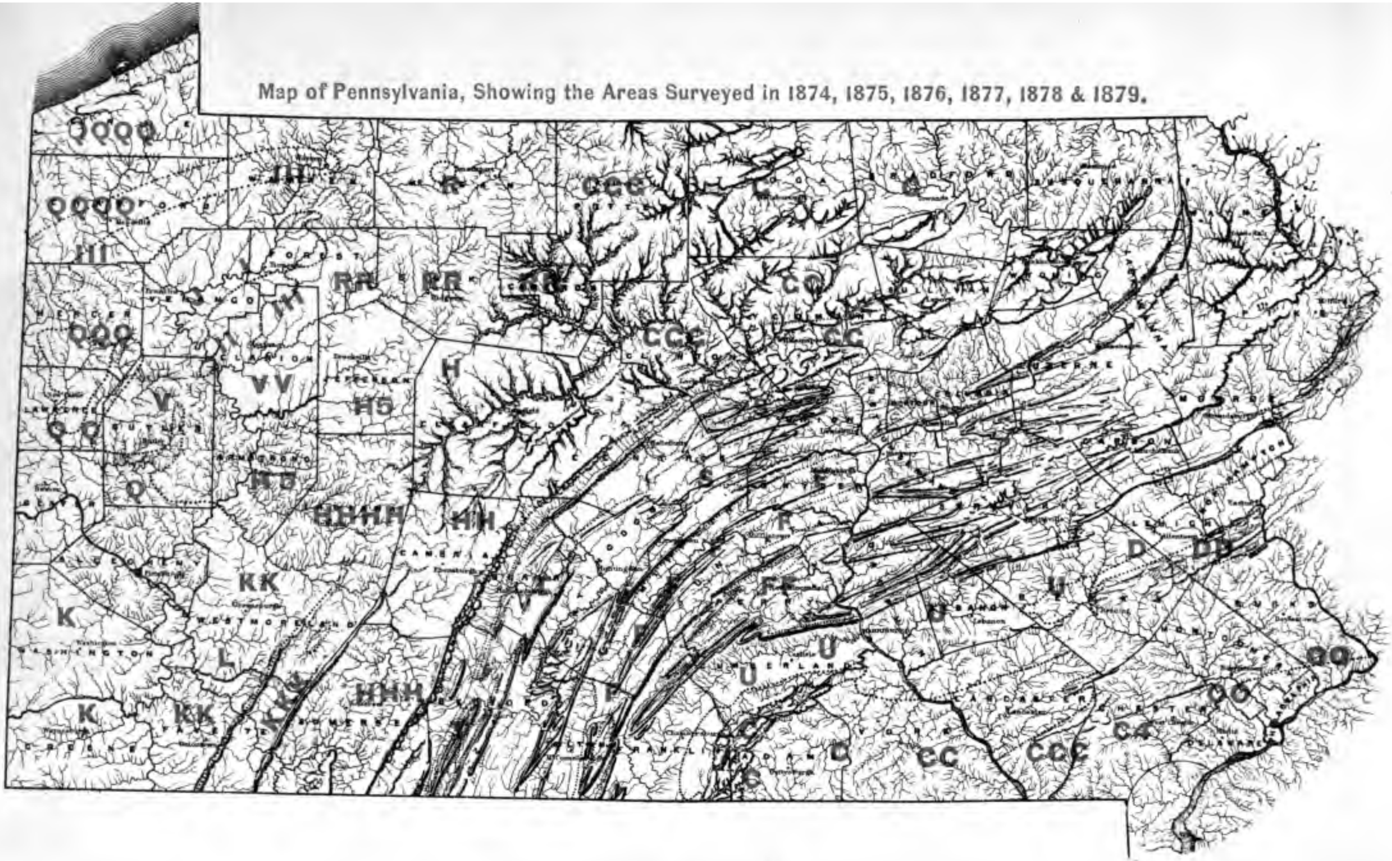

Map of Pennsylvania, Showing the Areas Surveyed in 1874, 1875, 1876, 1877, 1878 & 1879.

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:

REPORT OF PROGRESS IN 1877.

CCC.

THE GEOLOGY OF LANCASTER COUNTY.

BY

PERSIFOR FRAZER, Jr.

WITH AN ATLAS

CONTAINING A COLORED GEOLOGICAL MAP OF THE COUNTY;
LOCAL MAP OF THE GAP NICKEL MINE;
MAP AND SECTION OF THE EAST BANK OF THE SUSQUEHANNA RIVER;
OTHER GEOLOGICAL SECTIONS ACROSS THE COUNTY;
AND TWO GEOLOGICAL COLORED MAPS
OF
YORK AND ADAMS COUNTIES.

HARRISBURG:
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PHILADELPHIA, *March 13, 1880.*

To his Excellency Governor HENRY M. HOYT, *Chairman of the Board of Commissioners of the Second Geological Survey of Pennsylvania:*

SIR: The delay in publishing this Report of the progress of the survey in one of the most important counties in the State, by Professor Frazer, has been unavoidable.

In the first place the geology of this part of the State has special difficulties. A large area of limestone has been under cultivation for a century. The rocks are disturbed, closely folded and changed. The valleys are shallow, the slopes gentle, and the natural exposures of rock small and isolated. No deep wells or borings have been made. Fossils are rare. No continuous ranges of mineral beds exist to afford geological horizons of measurement.

In the second place, the large and numerous illustrations necessary for explaining the report, required a long time to prepare in a proper manner for publication. But the chief cause of the delay has been the difficulties encountered in harmonizing the unusual number of observations made along the Susquehanna river, and in so representing the structure by them as to afford those who choose to study the geology on the spot, with this report in hand, an easy reference to the exposures. A glance at the sheets of the combined map and section of the Susquehanna river bank will suffice to show how much pains have been expended on this point in the office of the survey.

The importance of this section for determining the order of the Azoic series of southeastern Pennsylvania could not be exaggerated; and I felt that every effort should be made to render its indications trustworthy for use in all that belt of country which, commencing at Trenton, crosses Berks, Montgomery, Philadelphia, Delaware, Chester, Lancaster and York counties.

The progress of the Survey in the Philadelphia belt and in the Chester valley had raised questions respecting the proper subdivision of the Azoic rocks into groups or formations. As these questions ought to find their answers largely in Lancaster and York counties, the report on Lancaster county was held back until certain division lines could be restudied in York county. It was even found desirable to make another minute survey of the Susquehanna river exposures, this time on the *western* bank, in a boat upon the canal, so that the two sections along the opposite banks might, when thoroughly correlated, help to establish the most important principles of structure across the Azoic belt.

Lancaster county is so large and so varied in its geological character, that no single geologist could possibly examine and describe it in a single year. Had the whole corps of the survey expended their combined force of observation upon it for that length of time, it would not have been overstudied. In fact there is work in Lancaster county for a diligent geologist for ten years.

The present report of progress, however, will suffice as a useful handbook in which the citizens of the county will find all the important features of its geology clearly stated.

I remain, Sir,

Your obedient servant,

J. P. LESLEY.

PREFACE.

The work which is embodied in the following report, with maps, &c., was, with a few trifling exceptions, performed during the field season of 1877, and was ready for the printer by May, 1878.

The geological examination of Lancaster county began in the spring of 1877 with the careful study of the left bank of the Susquehanna from the Maryland line to the Dauphin county border. This section was made slowly and on foot except over a short stretch below Peters' creek where soundings from a boat were necessary to discover the ledges of rock missing from the bank and thus make the structure continuous. The utmost diligence was imperatively demanded to cover this unusually diversified and difficult field without the aid of others.

The kindness and interest of the people of the county were unprecedented in my experience. Without such assistance the work would have been more unsatisfactory. My thanks are especially extended to Dr. C. H. Stubbs, Mr. A. J. Steinman, Mr. C. B. Grubb and family, Prof. S. S. and Mr. Paris Haldeman and families, Mr. Hutchinson of the P. R. R., Mr. C. B. Nourse and wife, and Col. Levi and Mrs. Smith, Mr. Bently Smith and Mr. E. G. Spilsbury; and besides these, generally, to many others.

To Mr. Joseph Wharton, the proprietor of the Gap Nickel Mines and Works, the Survey is much indebted for his generosity in putting into their hands, for copying, his private map of the property, and in facilitating, in every way, the labor of studying this very interesting deposit.

The report was written and the maps and sections drawn by May of 1878 and then submitted to the Chief Geologist, but the investigation of the neighboring county of Chester during the summer of 1878 having continually led up to the border of Lancaster; and the observations there having frequently shed new light on the work of the previous year several slight changes were made in the report to include these. The relationships between the quartzite, the porphyry, the syenite and gneisses of the Welsh Mountain and its continuation in the Gap Range, have not been and cannot be exhaustively treated until a great deal of work has been done within Chester county.

The proof was read during the continuance of the field work, in the summer and fall of 1878, at which time the greater part of the text was stereotyped. Owing to the arrest of further steps in the publication of the book, the plate proofs were laid aside by the author and not again taken in hand until a short time since.

During this time the Chief Geologist personally redrew the main section along the Susquehanna river after a new plan, so that the details of structure, which are entirely by him, do not exactly accord with the text of the description in the chapter devoted to cross sections, nor with the shape of curves, distance between dips, &c., &c., on my original section: but these changes affect the appearance more than the substantial information given by the map. It is very likely that some errors may have crept into the text or Index, which are due to the lapse of time which intervened between the execution of the field work and the final preparation of the book for its issue from the press.

In the lower right hand corner of the colored map is an ill-defined area of "chlorite" in which the Peach Bottom slates are situated.

The boundaries of this area are exceptionally difficult to to define and as an indication of this the colors are not separated by dotted lines as in other cases.

The same is the case with the boundary between Azoic and Chlorite on the York Co. map.

PERSIFOR FRAZER, JR.

PHILADELPHIA, *March 21, 1880.*

Chapter I.

General Geology.

Lancaster County, without comprising within itself so many geological formations as many other counties, and while notably deficient in representatives of the Devonian and Carboniferous ages, must yet be regarded, geologically, as it is agriculturally, as one of the most important and interesting parts of Pennsylvania.

Its south-west boundary line is the Susquehanna river, which, though scalloped, is evenly so from N. W. to S. E. Regarding this S. W. line as a base, Lancaster county forms almost a trapezium, or isosceles triangle with the angle at the apex cut off nearly parallel to the base; or, more than anything else, like an abused military chapeau.

It comprises within its limits the following formations and deposits either locally or continuously distributed within its area.

Commencing with the most recent:

Drift.—Two small areas, one, known by the inhabitants, and pointed out by Dr. C. H. Stubbs, of Fulton township, occupies an angle between the fork of two roads, about (0.6 mile) or one kilometer north of the Maryland line, and about the same distance east of the Susquehanna river in Fulton township.

The pebbles are rounded masses of pink and white quartz, resembling those which make up the Oneida conglomerate, mixed with occasional ferruginous matter.

Another deposit, of which the origin is a little more doubtful but fairly probable, about ±13 miles (21 kilometers) due north of the first locality, in Strasburg township, and about 1 mile (1.6 kilom.) north of the town of New Providence.

The material of which this deposit is composed are boulders and rounded pebbles of Oneida conglomerate, Mesozoic sandstone, and quartz. Nine tenths of it are various forms of quartz.

Traps.—These are all grouped together here, because there is not sufficient evidence at hand to prove any trap yet observed in this county to be of earlier age than the Mesozoic strata, though there may well be such dykes.

They are observed at very many places breaking through the Mesozoic formation, and frequently (as in the case of the Bellevue-Georgetown-Centerville dyke) leading in a well defined line through the older rocks; though this latter case is the only one in this county where such dykes are found so far from the margin of the New Red. All of the exposures are not indicated on the accompanying map; indeed, to trace all of them would have required much more time than was allowed for the entire geological survey of the county.

Another difficulty in such a search is the common one, that in a country covered with soil and the débris of the older rocks, such dykes only can be traced by the loose masses of trap which are here and there found lining the roads, or collected and buried by the farmers.

3. *Mesozoic or New Red Sandstone.*

This formation extends along the entire N. W. border of the county in a broad belt which widens to the N. E. or towards Berks county. It gives clear indications of having once covered a great deal of the surface, from which it is now entirely eroded. A curious geological feature is the large double lake or basin of limestone which it leaves at about half the distance between the extreme west and the extreme east sides of Lancaster county, and in which Ephrata is the principal town. This basin is entirely enclosed, or so nearly so as to render it doubtful if the gap indicated on the map is not one of topography merely, through which a small stream finds its way out of the basin.

The marginal parts of this basin (and indeed of a great part of the New Red) are composed of the same hydro-mica schists which play such an important part in the limestone series, but broken up into small angular fragments sometimes improperly called "gravel" by the country people, though differing from gravel in the important respect of not being rounded. These beds of broken up schist differ lithologically in no respect from the same beds as they occur in the limestone series, and the task of distinguishing the margin of the two formations becomes one rather of topography than of lithology.

After considerable practice the eye gets accustomed to the general difference between a hill composed in this way and that of the schist originally in place, and the practice is absolutely essential for this purpose, because very often this form of the hill is the only available phenomenon from which to judge; the rock in place being covered deep under masses of clay and soil. It is interesting to note that this schist formation (which for the want of a better name may be called after the name of the locality where it was first studied in this district, the *York schists*,) is the important Ferriferous or iron bearing belt of the limestone district, in the sense of producing the pyrite from which the limonites are derived as well as forming by the clay into which it weathers a fitting receptacle for this ore as well as for that due to the washings of solutions from external deposits. These strata, together with the schists and chlorites which sometimes underlie them, seem here in their re-composed form to play the same role; and have been the object of many efforts to establish successful iron mines in the New Red sandstone.

They contain pyrite here, as in their normal position, in various stages of decomposition, and from the frequency of trap dykes the oxides to which the pyrite gives rise are frequently rendered magnetic, but within the limits of Lancaster county are nowhere yet discovered to exist in paying quantities. The world-famous Cornwall mine is an example of the effect upon the iron ores of this (or the immediately underlying slate and schist formations) of the close proximity of trap dykes, and it may be that this valuable deposit will yet be found far back in the Elizabeth hills south of the Lancaster county line.

These broken schists which serve as the materials out of which the marginal New Red is made, do not seem to come in on the river shore, but are sparingly marked near White Oak P. O., which is not far from the line of strike of these measures from Bainbridge.

It has been suggested in a former study of the New Red sandstone that the uneveness of the southern margin of that formation might be, and in many places seemed to be, due to a varying amount of erosion. If this be so it would be easy to explain the absence of the softer broken fragments of the lighter thin schists from the vicinity of the water way of one of the largest streams in northern America, and also the sudden curve south and extension of the mesozoic in that direction at a distance from the channel apparently sufficient to remove the rocks from the greatest part of the fluctuations of flood and current incident to so large a river. At all events this fragmental character is found to characterize a very large part of this south-eastern extension of the New Red, (though not all of it,) to the limits of Berks county.

Lancaster Limestone.

The next formation in descending order and of primary importance to the agricultural industries of Lancaster is the limestone formation which contributes so greatly to the fertility of the soil. This is probably the equivalent of the Calciferous and Trenton limestone of the N. Y. series, and in irregular patches and broad basins covers over 300 square miles of the county.

This limestone was divided according to the first report into the great mass known by the name of the County, and of which the York limestone is a slender offshoot, and a narrow tongue of limestone coming down with the Chester Valley into Lancaster, and terminating near Quarryville on the south side of Mine ridge. A careful study of this latter region revealed the fact that these two districts were continuous, in fact, as Prof. Rogers more than once intimated his belief that they were in origin.

A glance at the map will show the nature of this connection. Narrow threads of older rocks connecting the Georgetown series with their Martic and Drumore township exposures divide the continuity of the limestone into slender bays and peninsulas, but do not actually sever it except in one place (and not a very wide one) near Camargo P. O., in Eden township.

This limestone has great masses of hydro-mica schists, argillites, rhomboidal slates, and gray weathered leached-out pyritiferous strata, containing other materials disseminated through them which make it very difficult to calculate the real thickness of the calcium carbonate which may be relied upon to exist comparatively pure in any one locality. Slates and argillites, and perhaps a little more rarely true hydro-mica rocks may come into any horizon of the limestone, and, in some circumstances, in such a way as to deceive very acute observers as to their relations to the oldest strata.. This intercalation of foreign beds does not seem to be at present reducible to any rule, though in general such transitions seem to be more frequent in the lower than in any other parts of the measures.

Calcareous Argillites, Nacreous Slates, Hydro-mica schists, &c.

Under these calcareous rocks, and apparently conformable with them, is a vast series of hydro-mica schists and decomposed argillaceous slates, which insensibly grow in the deep more and more chloritic until this mineral lends its color as well as its name to the larger part of the whole formation, but generally the chloritic series is divided from these nacrites by a quartzite.

An instance of this is afforded in the strip of land just below Columbia, and reaching to the upper part of the town of Washington. A ridge of comparative steepness but not very great height runs a little north of east from the mouth of Strickler's run to a point very near the eastern extension of the Chestnut Hill strata, and this topographical similarity in two sections of elevated land with a narrow belt of limestone between, seems to be based on a similarity of their geological relations.

But whereas the area in which the rich iron ores of Chestnut Hill are yet successfully mined is generally a deep mass of clay and interspersed with blocks of quartzite, the narrow ridge alluded to is simply a mass of hydro-mica schists not to any great extent reduced by weathering to clays, but to a loose sandy slate. The main points of difference between these two ridges consist in the greater disintegration of the Chestnut Hill than the Strickler's Run rocks; the greater predominance of quartzite fragments and of ore in the former, and the conformability and intercalation of the latter with the limestone series. This is not intended as a definition of *exclusion*, which does not seem easy, but simply a definition by the more prominent characteristics, for limestones occur close to the northern margin of Chikis rock when the quartzite is no longer visible, about half a mile (0.8 kilometer) east of the mouth of the Chikiswalunga creek; and on the other hand small beds of iron ore have been discovered in the quarries of those slates, (as in Upp's,) between Columbia and Washington. It has been mentioned before that these lower hydro-mica schists and slates are the materials from the débris of which the southern margin of the New Red sandstone itself has been recomposed. In some cases the bedding has been so uniform owing to the flatness of the fragments, that a casual observer could easily take the basset edges of such a pseudo-formation for a mass of strata which had been strained and cracked by a pressure exerted in place after the lower limestone slates were consolidated.

Chikis Quartzite.

Next in order of age comes "the Primal Sandstone" of Rogers, represented here by the quartzite of Chikis rock.

This formation (as quartzite) occupies a very small space when compared with those of all the other grand divisions except the drift.

It is found in large mass only on the northern half of the composite hills known as "Chikis." The quartzite and quartz slate which belong with it do not extend more than 115 paces (say 100 meters, or yards,) from the first bold, bare escarpment back of Prof. Haldeman's house to the point at which the quartzite character appears to give place *upwards* to the somewhat chloritic hydro-mica schists so often spoken of, and within this distance are no less than two small synclinals, and two small anticlinals, and the southern half of a large one—the whole forming one and a half large anticlinals, of which the first is collapsed. The actual thickness of quartzite above water-level is not much over this (100 paces, yards, or meters).

The schists which overlie it to the south, and form the ferriferous horizon of Chestnut hill, were assumed as the overlying part of the "Primal," ("Upper Primal slates,") or the lower measures of the limestone series.

They are, at all events, those slates in which the iron ores of Lancaster and York are invariably found, the transition series between the "Primal" and "Auroral."

Quartzite is found in fragments occasionally along the north face of the Welsh mountains, and along the north face of the North Valley hill, and within the area between the narrow and broad basins of limestone known as the Georgetown district. However in few of these places does it occur in place, but generally only in blocks and fragments. There are two localities where it seems to be in place and massive, but their extent is limited. One of these is on the left bank of the Susquehanna, about 1½ miles (2.5 kilometers) north of the Maryland line.

In one of these exposures it appears as a tightly folded, overthrown anticlinal, which is curious, as exhibiting, by homogeneity of material, the rare example of a stratum bent within a few yards (or meters) into two limbs perfectly parallel, and therefore giving the same in dip and strike. Besides this, there seem to be pulpit rocks of this quartzite near the same locality, standing boldly out, but further from the shore than at the above named locality, and but little inferior in height to Chikis rock itself.

The Chikis Quartzite has been colored to indicate

"Primal," as in the first geological map, but the larger part of the strata above are here differentiated, to show that they possess different lithological character.

A small exposure of hydro-mica slates in the southernmost of two hills just south of Neffsville are referred to the slates overlying the Quartzite, rather than to the lowermost slates of the limestone series, owing to the large quantities of quartz fragments intermixed with them, because the veins and seams of quartz increase in proportion to the age of the formations. The fracture of these slates, however, which is rhomboidal, would rather tend to confirm the view that they were simply the lower members of "No. 2," or the "Auroral" (Lancaster) limestone.

The only fact which seems certain about this exposure is that the rocks belong to an horizon older than that of the limestone, and here immediately underlying it.

The quartzite of Chikis rock can be followed out into and across the river, in the bed of which it makes numerous riffles: while it plays a part in the long ridge on the York county side similar to that which entitles it to give its name to a great thickness of heterogeneous strata south of the Chikiswalunga creek.

Chloritic Series.

A vast series of slates intervene between the lowest rocks of all on the Susquehanna and the formation last described. These are frequently alluded to in this report as the Chloritic or Chlorite series.

These rocks are best exposed in two places along the line of the river section, viz: In the northern end of Turkey Hill, (including all of the promontory which juts out into the river and the region below as far as Milton's (?) run,) and in the space between Fishing and Peter's creek.

If the structure which has been assigned to these two localities be correct, and if the Peach Bottom slates be contemporaneous in time (if not identical in composition with these chlorites; their thickness as given by the folds of both localities is about 5,600 feet, (1.7 kilometers.)

The lower (southern) part of the triangular bluff known as

Turkey Hill seems to be composed of the older mica schists and gneisses for some 7,200 feet, (2.194 kilometers) over the ground above the mouth of the Conestoga.

Eozoic Series.

The last and lowest of the formations embraced in Lancaster county is that of the mica schist and gneiss belt, which is represented on the old geological map as covering the ground from the Welsh mountain to the North Valley hill, and extending in a narrow area southwestward from Guthrieville between "Mine ridge" and the same North Valley hill to a short distance beyond Georgetown where it is enclosed. For reasons to be stated below the boundaries of this formation are enlarged on the present geological map, and instead of running to a sharp point and ending near Quarryville, it is represented as merely crossed by a very narrow band of blue limestone, (that which unites the Chester valley with the Lancaster limestone); to the south-west of which it widens until it covers along the river front a space of nearly eleven miles, (17.7 kilometers,) or from Milton's run north of the Conestoga to Fishing creek.

It follows as a matter of course when such a wholesale change of color is recommended in a geological map made by the most accomplished geologists, not only that he who assumes the responsibility of such a change has weighed well the reasons on both sides; but that the change, if desirable, will not be so because of any oversight in the first map, but because of different views as to the age of the rocks which are under consideration. Lithological evidence would not here quite suffice, for it may be viewed as doubtful whether the mica schists necessarily imply an horizon any more fixed within their domain than the hydro-micas* which they support, in theirs; and in any case, the superposition of the latter on the former occurring without *certain* evidence of non-conformability, the transition from one rock to the other is gradual, and the line between them

*By "mica schist" is meant *crystallized* aggregations of feldspar and mica which assume often the form of gneiss, (sometimes indeed of a granite,) when the inter-mixture of quartz is sufficiently large.

difficult to define. It is not meant here that these two formations *are* conformable, for the evidence on the point in Section 1 is not of itself sufficiently conclusive either way.

The character of the rock is very much like that of the softer gneisses when viewed a short distance off, and the two merge insensibly into each other. The hills which such rocks produce are seldom very high, but often dome shaped, and, at their base, steep; and the soil with which they are generally deeply covered is filled with sparkling fragments of mica. The presence of blocks of quartzite lying loosely imbedded in such rocks is pretty strong evidence of the existence of this member of the series at one time, and of its fracture and dissipation above ground by the weathering and wasting away of the lower and softer strata on which it rested. In a country where these indications are all that are available for the purpose of judging of the age of the rocks, I have usually assumed that the schists belonged to the class of "hypozoic" of Rogers, and were a part of the Gneiss belt described by him.

