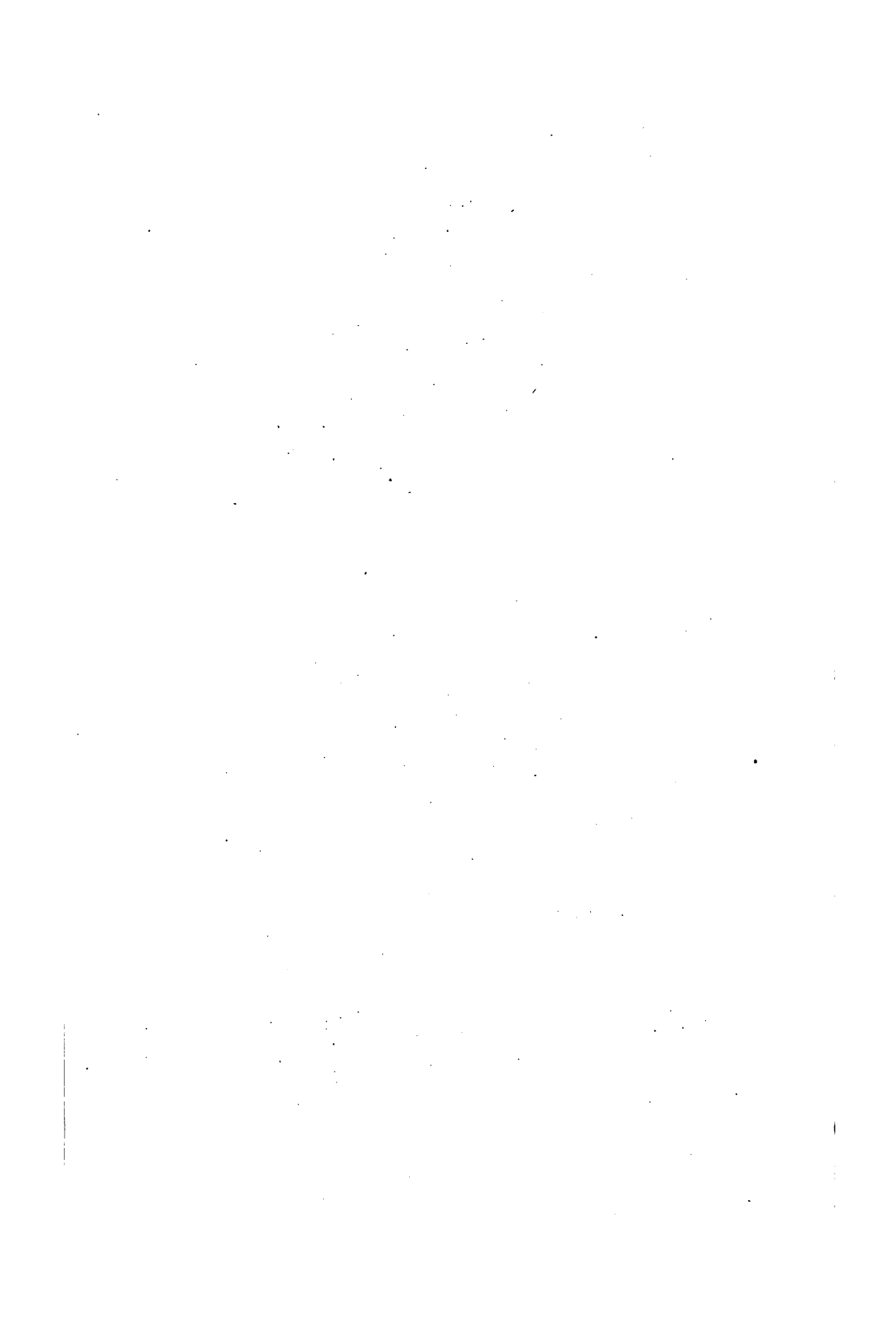




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(**AA.**) ATLAS of WESTERN MIDDLE anthracite field, Part I, containing 11 sheets: 4 mine sheets between Delano and Locust Dale, 3 topographical sheets between Quakake Junction and Mount Carmel, and 4 cross section sheets. 8°,

NOTES.—Single sheets of the Anthracite Survey, with the exception of those in the Panther Creek atlas, can be purchased by addressing Chas. A. Ashburner, Geologist in Charge, 307 Walnut street, Philadelphia. See page 9.

1884. Chas. A. Ashburner, Geologist in charge; A. W. Sheaffer and Bard Wells, Assistant Geologists. Price \$1 65, postage \$0 11.

(AA.) ATLAS of NORTHERN anthracite field, Part I, containing 6 mine sheets between Wilkes Barre and Nanticoke, 3 cross section sheets, and 4 columnar section sheets. 80, 1885. Chas. A. Ashburner, Geologist in charge; Frank A. Hill, Assistant Geologist. Price \$ , postage \$ .

(AA.) GRAND ATLAS, Div. II, Pt. I, 1884, port-folio containing 26 sheets (26"×32") as follows: 13 sheets Atlas Southern Anthracite Field, Part I, 11 sheets Atlas Western Middle Anthracite Field Part I, 1 sheet photo views of plaster models in Western Middle and Southern Fields, and 1 specimen sheet Report A 2. Price \$4 25, expressage from Harrisburg \$ .

For anthracite coal in SULLIVAN county, see G 2.

For Conglomerate beds near Carbondale, Pittston, &c., see G 5, G 7.

For Utilization of anthracite slack, see M 2.

For single sheets see page 9.

## BITUMINOUS COAL FIELDS AND SURROUNDING AREAS.

**H.** First report on CLEARFIELD and JEFFERSON counties, by F. Platt. With 8 maps, 2 sections, and 139 cuts in the text. 80, pp. 296, 1875. Price unbound \$1 50, postage \$0 13 (*For second report see H 6, H 7.*)

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**H 4.** Report on INDIANA county, by W. G. Platt. With a colored geological county map and 87 cuts in the text. 80, pp. 316, 1878. Price \$0 80, postage \$0 14.

**H 5.** Report on ARMSTRONG county, by W. G. Platt. With a colored geological county map, and 58 cuts in the text. 80, pp. 338, 1880. \$0 75, postage \$0 16.

**H 6.** Second report on JEFFERSON county, (*See H above,*) by W. G. Platt. With a colored geological county map, and 57 cuts in the text. 80, pp. 218, 1881. Price \$0 60, postage \$0 12.

**H 7.** Second report on CLEARFIELD county, (*see H above,*) by H. M. Chance. With a colored geological county map, an outcrop map of the Houtzdale basin, and 58 cuts in the text. 80, pp. 197, 1884. Price \$0 85, postage \$0 11.

**I.** Report on VENANGO county, by J. F. Carll. The geology around Warren, by F. A. Randall. Notes on the comparative geology of N. E. O., N. W. Pa. and W. N. Y., by J. P. Lesley. With one small map of the Venango oil region; one small map of the region south and east of Lake Erie; one long section of the rocks at Warren; and 7 cuts in the text. 80, pp. 127, 1875. Price in paper, \$0 60, postage \$0 05.

**I 2.** Report of oil well records and levels in VENANGO, WARREN, CRAWFORD, CLARION, ARMSTRONG, BUTLER, &c., by J. F. Carll. 80, pp. 398, 1877. Price \$0 60, postage \$0 18.

**I 3.** Report on the VENANGO, WARREN, CLARION, and BUTLER OIL REGIONS; descriptions of rig, tools, &c.; survey of the Garland and Panama conglomerates, &c.: discussion of preglacial and post glacial drainage; by J. F. Carll. With 23 page plates, and an atlas. 80, pp. 482, 1880. Price (of volume and atlas together) \$2 30, postage \$0 30.

(I 3.) ATLAS of 22 sheets. Map of Venango county, colored geologically; map of lower oil field (Butler, Armstrong and Clarion) in 2 sheets; 3 local contour maps at Franklin, Titusville, and Spring creek; two maps of N. W. Pennsylvania showing the past and present drainage; long section across W. Pennsylvania; vertical section of the formations from the Upper Coal Measures down to the bottom of the Devonian; diagram map and section of Third sand; profile section from Meadville, S. W.; 5 sheets of grouped oil well sections; 5 sheets of working drawings for well boring, &c.; diagram of daily rate of drilling six wells at Petrolia. (*Sold only with the report.*)

I 4. Report on WARREN county, by J. F. Carll. With a colored geological county map, a map of the Warren oil region, and 2 sheets of oil well sections. 80, pp. 439, 1883. Price \$1 12, postage \$0 20. (*Note. The first 147 pages of this book contain oil well records; see under Petroleum Fields below.*)

J. Report on the OIL REGION, by H. E. Wrigley; map and profile of line of levels through Butler, Armstrong, and Clarion, by D. J. Lucas; map and profile of Slippery Rock creek, by J. P. Lesley. 5 maps and sections, a plate and 5 cuts. 80, pp. 122, 1875. Price in paper \$0 75, postage \$0 06.