The *hydro-mica slates*, on the other hand, less frequently form hills, and more frequently form ridges of no great height, often steep on one side. In south Lancaster they stand perhaps, on the average, at higher angles than the mica schists; they do not by their weathering produce so deep a soil and subsoil, while the latter is more sandy than micaceous. They are, when compact, less influenced by the weather than the mica schists and gneisses and offer more exposures of rock in place. The characters of the rocks included in the term hydro-mica schist are very various. Some are calcaroid, or resemble limestone so nearly that it is almost impossible to tell them apart by simply optical examination. Some have minute or large crystals of pyrite or other minerals enclosed within them; others have simply pits where their minerals have been dissolved out, and these latter, which are very variable in size, are often filled with a dark brown powder, which is an iron hydrate. Some are very arenaceous in character and friable under small pressure between the fingers, and others are composed of such fine flakes of damourite and other hydro-micas as to assume the character, and merit the name of true argillites. But the character which is common to all varieties is that of being built up of indefinitely small microscopic crystals of mica, which gives them a peculiar gloss or lustre in reflected light. These hydro-micas are very frequently associated with green chloritic material, which adds to their earthy character, as it deprives them of the power to resist atmospheric disintegration. In fact, the greater part of the chloritic series along the lower banks of the Susquehanna are true hydro-micas, to which this latter substance has been added, which gives them the name.

In passing along the Columbia and Port Deposit R. R. from Turkey Hill station to Conestoga creek, one passes comparatively abruptly from the limestone and limestone slates near the R. R. station to hydro-mica schists of greenish color. No plausible construction will dispose of these strata to the north, and there has been supposed to be here a fault. Succeeding these chloritic argillites and damourites are chlorites, which, however, do not altogether lose the other character.

These chlorites are followed over what appear to be two synclinals over an anticlinal in the middle, until a change occurs at Milton's creek to a mica schist with pink and white quartz. This latter mineral is, of course, regarded as accessory, or the strata would be denominated "gneiss," (which they, not long afterwards, become.) The alteration in the dip at this point is too trifling to base any theory of non-conformability upon. The last chlorite dips N. 25° W. 50°, and the first mica schist, 900 ft. (274 meters) away, N. 20° W. 58°.

No note of chlorites is found along the river bank from here to Fishing Creek, in Drumore township (about eleven miles, or 17.7 kilometers), though, in the neighborhood of Colemanville, a short distance from the river on the Pequea creek, and in Conestoga township, along with "gravel" and sandy clays mixed with profuse débris, of white, and colored quartz, is a narrow patch of what may be from the above characters, the decayed remains of crypto-crystalline rocks, but, in lack of sufficient evidence for this view, has been colored similarly with the adjacent strata.

In the vicinity of Fishing Creek, is a change from the mica schist ("gneissoid mica schist," "quartzose mica schist," and finally coarse mica schist dipping W. 35° N. 30°) to brown sandy slates dipping E. 35° S. 78°, and this is continued with the interruption of the Peach Bottom slate and two points of Quartzite, through this entire chloritic belt.

The reasons, then, for assigning to this belt the place of a continuation of the Georgetown and Chester County gneiss belt are, briefly, as follows:

1. The lithological resemblance between the two sets is striking, and the differences between them and the chlorite series on either side, or the Quartzite equally so.

2. The limits thus traced out by lithological character alone fall easily into the boundaries between these formations established beyond peradventure from this to the north-east.

3. A study of the contact line between New Providence and Quarryville reveals the fact that in one place (somewhat destitute of exposures of rock in place it is true) there seems to be actual continuity of strata between the Georgetown belt and that which penetrates Providence, Martic, and Drumore.

4. The shape and appearance of the so-called "Martic hills" are confirmations, however slight, of their primordial origin.

5. The palpable flat anticlinal axis at Tocquan creek lies nearly midway between the extreme edges of the formation as here laid down: and

6. In direct line with the strike of the Georgetown belt.

7. On each flank of this great anticlinal the same chlorite series comes in.

8. The enormous thickness of strata perpendicularly measured from the Tocquan creek upwards, is out of all proportion to what is known of the Primal or Siluro-Cambrian series elsewhere by itself.

Boundaries of the several formations. Southern edge of the New Red Sandstone.

The Mesozoic or New Red Sandstone intersects the Susquehanna River at the upper part of the town of Bainbridge and runs thence in a waving line E. 27° N. through the townships of Conoy and West Donegal into the township of Mount Joy to a point about 1¼ miles (2 kilometers) S. W. of Milton Grove where its direction changes to E. 40° S. It crosses the Little Chikiswalunga about one mile (1.6 kilom.) north of the borough of Mount Joy into Rapho township and bending abruptly to the south for about a quarter of a mile near the house of Jacob Eby, turns to the N. E. past the farm of Emanuel Eby and shortly after N. N. E. through the farm of Mr. S. Nissley near the house of Abraham Brubaker. It changes its direction to south of east near the house of Jacob Krady whence by another semi-circular curve it skirts the village of Sporting Hill and crosses the big Chikis Creek into Penn township half a mile (800 meters) south of the village of Manheim.

From here it pursues a line slowly gaining in southing as it is pursued eastwardly. It passes close by C. Kreider's, H. Neff's, and H. G. Sahm's farm houses about half a mile south of the village of Mount Vernon near Levi Hess' and R. J. Erb's across the Warwick township boundary and to the banks of a little stream which runs through P. B. Longenecker's and Joseph Baker's.

It turns abruptly at this point and pursues a course nearly parallel to that described, leaving a strip about half a mile in breadth of the Mesozoic measures. The line runs near Christian Bomberger's and Jacob Bender's and H. H. Cassel's when after a short jog it continues nearly westward through the properties of Widow Summy, Graybill and H. Stahman, and crosses the Big Chikis Creek on the southern margin of the village of Manheim into Penn township.

It sweeps around Manheim in a curve and crosses the Chikis for the third time a little less than a mile above this village.

The line descends thence rapidly S. E. by J. B. Hershey's to a point near the house of S. Hoffer when it as abruptly resumes a N. E. course from A. Minnich's house to that of J. Graybill when it changes to an almost easterly course marked with sufficient exactitude by the county road and after making scallops at the crossing of several small streams it crosses into the N. W. corner of Warwick township near the house of Henry Hess.

The general direction is still pretty well marked by the county road which runs S. E. in the direction of Rome, but the loops become more frequent and more attenuated or narrower and longer. The general line passes a short distance W. of Pine Hill and describes a curve convex to the south which includes all the upper or northern part of Warwick township and meets Hammer Creek near Brunnerville P. O.

Near the farm of Isaac Ealy on the Warwick border, Hammer Creek cuts off a jutting point of Mesozoic and makes of it an island entirely surrounded by limestone, (if, as is supposed, the bed of the creek is down to the limestone horizon.)

The boundary between the Mesozoic and the limestone follows Hammer Creek to its intersection with the Durlach P. O. and Pennville road when it turns suddenly to a direction a little north of east.

The boundary line from here was drawn in from observations made at only a few points in Clay, West Cocalico and East Cocalico townships so that its apparent uniformity of direction may turn out to be more apparent than real. The line pursues nearly an easterly direction through Clay township, passing a very short distance south of Durlach P. O. This general direction is preserved in West Cocalico township, the line passing just across the southern edge of the settlement of Schoeneck and making a loop to the south near the farm of J. M. Brubaker.

The boundary of limestone and Mesozoic crosses the Reading and Columbia R. R. near Union Station around which it sweeps while taking first a S. E. and then a south, which it shortly afterwards changes for a south westwardly direction as it passes out of East Cocalico and into Ephrata township, and follows the Ephrata Hills to the town of Ephrata. Here the hard red sandstones are replaced by the soft "gravel" hills, or sediments of fragmentary schists, which from Akron cross back again into Warwick on a curved line which is the border strip of the New Red. This line passes through Grossman's south of Millway and across the northern limit of Rothville, makes a loop to the south at Kraatz's saw-mill, pursues its course near Pfaatz's and Christian Martin's in curves of which the general trend is south of west; thence runs nearly west to the house of John Burkholder and from this point in a direction nearly straight and marked by a road S. 43° W., to the stream already mentioned as bounding the Mount Vernon area of New Red.

The course is here abruptly changed to N. E. through D. Erb's and Henry Becker's; thence south about ⅛ mile; and in a short curve around a school-house near New Haven when after a number of curious irregularities it follows a parallel line to the direction of the road from New Haven to Ritzer's Mill leaving the former near to the margin but completely in the Mesozoic Measures. At C. Cornihoff's it follows the Millport road and skirting the northern edge of the mill dam in that town makes a bend to the southeast and back which leaves a spur of the New Red measures in West Earl township; and enters Ephrata township in a N. E. course which brings it to the Greenville Hotel in Greenville. It changes again to the S. E., and running close to the southern border of the township, finally passes almost due east about a mile north of Hinkletown to Jno. Messner's, where it changes again to the S. E., crosses the Muddy Creek and the Ephrata-Earl boundary into the latter township.

The direction of the southern border the New Red across Earl township is approximatively that of the Conestoga Creek; which it however leaves to the south shortly before crossing the Earl, East Earl border.

The course of the margin across East Earl is in a gently curving line south of Fairville or Terre Hill P. O.; but there appears to be an isolated patch of New Red to the south of the main border of this formation and in the vicinity of Weaver's Mills.

The boundary keeps this general course through the Northern part of Caernarvon township commencing with Turkey Hill and enters Berks County a short distance from Morgantown.

The main features of this southern margin of the New Red may be thus summed up.

1. It marks the northern limit of the Lancaster limestone.

2. It crosses south of the northern limits of the county and therefore the northern part of Lancaster County is covered by its rocks.

3. The New Red is very shallow toward its southern limit and the greater part of it is composed of the broken limestone schists on which it was laid down.

4. It nearly or entirely encloses a great double valley of limestone called sometimes the Ephrata basin the forms of its enclosing arms being irregular and grotesque.

5. The hill-making parts of the New Red lie two or three miles (3 to 5 kilometers) north of, the southernmost margin, but for some distance from the shore of the great water course (the Susquehanna) the soft shales which elsewhere form the southern belt of Mesozoic are entirely swept away.

Boundaries of the Limestone.

As just before stated, the description of the sinuous line which marks the S. boundary of the New Red Sandstone, will answer for that of the northern edge of the limestone.

Along the left bank of the Susquehanna the limestone is continuous (although in default of exposures this is not proved on the section) to the Chikiswalunga creek. Here the Chikis Quartzite cuts it off, crossing the river very nearly in an easterly direction and passing across West Hempfield township; first close to the bank of Chikis creek but shortly skirting the Chestnut Hill ore properties and the hamlet of Silver Spring and crossing the Marietta turnpike at about the boundary between West and East Hempfield. From here, owing to a knob with which the Chikis series terminates, and which extends about 1½ miles (or 2.4

kilometers) to the north; the edge of the limestone follows about this course to the Harrisburg turnpike or between that and the P. R. R., (Middletown Section). It thence descends and sweeps around in a short curve ending by trending nearly due west and touching the river at the northern extremity of Columbia near the St. Charles Furnace. This description will be referred to as also defining the limits of the Chikis ridge.

It should be borne in mind also that the limits can only be given as a rude approximation to the truth for the larger portion of the rocks which go to make up the Chikis ridge and the Chestnut Hill are not quartzite but hydro-mica schist, and all that can be said of them is that they lie between the former and the limestone. Rogers recognized them as "Upper Primal" and colored them like the rest of the Primals yellow. They may (it seems to the writer) with equal propriety be ascribed to the lower horizon of the limestone of which they resemble the typical strata very strongly.

The first stretch of limestone is nearly in an easterly direction and is not found on the opposite side of the river; but at Columbia an arm of the limestone extends across the Susquehanna and penetrates York and Adams counties to a point very near the Maryland line.

As the reasons for excluding the belt of "Primal" which was represented on the old geological maps between Columbia and Washington, have elsewhere been somewhat fully stated, it will not be necessary to enter upon that subject here. According to the best information which the writer was enabled to obtain, the steep ridges just south of Columbia, extending east to Mountville are the lower limestone slates, and as such are a part of the Lancaster limestone formation whose boundaries are here to be given.

The second abrupt interruption of the continuity of the limestone is found at Turkey Hill where a high mass of chloritic hydro-micas cuts it off.

The form of this mass is approximately triangular the base being to the north. The margin of the limestone passes around this barrier in a direction a little north of east to a point near the barn of Christian Ely and thence south-east to the mouth of the Conestoga at Safe Harbor.

The line thence starts E. S. E. into Conestoga township but shortly changes its general direction to N. E. which it pursues in a series of flat waves to the Conestoga and Pequea line where it changes to more nearly East with a little northing and crosses just at the south end of West Willow Street village. It passes the township line into West Lampeter where it shortly turns back on its course and follows one nearly parallel with the above described line but widening the distance between the two gradually to the S. W. and nearly following the Pequea creek (which however lies wholly in limestone) to the vicinity of Marticville.

Here the direction of the limestone is changed to N. E. and the line which separates it from the Eozoic rocks on the south passes, on the average, up to the corner of Providence, Strasburg and Pequea.

From here the details of its course to Quarryville, which is about S. E., are extremely intricate and will be better given by comparing the Mill Creek-Quarryville Section with the General Geological map; but in the main, omitting slight or apparent breaks of continuity, the line may be said to be roughly S. E.

At Quarryville the limestone runs almost in a straight line E. 15° to 20° N. up the Chester Valley against the South Valley Hill and ending near Willow Grove in Montgomery Co. returns along the North Valley Hill to Quarryville and thence north and northeast through the upper portion of Eden and through the S. E. corner of Strasburg township to near the eastern border when it takes a sudden extension to the north. Hence it runs a little north of east through the lower part of Paradise township and through Salisbury township as far as Bellevue; the spurs of the Gap Hills (really part of the Welsh Mountain) force the line sharply to the N. E. and afterwards to N. N. E. the limestone everywhere closely skirting the Gap Hills and lying against the quartzites and schists in irregular lines dependent upon the shape of the spurs and the amount of the erosion. From Cambridge P. O. for about a mile the direction is nearly due north when it changes to S. W. to form the Mt. Airy promontory. The promontory is terminated near the junction of East Earl, Earl, and Salisbury townships by an irregular curve convex to the S. W. which sweeps around Green Bank P. O. and runs N. E. nearly to Beartown, when after another swell to the west it skirts the north side of the Welsh Mountain in the narrow Churchtown valley (following very nearly the course of the Conestoga Creek) and passes into Berks County but a short half mile south of where it was left near Morgantown in contact with the New Red Sandstone.

Boundary of the Chikis Quartzite.

There are but two localities where the Chikis Quartzite seems to be unmistakably represented, or at least where it forms the prominent part of the formation in place. One of them is at Chikis itself and the other at a point about 1½ miles (2.4 kilometers) north of the Maryland line on the Susquehanna, where two narrow strips of quartzite occur.*

There are very numerous localities along the North Valley Hills and along the Gap Range and the Welsh Mountain where quartzite is found but aside from a certain doubt as to the contemporaneity of these exhibitions with that of the rock whose name is given above, the exposures in place are few and a settlement of the proper location of these quartzites is postponed till after the study of the Welsh Mountain, &c., in Chester county which will supplement what is wanting in statistics here.

The approximate boundaries of the Chikis series were given when speaking of the limestone. The accurate boundaries are not easy to give owing to the great amount of weathering which they have undergone; but with the assistance derived from the topographical features of the hills they form the foregoing statement may be regarded as near the fact.

The Quartzites on the river shore and near Williamson's Point are of very small extent and will be found described in Section 1.

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*See remarks about sandstone in contact with roofing slates to the south.

A small isolated patch marked "Primal" in the first Geological map occurs just south of Neffsville, Manheim township, and fairly in line of strike with the great exposure at Chikis. This exhibition which will be alluded to in the Lancaster limestone section is principally of hydro-mica schists and belongs (with uncertain relations) between the quartzite and the limestone. A considerable quantity of quartz gives some support to the hypothesis that these may be the hydro-micas just above the quartzite (if not members of the Chloritic series).

Boundaries of the Chloritic Group.

The chloritic group is in many respects very similar to that which is intermediate between the limestone and Quartzite from which a not very great thickness of the latter separates it.

The differences between the two are chiefly lithological, and consist mainly in an additional quantity of magnesian silicate taking the form of chlorite and giving the rocks a dull greenish color characteristic of this mineral. It must not be understood that the presence or absence of chlorite from hydro-micaceous or nacreous schists will of itself detetermine the position of the rock as between these two groups. On the contrary there is abundant evidence of the existence of chloritic materials in those argillites which are found interbedded with the limestone itself and assuredly many horizons of the group under consideration are devoid of chloritic matter.

As a rule however the schists which underlie the Chikis Quartzite are much more chloritic than those which overlie it and are easily distinguished from them even at a distance, when in large mass.

A notable instance of this may be found on the Susquehanna at Turkey Hill, where the lower limestone slates and their limestone comes in contact but may be without difficulty discriminated lithologically.

This latter locality is the first instance of the occurrence of these measures which will be described. The greater part of the boundary has already been given in describing that of the limestone but an important geological feature was then omitted as having no bearing on the limestone and its slates which finds its appropriate place of mention here.

The rough triangular area left by the limestone between the Turkey Hill Station (C. and P. D. R. R.) and the mouth of the Conestoga seems not to be all of this chloritic series.

The southward turned apex of this triangle is tipped for a little more than a mile with *crystallized* mica schist and gneisses also lithologically dissimilar to any of the crystalline rocks which lie above them. The reasons which have led to the adoption of the view herein set forth of the contact of an inferior and a superior series, and the confirmation of this view by observations made in widely distant parts of the county will be found in another place.

6,700 ft. by the R. R. survey line N. W. of the mouth of the Conestoga is the first appearance of these mica schists which thence continue a number of miles down the river without interruption.

This area of chlorites extends thence from a little below Turkey Hill Station or 36,000 ft. south-east of Columbia (along the track of the R. R.) to 53,500 ft. south-east of the the same point (or 6,700 ft. N. W. of the mouth of the Conestoga) in all a distance of a little more than 1¼ miles, (or 2 kilometres.)

Its northern boundary runs from the same initial point a little north of east for about two miles from which its eastern border is found by joining this point to one about 1 mile east of the termination assigned it on the river shore.

This comparatively small mass of chloritic slates occupies its proper position so far as regards the broad and complex anticlinal of Eozoic rocks next to be described, but its contact with the Quartzite which should immediately overlie it to the N. W. seems to be hidden from view by the wide expanse of limestone separating Turkey Hill from Chikis. Here the rise of an extensive anticlinal to which the appearance of the latter is due has apparently not been great enough to expose this series but only to display the strata lying on and above the horizon of the Quartzite with the overlying nacrites.

A brief comment must be made here on these strata of which the structure has an important bearing on all the other formations.

It will at once appear that were the deposition of these strata in their order regular and conformable, we should not find limestone lying against the lower chlorite series at one point and against the Quartzite at another not very distant. But this is seen in the relations between the limestone to the rocks of Chikis on the one hand and to the chlorites of Turkey Hill on the other. Here then is strong evidence from this river section alone of the non-conformability of the limestone to the underlying formations; an evidence which the frequent *apparent* conformity of dip between it and the floor on which it was laid down (whatever that floor may be) will not perceptibly weaken; for, although unexplained and imperfectly understood by the writer, it is nevertheless a collection of local phenomena which *may* be due to the alteration of the structure of the limestone itself by pressure producing cleavage planes closely imitating planes of bedding and subsequent to the actual placing of the whole formation. But in a phenomenon of such vast extent as the contact of formations, such accidents are eliminated and but one explanation is possible.

Still if these contacts were confined to the river section the writer would have great hesitation in announcing them; but in fact the observations from the inland townships lend the strongest support to this view.

Thus, but 4 miles N. E. of the mouth of the Conestoga the limestone occurs in contact with the very Eozoic series from which it is separated on the river section by the entire thickness of the chlorites of Turkey Hill: and indeed on the east border of Turkey Hill itself the contact may be followed from the outcrop of the upper chlorites to the gneiss of Safe Harbor thus annihilating an interval of over 4,000 feet (1,219 metres.)

At these points, then, within a few miles of each other the same limestone is found in contact with these separate formations, and at all horizons within a perpendicular distance of 4,500 feet (1,828 metres.)

This area of chlorites is supposed to be the N. W. continuation of one great (perhaps continuous) deposit of which the south-eastern member including the Peach Bottom Slates will be next described, and between which two displays of chloritic schist the wide Tocquan anticlinal rises to the surface; while possibly the intervening chlorite mass has been eroded during the many changes which have taken place since the mica schists were layers of ocean sediment.

The next area of chlorites occurs south and east of Fishing Creek in Drumore township and (according to the best information of the writer) seems to cover nearly all if not all of the area between Fishing Creek and Peters Creek, and perhaps more. Nevertheless this region is very well adapted to be misinterpreted and an exact definition of the line separating the Eozoic and chlorite belts is very difficult on account of the few and much weathered exposures.

The region thus provisionally marked off as covered by this formation is unique in containing the world famous Peach Bottom Slate quarries. The occurrence of these slates here, and their absence from other localities where the chlorites abound, naturally renders an explanation necessary and requires the existence of special conditions to produce them.

It will be explained elsewhere as to the Peach Bottom roofing Slates that their study has impressed the writer with the belief that they are simply one belt of the Chlorite strata not appreciably differing in chemical analysis from the rest but which through the local influence of one of the most remarkable trap dykes in the State (a dyke of dolerite which traverses some eighteen miles of the Eozoic strata in a direction having no relation either to the strike, cleavage or other genetic or exagenetic accidents of the latter at present known) has been altered in texture to the fine grained blue-black rock elsewhere described. At least the upper termination of these slates appears to be about at the point where this dyke crosses their strike and the line of the dyke from here to the river is closely accordant with that of the slates. The total thickness of the slate-bearing belt is not great, and interleaved with the marketable stone are many layers of material which show their intimate relationship with the chlorites in the midst of and conformable to which they are found.

Boundaries of the Eozoic Strata.

It might be simply said that all of the area not already included in the above description is covered by Eozoic rocks, but as this will scarcely present any picture to the mind in a county so geologically diversified as Lancaster, a short description of the northern border (as limited by the unconformable limestone with its associated slates) will be necessary.

Commencing again with the southern tip of the Turkey Hill area we have the northern margin lying against the Chlorite series (*apparently conformably*) but soon cut off by the limestone which descends southwardly to Conestoga creek. Thence the border follows the line already given in speaking of the southern limit of the limestone and which may be condensed by saying that it extends up in a general north eastwardly direction making a narrow arm which traverses Conestoga, Pequea, and a part of West Lampeter townships and descends as rapidly owing to the south westward projection of a similar arm of the limestone to Marticville.

From this point the border line extends again northeast for two or three miles, and this is the limit of its northeasterly extension from the southern corner of West Lampeter to the town of Quarryville. But along this border there are frequent loops in the line caused by the Eozoic prevailing for several hundred yards or meters north-east and prongs of the limestone surviving for the same distance south-west, the whole presenting a very interesting picture of the phenomena of *border-line* geology. At one point near Camargo P. O. there seems to be a clear channel opened between the Georgetown belt and the Martic belt as if to clinch the supposition that they were continuous one with the other and only different parts of the same formation.

From Quarryville along the line of the South Valley Hill (and of course along the line of the Chester Valley itself) the northern edge of the Eozoic runs into Chester county in almost a straight line E. 10° to 20° N.

Returning by the North Valley Hill along the line already given when describing the course of the limestone near Quarryville; it ascends in a curved line in general direction a little east of north to the S. W. corner of Paradise township; thence E by north to Bellevue and the Gap Hills leaving a wide promontory here called the Georgetown belt and containing the Gap Nickel Mines. From the Gap Station the line ascends a little east of North to a point one or two miles above Cambrige P. O., when it again changes in direction to the S. W. for about four miles, culminating at Mt. Airy, where after returning more or less N. E. in a series of curves to a point opposite Goodville it breaks suddenly to E. 10° to 20° N. and passes into Berks county as the southern limit of the Churchtown limestone basin and nearly parallel to its direction in Salisbury township where, playing the same part with relation to the Chester Valley basin it crosses the Chester county line.

There are several outlying isolated patches of Eozoic surrounded by limestone in Strasburg and Providence townships closely related to the arms of the two formations which there jut into each other and which seem to have been produced either by a greater amount of weathering at those points, or by the result of the same amount of weathering on a decreased thickness of the covering rock. Their position and alignment leave little doubt of the comparative shallowness of the limestone at the points where they appear.

Another outlying patch of the Eozoic is seen near Goodville where it is represented in the map as separated by a strip of limestone from Mt. Airy though in point of fact it may be actually a spur of the Welsh Mountain. Whether one or the other is not a question having any important bearing on the general structure.

These Eozoic rocks also fill Colerain, Little Britain and the eastern half of Fulton townships where they are locally interrupted by two belts of Serpentine to be seen on the general map.

Serpentine Areas.

There are only two of these of any consequence known within the limits of Lancaster county and both confined to Fulton and Little Britain townships.

The largest and northwesternmost starts on Mason and Dixon's line about $\frac{1}{4}$ mile (400 meters) E. of the residence of Jas. Kidd. Its northern boundary from here runs N. N. E. to a quarter of a mile E. of Jno. Blake's; thence N. N. W. to the neighborhood of Jos. R. Blackburn's house; thence N. N. E. to the tenant house of L. King; thence E. S. E. to the vicinity of the house of Wm. Brown; thence N. N. E. past the house of Mary Brown, and across the township border into Little Britain half a mile (800 meters) N. E. of Smedley's mill. The S. E. border of this mass starts from very nearly the same place as the N. W. border and leaves a very narrow belt to the vicinity of Blake's. The general course of this border is about N. N. E. through the upper part of the town of New Texas and thence in a waving line nearly due east to the Little Britain township line.

The lower line appears to head up along this line about $\frac{3}{4}$ mile (1.2 kilometers) to Collins' house whence a narrow horn stretches about N. E. terminating near the house of Hannah Taylor.

The northern limit of the Southern belt begins near the old "Line Pit" about $\frac{1}{2}$ mile (800 meters) S. E. of Dr. G. B. Wood's house, and running E. N. E. near McVey's, Jas. Jenkins' and a short distance south of Ahia Reynold's, cuts the extreme south-western prong of Little Britain township; and from here (owing to the tortuous course of the Octoraro) crosses the latter three times and the boundary of Little Britain four times before passing East into Chester county.

The celebrated Wood Chrome mine is situated in this belt in an ox-bow of the Octoraro and just within Little Britain township.

The southern limits of this belt lie in Maryland and Chester county, Pennsylvania.

General Remarks on the Trap Dykes.

The trap dykes are so numerous throughout the area of New Red sandstone that the time employed in making this Reconnoisance Survey was not sufficient to follow and locate them all throughout the entire course of each.

It would greatly enhance the appearance of the map could this have been done although the utilitarian gain to the Report would in most instances have been trifling. Still in certain cases there would have been an economical importance in tracing these dykes for the reason that they seem to be the magazines from which moderate supplies of magnetite have been distributed to the surrounding localities: and, the accidental concentration of this supply over a small area has sometimes led to unsuccessful ventures in mining. Examples of this may be found in the exploitation pits sunk for magnetite on the hill carrying the dyke which makes "Haldeman's Riffle" a mile or so east of Bainbridge, and in those met with in various parts of the "Ephrata Mountain" and elsewhere.

As magnetite seems to be an ever present constituent of dolerite, there is no reason why a sufficient disintegration of a large enough belt of this igneous rock followed by such thorough concentration as a combination of impervious substrata, sufficient slope and occasional rain-fall might easily effect, should not give rise to great and important beds of magnetite. Indeed it has been suggested that the great Cornwall deposit and some of those at Dillsburg* may partly be traced to such an origin. But within the limits of Lancaster County there is no proof of such deposits in the New Red strata or derivable from them, as there is no proof of the existence of the congeners of the Midlothian coal fields of Virginia: though theoretically both are inherently possible.

In many cases the successive points where a dyke has been observed render its continuity over intermediate points so likely that there would have been little risk in "drawing it in" especially where the very able observers on the

*See Report CC. of Progress in 1875.

first Geological Survey of the State have done so; but evidence having appeared in some cases which has led the author to differ in opinion with the observers of that Survey as to the continuity of certain outcrops of this as of other rocks, it was deemed better for this reason alone (and independently of the still more cogent one to produce only in this report entirely original work, and to leave the harmonizing or modification of views to a future stage of our own Survey) to leave these isolated outcrops wherever found, and not to connect them unless their connection was certain.

An example of this method of procedure may be found in the dyke which crosses at Falmouth and (with little doubt) traverses the county to the environs of Elizabeth. There was a strong probability that this was the fact outside of the corroboration of this view by the old State geological map; but the writer had not intended to put it on the map. A recent visit has enabled him to do so.

There is one dyke however so extraordinary in its surroundings and in the phenomena which it must be strongly suspected to have aided in producing, that it was followed from its visible origin to its apparent disappearance. This dyke has been often alluded to, and a brief description of its course will be therefore sufficient.

A bold and well marked trap dyke (Dolerite to the eye) crosses the Churchtown arm of limestone from a little West of north of Churchtown southwardly in the direction of the gap between the Goodville isolated outcrops of Eozoic and the nearest prominent Knob of the Welsh Mts.

It was not found any further to the S. W. as indeed experience in other parts of the State has shown there is little likelihood that it would be, owing to the mass of débris which covers the flanks of the Welsh Mountain.

This line is very nearly continuous with the line of the great dyke about to be described, but however tempting to "draw it in" with that dyke the considerations above presented forbid it. There is a certain analogy between the case of this trap dyke and another perhaps the greatest in the State, which appears on the old geological map crossing most of the formations of the State to the South but terminating on the north slope of the South Mountain enticingly in line with one of the long leaders which unite to form the large trap outburst near Gettysburg. The writer has examined the South Mt. between the two extremities of these two dykes, and has already noted in a report for 1876 (not yet published) some evidences of the continuation of this dyke across the South Mountain and into Adams County. But the tracing of such a dyke across such a mountain is so difficult as to be in most instances impossible; owing to the immense mass of boulders and débris under which the Mountain is buried.

Abandoning, then, for the time the thought that the Churchtown dyke is but a part of that long and important one whose course is here to be described; we will confine our attention to the visible parts of the latter.

The first outcrop of this dyke is seen close by the foot of the steep slope which is the southern limit of Mount Airy and the upper prong of the Welsh Mountain near the house of Mrs. R. Dixon. Hence it proceeds a little west of south through Springville (Salisbury P. O.) to the Lancaster and Spring Garden road which it intersects a half mile or so West of the last named village. It is either terminated here, or its connection with the dyke at Springville is by an easterly jog in its general line. The whole surface of the ground being covered with fragments of traps from the two dykes it is difficult to ascertain whether or not there may be an actual continuity under ground. From Spring Garden the dyke continues in a direction S. by W. through Boyerstown to the Strasburg-Bellevue road which it intersects about half a mile (800 meters) west of the latter and crosses thence into Paradise township.

Another dyke appears about half a mile N. E. of Boyerstown and from indications of its continuity would seem to intersect the former dyke at its traverse of the Salisbury-Providence boundary.

The two dykes thus united cross the south-eastern corner of Paradise from the store west of Bellevue, to the house of Mr. D. Brooks, a distance of about a mile and a half. Here the dyke enters the north-eastern corner of Bart township and passing close to the houses of J. Rogers and C. Wiggins and a little west of that of C. McKee cuts the south-easterly side of the hornblende rock which is the gangue of the Gap Nickel Mine.* It appears that another dyke of similar trap enters the township from the east near S. W. McClures, and after proceeding a little south of west to the vicinity of Nickel Mine Run alters its direction to one parallel to the altered direction of the main dyke. The two are about half a mile apart, a mile above Georgetown. They both seem to change to a direction S. by W. and the easterly or subordinate dyke could not be traced south of the limits of that town; while the other after attaining the vicinity of the house of Mr. A. E. Boughman strikes W. by S. to the farm of Mrs. A. Scott, where it crosses into Eden township. Hence its course seems to be across the North Valley Hill through the property of Mr. Edw. Johnson and crossing the narrow Chester limestone valley throughout whose course are to be found fragments and boulders of this rock; it crosses the South Valley Hill by Jos. Montgomery and Elisha Hammill's and passes through the S. W. corner of Eden township on its transit into Drumore township. From this point it continues to a point on a road a few hundred yards or meters S. E. of Jacob Aument's house and about 1 mile (1.6 kilometers) N. W. of the village of Mechanics Grove.

Hence it runs generally S. W. but curving more to due south near Thos. Linton's and Mrs. Hess'; whence it swerves again to S. W. and passes near the saw mill below Chas. Acheson's. It thence traverses a course a little E. of S. cutting the lower end of Centreville near the store. It changes its course again to S. W. and enters Fulton township at or near Miller's tan yard. Thence it cuts obliquely the Fulton-Drumore boundary, crossing the road a short distance above Wick's mill; and passing through the farms of Joseph and Thos. Stubbs intersects the river near the mouth of Peter's creek. Its course across the river was not ascertained, nor the exact point where it touches the river; for though there

*A portion of this dyke will be seen on the map of the mine.

are a number of trap boulders just below the mouth of the creek, they might have been carried there by the ice from up the river.

But six to seven miles (9.6 to 11.3 kilom.) from Peach Bottom, York county, in the State of Maryland, a dyke was found about half a mile (800 metres) South of the State line and one mile S. of the Slate Ridge.

This makes it very probable that this dyke (despite its not having been observed at all intermediate points) skirts quite closely the Slate ridge and is only a mile from it when the southern limit of the, as yet, worked quarries is attained.

With the exception of the dyke referred to at the commencement of this description this is the largest continuous trap dyke yet figured in the State and of vast importance if it be conceded that it plays a part in the production of two such mining treasures as the Nickel deposit and the Peach Bottom roofing slates.

Reference to an offshoot from this dyke observed between Thos. Griest's and Geo. Hewes, and also to an exhibition of trap in place near the Fulton House, will be found in the more detailed description of the geology of Fulton township.

Position of the two supposed remnants of drift.

About these there remains but little to say. All that is known of them has been said elsewhere. They are nearly 14 miles (23.55 kilometers) apart on a due north and south line.

One occurs in the lower part of the Lancaster limestone and close to an isolated eozoic patch. The other occurs on hills of Fulton township a little over 1½ miles from the river. Neither is extensive but their existence renders it extremely probable that there are other and perhaps larger patches of drift in this and adjoining counties which might throw much light on this very late period of our earth's existence.

CHAPTER II.

Township Geology.

There are forty-one townships in Lancaster county, which it will be convenient to consider in the general order of a line parallel to the N. W. boundary of the county, (Dauphin and Lebanon county line,) and passing to the southeast, beginning always each tier of townships on the southwest, and passing to the north and east.

It must be borne in mind that in so extensive and diversified a field as Lancaster county it is impossible to note, in the short space of one season, and with a party consisting of one person, all the minute details which a final and instrumental survey would permit, so that there will doubtless be found local outcrops of trap, &c., which are not given in the map, and in certain cases to be hereafter alluded to, there may be less uniformity in the boundaries of formations than appears on the maps. The aim of this preliminary survey was rather to furnish an outline of the salient geological features of the county, than to exhaust the detail.

Conoy Township

Lies in the extreme western corner of the county, and is the northernmost county bordering the Susquehanna river. It is separated from Dauphin county by the Conewago creek, which empties into the river at the town of Falmouth. About 800 m. (half a mile) below this town is a large quarry of trap, used for building stone, called Keller's quarry, and at nearly the same distance below this is the little settlement of Collins P. O.

A little more than half the distance between the extreme ends of Conoy, on the river, is the town of Bainbridge, through the upper part of which the boundary line between the Mesozoic and Silurian limestone passes.

All that portion of the township above (N. W. of) this point is covered by the shales and sandstone of Mesozoic age, while the south-eastern half is covered by limestone and the lower slates of that formation.

The boundary line is comparatively straight through this township, and its general direction E. 17° N.; though between the houses of Christian and David Miller it turns to due east for a while; but it shortly resumes about the same course. It has been stated, that below Falmouth, and at about an equal distance between this point and Collins station, a broad band of trap crosses the river, and preserves a north-easterly direction.

This trap, which is a dolerite similar to those described in Report C for 1874, occurs in the same favorable condition for quarrying in which the same rock is found near Gettysburg. Large slabs are taken out and split to the required size, and the industry has grown to be both extensive and profitable.

About one mile, (1.6 kilometers) above the southern township line, and between the properties of John Haldeman and John A. Brenneman is the lower outcrop line of a ridge of trap which in crossing the river forms "Haldeman's Riffle." This dyke is one of those whose line is traced entirely outside of the mesozoic formation, which seems to be the natural home of this igneous rock.

A specimen of galena, (very probably argentiferous,) found in the limestones near this dyke was presented to the Survey by Prof. Haldeman, and will be found in the catalogue.

This dyke which is very narrow, and scarcely visible at the river's edge, passes beyond the eastern township line, and its trace is lost several miles to the north of it.

Its course through the township is about N. 30 E.° from the place where it intersects the left bank of the river, nearly straight to the town of Bridgeville, and along the general course of the Conoy creek out of the township.

A small amount of stream magnetite was found distributed over the slope of this hill, but it is probable that this magnetite was the result of a natural process of separation by running water after the trap itself had been much decomposed on the surface; the magnetite grains being those components of the dolerite whose high specific gravity and stable composition would tend to deposit them in small masses in clefts and hollows as the only representatives of the rock of which this formed originally but a small percentage.

The same thing is often observed by the side of the roads crossing a trap ridge, or indeed any other rocks, (such as some old Huronian strata in which magnetite occurs.) The gulleys and occasional pot holes will be seen to be filled with a black heavy sand which usually turns out to be chromite, magnetite, or menaccanite.

There are numerous limestone quarries in Conoy township among the most important of which is that called the Haldeman quarry on the P. R. R. just above John Haldeman's house. This limestone is of light color and very irregular fracture as is very apt to be the case with limestone beds so near a trap dyke.

West Donegal Township

Lies next N. E. of Conoy, from which it is separated by an artificial boundary line. Like the latter it is divided into unequal parts by the line of contact of the Mesozoic series with the Lancaster limestone. The general line of contact is E. 21° N., but this line is not straight but composed of numerous sharp re-entrant angles like the parapet of a redoubt. This line breaks to the north just west of Nissly's mill, and gaining easting passes close to J. S. Gish's and Widow Ebersole's, where it again takes a course nearly parallel to the county road to Ream's station, and crosses the Pennsylvania R. R. single track about (400 meters) ¼ mile south of the county road bridge over the same. The north-western portion of this township (nearly four fifths of its entire area) is covered with New Red sandstone with occasional outcrops of trap, while the S. E. remaining fifth, with an area of about five square miles (13 square kilometers), is covered entirely by limestone and occasionally the limestone slates, and contains several valuable quarries of this material.

The dyke which was spoken of as forming Haldeman's riffle, and which was traced from the mouth of the river to the intersection of the Salunga creek with the Conoy—W. Donegal boundary, appears to fork shortly after entering the latter township, and (to judge by fragmentary relics) one branch follows, for some distance not exactly determined, the county road which runs parallel to this township, a little west of north.

Evidences of the other fork are met with at intervals approximately along the line of boundary of the formation, and may possibly be continued to the fragmentary outcrops of traps presently to be mentioned in the centre of the next township; but this is not certain.

Mount Joy Township

Lies next north-east of West Donegal. It is again divided into a northern Mesozoic portion and a southern limestone portion. The line of junction between these two formations is less regular than those heretofore noticed. Entering near Ream's station, (Middletown branch of P. R. R.,) it makes one curve, of which the convex side is turned to the south, and then changes its direction sharply to the S. E. and crosses the Salunga creek and the township line about 400 meters (¼ mile) N. E. of Horst's* mill.

A fragmentary indication occurs near the centre of the township and extends along the road from near H. Wilmer's to S. Eversole's.

In following the line of demarcation between these two formations a fact was noticed which may throw some light on the manner of composition of these Mesozoic beds.

From Bainbridge, in Conoy township, to the abrupt change of direction of the line to the S. E., mentioned

*The writer is not responsible for the correctness of these names. They are given as they appear on the atlas map, which was made the basis of the notes in the field. Many changes necessarily occur in the ownership and boundaries of property which cannot be noticed in a work like this.

above, the rocks constituting the New Red series were the kinds of shales and sandstones popularly and generally attributed to this formation, but at a point less than half a mile (700 meters) S. E. of the village of Milton Grove this character changes and the extension to the south-east of the Triassic (?) seems chiefly, if not exclusively, composed of fragments of the argillite and hydro-mica schists belonging to the limestone, but broken into small (sometimes angular) fragments and laid down with almost as much regularity and compactness as their beds could have exhibited before they were crushed by the waves of the Mesozoic sea (or estuary). The resemblance is so strong to the original limestone slates from which they were derived that it would be quite impossible to distinguish the two by mere lithological characteristics. This general character continues over most of those portions of the rocks, which must be spoken of in following their margin to the N. E.

Rapho Township.

This is the largest township in the county, as it extends from the Lebanon County line almost to the mouth of the Chikiswalunga. This township is divided into very nearly equal halves by this Mesozoic border line. It crosses the western township line a short distance above Mount Joy borough, and proceeds in a waving course, of which the average line runs E. 13° N. to below the village of Sporting Hill, where it crosses Chikis creek. The beds towards the lower margin are composed as above indicated of the débris of the calcareous slates, from the southern boundary to an abrupt angle in the township line about 2¾ miles (4.43 kilometers) north of Manheim, where the transition is sudden, and striking from these calcareous re-made strata to the ordinary shales and sandstones. The subordinate boundary line between normal and argillitic New Red was not followed through the township, but it is probable that it is more or less parallel to the first mentioned boundary at least as far as the western edge of Rapho township line, since the absence of fragmentary limestone slates from the vicinity of the river would seem to indicate Upper Bainbridge as about the southern edge of the normal Mesozoic.

Penn Township,

Like Rapho, is an exceedingly long and narrow township. Its northern end rests on the so-called "South Mountain," or that portion of the "Elizabeth hills" (a range of Mesozoic rocks which lies between Lebanon and Lancaster counties) and is traversed by the hill making rocks which cross the route from that city to the Cornwall mine. The town of Manheim lies against the border of Penn township, but no part of the borough is within its limits. Just south of this town there is a singular exhibition of the freaks of erosion in the prolongation of a narrow and low promontory or peninsula of Mesozoic rocks which extends like a break-water to enclose the double basin in which Ephrata and Litiz are situated. The southern edge of the peninsula crosses nearly due east, about half a mile (800 meters) south of Manheim, and taking a course to the south runs along with generally parallel sides not more than half a mile apart, enclosing the hamlet of Mt. Vernon, and is almost directly connected with another similar peninsula extending west from below Litiz.

The northern limit of the limestone thus enclosed forms a curved and indented line which sweeping around Manheim and leaving that village in the limestone, and leaving an island of mesozoic about two miles (3.22 kilometers) east of that village crosses the north-western edge of Warwick township.

Penn township is thus divided into two sets of alternations between Mesozoic and Silurian limestone.

Warwick Township.

The northern part of this township is covered by Mesozoic strata of which the boundary is broken and wavy. A limestone area interposes between this and the long arm or peninsula of New Red which stretches out from Millport as if to meet the other. The lines of this area are neither so parallel nor so regular as is the case with the rocks which form the Manheim belt. The line which comes in from the east dividing the limestone and New Red, runs with several small waves nearly east and west from its crossing of the Cocalico creek to Millport. It takes a bend to the north there, and passing around the mill dam which lies nearest north-west, passes thence with a slight bend to the south, to within a few hundred yards or meters of the settlement of New Haven; thence it runs south, and pursuing a very irregular course whose tracing somewhat resembles a crab's claw it turns and runs N. by E. to Pfaatz's saw mill, when it bends southwardly, and afterwards still further to the south down the bed of the larger branch of New Haven creek.

From here it extends in a long and tolerably even sweep making a curve with the convex side to the north, and crosses the Cocalico creek near the first branch south of the Reading & Columbia R. R.

The northern area of Mesozoic sandstone is bounded by a line entering the north-west corner, and with frequent curves passing south-east enclosing the towns of Lexington, Pine Hill, and intersecting Hammer creek near Brunnerville P. O., and thence passing up the bed of the creek into Elizabeth township.

Litiz is thus as it were in the Bosphorus, separating a calcareous Black Sea of Silurian age from a similar sea of Marmora, while the narrow passage to the south-west of Litiz may be likened to the Dardanelles, connecting both the above with the Mediterranean limestone which covers and renders fruitful so large a part of Lancaster county.

Elizabeth Township.

The division here is again into the two great formations, but the line is a complicated one. The southern end of Elizabeth forms a promontory which juts out into the limestone basin and partially divides it into two parts.

The dividing line is not easy to ascertain, even by an inspection of the ground, owing to the peculiarities of these rocks and the difficulties connected with determining their age.

The line dividing the formations follows approximately the right bank of Hammer creek to a point near David Greiner's house, where it turns abruptly, and in a few small and large scallops passes around the German Reformed church and passes into Clay township by the mill dam near Henry Bingaman's and George Weideman's.

The southern half of the township therefore (like all those thus far reviewed) lies in limestone, and the northern half in Mesozoic shale and sandstone.

Brickerville is the principal town in this township and near it some curious phenomena may be seen.

Near the crossing of a lane which leads off to the N. E. from the lower end of Brickerville, across Furnace Run, the hills are very steep and composed almost entirely of shales and slates of Lancaster limestone age. Excavations were once made here for coal, on account of the very black and lustrous slates. These slates, however, are hydro-micas, and in some cases strikingly resemble the Peach Bottom roofing slates, as is the case in several other places in the county.

A few hundred yards (or meters) N. W. of Brickerville there are profuse displays of boulders of trap which extend nearly to the high hill through which Hammer Creek has cut its bed and makes its way to the plain.

The Elizabeth furnace is situated in Elizabeth township about 1¼ miles (2 kilometers) N. E. of Brickerville but the ore is obtained elsewhere and out of the township.

The hills from Dingeman's (near the easternmost point of the township) to the Lutheran church, are sandy and hard, forming an excellent road. Near Dingeman's the main mass of the rocks is composed of limestone slates but little altered; but on approaching nearer to Brickerville the road is thickly strewn with quartz and other pebbles.

The red soil commences at the N. W. end of Brickerville. At this point also trap boulders and fragments increase in number along the road. From Solomon Engle's to the meeting house just south of Newman's, the soil is red and very large quantities of trap are scattered about. Quite a steep valley divides this ridge from the main ridge of the Furnace Hills. The rocks of this hill nowhere show in place but seem to be composed (to judge by the fragments) of rounded pudding stone of Mesozoic age.

The height of the hill as determined by an uncorrected barometer observation, is ± 584 feet above Ocean level.

The slates at Dingeman's dip S. E. and seem to belong to the Limestone. There are no good exposures N. W. towards Brickerville, though there are general indications of similar dip in the roadside banks which they form. A careful examination of this region inclined the writer to regard the mingled gravel and sand to the S. E. of Brickerville to the intermingling of the débris of the two formations.

Near J. B. Erb's these same beds on a third inspection tended to corroborate the above views. As to material this might be either limestone slates in place or those slates redistributed in Mesozoic time.

About 1860 an excavation in the steep hills which descend to the junction of Seelock's and Furnace Runs was made for the purpose of discovering coal; and coal is said (on quite insufficient authority) to have been obtained.

The slates in the dump piles of these excavations are dark bluish hydro-micas not at all like the Mesozoic shales but resembling more the Primal or perhaps even the Hudson River shales, but still more than any of those when viewed at a short distance, the Peach Bottom slates. No indications of coal were observed. A curious concretion resembling the bough of a tree in which the rind had been replaced by quartz was found among the débris.

The creek is here the dividing line between the clearly Mesozoic measures and these slates.

Clay Township.

This township is divided also into a limestone and a New Red Sandstone portion and the line seems to be both straight and nearly East and West. This part of the line was not actually visited, however, but was drawn in from other established points, and on a report of an examination by Major Spera of Ephrata, kindly furnished to me by that gentleman.

According to this information, the line continues from Weideman's Mill, where the writer observed it, a short distance (400 yards) south of Durlach P. O. and cuts the eastern township line a little north of east of that town.

Black Oak Ridge and the other steep hills which form its northern barrier were not examined for trap and other local details. It is possible that several instances of the former may exist which are not given on the present map.

At Eberly's Mill Middle Creek separates the Mesozoic from a "gravel" or fragmentary formation which is, likely, derived from it.

A sandstone quarry in Elizabeth furnace Gap is said to have furnished the steps to the court house in Lancaster and some of the flags in the streets. The stone seems to wear unevenly and is of only moderately good quality.

West Cocalico Township

is the northernmost township in the county, and borders the two counties of Lebanon and Berks.

Its northern part is very rough and rocky, though fairly fertile as the farms testify. The whole township is well drained and watered. The dividing line of Palœozoic and Mesozoic continues from the point last mentioned in Clay township, and runs in a slightly waving line just south of the town of Schœneck; and after making a curve at Jno. M. Brubaker's to the south, resumes abruptly its northerly direction and crosses the line of the township just south of Geo. Walter's house and the Reading and Columbia R. R., about half a mile, (800 meters) N. E. of Union Station.