K. Report on GREENE and WASHINGTON counties, by J. J. Stevenson. With two county maps. (Showing the calculated local depths of the Pittsburg and Waynesburg coal beds beneath the surface,) and 3 page plates of general sections. 80, pp. 419, 1876. Price, in paper, \$0 65, postage \$0 16. (*Note.—Since the publication of this book, two colored geological county maps have been published, and will be found in pocket of volume K 3 described below.*)

K 2. First report on FAYETTE, WESTMORELAND, and S. E. ALLEGHENY counties, (i. e. west of Chestnut ridge,) by J. J. Stevenson. With 3 colored geological county maps, and 50 cuts in the text. 80, pp. 437, 1877. Price \$1 40, postage \$0 20.

K 3. Second report on FAYETTE and WESTMORELAND counties, (the Ligonier valley,) by J. J. Stevenson. With 4 page plates, and 107 cuts in text. 80, pp. 331, 1878. Price \$1 40, postage \$0 16. (*Note.—In a pocket in this volume will be found the colored geological maps of Greene and Washington counties, alluded to above.*)

K 4. Pt. I, Report on the MONONOAHELA river COAL MINES, from the West Virginia State line to Pittsburgh, (including some on the Youghiogheny and other streams,) by J. Sutton Wall. With a map of the region in a pocket, 12 heliotype pictures, and 26 page plates. 80, pp. 231, 1884. Price \$1 15, postage \$0 14.

L. Report on the YOUGHIOGHENY coke manufacture, by F. Platt; Notes on the coal and iron ore beds, by C. A. Young; Report on methods of cooking, by J. Fulton, (*See G below*;) Report on the use of natural gas in the iron manufacture, by J. B. Pearse and F. Platt; The Boyd's hill gas well at Pittsburgh, by J. P. Lesley. With a map of the coke region, two folded plates of coke ovens, and page plates and cuts in the text. 80, pp. 252, 1876. Price \$1 00, postage \$0 13.

Q. Report on BEAVER, N. W. ALLEGHANY, and S. BUTLER counties, by I. C. White. With 3 colored geological county maps, and 21 page plates of sections. 80, pp. 337, 1878. Price \$1 40, postage \$0 20.

Q 2. Report on LAWRENCE county, and special Report on Correlation of the Pennsylvania and Ohio coal beds, by I. C. White. With a colored geological county map, and 134 cuts in the text. 80, pp. 336, 1879. Price \$0 70, postage \$0 15.

**Q 3.** Report on MERCER county, by I. C. White. With colored geological county map, and 119 cuts in the text. 80, pp. 233, 1880. Price \$0 60, postage \$0 11.

**Q 4.** Report on CRAWFORD AND ERIE counties, by I. C. White. With two colored geological county maps, and 107 cuts in the text. Also, a Report on a preglacial outlet for Lake Erie, by J. W. Spencer. With two maps of the Lake region. 80, pp. 406, 1881. Price \$1 17, postage \$0 18.

**R.** Report on McKEAN county, and its geological connections with Cameron, Elk, and Forest counties, by C. A. Ashburner. With 33 page plates of vertical and columnar sections, pictures of Rock city and Olean conglomerate, Wilcox and Kane spouting wells, map of Howard Hill coal field, &c., and an atlas of 8 sheets. 80, pp. 371, 1880. Price of Volume and Atlas together \$1 70, postage \$0 22.