Trap exposures in loose and detached masses are so frequent, (*i. e.* just south of Schœneck, on P. Griss's and Isaac Eberly's farm; just S. E. of Reinholdsville, &c.,) that there can be little doubt of locating it in other parts of the township were the necessary time and expense devoted to the purpose.

At H. Steely's and J. Redding's, on the southern margin of West Cocalico and on the Ephrata-Schœneck road, the road is flat and the soil clayey and yellow. Near M. H. Shirk's, a large number of trap fragments are found by the roadside. The outcrop of fragments is largest at an old lime kiln about 400 meters (437 yds.,) south of the town of Schœneck. It composes the entire mass of a number of stone fences. It colors the soil red, and by its decomposition, and that of the rocks adjacent to it, furnishes a clay which is employed in a brick yard S. E. of the town.

Mesozoic slabs in place come in at the south end of Schœneck, dipping, N. 20° E.—45°. A large number of boulders and fragments of trap are also found here, but the trap is very much weathered, and in many instances resembles a baked mud rock, with streaks of dolerite through it.

The Mesozoic outcrop just north of Schœneck is principally of sandstone and conglomerate, with small pebbles. North of the town, on the road to Cocalico P. O., is a hill of sand and clay with indications of a dip ±N. ±45°. The soil is very red and sandy.

Near McQuade's a heavy sandstone and conglomerate comes in with pebbles of very large size. It is nowhere found in place, but makes the steep hills which abound here, and are clearly the western continuation of the similar conglomerate in the Elizabeth Furnace Gap. The northern part of this township is mainly composed of these steep hills, of which the cause seems to be the superior hardness of this conglomerate and its resistance to weathering.

The road from Hertzog's to Wealand's is along a valley between abrupt ridges of this kind, and over the spurs which project from them.

East Cocalico Township.

In order not to lose sight of the boundary line which has been followed to this point it will be necessary to somewhat invert the order of the townships which was proposed.

This line after making a regular curve around Union Station changes from a general E. by N., to a south by west direction; and skirting Reamstown, and being deflected more to the westward, enters Ephrata township about 1¼ miles (2 kilometers) N. of E. of Ephrata.

With the exception of the southwest corner of this township the remainder is New Red Sandstone and, with the exception of a few dykes of trap, is not known to contain anything of more than ordinary geological interest, or valuable minerals; though as it was not thoroughly examined except in the neighborhood of the above described boundary, this statement is made with reservation.

Ephrata Township

lies next southwest of East Cocalico and contains the moderately high hill which goes by the name of the Ephrata Mountain. A narrow strip of Mesozoic strata crosses Ephrata township from E. by N. to W. by S. becoming narrowest near Akron and widening out again near Rothville. The town proper of Ephrata lies in the limestone valley but the houses extend up and back over the road across the Mesozoic hill. The boundary line skirts the towns of Ephrata and Akron, where it joins the line of the Eastern peninsula already described. This hill is 794 feet (241.4 meters) above sea level, and 410 feet (147.32 meters) above the level of the R. R. track in front of the Ephrata Station, by repeated barometer data.

An observatory sixty-five feet high crowns this summit, whence a very fine view of the country can be obtained.

Back on the ridge about ¼ mile (400 meters) north of Isaac Stillwell's house Mr. Jno. Mukly (?) sank a shaft for coal in 1842. Coal is said to have been obtained (?) and tried with good results in a blacksmith's forge but the quantity was but small.

Scarcely half a bushel (17+liters) was obtained. The shaft is said to have been sixty feet deep but has now entirely fallen shut. All the débris which still remain around the opening are of brick red color and consist of fragments of shales and sandstone.

Back of this locality N. E. of Hahnstown and opposite Erschik's on Sweigart's private lane, another company started to work a shaft about the same time. Wm. Amweg and Messrs. Killian, Sweigart, and others were shareholders, and formed a company, it is said, at the advice of Dr. Fahnestock, of Lancaster. This latter operation grew out of the first, but was not rewarded with even equal success.

No traces of coal were found.

Near Akron is a steep hill marked "Gravil Hill" on the map. The material which causes the name consists of the same broken fragments of slates often mentioned before; but in this instance more loosely aggregated, and resembling a pile of broken slates. Some rolled pebbles and a large quantity of white quartz found here lends some justification to the name and calls attention to the possible existence of an island of Cambro Silurian slates similar to that near Neffsville of the line through which and the Potsdam at Chikis it is, however, 20° north.

Although the width of the limestone basin in a line from Ephrata through Lincoln (or New Ephrata) to the New Red Barrier is not less than four miles (6.4 kilom.) yet the country is not flat, but rolling, owing to the occasional prominence of some of the harder belts of the limestone slates.

Lincoln is just on the northern slope of a hill and is 420 feet (128 met.) above tide and 36 ft. above the rail at the station at Ephrata. The highest point of the ridge eastwardly, and close to Lincoln is 480 ft. (166 met.) above ocean level and ninety-six feet (28 met.) above the Ephrata datum plane.

A short distance east and on the strike the rocks are slaty limestones, dipping about S. 30° E.—very gently—in fact almost flat.

The boundary between the Lancaster limestone and Mesozoic in the S. E. corner of Ephrata township is very obscure (though the general trend of the strip is a little N. of E.) and chiefly determinable by the condition of the water in the wells which lie along this border: and the facts obtained from an examination of them prove incontestably that this rim of New Red is very shallow towards its Southern margin. There appears to be no representation of limestone among the Mesozoic measures here; so that the hardness or softness of the water may be taken as a safe indication of the proximity of the older series.

On Mr. Henry S. Stoner's place near the turnpike from Ephrata to the Blue Bell Tavern, and also near the southern edge of the township; there is a well 42 ft. (12.8 meters) deep, from which, in ordinary states of the water, an abundant supply of soft water is obtained; but when the springs are low the water becomes too hard for use.

Samuel Stoner who lives near the N. W. limit of Greenville and but a short distance from the last mentioned locality has a well 40 ft. (12.2 meters) deep from which the water obtained is always soft. It is cut through soft sandstone.

Mr. Shiffer (Greenville Hotel) has always hard water from his well. The depth of the well was not ascertained.

One well at Theodore Glass's produces water always hard. This well is 22 ft. (6.7 meters deep.) Another well which produces soft water is 20 ft. deep.

The irregular occurrence of hard and soft waters will thus not permit of a sharp definition of the boundary line between the formations but shows that the thickness of Mesozoic is in this part of the township is slight.

Opposite Solomon Smith's a road branches off from the Ephrata-Downingtown turnpike and runs for some distance along the Southern slope, but near the crest of the "Ephrata Mountain." The barometer makes this intersection of roads 467 ft. (142.33 meters) above Ocean level.

200 meters (656.2 ft.) N. E. from the turnpike on this road the barometer gives the height above the same datum as 600 feet (182.87 meters).

There are no exposures for dip along this road but all the débris are of loose red sandstone with but little slate.

At John Lippus's house about ½ mile (800 meters) from the turnpike the greatest height is reached on the roads viz., 600 ft. (182.87 meters) above ocean level.

The northern margin of the New Red is the same which extends west from East-Earl and Earl townships. It comes between Levi and Lewis Mohler's where blue limestone in place dips ±S. by E.—gentle.

The soil changes from here to Levi Mohler's from red and full of fragments to yellow and clayey.

158 yds. (150 meters) north of Mr. Kilhoeffer's place the limestone dips S. 30° W.—±12°.

Opposite Mr. Kilhœffer's barn the limestone S. 15° W.—25°.

At Solomon Slough's house the limestone dips S. 40° E.—28°.

A brick kiln is located on the West side of the Reading and Columbia R. R. at the foot of a small hill which is red from free oxide of iron, but belongs most probably to the ferruginous strata of the Auroral limestone.

Just below the residence of J. R. Keller finely laminated limestone dips W. 40° S.—14°.

This exposure is about 219 yds. (200 meters) S. E. of Keller's house.

Thirty yards further N. W. a very clayey finely laminated limestone dips S. 40° E.—14°. This dip rapidly steepens within 30 yards more to ± 60° and the limestone becomes of light bluish color and shows the effects of great crushing.

By Wm. Konigmaker's on a hill just S. E. of Lincoln, limestone dips S. 20° E.—28°.

The soil is a yellowish clay in which south of the town there is a brick yard.

A muddy blue limestone on a street south of the hotel at Lincoln dips S. 40° E.—33°.

About 437 yards (400 meters) south of this, milk quartz and débris of Mesozoic age commence to abound though no prominent outcrop of this age occurs to justify the placing of an outlying patch of these rocks here.

On Stoner's land ± ½ mile (800 meters) W. by S. of Lincoln, a quarry of limestone is found with a dip of S.—32°.

Near Jacob Minnich's house the strike of the limestone is about N. 40° E., the dip uncertain—probably W. 40° N.

Just South of Minnich's house the strike of limestone in a gully by the roadside is E. 40° N. A small block seeming to be in place gives the dip North or over the basset edges of the larger mass. This may be a dislocation and reunion of Silurian age.

The larger mass seems to strike E. 40° N. and dips probably S. 40° E.—80°.

The hill just South of the Reading and Columbia R. R.

near Keller's Mill is composed of quartz and Mesozoic, rolled pebbles and sand, (a part of "Gravil Hill") The road here is colored deep red in the South side of the hill but no strata are visible.

In the road by M. Schminky's house friable sandstone occurs in place with uncertain dip.

Brecknock Township

appears to be entirely within the borders of the Mesozoic and no boundary runs through it. It was not made the subject of special examination.

Earl Township.

The lower and main boundary between the Mesozoic and Palæozoic after passing a little north of east from the neighborhood of Akron, turns in a gentle curve to the S. E. and crossing the upper end of Earl township near Hinkletown, passes out, after having cut off little more than the projecting N. E. corner of the township which it leaves represented by Mesozoic strata while all the remaining part of the township is covered with Lancaster limestone.

The road through Pleasant View is over Mesozoic strata. The soil is red or yellowish red.

An exposure of fragments of trap is seen ½ mile west of Pleasant View just inside the limits of the Red shale opposite Dan'l Zimmerman's.

At Buckholder's about 0.62 mile (1 kilometer) West of Pleasant View blue associated with buff decaying limestone comes in with a dip of W. 30° N. ±40°.

East Earl Township.

lies immediately east of Earl township. It is the first of the townships yet considered, which contains representations of more than two of the great geological formations which occur in Lancaster county. The boundary line which we have been following, enters the township near the Welsh graveyard; very nearly follows the road thence to Terre Hill P. O. and Fairville; crosses close to a lime kiln near Peter Zimmerman's house; and thence enters Cærnarven township on the same general line. An isolated hill of Mesozoic age stands out near Weaver's Mills entirely surrounded by limestone, and not far south of it stands another hill of archæan rocks detached from the rest of the Welsh Mountain, and also apparently surrounded by limestone, (though this is by no means so certain since the débris of decomposed rock from this mountain covers the exposures for some considerable depth.)

The soil from the crossing of the Conestoga to Fairville, near Spring Grove, is red and sandy, ½ mile, (800 meters) S. E. of Fairville. All the rock fragments are pebble conglomerates, the pebbles being of all sizes. At Zimmerman's lime kiln, 1 mile (1.6 kilometer) S. E. of Fairville, there is a limestone quarry which is interbedded with reddish rock resembling the color of the soil. From a distance, this limestone, which dips W. 30° N.—40°, seems to be covered over with a white powder, which on nearer view, is seen to be caused by innumerable crossing seams of calcite, in some of which the crystals are very large. Just S. W. of Fairville, the soil still continuing red, red Mesozoic, shaly sandstone, appear for the first time with a gentle dip ±N.

The conglomerate appears here also in large blocks and fragments. The matrix is reddish, but contains the same constituent minerals which made up the original beds; micas, quartz pebbles, and the like.

The lower end of this township is much diversified from the irregular outline of the Welsh Mountain. This mountain skirts the Conestoga Creek, and in entering East Earl, bends back, leaving a bay of limestone near Beartown and west of it. It then trends to the South West with many deflections, and reaches the extreme point of this projection from the main body of the rocks, about ½ mile (800 meters) west of Green Bank P. O., and 1 mile (1.6 kilom.) north of Mt. Airy.

At the Blue Ball tavern, a light blue limestone with crystalline streaks occurs, dipping N.— ±28°. On top of this is another layer with the same general dip, but with two other planes of cleavage somewhat better defined than those of bedding, and looking like calcareous shales, formed of small round grains of whitish blue limestone, and filled with hydro-mica.

One of these planes dips ±S. ±38°, and the other E. 38° N.—steep to vertical.

At the fork of the road, half a mile or ±800 meters E. of the Blue Ball, the elevation by barometer is the same as on the R. R. at Ephrata Station, *i. e.* 384 feet above the sea.

Cærnarvon Township

Is remarkable for the diversity of its geological formations. The southern third of the township is filled by the Welsh Mountain and its spurs, the rocks being chiefly if not entirely eozoic. The middle belt is formed of limestone of Silurian age, and the northern third is taken up with the outlying spurs and detached hills of Mesozoic age.

On entering this township on the road from Goodville, and after passing the outlying hill of Eozoic over which the road passes in an easterly direction from that town, one meets in the large and scarcely decayed fragments which abound along the road, evidences of a trap dyke which crosses near the township line. This same dyke cuts the upper road near Christopher Trabert's house and in general direction accords closely with the great dyke afterwards to be mentioned which intersects the measures of the eastern part of the county and crosses the Susquehanna near Peter's creek, but is separated from this prolongation by a spur of the Welsh Mountain.*

The Conestoga Creek throughout its entire course in this township seems to separate the Eozoic and Silurian rocks, in the former of which are a number of valuable iron mines of which a description will be found in another place.

Due north of the first trap exposure mentioned, and near the south base of "Turkey Hill," just south of the house of Mr. Jacob Souder, a large quantity of fragments of pink and white quartzite as a conglomerate in a mica schist base is found, reminding one of the "conglomerate schist," or "Mountain Creek Rock" of the South Mountain in Adams

* Two of the Goodville eozoic hills prove continuous with that mountain.

and Franklin Counties and on the Potomac by Harper's Ferry.

The Washington Hotel at Churchtown is by barometer (compared with the R. R. elevation at Lancaster) 620 ft. above Ocean level.*

The limestone at the county line bridge separating Lancaster and Berks Counties dips N. 15° W.—45°.

The height of the Welsh Mts. at the intersection of the Churchtown, Morgantown, and Waynesburg roads near their summit is by barometer 982 ft. above Ocean level.

The rocks which are in fragments are pink, white, and brown varieties of granular quartzite. The débris of rocks on the slope of the Welsh Mountain in this vicinity are very closely similar to those everywhere met with on the slopes of the South Mountain south of the Susquehanna. They are quartzites exclusively, but here and there showing the tendency to resolve into a decomposed matrix with angular quartz and often assuming a pink color. No *scolithus* was observed though there is little doubt that this fossil may be found here.

It has been said that the Conestoga Creek marked the boundary throughout its entire course in this township between the eozoic and limestone. This is only strictly true as far east as Churchtown. Here the limestone margin courses the creek and is found nearly as far south of the creek as the residence of David Shirk. It seems to run from this point nearly east to the house of the Widow Beiler, whence it skirts the foot of the mountain closely into Berks county.

East Donegal Township

lies on the Susquehanna, immediately East of West-Donegal. It cônsists entirely of limestone with the exception of several fragmentary exposures of trap. Its north-western boundary sweeps in a long curve concave to the S. E. from the river to Mount Joy borough, and from there south to the town of Marietta.

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* The day when the observation was made was clear and warm, with light clouds.

The greater part of the country along the river, west from Marietta, in this township is destitute of exposures and mostly composed of clay, which is utilized in an extensive brick making establishment at John Musser's, about 1.86 miles (3 kilometers) west of Marietta, an account of which will be found in the account of mining and other industries.

North of Marietta are a number of iron ore Mines which will be also found described in the same chapter. These Ore Mines seem to belong to the limestone slates underlying the limestone proper, or at least to those slates which are depicted on the east side of Chikis ridge, and above Chikis rock. But the latter, owing to its fault, cannot be placed in certain relation with this part of the section.

On the road from Maytown to Bainbridge and just west of the former town is a fragmentary outcrop of trap which does not seem to be traceable as a continuous dyke.

The limestone exposures along this part of the township seem to indicate the N. W. side of an anticlinal of which, were the data consecutive, the generally S. E. dipping limestone along the Chikiswalunga creek would seem to be the other side.

Those dips proceeding West are as follows :

Near Abm. Snyder's house,	N. 25° W.	—30°
" Jno. Stine's "	N. 15° W. (?)	—50°
" Hoffman's "	±N. W.	—15°
" B. Herr's "	±N. W.	—40°
" Glenhart's "	=N. W.	—30°
" D. G. Reich,	=S. E.	—40°
100 yards (or meters) further west,	±N. W.	—15

West Hempfield

Lies S. E. of East Donegal and the Southern end of Rapho townships on the river, and includes some of the oldest as well as the most important mining districts of the county. Chikis rock commences the geology to the west, where a superb rock arch is broken in its second rise above water level and ends abruptly with its rising southeast side resting on Chikis Creek. The anticlinal of which this is the S. W. end in Lancaster County seems to die down a little E. of north and is then covered over by immense masses of clay and broken fragments of the quartzite which composes it. This state of things does not permit an exact description of its limits, which must be gleaned from topographical features and the lithology of fragmentary masses. It seems to be evident however from the section from Columbia to Chikis that the hydro-mica schists belonging to the lower Auroral horizon rest on its southern flank and that the true quartzite which is known to produce the ridge does not appear south of the Henry Clay Furnace.

The belt of country south of Columbia to the borders of Strickler's Run and the limit of the township is composed of limestone and the associated hydro-mica schists; but further east the limit of the township is along a line of not high but somewhat steep hills considered to belong to the Primal Slates in the old Survey, but which seem to ally themselves more closely with the limestone which occurs at frequent and irregular intervals along their cross section from Columbia to Washington. A strip of limestone is thus shut in between the calcareous slates on the south and those decayed measures which are heaped along the line of the dying Chikis anticlinal to the north, and are intimately associated with the genesis of the Chestnut Hill ores. The difference after all is not so great as would at first appear between the structure assigned in the first survey and this: The main divergence being in the answer to the question as to whether the slates and these nacreous schists are "upper Primal" or "lower Auroral" for that they lie between the Chikis Quartzite and the limestone is undisputed.

This limestone valley becomes exceedingly narrow at Mountville, whence it widens around the sinking nose of Chikis to the east, into the great Lancaster limestone.

The Chestnut Hill banks are a subject of great interest and importance, and must be studied by themselves. So far as concerns their mining importance, a short description will be found in the chapter devoted to this subject. A special map of the district of these ores will be found in another part, compiled from the title deeds of the various mining companies which operate in this locality.

About half a mile (800 meters,) east by N. of Ironville, on a ridge in the middle of the property of the Chestnut Hill Iron Co., is a shaft sunk 70 ft. (21.33 meters,) and called the Rock Shaft. This shaft is sunk through the top of an anticlinal in quartz slates, and therefore confirms the theory of structure of Chikis given before. A small vein of Magnetic Ore was struck near this shaft and the top of the dividing ridge.

The best approximation to a dip which was obtained, was that of S. 20° W.—25°, and the measures seemed to be getting steeper in the depth. This anticlinal dies very soon to the ±N. E.

The mass of the dividing ridge of the Chestnut Hill Iron Co's. mines appears to be a loose quartz conglomerate of exceedingly fine grain, cemented together by a ferriferous earth.

The hill just south of the Chestnut Hill property is of slates. Shafts have been sunk in it, but no ore was found.

On the S. E. corner of the property against the Reading R. R. track, a shaft was sunk about 20 feet, (6 meters ;) the ore dipping north-westerly. Much of it taken out of the shaft was mixed with fragments of quartz into a coarse conglomerate.

From a second shaft, 30 feet (9.14 meters) deep, all the hydroxides of iron seemed to be represented with some red hematite and quartz.

In the Reading R. R. cut, hydro-mica schists dip S. 20° E.—36°, showing that this hill is of later date than the Chestnut Hill quartzite and quartz slates, and lies on its flanks, whether conformably or not it would be rather hazardous to say from these records, but at least there is nothing in them inconsistent with this view.

These decayed rocks and clays with ore, ascribed to the super-Chikis horizon, extend in nearly a straight line south of Bruckart Station, R. & C. R. R., and across the Marietta turnpike near where it crosses the boundary between the two Hempfield townships.

The dip of S. 20° W. must be considered as local and abnormal as the general trend of the elevation or ridge due to Chikis, is E. 20° N., in which direction the anticlinal is dying, though it widens out into a knob at its extremity as will be seen in considering the geology of the next following township.

The parts of West Hempfield not specifically mentioned, are filled with Lancaster limestone.

East Hempfield Township

lies just east of the last named, and south of Rapho. The southern and northern parts of this township are in the Lancaster limestone, while the middle portion is taken up by the end of the Chestnut Hill rocks, which here broaden out into a knob between the two branches of the P. R. R., and terminate in about the longitude of Hempfield P. O.

On the first road east of the western margin of the township, and leading somewhat northwest, the limestone near the southern margin of the township dips about south—85°. From this place to its crossing with the Columbia and Marietta turnpike, this road is strewn with fragments of trap, and in proportion to its proximity to the last named road, also with fragments of quartz and débris belonging to the Chikis measures.

A very interesting locality in the northern part of the township is that of the Bamford Zinc mines, concerning which a special chapter, by Mr. Spilsbury, will be found in another part of this report. The limestone of certain belts of this region is impregnated with finely divided zinc blendes, like that of the Saucon Valley, though it is difficult to detect it by the naked eye, usually. In opening No. 1 the excavation runs E. 15° N., and W. 15° S. The vein at the surface dips about N. 15°, N. ±70°, and turns under about 15 feet from the surface to dip S. 15° E.

In the hanging wall of No. 1 the same seam of hard ore was found as in the hanging wall of No. 2.

A winze shaft was sunk at the west heading of this cut, because the vein seemed to be turning, and two or three successive belts, rich in zinc, were passed through.

In the east heading of No. 2 shaft the vein seems to run E. 5° N. The east heading is through the hanging rock. About ¼ mile (400 meters) west of the crossing of the Little

Conestoga creek, by the R. R., is a small opening, made by Mr. Herr, in limestone. One is a "Calamine" (?) and zinc blende, intimately mixed with limestone.

The R. R. took out about 40 tons (40.64 tonnes) of ore from this cut, and Mr. Herr about an equal amount. The rock is a sandy limestone, with soft seams of calcite, of which the apparent dip is N. 10° E.=50°. On the P. R. R., just above, the limestone dip is N. 5° W.—8°. The strike of the vein in the Bamford Zinc Mine would have to be E.—15° S., if these two deposits are really parts of one belt.

In a road parellel with the R. R., and about 800 feet (244 meters) distant from it, between the 74th mile-stone from Philadelphia and the zinc works, is a fine quarry in calcaroid hydro-mica schists, dipping E. 30° S. —32°.

The exposed surfaces are very ferruginous, and reddish-brown.

Lead ore (Galena) occurs also in these mines.

Manheim Township

Does not enclose the town of Manheim and appears to be covered exclusively by the Lancaster limestone except in a narrow patch just south of Neffsville (already alluded to under the general remarks on the Geology where the Siluro-Cambrian rocks appear to crop out.)

Two ridges about 100 ft. (30.5 meters) above the general level cross the road just below Neffsville. The southernmost of the two is the altered primal of Rogers. The distance between the highest points of these ridges is about 1500 ft. (457 meters) while the narrow valley between the bases of these slopes is scarcely 200 ft. (61 meters) wide.

West-Earl Township

Lies east of Warwick and south of Ephrata townships. It is entirely covered with limestone except in the N. W. corner where a spur of the narrow Mesozoic strip which encloses the Ephrata basin penetrates a short distance into its measures. The township was not examined except in this locality.

On the right bank of the Cocalico Creek in Warwick township but just at the crossing, a limestone dips ±S.W. ±25°.

On the opposite side limestone slates dip vertically. Near Jacob Erb's house a dip in limestone slates and limestone give ±S. E.—(?). Just north of the fork to Brownstown limestone slates dip ± S. E. ± 30°. From here for a distance of a quarter mile (400 meters) or thereabouts the soil is principally gravel indicating a continuation of the Mesozoic beds to the south where the limestone comes in again still dipping to the S. E. This general structure is maintained to the School House north of Geo. Lomber's house where the dividing line between the peninsula of Mesozoic and the limestone measures passes. The latter dips south of this line ± S. E. and the former north of the line about N. by W.—steep.

A small run which crosses the road is very near the actual dividing line.

The southern edge of this arm of Mesozoic merely cuts off the corner of this township in its eastward course through Ephrata and Earl.

Manor Township

Lies just south of West Hempfield and part of East Hempfield. It is very extensive in area and its geology is important. The strip of Manor township which intervenes between the northern boundary of the township and Washington has been already alluded to in the General Notes, in the Section along the Susquehanna, and also incidentally in the description of West and East Hempfield townships. It will therefore not be necessary here to repeat the reasons which have induced the author to consider the slates which are intercalated with limestone, and form together a broad ridge on the river shore, as belonging to the under half of the limestone itself.

In the southern part of Manor township also on the river is the prominent elevation known as Turkey Hill which has also been differentiated into two formations chiefly by the lithological evidences accumulated along the river bank. The upper of these seems fairly to belong to the chlorite series considered as lying under the Potsdam and therefore below the slates just referred to which the lower quarter of this township appears to be cut off by the ill-defined boundary noticed elsewhere between the Mica Schists and Gneisses (Eozoic) and the chloritic hydro micas.

The rest of the township is mainly covered by Lancaster limestone which sweeps north-west from the mouth of the Conestoga Creek close around the base of Turkey Hill which it thus isolates.

The first of these exposures is a quarry near G. Doll's, just south of the last mill dam on a little Run emptying into the Conestoga near its mouth. This limestone is vertical with a strike of E. 25° N.

Just north of it and between this dam and the next above it the limestone dips N. 10° W.—44°.

At M. R. Shenk's is a large ore bank (or four small ones) intersected by cross roads which will be found noticed in the chapter devoted to these industries. A little further west on the road over the back of Turkey Hill the Hydro-Mica Schist appear dipping N. 5° W.—60°.

Further up the Conestoga about 1 mile (1.6 kilometer) above the abrupt bend in that stream and near L. Binkley's house, a limestone dips ±N.—very steep.

Near Fenstermaker's a short distance north of this point trap boulders begin to appear in sufficient quantity to justify the assumption that a portion of a dyke exists near here, and these exposures are continued as far north as the house of Abraham Funk.

The interior of the township was not visited up the course of the West Branch of the Conestoga.

Lancaster Township

Lies west of Manor and a small part of southern East Hempfield townships. It lies wholly in limestone and the limestone shales, and this formation must be of great thickness, as the strata are inclined at very high angles, and the breadth of outcrop is very wide.

The apparent axis of the great synclinal in this limestone seems to cross the Conestoga nearly east and west, about a mile below the limits of the borough.

Almost all the dips south of this line are north dips, and almost all those north of it are south; or in other words, both north and south of this line the strata appear to dip towards it.

It is intended to furnish a section of this limestone belt, through the city of Lancaster, (which the complete data gathered will enable the writer to do,) in which the probable thickness and structure of this most important belt will be manifest.

Pequea Township

Lies east of Conestoga and Lancaster, south of Lancaster, and south and west of West Lampeter townships. The greater part of the township is overlain with Lancaster limestone, but a belt passes across its middle which is about evenly divided between Eozoic and limestone slate.

The ore banks, owned by Mr. Mylin, occur near the line of the Reading R. R. (Quarryville branch.)

The data which have been collected here will be found chiefly under the head of the section across the limestone belt north and south of Lancaster.

West Lampeter Township

lies east of Lancaster and Pequea townships. It is entirely covered by limestone and limestone slates. It was not examined in the interior, but the southwestern boundary formed a most important part of the section across the limestone belt, viz: from Willow Street to Groff's Landing, on the Conestoga.

On the northeast, or adjoining East Lampeter, it presents the same generally flat but gently rolling country, with fertile fields, everywhere characterizing this limestone formation.

East Lampeter Township

lies east of Manheim and Lancaster, and north of West Lampeter and Strasburg townships.

It is entirely covered with the Lancaster limestone, and no geological features of important bearing on the questions discussed in this Report were noted.

Upper Leacock Township

lies east of East Lampeter and Manheim and North of East Lampeter and Leacock townships. It seems to be entirely covered with Lancaster limestone and the accompanying slates and along the lines in which it was traversed showed nothing promising or important bearing on the geology of this county as embraced in this reconnoissance survey.

Leacock Township

lies south of Upper Leacock and Earl and north of East Lampeter and Paradise. It is covered by the Lancaster limestone and slates and offered nothing along a line traversing its middle belt to Intercourse and from there north towards New Holland of important bearing on the questions presented in this report.

Its south-eastern portion was not examined.

Conestoga Township

lies south and east of Manor and south and west of Pequea and north and west of Martic townships.

It is an important district because here are to be traced on its much decomposed and hilly surface boundary lines between formations which have a most important bearing on questions of geological interest outside of the limits of the County and even of the State.

The north western half of the township is covered by limestone of the Lancaster age and in which the dips appear to be generally to the N. W. especially along the margin.

On the road from Conestoga Centre to Safe Harbor near the houses of Levi and Benj. Good, Limestone dips ±N. 30° W.±45°.

The limestone seems to run through the village of Conestoga Centre starting from a short distance north of the mouth of Conestoga Creek and bending first to the south and afterwards abruptly to the north in an extended curve whence it passes out of the township in a direction a little east of north.

The rest of the township is taken up with the oldest (or Eozoic) rocks which dip generally also N. W. and at moderate angles.

Northeast of Colemanville and near the banks of the Conestoga are two steep hills whose extremities but a few hundred yards or meters apart point to the S. E. while the dip seems to be N. W. and a ledge of quartz interbedded with the strata and about 1 foot (2 decimeters) thick shows the same dip.

Among the most striking features of topography seen at this place ½ mile (±800 meters) N. E. of Colemanville was a palisade of red and partly gravelly mica schist sweeping around with striking regularity like a natural rampart, while from there the two saddles just mentioned project S. E. for a distance of 219 yards (200 meters) apart; and each terminating in a knob higher than the rest of the hill: indeed the regularity of the curve reminds one of the "Roches moutonées."

Near Jacob Harnish's ±¾ mile (1.2 kilometer) north of Conestoga Centre the limestone strata are replaced by Mica Schist dipping ±S. E.—gentle.

The water of Conestoga Centre is calcareous, though exposures of limestone are wanting.

The trap dyke which crosses the river below Safe Harbor is interesting. It is about 33 feet (10 meters) broad and enters the river from between two walls of Gneiss striking about W. 20° S. towards the York County side.

After re-visiting the locality of this dyke its continuation northward as far as the upper Safe Harbor road was considered proven; but no evidence was obtained sufficient to warrant the connection of this dyke with the trap outcrop near Millerville, however well the general direction of the two exposures may seem to accord.

The very interesting Sculptured Rocks are in the river opposite to Safe Harbor. These rocks are simply outcrops of mica schist crossing the river. One of them the "Indian Rock" dips N. 30° W.—30°.

The inscriptions on these rocks have been viewed by a number of archæologists, and reproductions of them have been made and are preserved, unless the writer is mistaken, by the Linnæan Society of Lancaster. They have been greatly injured by time and weather, not to speak of the ice floes which have dislocated some of them and effaced the aboriginal tracings on others. In addition to these causes of obliteration it is a pity to have to record another which is the vandalism of some visitors to the locality, who have thought it an excellent practical joke to cut spurious figures alongside of and sometimes over those made by the Indians. It is not unlikely too that the "Fish Pots," here as in the other case of the Bald Friars inscriptions, a few miles below the Maryland line, may have been constructed in great part out of fragments of rock containing these hieroglyphics, so that the parts of the connected story which they relate are separated, and the record thus destroyed.

Others have cut their initials or full names in these rocks, thus for an obscure record whose unriddling would reward the antiquarian, substituting one, the correct deciphering of which leads to obscurity itself.

There are several iron ore mines of greater or less importance in this township, but of which the principal interest is connected with a series of excavations being wrought by Clement B. Grubb & Co., about half a mile (800 m.) from the Columbia and Port Deposit R. R., and twice that distance N. W. of Colemanville.

The description of these mines will be found elsewhere. Just above Colemanville, and also near Reeves & Co.'s ore bank, is a deposit of Black Magnetic sand. The soil just north of Colemanville is red and very largely mixed with white quartz.

At S. Harnish's house, on the C. &. P. D. R. R., a ferruginous rotten gneiss dips N. 25° W—50°.

At that one of the Grubb's banks nearest to the river, the decomposed strata dip N. 15° W.—72°.

A compact, finely laminated gneiss, dipping about like this, crosses just above this bank.

Strasburg Township

Lies east of West Lampeter and Providence, and north of Providence and Eden townships. It is chiefly covered by the Lancaster limestone, except on its southern and southwestern border, where fingers of the eozoic extend upwards from the large mass of the crystallized rocks in Providence township. The southernmost boundary of the limestone follows the uneven line caused by these projections, but in general, nearly conforms to the boundaries of the township itself, to New Providence. In passing S. E. from the town of Strasburg to Georgetown, at one mile (1.6 kilom.,) from Strasburg, and five miles (8 kilom.,) from this to Gap mines, the soil is very loose and sandy. The rocks stand vertical and strike about W. 20° S. The parent rock, seems to be gneiss or mica schist, for the hills are rounded and smooth. No rock is seen in place, but the soil is rich in large flakes of mica, which is intermixed with clay and the other ordinary concomitants of these rocks.

There are some ore mines and many quarries in the township. Of the former, one of the principal examples is that near Christian Eby's farm and a short distance south of Franklin's mill-dam. The limestone west of this mine, and on the Strasburg-New Providence road is vertical. Near M. J. Brenneman's house on this road, the limestone dips ±N. W.±45°. Alongside of this gentleman's barn, and on the east side of the New Providence-stone school-house road, a gravel bed was uncovered consisting of small rounded pebbles of pink and white quartz, reminding one of those found in the Oneida conglomerate.

In an excavation being made for a carriage house were uncovered many fragments of iron ore. This is probably a *drift deposit.*

At Geo. Bowman's farm, about a quarter of a mile (400 meters) south of this place, mica schist appears in place, dipping N. 15° W.—40°.

The absence of the two larger series of the chlorites and hydro mica schists which usually accompany the limestone suggest a non-conformability of striking importance, because but a few miles N. W. and S. E. of this horizon on the river shore these strata are developed to a thickness of thousands of feet.

The supposition is confirmatory of the evidence observed in the vicinity of Turkey Hill, where, within the space of a few miles, the same limestone is observed lying on the hydro mica schists ; against the chlorite series ; and (near the mouth of the Conestoga) on the Eozoic gneisses.

A number of small isolated patches of the latter formation are to be seen in the southern part of Strasburg township, as if to lend further probability to this view. They seem to prove that the limestone is very thin, and has been eroded and washed away from this portion of the township in many places.

Paradise Township

Lies east of Strasburg and south of Leacock and part of East Lampeter. The township is roughly divided into two unequal portions by a line which commences at D. Banzhoff's farm and crosses the township nearly in a straight line, to a few hundred yards (or meters) below the store on the Strasburg and Bellevue road, just within the limits of Salisbury township.

The dips of the limestone all along this marginal line were, when observed, steep, and varied between $\pm$N.—85° and vertical.

The change in formation from the southern part of Strasburg in an easterly direction is as abrupt as that in passing over this imaginary line. Two limestone quarries within Strasburg township but close to the border give N. W. dips, whereas just across the boundary and near R. Girvin's store the formation is mica schist, also with a northwesterly dip. Close by is a hard gneiss with the same dip and a strength of $\pm$50°.

Near J. K. Girvin's house a few hundred yards S. E., the dip changes in soft Gneiss to $\pm$S. 5° E. — $\pm$20°, a small anticlinal in Gneiss shows the southern side, dipping gently. The ground is here strewn with quartz. Near J. Fox's the soil is very argillaceous and red. Near J. Gregg's, about

400 yards (or meters) north of the southern boundary of the county, a hard mica schist dips±N. W.±30°.

The southern part of this township is taken up by the Eozoic rocks belonging to the "Georgetown belt." Exposures here are rare, but all the facts gathered agree with the hypothesis elsewhere explained of the continuity from the Tocquan creek, of an anticlinal which nearly bisects this region.

The smelting works of the Gap Nickel Mine are located just north of the southern township border, and where the last dip was recorded.

Part of the great trap dyke, which was mentioned in the chapter on general Geology, crosses the S. E. corner of this township.

Salisbury Township

Lies east of Paradise, and Leacock and East Earl townships, and on the Chester county border. It is mainly covered by the Lancaster limestone and slates, which fill up here a deep bay in the Welsh Mountain; or, as they are generally known, the Welsh Mountain and the Gap Hills. The county line runs for some distance along these hills, from nearly a mile (1-6 kilometer) north of the hamlet and P. O. of Cambridge to Slaymaker's, whence the township line branches off to Monahan's.

Exposures are rare in this region, except in the limestone, for the older mountain-making rocks are fractured and broken into loose masses and boulders, and the slopes are covered deep under this debris for the most part.

In passing over a part of the gap range towards the east, by what used to be the Lancaster pike, no rock is seen for some time in place, but a sure indication of the country rock is found in the material out of which the stone fences are made. This is a quartzite, white and somewhat fissile, and a little arenaceous in places, but crisp and crystalline.

Near Cummen's place on road, and 656 feet (200 meters) north of the Mount Vernon Hotel, arenaceous thin laminated quartz slates dip S. 30° E.—83°. Some mica is scattered loosely through this slate, but in the main it seems to be the siliceous skeleton of a gneissoid or mica schist rock. Every fragment here seems to be in the highest degree crystalline except the boulders of pure quartz which are not infrequent.

No Scolithus was found.

A large limestone bank northwest of Mrs. Myers house dips±N. W.±35°.

Near F. Stoltz's, limestone dips±S.±45°. At a limekiln near the crossing of the Pequea Creek the strike is a little north of east and the dip vertical.

Near Mrs. Clemson's the dip is±N. 15° W.±28°. A few hundred yards further N. by W., and nearly in the direction of the average dip, the limestone dips±S. 15° E.±85°.

At Salisbury P. O. the limestone dips±N. 20° E.—40°.

This last exposure is in close proximity to the northern end of the dyke of trap, which has been mentioned before as appearing in the geological delineation of the county now for the first time.

Near Kurtz's, ±437 yards (400 meters) N. W. of Salisbury P. O., a ridge is observed striking±N. E. and± 43 yards (or 400 meters) between the commencement of the rise on each side. Very large boulders of trap line this road on each side. This is the trap dyke which crosses near the Gap Mine.

Near Henry Wortz's, 875 yards, or about 800 meters N. of Salisbury P. O., fragments of coarse grained breccia (?) of quartz begin to be seen. These are colored in masses as large as a walnut purple and white, and along with them is a great exposure both of a coarse quartzose conglomerate, with traces of feldspar crystals, and friable as if such had been weathered out of their proper places in the rock; and of huge masses of trap.

A careful examination of the road from G. Bort's, on the Welsh Mountains, to Dunlap's, failed to discover any signs of the great trap dyke which one would be inclined to think, nevertheless, from the direction of that in the Churchtown valley and its close agreement with the other portion in the Salisbury basin, must be connected through the Welsh Mountains. The rock is all quartzite, generally white and fissile, and looks as if it were the result of the decay of another rock by the weathering out of the cementing material.

For 218 yards (200 meters) north of the Springville road, near Solomon Wanner's, among the quartzite blocks are found very much decayed trap boulders and fragments.

Two hundred and eighteen yards (200 meters) north of the Pequea mill dam large quantities of dolerites of fresh fracture and in large masses are found.

On the farm of John Bissel, five miles (8 kilom.) N. E. of Gap Station, and ½ mile (800 meters) N. of Compassville, at the lower base of the Gap Hills specimens of good limonite were obtained.*

The Mt. Airy—Peter's Creek dyke of trap crosses the Pennsylvania R. R. west of Bellevue and Gap, and near the northern edge of the township where the Lancaster turnpike and the R. R. approach each other very closely.

About half a mile (800 meters) south by west of Spring Garden village is a very peculiar sharp ridge running about ½ mile E. 30° N., and terminated at each end by a knob, the western knob inclining slightly to the north.

On the apex of this ridge in the road is one edge of white limestone dipping S. by E.—80°. The soil is very red, and some floating fragments of Mesozoic rock are found on the south slope and summit, but these are not of any great size.

Near John Shimp's, ±¼mile (400 meters) south of Spring Garden, trap is found, to all appearances in place, and forming a *bedded dyke*, controlling the structure of the hill.

Its dip is N. 35° W.—31°.

Its total thickness was not determinable. Its visible thickness to the ground was about 2 feet (6 decim.)

Between the village of Spring Garden and the blacksmith shop, just west of it, is a very large display of large trap boulders.

200 meters (218 yds.) east of John Hershey's house, and ±800 meters west of Spring Garden, fragments of quartzite

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* These specimens were not collected by the Assistant Geologist, but were furnished by Mr. Bissel himself, on whose authority the above statement is made.

and some very fine grained and clean traps (the latter in small fragments) begin to appear.

A very heavy outcrop of trap is observed near the store on the Bellevue road near Wilkinson's. The blue limestone fragments show traces of alteration.

In the cut through the east branch of the Welsh mountain, which is called "the Gap," no rocks are shown along the sides of the R. R. The soft earth, gravel and stones are fenced in by a wall, and in a part of this Gap, the R. R. Co. had considerable difficulty in steadying their track on account of quicksands.

When the masses of loose stones were examined, they were found to be composed of quartzite, friable and somewhat like sand from the partial disintegration of the cementing material, or representatives of many varieties of Gneiss including that which is banded and hornblendic.

At Pownal's house, 1½ miles (2.4 kilometers) east of the Gap Station, a hornblendic gneiss dips in one place N. 15° W.—85° to vertical. A light purple and white quartzite occurs amongst it.

Two dips in gneiss near the Gap Hotel give ±S. E. ± 45°.

A quartzite on the flank of the hills, about a mile (1.6 kilometers) south of Cains P. O., dips S. 20° E.—80°.

There seem to be two trap dykes in this township, of which one starts from near Mt. Airy, running through Spring Garden, Boyertown and Bellevue, the other first seen near Solomon Wanner's, and not everywhere visible, running through Pequea dam and gradually converging with the other dyke, until both unite in Bart township just above Georgetown.

There is little or no probability that these are simply the marginal exposures of a great dyke, because in the first place such a dyke would affect the topography greatly and produce results different from those observed. In the second place, the country between these exposures, though not always showing rock in place (not trap) does sometimes show it, and this, of itself, forbids such a supposition.

But it may be significant, as it is undoubtedly the case, that the eastern dyke is far less regular than the western. If the latter is mainly an outflow between strata, it is not improbable that there may have been a number of such flows also in their average planes more or less parallel to each other, but some following planes of cleavage and thus crossing the lines of other plates of trap.

Martic Township

Lies on the Susquehanna river south of Conestoga and west of Providence and Drumore townships. According to the views of the geological structure here advanced, it lies almost entirely in Eozoic rocks, and nearly equally divided by the Tocquan Creek, which marks the apex of the great anticlinal in these rocks.

It is proverbial in the county for being hilly, but it is not barren. The soil adapts itself to the same kind of farming as that of some of the best parts of Chester County, though the steepness of its hills is greater than in the latter.

The northern part, as far south as Marticville, is covered by limestone dipping in the main gently N. W., like the majority of exposures south of the synclinal located in the section through Lancaster township.

Marticville is due south of Lancaster eight miles, (13 kilom.,) and the line between these two points would be one of the most favorable for a section, to ascertain the thickness of the calcareous formation, were it not that an area of Eozoic intervenes, and cuts out the limestone over a breadth of about one mile (1.6 kilom.) in Conestoga and Pequea townships.*

The rock exposures along the river have been already sufficiently treated in the General Section, and they will not be adverted to again here, except when bearing on any points which may come up in considering other exposures.

The lower portion of the township is taken up with long ranges of hills averaging several hundred feet above the

* It would lead to a clearer idea of what is meant if one imagines the limestone laid down unconformably on the Eozoic rocks, and a slice, of the size and shape above alluded to, bodily cut off, leaving the under rocks visible.

general level, steep on the flanks, but comparatively level on top in the direction of their trend, and from the loose sand and débris into which they were weathered affording excellent roads for driving. The general direction of these ranges is N. E. and S. W.

One of these ridges whose comb is well marked by the line of the Lancaster and McCall's Ferry road, stretches from Rawlinsville through Bethseda P. O. to the Ferry. (The road touches the river bank a short distance below McCall's Ferry, and turns thence up the river to the Ferry.)

Another ridge extends from near the river up through the "Spring Valley Lodge House of the Grand Templars," and thence into Providence township.

Another from the north stretches from Mount Nebo through the property of Mr. Geo. M. Steinman, and also dies down in Providence township.

Still another pursues a nearly parallel course starting from the Martic Forge.

The view of the country from Mr. Steinman's place is superb,* although there is a lower range of hills intervening between Mr. Steinman's and the great Lancaster plain. Portions of Lancaster, York, Dauphin, Lebanon, Berks and Chester Counties can be seen.

In order to get some general view of the structure of this township in detail it will be advisable to commence on a line parallel to that of the river section, and comment on the phenomena passed over.

Just south of Colemanville and across the Pequea Creek the topographical features of the country are striking.

Near the old Martic Forge the hill is abrupt and precipitous for the same reason that similarly formed hills in the coal measures (*i. e.* those with nearly horizontal strata) are precipitous. The soft rocks give way on their edges rapidly, but cohere even after decomposition a short distance back from the precipice. The streams cut their way down through scores of feet of thick rocks without in any way disturbing the equilibrium of those that remain, and

*As also is that of the valley of the Susquehanna from a hill just west of Colemanville, and near the house of Mr. Fred. Hill.

the result is a dome shaped or half cylindrical hill very steep at the bottom and flattening more and more at the top.

There is a barely perceptible anticlinal here with sides sloping ±5° to 10° on either side.

The river side of the road is supported on an artificial wall.

At Martic Forge the mica schist dips ±N. W. ±45°.

About ½ mile (800 meters) south of this the dip is ±S. E. very gentle. Just north of Mount Nebo the soil is red from the presence of oxide of iron.

At the west end of the town the mica schist dips ±W. — very gentle, though the hill which is formed is a very steep hill.

In the middle of the town the mica schist dips W. 25° N. — 30°.

While a short distance east of the town a doubtful exposure gave ±S. E. — (?). If this direction be not wrong it is local, for it rests on the N. W. side of the Tocquan anticlinal where the normal dip is ±N. W.

Half a mile south of Mount Nebo the hills are composed of gravel and this extends S. W. down the road to J. B. Gibson's place.

On this road, and at the crossing of Tocquan creek, the dip in bluish, mica schist in ±N. W. gentle while the hill again is exceedingly steep.

A quarter of a mile (400 meters) further on, near a saw mill, the dip in mica schist is noted as "*very* gentle," *i. e.* almost flat, and this may be considered the true place of the crown of the anticlinal. As if to mark this important point in the geology of South Eastern Pennsylvania, Nature has planted here pulpit rocks about 36 yards (33 meters) in height.

Still southward, towards Bethseda P. O., and over a space about as long as that filled above by the same deposits, are seen deposits of gravel down as far as Cedar Grove school house.

The hill which begins near Mr. Streigle's, and up which ascent is made to Bethseda, is in Blue mica schist. Red soil is found both south and north of Bethseda, and near

Mr. F. B. Groff's, red mica schist with a dip of ±W. 15° N.—±48°.

Near D. Landis's house, on the Marticville road, at the lowest point between two branches of the creek, a mica schist dips N. 20° E.—gentle. 100 yards further north—N.—gentle. 200 yards north of this last—N. 20° W.—gentle.

Between the houses of Tobias Shunk and Wm. Burton, and about half a mile (800 m.) south of Marticville, a mica schist dips±N. W.—±25°.

Hence, around the turn in the road, the soil is a heavy clay colored red on one side, and a heavy clay with white sand on the other.

Just north of here, and near Mr. Martin Miller's house, limestone comes in abruptly, dipping N. 20° W.—45°.

On the borders of the creek, near T. Baumgartner's, a small patch of mica schist appears amongst the limestone, adding one more to the evidences of shallowness of the latter in this locality.

Muddy Creek divides Drumore from Martic township, and on the west bank, or just inside of Martic, and not far from the Spring Valley Grand Lodge building before alluded to, a greenish mica schist containing quartz (*i. e.* a gneiss) dips N. 25° W.—52°*.