(**R.**) ATLAS for McKean county of 8 sheets:—Colored geological county map; three topographical maps; of Buffalo Coal Company tract, Alton coal basin, and Potato Creek coal basin; map of McKean oil district; one sheet of columnar sections between Bradford and Ridgway; and 2 diagram sheets of the Well account and Production account in the Bradford district. (*Only sold with Report R.*)

**R 2.** Part II. Report on township geology of CAMERON, ELK AND FOREST counties, by C. A. Ashburner. (*To appear about March 15, 1885.*)

(**R 2.**) ATLAS for CAMERON, ELK AND FOREST counties, of 11 sheets (*published November, 1884, in advance of the report*):—3 colored geological county maps; 1 anticlinal and synclinal map; 1 topographical map McKean county; 2 tract maps Forest and Elk counties; 1 map Straight Creek coal basin; 2 sheets oil well sections; and 1 sheet coal sections. Price \$0 65, postage \$0 08.

**V.** Report on N. BUTLER county; and (Part 2) special report on the Beaver and Shenango river coal measures, by H. M. Chance. With a colored geological map of N. Butler; a contour local map around Parker; a map of the anticlinal rolls in the 6th basin; a chart of the Beaver and Shenango rivers; profile section from Homewood to Sharon; Oil well records and surface sections; and 154 cuts in the text. 80, pp. 248, 1879. Price \$0 70, postage \$0 15.

**V 2.** Report on CLARION county, by H. M. Chance. With a colored geological county map; a map of the anticlinals and oil-belt; a contoured map of the old river channel at Parker; 4 page plates, and 83 cuts in the text. 80, pp. 232, 1880. Price \$0 43, postage \$0 12.

For the coal basins of BRADFORD and Tioga counties see report G.

For the coal basins of LYCOMING and SULLIVAN see report G 2.

For the coal basins of POTTER county see G 3.

For the coal basins of OLINTON county see G 4.

For the coal in WAYNE county see G 5.

For the East Broad Top coal basin in HUNTINGDON county see F.

For the mountain coals in BLAIR county see T.

For the Broad Top coal measures in BEDFORD and FULTON counties see T 2.

For the coal basins in CENTRE county see T 4.

For coal analyses, see M, M 2, M 3.

For classification of coals, see in M 2.

For coal plants, see P, P 2.

For fossil crustaceans in coal slate, see P 3.

## PETROLEUM AND GAS.

See reports I, I 2, I 3, I 4, and J under Bituminous Coal Fields.  
 See L, for the Pittsburgh gas well, and the use of gas in the iron manufacture.  
 See Q, Q 2, Q 3, Q 4, for references to oil rocks in Beaver, Lawrence, Mercer, Crawford, Erie, and S. Butler counties.  
 See K for the Dunkard creek oil wells of Greene county.  
 See R, R 2, for descriptions of oil rocks in McKean, Elk, and Forest counties.  
 See V, V 2, for notes on the oil rocks of N. Butler, and Clarion counties.  
 See H 2 for oil boring at Cherry Tree, Cambria county.  
 See G 5 for oil boring in Wayne county.

## NORTH-EASTERN AND MIDDLE PENNSYLVANIA.

(*Palæozoic formations from the Coal down.*)

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**D 2.** Second report on LEHIGH county iron mines, by F. Prime. With a colored geological contour line map of the iron region, (in 4 sheets,) a colored geological contour line map of the Iron ton mines, 4 double page lithograph pictures of Limestone quarries, and one page plate of *Monocraterion*. 8°, pp. 99, 1878. Price \$1 60, postage \$0 12.

**D 3.** Vol. 1. Report on LEHIGH and NORTHAMPTON counties. Introduction, by J. P. Lesley; Slate belt, by R. A. Saunders; Limestone belt and iron mines, by F. Prime; South mountain rocks, by F. Prime and C. E. Hall. With 3 lithograph pictures of quarries, 4 pictures of triangulation stations, 14 page plates of sections, and an atlas of maps. 8°, pp. 283, 1883. Price \$0 65, postage \$0 13. (*Note, for atlas see below.*)

**D 3.** Vol. II, part I. Report on BERKS county, (*South Mountain belt*), by E. V. D'Inwilliers. With 10 page plates of sections and Indian relics, and 3 pictures of rock exposures. 8°, pp. 441, 1883. Price \$0 55, postage \$0 18. (*Note, for atlas see below, as before.*)

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**D 5.** **ATLAS** of colored geological county maps of CUMBERLAND, FRANKLIN, and Adams, (*three sheets*); and first instalment of contour line map of the South mountains, Sheets A 1, A 2, B 1, B 2, (*four sheets*), by A. E. Lehman. Price of Atlas \$1 25, postage \$0 08.