In a stone fence nearly opposite the Spring Valley Lodge, are found a number of specimens of magnetite in quartz, said to have been taken from the excavations in the vicinity.

The ore was similar in its occurrence to that from near Cole's farm in the Catholic valley, Adams Co., but was softer and more micaceous.

Between Messrs. J. and B. Simpson's farms, and between his house and the public road, a black magnetic limonite was dug out from a depth of 6 or 7 feet (±2 meters).

About a bushel (35 liters) of specimens were dug out of a hole 3'×6'×7' (.9 m.×1 .8 m.×2 .1 m.).

* In this locality a series of observations, with the Brooke, or Dial compass and the Dip Needle, or Miner's compass, were undertaken, to ascertain the probability of the presence of Magnetic Ore. The results will be found elsewhere.

A manganiferous variety, containing some Pyrolusite, was obtained from a shallow shaft in the magnetic ore hill.

Trial pits have also been sunk on Mr. Eshleman's farm, west of Simpson's, but as yet very little has been found. The neighbors thought there was copper in the specimens found.

Mr. Schenck reports the hill north of Mr. Eshleman's house "full of hematite like that of which specimens were taken."

Close by "Indian Rock," in this vicinity, a doubtful exposure of red mica schist dips W. 30° S.—30°.

A more reliable exposure near this place gives N. 10° W. —37°.

Providence Township

Lies east of Martic and Pequea, and south of Strasburg townships.

The greater part of this township is covered by Eozoic measures, but along the northern and northeastern borders the boundary of the limestone and slate is complicated, and its unravelling has led to the discovery of an important and intimate connection between the limestones of the great Lancaster basin and of the Chester Valley. The details of the structure will be given in the chapter on the section from New Providence to Lancaster. One of the numerous small arms of Eozoic which indent the limestone near the town of New Providence passes directly through the southern edge of the town. The rock exposed is mica schist, in which Peacock's Ore Mine back of A. Groff's barn is opened. No rock is shown in place in the bank, but streaks of decomposed strata in the bank seem to indicate a dip of ±N. W.—gentle.

The ore is a very ferruginous mica schist. One specimen on being broken opened into a flat geode filled with gray micaceous dust.

When the ore is concentrated it is testaceous, but without a trace of magnetism.

On the road from New Providence south to Geiger's farm the rocks in place are gneiss, curling and not showing definite dip. Large blocks of disjointed and re-cemented quartz are strewn about. One exposure at Adam Groff's, just outside of town, dips ±N. W.±35°.

The roads are very heavy and dusty and filled with spangles of mica like those out of Philadelphia and Wilmington. Limestone was quarried "out of the bottom" of a well sunk near the Eckman and Patterson ore mine, which is situated about 1 mile (1.6 kilometers) S. E. of New Providence.

The explanation of this apparent anomaly is that the margin of the limestone passes through this bank and that the well was sunk in the calcareous strata. The limestone was struck at a depth of about 50 ft. (15.2 meters).

The character of the limestone, as judged from a block purporting to be from the bottom of a well, is highly crystalline with micaceous specks.

Near Baer and Shenck's ore mine, about 1½ miles (2-4 kilom.) S. E. from the town of New Providence, 100 yards or meters, W. of the Lancaster and Quarryville R. R. house, a micaceous limestone dips S. 15° E.—60°. The limestone at the bottom of the hill is of good quality.

The limestone here seems to be like that of the Chester valley, and to overlie a synclinal of ore conformably or unconformably. The general similarity of the gneiss which is mixed with both ore and limestone seems to speak in favor of this view. No limestone is found further to the S. W. than this point, on the authority of Mr. Fisher.

Near Mr. Kunkle's house, ±⅝ mile (1 kilometer) S. E. of New Providence, on the road to Adam Eberly's (Buck Road), a mica schist occurs weathered to a sand. The dip of the decomposed layers is W. 30° N.—±14°.

A quarter mile (400 meters) north of Fairview School House, a large quantity of pink and white quartz is found among the mica schist.

The rock gradually changes and becomes more coarsely micaceous in character.

At H. Furgeson's house it becomes a pink and gray crystalline schist with occasional flakes of mica nearly 0.4 inch (1 centimeter) square in area.

Eden Township

Is one of the smallest in Lancaster County. It lies east of Providence, south of Strasburg and Paradise, and west of Bart townships. It is in this township that the evidences of the continuity and junction of the Chester Valley and Lancaster limestones are to be seen. The northwestern part of the township is covered by the latter which extends a short distance southward over the border from Strasburg and passes close to the Cabine ore mines.

On the other hand the limestone of the Chester Valley which ends (according to the old Survey on the western edge of this township) extends across in a direction east by north in a narrow belt which is almost perfectly straight.

The country north and south of this belt is filled by mica schist and a sandy slate which may be one variety of its weathered remains, or may belong to the under-calcareous or hydro-mica series.

The question of structure here is very complicated, and for its elucidation needs a short general sketch of the appearance of the valley.

In passing from east of Quarryville, where a view is had of the parallel enclosing ridges of the limestone valley, N. W. to New Providence, one takes the right hand fork at a blacksmith shop, between May P. O. and Quarryville.

The valley up to this point runs, as stated, slightly south of west, and closely resembles the Chester Valley at Downingtown and elsewhere, except that it is narrower.

The telegraph line and road run along the North Valley Hill at a tolerably uniform height. Opposite the fork, the course of the valley commences to change. The north boundary wall sweeps up to the northwest, leaving the level limestone land between itself and Quarryville. The south wall sweeps around Quarryville, and almost closes up the valley a short distance due north of that town, and west of the Mount Holly School House. A spur (observed as the connecting band between the Georgetown and Martic rocks on the colored map) seems to divide this valley from the great limestone of Lancaster, and may do so actually, but only on the summit of this subordinate anticlinal, and only for a short distance; as the limestone appears on each side of it, identical in lithological and structural peculiarities.

At a quarry near Dr. Lefevre's, just on the outskirts of the town, a limestone dips W. 30° N.—±30°.

±200 meters (or yards) from the northwest, in the large limestone quarry of Milton Hess and others, is an exposure dipping N. 40° W.—20°, and about 80 yards, or meters, north of the water tank of the Lancaster and Quarryville road is a calcareous gneiss, very much convoluted and interspersed with layers and nodules of limestone. The upper layers have the appearance of having been deposited unconformably on the upturned edges of the lower layers, but the material in both seems to be the same.

Near J. E. Lefevre's house (±437 yds., or 400 meters,) further northwest, thin laminated mica schist dips N. 20° W.—30°.

Near J. W. Lefevre's house a black micaceous gneiss comes in, dipping N. 20° W.—45°.

±200 yards (or meters) west of J. H. Lefevre's house calcareous gneiss, very much twisted, dips N. 40° W.—20°.

About 200 meters southwest of G. Witmer's house, and on the R. R., gneiss dips N. 20° W.—45°.

About 273 yards (250 meters) S. E. of that house of Geo. Witmer's, which is built close to the R. R., a calcareous gneiss comes in, dipping N. 40° W.—18°.

Between the R. R. "Y" leading to Cabine's ore banks and the crossing of the R. R. by a county road are two exposures with about the same dip, viz: N. 20° W.—15°.

The southernmost of these two (which are close together) is in mica schist immediately overlain by a true limestone.

These dips, which will be found elsewhere in the section from Quarryville to Lancaster, sufficiently prove the former structural continuity of these two strips of limestone, and also that the materials out of which the lower beds of this limestone were made, and on which the limestone was here laid down, were the ancient *crystallized* schists here called Eozoic.

In a pit sunk by Eckart, and opposite J. M. Eckman's barn, a lot of dark gray gneiss has been thrown out in a search for magnetic ore, of which latter there appears no evidence.

Opposite John Hopkins' house, near Camargo P. O., a curious conglomerate of transparent quartz in limestone dips W. 35° N.—18°.

About 30 meters from this place, and on the hill, the limestone dips ±N. W.—gentle.

The ridge which has been described as the continuation of the South Valley Hill is, by the barometer, 165 ft. (50 meters) higher than Quarryville.

South of it the character of the rock changes to fine grained mica schist.

On Isaac Myers' property there is an exposure of alternate beds of bluish and yellowish sand, dipping ±S. 30° W.—45°, the layers colored more or less with iron.

The sand appears to be the disintegrated grains of the quartzose variety of gneiss, and of good quality.

Genuine dolerite boulders are found along the road, which exhibit in part concentric shell structure, noticed near Gettysburg.

On an old abandoned iron mine on Isaac Montgomery's place the ore is struck in passing to the South Valley Hill.

The dolerite boulders are strung along the place of Robert Montgomery.

The brick clay of Jas. DeHaven seems to be in the weathered under slates of the limestone, which may be added to by the results of the decomposition of the schist which adjoins.

Between the supposed outcrop of magnetic ore at B. B. Meyers' place and Stauffer's (now Schultz's mill), a coarse mica schist occurs south of the mill, dipping ±N. W.—gentle.

With the ascertained direction of the trap dyke through Eden township and the existence near it of iron mines, there ought to be some indications of magnetic ore (even if in small quantity) about where Heidelbaugh's name appears on the township map, but they were not observed.

Near Quarryville, on Elisha Hammill's property, two holes are said to have been sunk through limestone in place. Mr. Collins asserts that the edge is there 300 yards (274 meters) N. W. of Elisha Hammill's house in a limestone quarry owned by Mr. Collins, but now full of water.

The great dyke of trap, often alluded to before, crosses Eden township, and within its borders both the north and the south valley hill in its course to the river.

It may be followed by its debris which are here numerous, though the dyke itself is not found anywhere in place.

Bart Township

Lies east of Eden, south of Paradise, west of Sadsbury, and north of Colerain. It is remarkable for containing one of the most celebrated mines in the United States, and one which for a long time produced all the nickel which was used here, besides furnishing quite a large amount for exportation. A detailed account of this mine will be found elsewhere, from Capt. Doble, the efficient superintendent and boss, besides notes taken during several inspections.

The rocks which cover this township are mica schists and their congeners, except where the narrow strip of the Chester Valley limestone crosses below Georgetown.

On the eastern extremity of the nickel vein, about 1½ miles (2.4 kilometers) N. by E. of Georgetown the mica schists dip ±W. (?) at a high angle, and about the same on the southern side. The rock in the cross cut near the west pump shaft dips N. 15° W.—80°. Its character is a decomposing mica schist, very arenaceous.

The nickel ore is found encrusting masses of hornblende rock, or at the contact of that and the mica schist or country rock.

It is almost entirely Millerite, though some nickeliferous chalcopyrite and chlorite are found; besides siderite, native copper, pseudomorphs of quartz after siderite, and mispickel or arsenopyrite.

The structure of this mine appears to be a lenticular mass of hornblende rock imbedded in the mica schist. The wedge of the former stands almost vertical in many places, but its slope in detail is very irregular, and this makes the operation of mining it a very difficult one.

In the N. W. heading of the 110 ft. level, 200 ft. from the pump shaft, a breast in a vein ±40 ft. thick showed many boulders (some of them 1 yard or meter in diameter). It is frequently though not always the case that the contact surface of these boulders with the mica schist is richest.

About 150 ft. north from the shaft, on the 60 ft. level, is a very rich pocket of ore. The millerite usually coats the upper or lower surface of the vein, the solution of nickel being often carried along the cracks.

Stalactites are often noticed leading from one wall to the other, or joining the little protuberances which make the botryoidal character.

A valuable iron ore deposit, formerly the Rakestraw but now owned by the Phœnix Iron Company, was discovered by Capt. Doble, in 1863. It is situated ¼ mile (400 m.) S. E. of the Green Tree. The ore is described as like that of the Grubb mines in Conestoga township, but the locality was not visited. This ore is probably collected in the sub-limestone schists of the Chester Valley.

Important geological features of this township are the trap dykes which cross it either entirely or partially, and to one of which seems to be in some sort due the deposition of the rich nickel deposit of the Gap mine.

The largest of these is the same which has been so often alluded to as uniting in one homogeneous line the Eozoic rocks of Mt. Airy on the Welsh Mountain with the Peach Bottom slates on the Susquehanna.

The least distinctly defined enters the township from the east, near S. McClure's, and running obliquely to the direction of the main dyke near the houses of Messrs. Geist, Ressler, and Baxter, north of Georgetown, crosses that town in a line almost parallel with the larger dyke, where its trace is lost, though it is very probable that it unites with the larger dykes in this vicinity.

Mr. S. McClure asserts that the dyke which crosses his place can be traced through Eden township, in which case the junction between the main dyke and this subordinate one would be established, but this was not verified. He also speaks of a "bastard" dyke (?) ½ mile N. W. of his place, which cuts the road. He thinks there is no instance where a large ledge shows in place, but only very large fragments.

His statement seems to be correct, that the dyke which intersects his farm passes through Rockey's.

The main and larger dyke passes into the township near Murry's and Greenleaf's houses, and takes nearly a southwest course to the residence of J. Rockey, where it turns nearly south to M. Pickel's, and there sweeps around a regular curve, with a radius of about half a mile, (800 m.,) until it enters Eden township north of the Chester Valley, in a direction but little south of west.

Sadsbury Township

Lies next to Chester County, from which it is separated by the Octoraro Creek from its source to where it crosses Colerain township's northern border.

The road which leads E. by south from Gap Station follows the summit of a ridge into Chester County.

Mr. F. McClure's farm is on this ridge, about 400 meters (or yards) north of the Chester County line, on a road which intersects that line obliquely.

A micaceous quartzite on this road, and but about 30 yards, or meters, south of Mr. McClure's farm limits, dips N. 15° W.—85°. It is fissile, but sufficiently compact to be used for making turnpikes, for which purpose it was quarried 30 years ago. A great part of the mica seems to be Biotite.

An inspection along the line of the railroad, from the Gap south by east, failed to disclose any rock in place. The water divide occurs about 600 yards, or meters, south of the station, where two small springs, but a few steps apart, rise and flow in opposite directions.

At Pownal's house, just south of the crossing of the R.

R. by the county road, a Hornblendic Gneiss dips N. 10° W. 89°, *i. e.* is vertical with a strike of E. 10° N.

A light purple and white quartzite occurs diseminated through it.

On the farm of Robert Maxwell, a short distance east of the corner where Salisburg, Paradise and Sadsbury townships touch and just south of the boundary between the first and last, Thos. and Wm. Hess had been sinking shafts for Mr. Betz and others of Philadelphia. The shaft near the road was sunk 53 ft., (16 meters). At the time of a visit to this pit (Sept. 4, 1877), there was 16 ft. (5 meters) of water in it, and nothing showing inside.

The rock thrown out was a hornblendic slate with occasional pyrite. Large tabular crystals of Pegmatite and quartz also were found. The rock was possibly a syenitic granite in part, but not enough of it was seen and in place to state accurately its character.

The Chester valley limestone crosses the township in an approximately straight belt of which the Valley Creek forms nearly the southern and the Valley Road the northern border.

Drumore Township

Lies on the Susquehanna River southeast of Martic and northwest of Fulton. It is one of the largest townships in the county, and is interesting on account of various geological as well as topographical features.

The southeastern margin of the Eozoic rocks which are affected by the great Tocquan anticlinal is found near the junction of Fishing Creek with the River, and from here to curve to the N. E.

At an ore opening on J. W. Johnson's place about 1 mile (1 .6 kilom.) S. W. of the Buck P. O., mica schist in place dips S. 30° W.—30°.

On Mr. Lamborn's place, about ⅝ mile (1 kilom.) east of Muddy Run, there appears to be Pyrolusite along with some iron ore.

The specimens were obtained from a ploughed field±200 yards E. by N. of his house.

A specimen of very slightly magnetic specular ore was found between the properties of D. and J. Miller just south of his house.

An exposure of mica schist just north of Jason Bolton's house dips S. 15° E.—55°.

Mr. Lamborn has a small cabinet of minerals and fossils principally collected by himself, including many of the former from his own neighborhood.

At the first cross road north of Mr. J. F. Steinman's house the soil is red from an excess of ferruginous material. On the head waters of Fishing Creek nearly opposite to Mr. J. F. Steinman's place mica schist dips S. 15° E.—17°. This exposure is about 200 yards or meters above the intersection of Fishing Creek and the road south of Steinman's. The mica schist lies in the bed of the stream.

At Hutton's (on township map Miller's) mill a large exposure of mica schist dips S.—37° to 47°. The rocks are laminated like gneiss.

About 150 meters (164 yards) below the dam, mica schist dips S. 5° E.—32°. About 328 yards (300 meters) below this point the same rock dips S. 5° E.—42°.

A short distance below this, still on the creek and near the lower end of the horse shoe the same rocks dip S. 10° E.—47°.

Down from here, to the middle of the band, the thin bedded gneiss seems to dip tolerably constantly S.—30°.

Still further down Fishing Creek, large fragments and even ledges of rotten gneiss and mica schist are encountered, but none in their original position.

Just above Penrose's dam (±200 yards, or m.,) a mica schist, intercalated with quartz, dips S. 20° E.—58°.

At the crossing of a stream by the road just south of the dam, the rock dips S. 15° E.—38° to 40°.

At Hess's (on township map Penrose's) grist and saw mill, next south of this, a mica schist dips S. 10° E.—50°.

This rock is a greenish mica schist containing specks of decomposed feldspar.

A couple of hundred yards, or meters, below the mill, and just below Mr. Hess's house, a large exposure of mica schist gives a dip of S.—±60°.

About 200 yards, or meters, north of the second crossing of Fishing Creek by the road below Hess's mill, thinly laminated sandy mica schist dips S. 25° E.—72°.

From here to the village of Fairfield no exposures were found.

At Pennock's mill, on the southwestern part of Fishing Creek, and near the river, a mica schist dips S. 45° E.—70°, which dip is continued from that place to the Susquehanna.

Leaving this sub-section, a few more lithological notes are scattered through the township.

About 328 yards or 300 meters N. E. of Miller's house, (Liberty Square road,) the rocks are much broken.

The dip seems to be ±S. W.±18°, but another and more reliable exposure, about 30 yards (or meters) north, gives ±S. E.—very gentle.

Another exposure, almost certainly in place at the top of the hill, gives S. 30° E.—gentle.

This rock appears to contain Muscovite, Biotite, Margarite, decomposed feldspar, and some quartz.

Near Wm. M. Lee's house, in Fairfield, on the Chestnut Level road, thin bedded mica schist* (?) dips ±S. E.—±75°.

The elevation on which Fairfield is built is mainly argillite.

At the cross roads just south of Chestnut Level, the soil is white from an unusually large amount of quartz in the rocks.

At the first fork of the road S. E. of Drumore Centre, a light colored mica schist dips ±S. E.—(?).

Opposite the store at Centreville a mica schist strikes ±N. E.—vertical.

Near Mr. E. J. Morrison's a similar rock dips ±N. W.—(?). Just east of here, the trap dyke crosses the road, and within a short space, the township line.

Near the house of Sarah A. Black the soil is argillaceous.

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* Hydro-mica-schist (?).

At the Unicorn the mica schist strikes ±N. E —vertical.

Close to R. S. Maxwell's house the soil is white, and the crystals of mica disseminated through it are large.

Colerain Township

Lies N. E. of Drumore and Little Britain townships, and between the forks of the Octoraro, to the east of which is Chester county.

The township seems to be composed principally of Eozoic.

The west branch of the Octoraro Creek and Stewart's Run separate Drumore from Colerain township. Puseyville and Pusey's mill and store are old landmarks here, and 1 mile (1.6 kilometer) up the creek from this settlement was situated the old Rock Furnace. Stewart's Run separates the roads which fork at its crossing to the old Furnace (right hand) and to Quarryville (left fork). The former has been abandoned about 19 years.

Just north of the fork in the roads there is a very steep ascent in the Quarryville road owing to the entrance of a series of ridges of mica schist, dipping S. 25° E.—65°.

The Furnace's road continues along the creek to avoid the hill.

On Mr. Jas. Collins' farm (at the junction of Eden, Drumore, and Colerain townships, close by the "Dry Wells" (which are so called on account of the scarcity of water along the ridge) a number of dips were obtained in passing down the valley of the West Branch of the Octoraro. Near the northern border and "Dry Wells," and just below Phillip Ann's mill, a mica schist is seen dipping S. 30° E.—30.°

A short distance further on and near Dennis Brogan's a similar rock dips ±S. E.—gentle.

Near a shingle mill high cliffs of rock dip ±S. E.—gentle. This general dip is continued to within a short distance of Clonmell P. O.

±200 meters (or yards) N. of Clonmell P. O. the rocks dip ±S. 10° W.±30°. ±100 yards (or meters) south of Clonmell P. O. massive gneissoid mica schist dips S. 10° E. —45°.

At Clonmell two sub-branches of the West branch of the

Octoraro Creek come together, one from the Gap Mine whose waters color the rocks of its bed.

About ½ mile (800 meters) N. E. of Dr. Geo. Dure's, and near the house of Wm. Whitman, the elevation is 165 ft. (50 .3 meters) higher than the rail at Quarryville Dip S. 25° E.—43°.

On the Puseyville Dry Wells road between Stewart's Run and the West Branch of the Octoraro a mica schist dips S. 5° E.—60°.

Near Mr. Wm. Barclay's house±600 yards or meters south of the township line a Red ferruginous mica schist dips±S. 10° E.—(?)

Near Jos. Barkley on the Quarryville road and a couple of hundred yards or meters nearer the township line the dip is±N. W.±45°.

Opposite Abraham Connel's N. E. of Colerain P. O. ferruginous schists dip S. 45° E.—45°.

Near Coate's saw mill finely laminated mica schists dip ±S. E.—±88°.

Near Josh. Bready's on a little branch of Morrison's Run light blue shaly schists much crushed and convoluted dip ±S. E.—(?).

At Henry Swisher's house a few hundred yards further N. W. a mica schist dips±N. W.—steep (*i. e.*±75°).

Little Britain Township.

The northern part of this township has in general a light micaceous soil, due to the weathering of the mica schists, which are here the fundamental rock. The fertility of this land appears to be great, and the tree growth, especially that of the Chestnut, more luxuriant than in most other parts of the county. Near the residence of Mr. Washington Walker there is a fine grove of chestnut trees, including the largest of this species in the township.

From the Unicorn, in Drumore township, to Bethel, on the border of Little Britain, the road is strewn with boulders and knobs, which resemble those of dolerite from a little distance, but upon breaking them are found to be fragments of one kind of quartzite in another. In some cases the imbedded fragments begin to show an arenaceous character.

Assuming the provisional barometer levels between Lancaster and Quarryville as correct, and that the strata at Quarryville is 170 ft. above the track of the Penna. R. R. station at Lancaster, and that this latter point is (as given in the level book) 359 ft. above ocean level, the height of the depot at Quarryville is 529 feet above the ocean datum. With this assumption the barometer level for the summit of the hill just N. E. of Bethel, on a short cut-off road connecting two others which intersect in the village, is 579 ft. above the ocean.

The country from Bethel east to Mr. Ralph Clendenin's house, at the intersection of the road with the Peach Bottom Narrow Guage R. R., is covered with fine grained hydro-mica schist, but no exposure of rock in place occurs as far east as the road to Wm. Black's (about 0.6 mile or a kilometer).

Near Mary Shade's house a dip in hydro-mica schist of S. E. ±80° was observed, but from this point about 1 kilometer (0.6 mile) east to Oak Shade P. O. there was no rock in place.

For about 4.5 kilometers (2.8 miles) north of Oak Shade the soil remained of the same light micaceous character, but without rock in place until an exposure a short distance south of King's bridge gave S. 35° E.—55°, representing in all probability the northwest slope of the synclinal which appears below the outcrop of Peach Bottom slates on the river.

About ¼ mile (400 meters) south of King's bridge, another exposure in sandy, finely laminated mica schist, dips E. 30° S.—60°.

1¼ miles (two kilometers) south of King's bridge on the West Branch of the Octoraro Creek is White Rock at one time owned by a Mr. Sproule about 1810 or 1812. The old Forge was then in operation, using the iron from the Conewingo and Rock Furnaces. It was leased by Jno. Alexander many years ago, but at present is in a state of ruin.

1 .6 kilometers (one mile) northwest of King's Bridge a light mica schist dips N. W.—steep.

This dip cannot be represented in the section along the Fulton township shore as it lies above or landwards from all the structure there represented, but it serves to explain the apparent uniformity of the soil and the absence of rock in place over so wide an extent of the northern part of the township from the fact that the pinched and overturned anticlinals which appear on the river section are here spread out into wider and more gentle folds which extend the same soft micaceous rocks over a much broader area.

At Spruce Grove Station P. B. R. R. on the Octoraro Creek occurs chloritic arenaceous hydro-mica schist mixed with a great deal of quartz and containing many cavities filled for the most part with mica dust, dipping S. 40° E.—70°. The top of the railway cut showed the schists crushed down on each other and assuming all imaginable dips, but the above seemed to fairly represent the average near the surface of the road. Some large fragments of Serpentine were found loose on the ground, but it was not quite certain that these were in place.

In a short cut made to direct a small stream which came in from the northeast less circuitously into the Octoraro a considerable quantity of chromite is said to have been found.

On Pine Grove road about ¼ mile (400 meters) N. of fork of Octoraro in a quarry, mica schist was observed to dip S. 35° E.—30°. It is difficult to allow at this place for the waving of the strata which brings alternations of very steep and very gentle dips in close proximity to each other. This last named exposure lies about 0 .6 kilometer (⅜ mile) N. W. of the first mentioned exposure and if each may be relied upon as a fair average dip a narrow synclinal between them seems assured.

The mica schist in this quarry comes out in flags or blocks and is used for building purposes. The exposures are in Colerain township, but just over the Octoraro which divides Little Britain from Colerain.

In the vicinity of the corner made by Colerain and Little Britain townships and Chester County, the rocks in Chester are hydro-mica schists, and dip generally N. W. On the Chester Co. side of Pine Grove there remain the sites of two forges and one rolling mill.

100 yards, or meters, N. W. of Pine Grove, on the Chester Co. side, the rocks are crypto crystalline slates, and dip S. 30° E.—35°.

A little more than three miles (5 kilometers) N. E. of Pine Grove, a hydro-mica schist dips±N. W.±45°.

At the bridge crossing the east branch of the Octoraro from Chester into Colerain township, the dip was±N. W. ±55°.

These N. W. dips confirm, in the most striking manner, the observations made above of the widening of the upper rocks and their spread over a greater area than below. The extent of this broadening will be proportional to the differences between the acute angles of the overturned, and the *saddle angles* of the normal anticlinal. The increase of this effect seems to be in this region from S. W. to N. E., since it is greater in northern Little Britain than in Fulton, and greater in Chester County than either.

One hundred meters (109 .3 yds.) east of Pine Grove, on the Chester County side, massive slaty crystalline schists dip S. 30° E.—35°. This dip builds, with the moderate N. W. dips just alluded to, a broad gentle saddle, which contracts in spread, and if it does not die out altogether before reaching the Susquehanna, becomes more steep to the N. W., and finally overturns.

The N. W. dip of 45° is situated near the fork of the roads which lead respectively to McClenagan's ford and (on the right, N.,)to Bunting's bridge.

A hill, close to the old forge on the Chester Co. bank, near Pine Grove, is about 180 ft. (55 meters) above the creek bed.

Fulton Township.

Fulton township is the southernmost river—township of Lancaster County, and, indeed, with the exception of a single point, where the neighboring township of Little Britain, in a bend of the Octoraro Creek, nearly touches the Maryland line, it may be said to be the southernmost part of Lancaster County, and the only part which is bounded on one side by Mason & Dixon's line.

In a geological point of view, Fulton township is peculiar, and of deep interest, and from an industrial standpoint, it claims equality with any equal area of land in the county from the richness and variety of its agricultural, but more especially its mineral treasures.

By reference to the Susquehanna section, from the State Line to Falmouth, the relation of its rocks to the series, and an attempt to represent the structure may be observed.

A discussion of this structure, and a comparison with that obtained by Rogers in his section along the right, or York County bank of the river, will be undertaken in the future.

Fulton township comprises about twenty-five square miles of rolling country well wooded and farmed, and watered by the Conewingo and lesser streams, the valley of the former being its most important topographical feature.

The northern part of this valley, or that portion from Fulton House (the birth place of Robt. Fulton and a mile south of Wakefield P. O.,) is fertile and well tilled. The rocks represented here are micaceous and chloritic schists, which by their decay and disintegration afford a good soil and low or at least gently sloping hills. South of this point, or from the neighborhood of New Texas, (a hamlet which is widely but improperly known as the locality of various rare minerals obtained from this region, which latter will be referred to in another place), the Conowingo cuts through a ridge of Serpentine rocks which form the "barrens" and are recognizable from a great distance, by the absence of any vegetation and a scarcity of springs and small rivulets.

After passing through this Serpentine ridge, the creek turns to the Southwest and flows through a bottom land of hydromicaceous and chloritic rocks of comparative richness, but between bounding walls of Serpentine barrens.

These Serpentine Ridges carry chrome ores, magnesite, Deweylites, Magnetites, Brucite, and a host of the more common species of minerals.

Strictly speaking, it is not the Serpentine which carries all these minerals. It would be more proper to say that they are indigenous to the belt of rocks in which the Serpentine is found. One of these is a dark green chlorite schist—a rock sufficiently common in all the pre-Silurian horizons, but which here is marked by the occurrence of rare forms of pyrite and hemitropes of magnetite.

Near Pleasant Grove this Chlorite is principally an earthy and sandy deep green chlorite rock traversed by rusty brown planes along which the specimens break with ease.

A few words concerning the early history of this township is important, because of the relics of a previous race which abound here.

From a series of papers in the "Oxford Press," of Jan. 12, &c., 1870, contributed by Dr. C. H. Stubbs, of Wakefield, the following may be excerpted:

"In 1608 Capt. John Smith found inhabitants on the eastern shores of the Susquehanna as high up as the present northern limits of Fulton, and they were called Susquehannocks."

"In 1631 Clairborn located a trading post at the mouth of the Susquehanna."

Many evidences of the existence of the Indians are to be found in various parts of the township.

As an example, the Rock Spring, a short distance north of the Maryland line, and about a mile S. E. of Lyle P. O.

The rock out of which the Rock Spring flows is very rotten, stained with iron rust, and comparatively soft. It is not easy now to define certainly its original lithological character. It seems to be a soft, rotten, sandy slate, resembling a conglomerate in those places where the basins have been excavated. Six or seven large hemispheres of the average diameter of nearly 8 inches (two decimeters) have been scooped out in pre-historic time. Holes bored in the bottoms of these basins seem to connect together and with the cavity whence flowed the water supply.

Mr. Osborn Mulligan's son, who lives near the spring, reports that the flow is very uncertain in summer, and the spring full only in Spring and Fall.

The water has neither taste nor odor. Its temperature as it issued from the rock on July 10, 1877, was 62° Fah., or 16.6 centigrade, showing that it is much diluted by surface water.

In the bed of Rock Spring Run, a liver colored jasper was found somewhat in color resembling Menilite ; and a variety of magnetic iron as sand.

It rises and flows over a Serpentine Ridge, viz: that one which starts from David Jenkins', by Jos. Jenkins, the Misses and Mrs. Hanna, and Samuel Overholt, where it enters Little Britain township. The Run flows north by west past the Jenkins Baptist church and the Rock Spring school house and empties into Carters' Run, a very short distance above the junction of that stream with the Conewingo.

On the *Boyce* farm, now owned by J. Harrison Spence, are abundant remains of Indian settlements. This locality deserves more than a passing notice, because it is known to all mineralogists over the world through Prof. J. D. Dana as the "Boice farm."

On the Boyce farm there are found a large number of spear heads, and chisels, besides bowls and other cooking utensils.

Mount Johnson Island on the Susquehanna river (and just opposite the slate quarry and mill) is another well known resting place of these remains. The island is about $\frac{5}{8}$ mile (or a kilometer) long, and 100 yards (or meters) wide. It is farmed for the Widow Caldwell, and is sometimes called Caldwell's Island. After ploughing the fields the relic hunters (among whom none have been more successful than Dr. C. H. Stubbs) follow the new furrows and, especially after a rain, are rewarded by the discovery of great numbers of these objects. Among the articles whose discovery may be said to characterize the place are stone axes and implements of the chase and of war, indicating the existence of a large colony there. "Susquehanna" is said to have meant in aboriginal tongue "River of Islands," and nowhere in the old or new world is the evidence stronger that the tribes of these primeval forests availed themselves of the greater security of these islands than there in the former home of the Susquehannocks or "River Islanders."

In and for some distance south of Pleasant Grove the rocks are green chloritic schists on fresh surfaces, but the soil is very red from diffused iron oxide. They form the valley of the Conewingo at this place, and lie between the aforementioned barren or serpentine ridges. The exposures are extremely difficult data on which to base reliable estimates of the position of the rocks, especially on the serpentine itself, owing to their shattered and twisted condition. About 300 meters or yards south of Pleasant Grove on the "Kidd" road a gray chlorite schist dips E. 30° S.—74°.

Passing the State line one reaches the southern barren serpentine rocks which are in general tolerably level for a considerable, and distance on which the view is unobstructed by vegetation of any kind.

About 700 yds., or 640 meters, south of the line on the river shore are rocks which have been named the Bald Friars. French's tavern is here at the mouth of a small stream which empties into the Susquehanna. About 874 yards (800 meters) south of this tavern are a number of islands which have local names, but which are curious as containing inscriptions of the Aborigines.

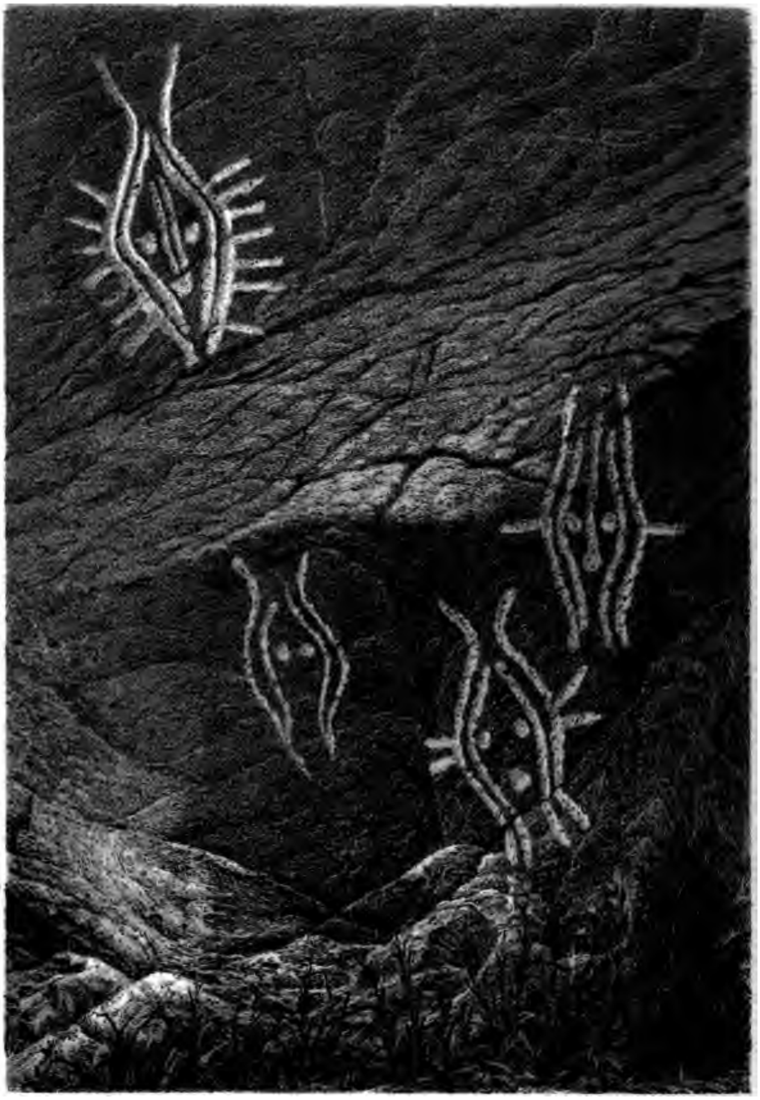
The material of which most of these islands are composed is chlorite schist, but as this rock is almost always distinguished by the quartz veins which intersect it; so in this case some of the islands are composed of this material almost exclusively, which gives them a very striking white appearance.*

One of those containing the principal inscriptions is called Miles' Island.

The rock of which this island is composed will be more carefully described elsewhere. In appearance it very much resembles a diabase, and is intersected very generally by a finely laminated and micaceous material in veins, the planes of the foliae being perpendicular to the walls of the veins.

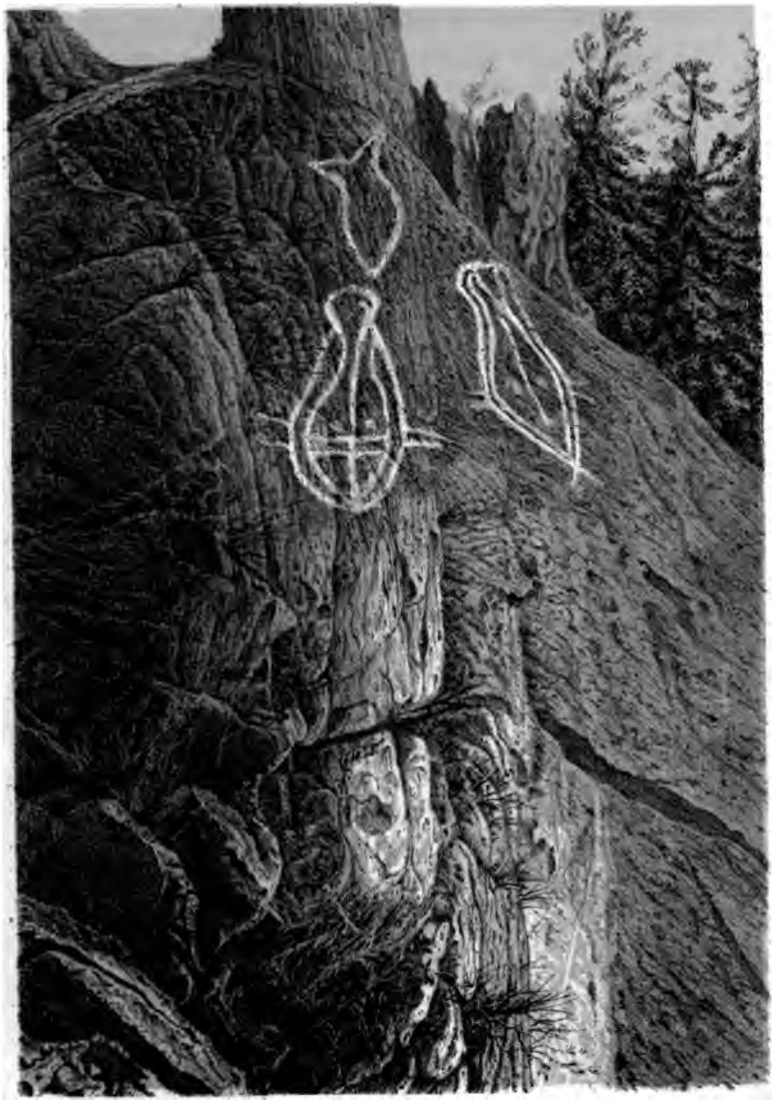
This island is the middle point of a line of rip raps and rapids which indicate a change in the character of the strata

* Hence the name.



INDIAN SCULPTURES ON THE SUSQUEHANNA RIVER OPPOSITE "BALD FRIARS," ABOUT HALF A MILE SOUTH OF THE MARYLAND STATE LINE.

CCC Plate I.



INDIAN SCULPTURES ON THE SUSQUEHANNA RIVER OPPOSITE "BALD FRIARS," ABOUT HALF A MILE SOUTH OF THE MARYLAND STATE LINE.

which cross the river at this point. Harder rock, whether interbedded and contemporaneous with the other strata, or intersecting them on a trap dyke, always indicates its presence in this way in the bed of a broad and comparatively shallow river. Many instances of this could be cited from the Susquehanna itself, such as "Haldeman's Riffle," the Falmouth and York Haven dykes, &c.

The rocks here are not sufficiently well shown in place to enable one to speak with confidence of the exact position of this harder stratum, but if the line of the Riffle may be taken as an indication of the strike of such a harder layer, it appears to proceed West and N. E. from Miles' Island, which latter is not far from the middle of the stream. The western shore here is in Harford County, and the eastern shore in Cecil County, Maryland.

Part of the lower portion of Miles' Island is cut by a small vein of diabase, (?) which is for the most part weathered into a green argillitic mass.

The rock is full of pot holes of from 1 to 2 decimeters (4″ to 8″) in diameter, in some of which the stone which produced the hole and the sand resulting from the attrition are still contained.

Other parts of the island seem to be composed of a dark green chlorite schist, filled with pits containing iron rust.

One of these stones was found sticking in a hole of a slightly larger diameter, and was easily recognizable as a fragment of Mesozoic sandstone, which was doubtless transported down the river from the more northerly latitude of that formation. This stone measured 25 centimeters (nearly 10 inches) in length, by 7.5 centimeters (a little less than three inches) in diameter. It was a fine grained sandstone and exhibited a good polish. The fragment had clearly been oblong when deposited on the submerged surface of the rocks, for the hole which it made, which, like most of the pot holes formed on these rocks, was nearly vertical, was but little larger in diameter than the stone itself. The excavation was funnel shaped, showing clearly that the lower end of the pestle had been held fast or at least restricted in motion, while the upper end had been free to gyrate under the varying pressure of the current.

In another island near the left bank, called from the owner of a fish pot on it, Jno. Barrow's island, the rock is similar to that of Miles Island, but without the intersecting veins.

As far as the direction of the dip could be made out it was moderate and down the stream, or ±S. E.

The broad flakes of the laminated matter intersecting the Rock of Miles' Island seemed to be of the Hornblende Species (Tremolite ?) or Anthophyllite.

The figures which covered every part of the rocks, which were exposed, were apparently of historical, or at least narrative purport, since they seemed to be connected. Doubtless the larger portion of the inscription has been carried away by the successive vicissitudes which have broken up and defaced, and in some instances obliterated, parts of which we find evidence of the previous existence on the islands.

Every large boulder seems to contain some trace of previous inscription, and in many instances the pictured side of the boulder is on its under side, showing that it has been detatched from its original place. The natural agencies are quite sufficient to account for any amount of this kind of displacement, for the rocks in their present condition are not refractory and offer no great resistance to the wear of weather and ice; but in addition to this must be added human agencies, for whenever rocks were needed for building a "fish pot," (and the very riffle caused by these rocks makes the place peculiarly well suited to the location of these illegal but enticing machines for capturing fish,) the fishermen have not been restrained by archælogical scruples from carrying away any rock they needed with or without inscriptions, and, when it was desirable, blasting parts of the yet solid mass.

Dr. Stubbs, some ten years ago, had these inscriptions, or rather a few of what were left on one or two islands, photographed, to do which it was found necessary to trace over the almost invisible depressions with whitewash. These photographs were not to be had, but others were taken by

VIEW OF THE "BALD FRIARS" SCULPTURED ROCKS IN THE SUSQUEHANNA RIVER,

Mr. Taylor, of Philadelphia, for this report. Amongst other things they represent the conventional Indian serpent's head, with varying numbers of lines.

Some of the signs next frequently recurring were concentric circles. In some cases four, and in other cases a lesser number.

At the bridge over the Conowingo, on Albert Haines' property, hard crystalline gneissic rock dips W. 20° N.—50°, apparently in place.

Peters Creek Station, on the Columbia and Port Deposit R. R., is that station nearest to the roofing slate quarries, about which more will be found in another place. The belt of slate crosses the river just S. E. of the Drumore township line, and traverses the eastern end of York County into Maryland, in which latter state, excepting one, the largest and finest quarries are wrought, and the greatest number exist.

The slate ridge is a marked topograpical feature when viewed from the summit of the first Serpentine range, extending as far as the eye can reach in the direction of the township line, but this topographical, geographical, and even geological continuity does not necessarily imply a lithological identity of the rock along the strike, though the same materials were doubtless originally concerned in laying down all that portion of it to which this short sketch applies.

The explanation of this is to be found in a trap dyke which comes in from the N. W., and crosses the strike of the slate range about two and a half miles from the river. This dyke is part of that which makes an important factor in the geology of the Gap Nickel Mine, and is mentioned elsewhere as extending from Mt. Airy, on the Welsh Mountain, through Salisbury, Sadsbury, Bart, Eden, and Drumore townships.

In the latter it obtains easting, and making a curve, crosses the measures to where we are now considering it, when it again pursues a southwesterly course, skirting the roofing slates of Lancaster Co., and crossing the river in the neighborhood of Peter's Creek into York County. In this latter county its trace was discovered only some miles from the river shore.

The probability is great that it has some influence upon the phenomena of these roofing slates since the strata with which they are continuous lose this distinctive characteristic N. E. of this crossing of the dyke.

The appearance of the rocks at the extremity of the Columbia and Port Deposit R. R. bridge which is S. E. of the slate deposit, is that of those slates which accompany the lower Silurian limestone until a mica bearing quartz slate is reached, which *may* (?) be of Chikis Quartzite age. The dip at the bridge is S 20° E.—55°.

The curved appearance towards the upper part of the rocks giving this dip is suggestive of an anticlinal or rock-arch, but if so, the overturn must been such that no N. W. dips are found along the present surface.

One hundred yards from the present terminus of the Peach Bottom narrow gauge R. R. at a creek crossing these same calcaroid slates dip S. 30°-E.—62°.

At Geo. Herr's house on the R. R. these same calcaroid sandy slates dip S. 25° E.—76°. The measures here are curiously waved and streaked and seamed with quartz.

Near W. F. Bicknell's on the Narrow Gauge R. R. green sandy slates with quartz dip E. 15° S.—50°.

At the curve of the road east of Wakefield Station P. B. R. R. a finely laminated mica schist dips nearly vertical and has a northeasterly strike.

In the R. R. cut N. E. of Dr. Stubb's house Wakefield Station a dark green chlorite slate dips S. 45° E.—72°.

Close by Vincent Stubb's property about 2 .4 kilometers (or 1 .5 miles) finely laminated mica schist dips±S. E.± 70°.

Close by W. H. Wick's House on Peter's Creek a greenish fine grained mica schist dips±S. E.—steep.

Between this and McClenahan's slate quarry the before mentioned dyke crosses the road.

S. E. of McClenahan's quarry a white slaty and sandy mica schist is opened with the cleavage planes and structure of the black slates, but is less smooth and tenacious.

General View of the "Bald Friars" Sculptured Rocks in the Susquehanna River,
1½ Miles South of the Maryland Line, (Looking S.E.)

The planes of jointage are similar to those of the Peach Bottom slates and their general direction of dip±S. W.

A dip at the lower end of the quarry gives E. 20° S.—55°. At the upper end S. E.—68°. The quarry is a large one, and some of the slate exposed of excellent quality. In general, however, it is coarser in texture and more full of ribs and ridges than that of the lower quarries.

The excavation which is on the side of a hill is now almost entirely overgrown.

On the northwest face of the quarry the dip of the slate is S. 45° E.—88°.

About one mile west by south of the town of New Texas, on the farm of W. H. Spence, many interesting forms of pyrite have been discovered. Hexahedral pyrite is found in large quantities in the gutters by the side of the road. A Serpentine range crosses a short distance S. E. of Mr. Spence's house.

The rock is generally loose and in an advanced state of decay, and consists principally of boulders. Some of them have veins of foliated Serpentine intersecting them, the edges of the foliæ standing out in the direction of visual ray, and parallel to the walls of the fissure.

About 500 ft. (152 meters) southeast, rotten rock (perhaps in place) dips E. 30° S.—20°.

This rock is so much decayed that its true character is undeterminable.

In the Magnesite Mine about 330 meters (361 yards) S. 25° E. of Spence's house the much broken rock gives a number of planes too numerous and unreliable to be recorded.

Seams of Magnesite of various thicknesses intersect and coat the rock, which is here chiefly Serpentine.

Near Uriah Gray's house, which is 219 yards (200 meters) further south, a large quarry has been opened.

Magnesite is here abundant.

The prevailing dip seems to be ±S. E.±50°.

The Black Barren Spring is situated close by.

On the farm of Mr. McCullough, next to that of Mr. Haines, at Pleasant Grove, this township, hemitropes of

Magnetite along with Octahedra were found. The gangue in which these specimens are found is principally an earthy and sandy deep green chloritic rock, with planes of rusty brown, along which it breaks with ease.

Drift in Fulton Township.

Dr. Stubbs, in an article published in the Oxford Press, thus refers to a locality which will be found marked on the maps:

"By far the most interesting geological formation in our midst is the high-land near the village of Pleasant Grove, just north of Blake's graveyard. Here, at probably a height of 250 ft. above low water mark on the Susquehanna, (the largest body of water near the locality, it being one and a half miles distant,) is a large body of conglomerate pebbles and sand, constituting a ridge half a mile in length. This deposit is drift." * * * * * * *

"To prove the Drift Period we offer the following reasons:

"1. It occurs in a situation where no agencies of the present could have produced it.