**F.** Report on the JUNIATA RIVER district in MIFFLIN, SNYDER and HUNTINGDON counties, by J. H. Dewees; and on the Aughwick valley and East Broad Top region in HUNTINGDON county, by C. A. Ashburner. With colored geological maps of East Broad Top R. R. and Orbisonia vicinity (2 sheets); Three Springs map and section (2 sheets); Sideling Hill creek map and section (2 sheets); and Isometric projection at Three Springs (1 sheet); six folded cross sections and 22 page plates of local maps, and columnar sections. 8°, pp. 305, 1878. Price \$2 55, postage \$0 20.

**F 2.** Report on PERRY county, (*Part I, geology,*) by E. W. Claypole. With two colored geological maps of the county; 17 geological outline township maps as page plates; and 30 page-plate cross and columnar sections. 8°, pp. , 1884. Price \$ , postage, . (*In press, October, 1884.*)

**G.** Report on BRADFORD and TIOGA counties, by A. Sherwood; Report on their coal fields (including forks of Pine creek in Potter county), by F. Platt; Report on the COKING of bituminous coal, by J. Fulton. (*See L. above.*) With 2 colored geological county maps, 3 page plates, and 35 cuts in the text. 8°, pp. 271, 1878. Price \$1 00, postage \$0 12.

**G 2.** Report on LYCOMING and SULLIVAN counties: field notes by A. Sherwood; coal basins by F. Platt. With 2 colored geological county maps (of Lycoming and Sullivan), a topographical map (in two sheets) of the Little Pine creek coal basin, and 24 page plates of columnar sections. 8°, pp. 268, 1880. Price \$1 06, postage \$0 14.

**G 3.** Report on POTTER county, by A. Sherwood. Report on its COAL FIELDS, by F. Platt. With a colored geological county map, 2 folded plates, and 2 page plates of sections. 8°, pp. 121, 1880. Price \$0 58, postage \$0 08.

**G 4.** Report on CLINTON county, by H. M. Chance; including a description of the Renovo coal basin, by C. A. Ashburner; and notes on the Tangascootac coal basin, by F. Platt. With a colored geological county map, 1 sheet of sections, local Renovo map, 6 page plates, and 21 sections in the text. 8°, pp. 183, 1880. Price \$1 05, postage \$0 12.

**G 5.** Report on SUSQUEHANNA and WAYNE counties, by I. C. White. With a colored geological map of the two counties, and 58 cuts in the text. 8°, pp. 243, 1881. Price \$0 70, postage \$0 12.

**G 6.** Report on PIKE and MONROE counties, by I. C. White. With two colored geological county maps, (1 sheet Pike and Monroe, and 1 sheet Wyoming,) a map of glacial scratches, and 7 small sections. Report on the Delaware and Lehigh water gaps, with two contoured maps and five sections of the gaps, by H. M. Chance. 8°, pp. 407, 1882. Price \$1 15, postage \$0 15.

**G 7.** Report on WYOMING, LACKAWANNA, LUZERNE, COLUMBIA, MONTGOMERY, and NORTHUMBERLAND counties, (*i. e.* the parts lying outside of the anthracite coal fields,) by I. C. White. With a colored geological map of these counties, (in two sheets,) and 31 page plates in the text. 8°, 464, 1883. Price \$0 85 and postage \$0 20. (*Note.—The colored geological map of WYOMING county is published in G 6.*)

**S.** Report on the Seven mountains in HUNTINGDON, UNION, AND SNYDER counties, by C. E. Billin. With a colored geological contour line map of the mountains (1 sheet); maps of the fossil ore outcrops, and Stone mountain fault; and colored geological cross sections, (2 sheets.) 8°, pp. , 1885. Price \$ , postage \$ . (*In press.*)

**T.** Report on Blair county, by F. Platt. With 35 cuts in the text, and an Atlas of maps and sections, (*See below.*) 8°, pp. 311, 1881. Price *with atlas* \$4 55, postage \$0 28.

(**T.**) ATLAS of colored geological contour line map of Morrison's cove, Canoe valley, Sinking valley, and country west to the Cambria county line, (14 sheets); Index map of the same (1 sheet); colored sections, (2 sheets.) 8°, 1881. (*Note.—The Atlas is not sold separately.*)

**T 2.** Report on BEDFORD and FULTON counties, by J. J. Stevenson. With two colored geological maps of the two counties. 8°, pp. 382, 1882. Price \$0 80, postage \$0 20.



**T 3.** Report on HUNTINGDON county, by I. C. White. With a colored geological map of the county; and numerous sections. 8°, pp. , 1835. Price \$ , postage \$ . (*In press.*)

**T 4.** Report on CENTRE county, by E. V. D'Inwilliers; also, special report by A. L. Ewing; and extracts from report to Lyon, Shorb & Co., by J. P. Lesley. With a colored geological map of the county, 13 page plates of local maps and sections, and 15 cuts in the text. 8°, pp. 464, 1894. Price \$0 80, postage \$0 19.

See also report on the line of the Terminal Moraine, Z.

### SOUTH-EASTERN PENNSYLVANIA.

**C.** Report on YORK and ADAMS counties, by P. Frazer. With one folded map of a belt of York county through York and Hanover, 6 folded cross sections, and two page plate, microscopic slices of dolerite. 8°, pp. 198, 1876. Price in paper \$0 85, postage \$0 10. (*Note.—The colored geological county map of YORK is published in the ATLAS to C 3.*)

**C 2.** Report on YORK and ADAMS counties, (South Mountain rocks, iron ores, &c.,) by P. Frazer. With one general map of the district; 10 folded cross sections; and 5 page plates. 8°, pp. 400, 1877. Price \$1 25, postage \$0 12. (*Note.—The colored geological county maps of ADAMS is published in D 5.*)

**C 3.** Report on Lancaster county by P. Frazer. With nine double page lithographic views of slate quarries, and Indian-pictured rocks; one plate of impressions on slate and one page plate microscopic section of trap; and an atlas. 8°, pp. 350, 1880. Price of report and atlas \$2 20, postage \$0 25.

(**C 3.**) ATLAS of 13 sheets:—Colored geological map of YORK county; colored geological map of LANCASTER county; Susquehanna river section (Sheets 1, 1A, 2, 2A, 3, 4); Lancaster section; Pequea section; Muddy run section; Chestnut-hill mines; Gap nickel mine. (*Note.—Atlas sold only with report.*)

**C 4.** Report on CHESTER county; General description, pp. 214, by J. P. Lesley; Field notes in the townships, pp. 215-354, by P. Frazer. With a colored geological county map, a photographic view of contorted schists, and 12 page plates. 8°, pp. 394, 1883. Price \$0 75, postage \$0 18.

**C 5.** Report on DELAWARE county, by C. E. Hall. With a colored geological county map; a contour line map around Media; 80 photographic page-plate views of granite quarries, Kaolin pits, &c., and 4 page plates of altered micas. 8°, pp. , 1885. Price \$ , postage \$ . (*Partly printed; but publication delayed.*)

**C 6.** Report on PHILADELPHIA and the southern parts of MONTGOMERY and BUCKS counties, by C. E. Hall. With a colored geological map of the belt of country between Trenton and Delaware county (in 3 sheets); a sheet of colored cross-sections, and 24 cuts in the text. 8°, pp. 145, 1882. Price \$1 65, postage \$0 13.

**E.** Part I of (historical introduction to) a report on the AZOIC rocks, by T. S. Hunt. 8°, pp. 253, 1878. Price \$0 48, postage \$0 12.

# **VOLUMES PUBLISHED AND ON SALE, MARCH 1, 1885.**

A.	D 2.	H 7.	P atlas.
A 2.	D 3, Vol. I.	I.	P 2.
AC.	D 3, Vol. II, part I.	I 2.	P 3.
AC atlas.	D 3 atlas.	I 3.	Q.
AA.	D 5 atlas.	I 3 atlas.	Q 2.
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Grand atlas, Div.	G.	K.	R.
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B.	G 5.	L.	T atlas.
B 2, (exhausted.)	G 6.	M.	T 2.
C.	G 7.	M 2.	T 4.
C 2.	H.	M 3.	V.
C 3.	H 2.	N.	V 2.
C 3 atlas.	H 3.	O.	Z.
C 4.	H 4.	O 2.	—
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D	H 6.	P, Vol. III.	

Other reports of the Survey are in the hands of the State Printer and will soon be published.

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1. Contained in Atlas W. M. A. F. Part I.

2. Contained in Atlas N. A. F. Part I.

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