"2. It occupies about the highest position in that vicinity —a characteristic of drift; whereas, if it were tertiary strata, it would be found in a lower situation.

"3. No force ever exerted by water alone could by any possibility have placed this deposit where it is now found.

"4. It has the general direction of all drift deposits situated further to the north.

"5. It is unstratified, and the constituents are very different from any other rocks in this section of the country."

This deposit had attracted the attention of the more intelligent residents of the vicinity fifty or sixty years ago, including the father of the gentleman just quoted. The tract alluded to and of which no better geographical description can be here given, is the property of Mr. Gilpin Stubbs. The constituents of this deposit are boulders and rounded pebbles (of Oneida conglomerate ?), Mesozoic Red sandstone, and rounded quartzose pebbles. The limits of the deposit do not seem to extend beyond the forked roads, and another small cross road or lane with which they form a triangle. Perhaps 90 p. c. of the constituent pebbles are of various forms of quartz more or less pure, and the remainder consist of the Mesozoic and Oneida rocks.

No reliable barometric or other hypsometrical data are at hand. The estimate of height, as given by Dr. Stubbs, is probably not far wrong. This summit, however, is no higher than others equally near the river on which no such deposit has been discovered. The only other such deposit (and that not so clearly separable from adjoining rocks as this one) lies about thirteen miles due north of this place, and will be mentioned further on. But between these two are the high and abrupt Martic Hills; the most rugged and mountainous part of Lancaster County on the summits of no one of which have yet been found traces of like kind.

Chapter III.

Description of Cross Sections.

Section 1, 1877. *From Falmouth Station P. R. R. on the northern boundary of Lancaster County to the Maryland Line; along the left bank of the river. Direction of Section about S. 20° E.*

Part 1. From Falmouth to Chikis.

In constructing this section from Falmouth to the Maryland line, it was separated into a number of constituent parts, as for example, the part from Falmouth to Chikis, the part from Chikis to Columbia; that from Columbia to Turkey Hill; Turkey Hill to Safe Harbor, and so on.

In each of these parts an average direction of dip was obtained by a comparison of all the dips, and the section line of this part was accorded this average direction.

The object of this was to combine, as well as possible, the very striking graphic method of representing section lines by sketches of the river shore, which Rogers employed, with a greater accuracy than that method admits of. That the method of drawing an approximate panorama of the appearance of the river bank, and putting on this line the dips, is not and cannot be accurate, either topographically or stratigraphically, must be clear if one reflects that the first abrupt bend in the river, where the bank follows the strike of the rocks, either must be omitted from the sketch, or else must lead to very erroneous ideas of the thickness of the measures which crop out above and below it. Now wherever the course of the stream is not exactly at right angles to the line of strike, the same error in apparent thickness must ensue; and besides this, the apparent direction and strength of the dip must be wrong; and since the observer is not looking along the strike line, and the apparent dip should be always steeper than the real dip in such a case; the amount of this steepening varies with every change in the direction of the stream, while its exact determination would involve tedious geometrical calculations. Since simplicity and intelligibility are the first considerations to be thought of in a report of this kind, it is better to present a more accurate, even if a less artistic picture of the relative positions of the rocks.

By dividing the entire section line into parts each containing one or more prominent features of structure, and averaging the dips in each part, the lines representing the directions of such averages are brought as near as is possible to the line of the River. If we assume an arbitrary line parallel to the average course of the River from Columbia to the Maryland line (in this case S 33° E.), and lay these sections down upon it with their extremities in contact, we will have a nearly perfect representation of the stratigraphy, but the sum of their lengths will be a little shorter than the average line of the river as plotted on the same scale.

In the present instance, however, this shortening is not very much (perhaps 0.62 mile or one kilometer), while the effect of much of the folding in the topography of the river can be well observed by comparing the structure with the plot of the river bank immediately above it.

It would, of course, very much heighten the effect of these section curves if a perspective plan of elevation were drawn, presenting to the eye the recession and approach of the high ground. This method, including the putting of the dips exactly where they occur, and omiting as many as were required when too much crowded, seems to be the best for rendering the plications of the strata (or to be more fair, a *theory* of these changes of dip,) intelligible.

It must have immediately struck the attention of the first geologist who oriented himself as to the courses of the rivers in Pennsylvania, that the Susquehanna presents the most favorable opportunity to construct a section line, as its direction over long stretches of its bed is generally across the strike of the strata. In fact the longest and a very careful section produced by the first Geological Survey of Pennsylvania was along part of this river. But at that time the left bank of the Susquehanna was in very many places inaccessible and the data of the section was exclusively drawn from the right bank from Wrightsville to Chesapeake Bay.

In a river forming such a very prominent feature in the geography of the water shed system it would be far from safe to conclude without corroborating observations that the structure on both sides was the same, because lines of fault are very liable by breaking through barriers otherwise impassable by running water, to become the natural channels for large areas of drainage. The fact therefore that the Susquehanna does cut with comparative directness through such a variety of different formations makes it necessary to pay stricter attention than usual to the evidence for and against such a fault.

The *principal* formations passed through by the river within the limits of Lancaster County are (by lithological character) a belt of New Red Sandstone, belts of limestone, beds of hydro-mica schist, a belt of quartzite, and a broad and complicated belt consisting of various crystalline and crystallized micaceous rocks which stretched to and far beyond the State line.

The exposures along the river bank are few and insufficient for structure where the banks are low and the rocks soft; and especially the light thrown upon the difficult problems connected with the New Red Sandstone is exceedingly feeble. Nevertheless the description of this new section properly begins at Falmouth.

One of the too numerous Conewago Creeks forms at once the north boundary of Conoy township and of Lancaster County. This creek flows, at its mouth, nearly westward into the river, over a bed of the soft shales of the Mesozoic age.

The first recorded dip is in soft green mud rock, about 100 yards or meters south of the post which marks "Collins Station 1 mile" (to the south). This dip is N. 20° W.—21°. At about this point the northwestern edge of the trap dyke, which is seen on the opposite side of the river near York Haven, crosses the river, and is especially noticeable for the large quarry which has been opened in it nearly mid way between Collins and Falmouth Stations.

The interval between the first exposure of quantities of loose blocks of trap, and a short distance N. W. of Collins Station, is plentifully strewn with trap; while the exposures of rock in place are few and unsatisfactory. The detached boulders and fragments of trap are prominent at intervals to a point nearly a mile about (1.5 kilometers) S. E. of this station.

The Mesozoic (lower?) pebble conglomerate comes in some distance below Collins Station with a dip of N. 20° W.—22°, which is shared by the overlying plates of sandstones immediately in contact with it.

At the 91st mile post from Philada. (1 mile or 1.6 kilometers) W. of Bainbridge, thin plates of sandstone dip N. 20° W.—19°. Just S. E. of this a sand quarry, opened in rotten argillaceous sand rock, is wrought to a limited extent.

About 1.2 kilometers (very nearly ¾ mile) N. W. of the town of Bainbridge, a coarse pudding stone of quartz pebbles, in a more or less sandy and ferruginous matrix, occurs, dipping about N. 20° W —30°. It is very nearly 273 yards (250 meters) in breadth.

382 yards (350 meters) N. W. of Bainbridge, a greenish gray member of the Mesozoic series dips N. 20° W.—30°.

In the upper part of Bainbridge a Mesozoic sandstone comes in with a dip of N. 10° W.—29°. This rock is a coarse, friable, micaceous, gray sandstone which follows a blood red rock with sandy talus, and is the southern limit of the Mesozoic sandstone on this side of the river.

From this exposure for about 5900 feet down the river no exposures are recorded.

At the mouth of Conoy Creek, near the station known as Locust Grove, the first well defined outcrop of limestone occurs dipping N. 20° W.—40°.

Fifty yards or meters further S. E. a striped buff and light blue limestone, with patches of pink, occurs. It is very hard, crystalline and brittle. The buff streaks are the basset edges of the seams, and dip N. 20° W.—32°. The outcrop is 174 ±yards (160 meters) broad.

22 yards (twenty meters) further S. E. a limestone dips E. 10° S.—60°.

11 yards (ten meters) further on the line of section there comes in a limestone dipping E. 10° S.—40°, curving rapidly in the depth to a steeper dip, as if near the saddle of an anticlinal.

Twenty yards or meters further S. E. a limestone occurs, one plane of which appears to dip E. 20° S.—80°., whilst another dips N.—gentle.

One hundred meters (109 yards) further S. E. a limestone dips N. 20° E.—24°. While a further and equal distance in the same direction another exposure dips N. 5° E.—70°.

±22 yards (twenty meters) further S. E. on the line occurs a blue limestone, marked by characteristics entirely unique in the writer's experience of contemporaneous and similar rocks. The dip was first abnormal—N. 18° E.—80°—yet that this dip was obtained on a true plane of bedding was evident from the fact that this bed plane was parallel with a very peculiarly ripple-marked stratum, which rendered any doubt as to the synchronism of the deposit of its several parts without foundation, though it is possible that the exposure may be a part of an extensive dislocated ledge.

The surface of the ripple marked stratum was a very striking object amidst the heterogeneous rocks amongst which it was observed. While it seemed to be the only plane which gave evidences of littoral washing, the curves of which the marks were composed could be traced a short distance along the normals to its surface.*

The furrows vary in breadth from crest to crest from a little less to a little more than 0.4 inch (1 centimeter).

The waves are irregular, sinuous, and comparatively shallow, very much resembling those left by the receding tide on a sand beach, or like the casts of those which are seen in the Mesozoic series. The disposition to attribute the

*Prof. Primo has since called the attention of the author to a similar phenomenon in his district.

the rock to this formation is all the stronger because, in fact, the southern border of the Mesozoic has been stated to be at the upper end of the town of Bainbridge scarcely 1½ miles (two kilometers) away, and the existence of outlying patches of New Red beyond the limits in which it is the predominant rock, is a very common observation.

But this supposition is negatived by the best possible lithological evidence.

Half the thickness of the specimen (No. 1724 current field number of my catalogue) is a characteristic hard, dark blue, fine grained crystalline limestone, streaked with white, which, to the best of the knowledge of the writer, is entirely unknown in the Mesozoic strata.

About 22 yards (twenty meters) S. E. of this singular and most instructive phenomenon is a dark blue limestone, dipping W. 20° N.—29°.

In Haldeman's limestone quarry, just opposite the mile post S. E. of Locust Grove, the rock shows a dip of S.—46°. The limestone is of light color, and very irregular fracture.

S. E. of this point the limestone is of much darker color, and streaked with white. Quite a large quarry S. E. of Haldeman's, exhibits a principal dip of N. 15° E.—32°.

The last exposure of limestone between Bainbridge and Chikis occurs not very far from a little stream which crosses the R. R. at right angles near the house of Mr. J. A. Brenneman, with a dip of E. 10° S.—58°.

Below Jno. Haldeman's, and N. W. of Brenneman's farm, on the R. R., is the "Haldeman Riffle," which, by the noise of agitated water, directs the attention of the passer by to the fact that a seam of harder rock than ordinary here crosses the river. On close inspection (for there are no signs of this intrusive rock on the canal bank or immediately on the R. R.) it is discovered in a hill standing inland from this point on the R. R. to be a thin seam of trap, which, however, has formed the stiffening nucleus of a narrow ridge of about 33 yards or meters in breadth, and 100 yards from the R. R. track; but which points out to nothing towards the river, descending also gently in a manner not at all frequent in the topography of trap hills.

An outcrop of limestone about 164 yards (150 meters) up a little stream, at whose mouth the dyke crosses the R. R., shows ±S. W.±28°. The appearance of the limestone is blue and unaltered.

A number of exploitation pits have been sunk in the vicinity of this hill, between the Marietta road and the river. No ore has been exposed, but from every hole great quantities of limestone. Large quantities of trap boulders are strewn each side of this little ridge in the woods and away from the R. R., but no trap in place was observed. It seems to be of those instances where the gradual erosion has broken down successive portions of the higher outcrop of rock, which latter has accumulated, the harder specimens resisting decay better, and being longer preserved. The trap is most probably a thin plate in an interstice of the strata forming the hill. Some ore of fine powdery black texture is found which is said to be magnetic. It is possibly the magnetite from the dolerite which has been washed together upon the disintegration of the larger lumps in which it originally lay.

On the Maytown road near Mr. H. Beatty's store occurs a limestone dipping ±N. W.—gentle, and just west of the built up limits of the town are to be observed masses of trap boulders which look as if a dyke passed in the neighborhood.

From Haldeman's Riffle along the river to the eastern extremity of the borough of Marietta there are no exposures of rock in place, so that it was impossible to indicate the structure of this belt of limestone, and therefore the commencement of the attempt to indicate the waves of strata in this section was necessarily placed at the N. W. end of Chikis Ridge.

The last exposure of limestone on the bank (at low water a better exposure is obtainable in the bed of the river) is north of the mouth of the Chikis Creek about ½ mile (0 .8 kilometer) where a dark blue limestone gives S. 20° E.—34°.

The last outcrop of limestone in the river at ordinary stages of water is about opposite to the northern end of Haldeman's house.

Part 2. Chikis to Columbia. Direction of Section Line S. 21° E.

Chikis is the boldest and most picturesque ridge of Rocks between Columbia and Harrisburg. It consists, in the main, of a quartzite replaced in portions by quartz slate and chloritic schists, which, as shown in Report of 1874, C, after making several upward curves in the lower part of the Susquehanna River without actually reaching the surface; but rising higher and nearer the present water level towards the N. W., finally just protrudes the top of one of its anticlinal waves a short distance below Wrightsville,* and at the next rise to the N. W. produces a series of fine bold reversed arches at the mouth of the Chikiswalunga,† when it again sinks and does not re-appear further N. W. on the river.

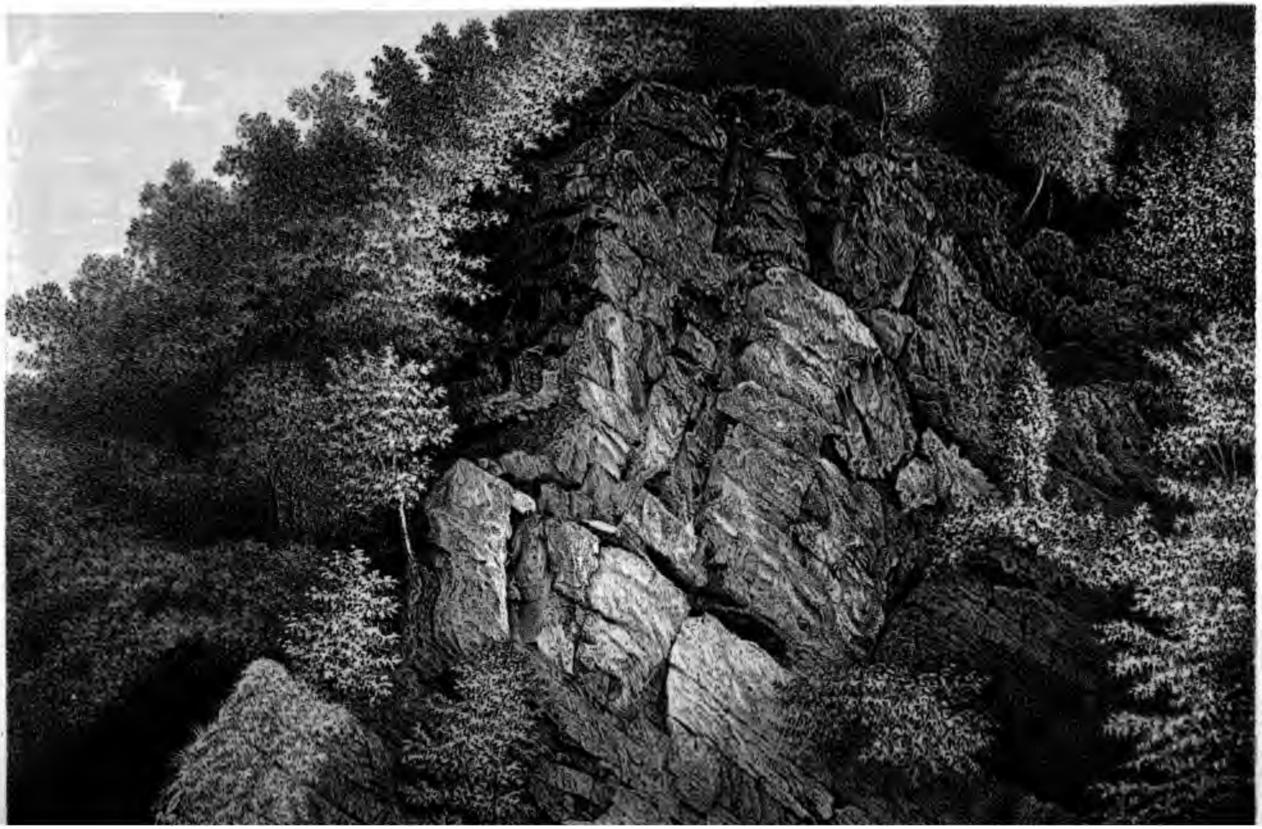
There is a gap of about half a mile, or 0.8 kilometers, between the last recorded limestone dip and the first well-marked exposure of rock south of the Chikiswalunga, at least along the R. R. and tow path, but at the mouth of the Creek, where the piles of furnace slag have not covered up the rock in place, and especially in the bed of the river at low water, the contact between the two formations is brought much closer together, say within a hundred yards or meters.

The creek may be taken at its mouth to mark nearly this dividing line.

Chikis Ridge appears first near the Chikiswalunga Creek as the southern half of an anticlinal whose northern half has been cut off by a fault along the bed of that stream The axial plane dips slightly S. E. The heavy beds of rock dip a little east of south and very nearly vertical, about 1400 ft. (427 meters) S. E. of the Creek.

* No analogous exposure is certainly made out on the Lancaster County side.

† In this report the spelling of Chikis is based on the authority of Prof. S. S. Haldeman, who, besides residing on the Creek and under the mountain all his life, has the additional and greater claim of being one of the most eminent philologists in the United States and a most learned Indianologist. Prof. Haldeman says in a postal card to the author on this subject: "Chikiswalunga" is right, "but the 'w' is dropped in pronunciation and Chikisalunga" substituted. "Of course Chikis and Salunga are equally entitled to the medial 'S.'"



North-Western End of CHIKIS Rock.

About 328 ft. (100 meters) further S. E. there occurs a dip of S. 10° E.—44°, which is the uppermost of a series of five (all in quartzite), which together form the S. E. or gently declining side of the first reversed anticlinal. They all lie within the space of 200 ft. (61 meters) and are as follows:

Quartzite, S. 10° E.—44°.
" S. 25° E.—47°.
" S. 20° E.—61°.
" S. 10° E.—73°.
" S. —77°.

Between this and the N. W. side of the next anticlinal lies a synclinal trough of about 500 ft. (152 meters) in breadth, and including four dips, but the rocks are chloritic and hydro-mica schists.

These dips are also equally divided between the two sides of the synclinal; the first two being on the naturally sloping N. W. side, and the last two on the overturned abnormally —dipping S. E. side of the synclinal. They are as follows:

Hydro Mica Schist	S. 10° E.—48°.
Hydro Mica Schist	S. 30° E.—34°.
Hydro Mica Schist	S. 10 E.—70°.
Chloritic Hydro Mica Schist	S. 20° E.—65°.

These two groups form the two sides of the synclinal made by the bending and gradual sinking of the Quartzite to the south.

The latter two form the covering to a broader anticlinal partially broken in on the crown and measuring (if the supposed structure be correct) 1600 ft. (488 meters) between the intersection of the outside of the limits with the present level.

The only dip recorded in quartzite which represents this normal side of the anticlinal is about 700 ft. (213 m.) from the last named chloritic stratum. It is quartzite—S. 35° E. —50°.

The next dip in quartzite on the line of section is about 280 feet (86 meters) from the last and is Quartzite W. 25° N.—78°.

This shows a break in the place where the summit of the anticlinal ought to be, but it is not of much importance as the normal dip is resumed about 150 ft. (45 meters) from there in a dip of Quartzite S. 35° E.—74°.

This is followed 200 ft. (61 meters) further on by a Quartzite dipping S. 30° E.—76°.

This represents the upper surface of this mass of quartzite, and the hydro mica schists of the synclinal to the N. W. come in here over a horizontal distance of about 200 ft. (61 m.) with an actual thickness of perhaps (115 ft.) 35 m.

The dips are:

Hydro-mica schist—E. 20° S.—21°.

Hydro-mica schist—S. 23° E.—60°.

Hydro-mica schist—S. 35° E.—50°.

This brings the section to the Henry Clay Furnace 231 ft. (75 meters) south of which occurs a quartzite with a dip of S.20° E.—34°.

This latter seems to be intercalated among the schists. This rock is a quartzite coated with peculiar scales of white quartz which also permeate the interior of the rock as if gelatinous silica had saturated cleft and fissure.

Just south of this the hydro-mica measures begin to reappear, dipping S.—50°.

For 800 ft. (244 m.) the exposures are too few to give perfectly reliable data for drawing the structure. It is extremely probable, however, that there is here an overthrown synclinal between these points, the rise of the measures on its southward side being indicated by a dip of S. 15° E.—62°.

The next dip is 400 ft. (122 m.) further on, and its great flattening would seem to indicate that it was the normal side of an anticlinal in the same slates.

The dip is S. 5° E.—40° in argillaceous slate. It is immediately followed by a hydro mica slate S. 10° E. to S. 20° E.—70°, and possibly due to a short fold in the strata.

At the west end of the tunnel, and close to the last dip an argillitic sandy slate dips S. 5° E.—50°, and an hydro-mica schist dips S. 20° E.—63°.

The tunnel is 600 ft. (183 m.) long, and its extremities mark very nearly the bounding planes of a slightly distorted synclinal.

At the south end there is an

Hydro mica schist S. 35° E.—79°, followed by

" " " S. 30° E.—76°.

These same strata seem to go down again 300 ft. (91.5 m.) further on, where they have become also more ferruginous. The dips here are:

Ferruginous hydro mica schist, S. 20° E.—59.

" " " " S. 25° E.—73°.

This outcrop, which is near the boundary line of the borough of Columbia, and a short distance from the St. Charles Furnace, is the last either in the hydro mica schists, or the quartzite series.

Within the next 500 ft. (152 meters) is the boundary line between the limestone and the eozoic strata.

The dips in limestone rock commence about the above stated distance from the ferruginous hydro-micas, and for 1200 ft. (366 m.) there are the usual crumplings of strata; building, as nearly as the observations permit a surmise, four alternately narrow and broad anticlinals, looking as if a pressure had produced the former after the latter were formed.

Some notes on a parallel line ±½ mile (800 meters) N. E. of that of Section 1, Part 2.

The road from Chikis to Columbia winds over Chikis rock back of the furnaces, for some distance parallel to the Chikiswalunga Creek. This road is broad, well kept, and reminds one somewhat of the Swiss roads over the principal passes. Many Chestnut and Maple trees shade it at intervals.

There are no exposures for the first ⅛ mile (half kilometer) or so. Near J. Sterline's a quartzite dips E. 40° S. —62°.

One hundred yds. (or m.) south of Sterline's house, on the Columbia road, an argillaceous crypto-crystalline slate barely glinting, dips S. 20° E.—52°.

These two last dips are taken on the opposite sides of a narrow valley, which is followed by a road to the river's edge, near at the Henry Clay Furnace. About ½ mile (0.8 km.) further S. E., under Mr. J. Kline's house, argillaceous slates give a number of dips within the space of a few hundred or yds. (meters) as follows:

About 250 ft. (76 m.) N. of his house a calcaroid rock dips ±S. E.—±50°.

Just opposite the house, and for 100 yds. or meters south, argillaceous slates dip S. 20° E.—50°.

A somewhat less distance south the same rock dips S. 20° E.—56°.

The strike of these slates carry them into and just north of the Tunnel on the section line from which they are distant inland about 2970 feet (905 meters). For a little over 1830 ft. (558 m.) the road crosses a belt of decomposed slates and clays, which very generally form the margin of the two formations, when a dip in true limestone is reached of S.—±50° in the streets of Columbia, and 1980 ft. (823 m.) on the strike from the river's edge.

Part 3. Columbia to Turkey Hill. Direction of Section S. 19° E.

The end of Part 2 is about 441 paces (330 meters) N. W. of Columbia bridge, and about 341 paces (255 meters) N. W. of the Round House for Locomotives which is the starting point in Rogers Survey.

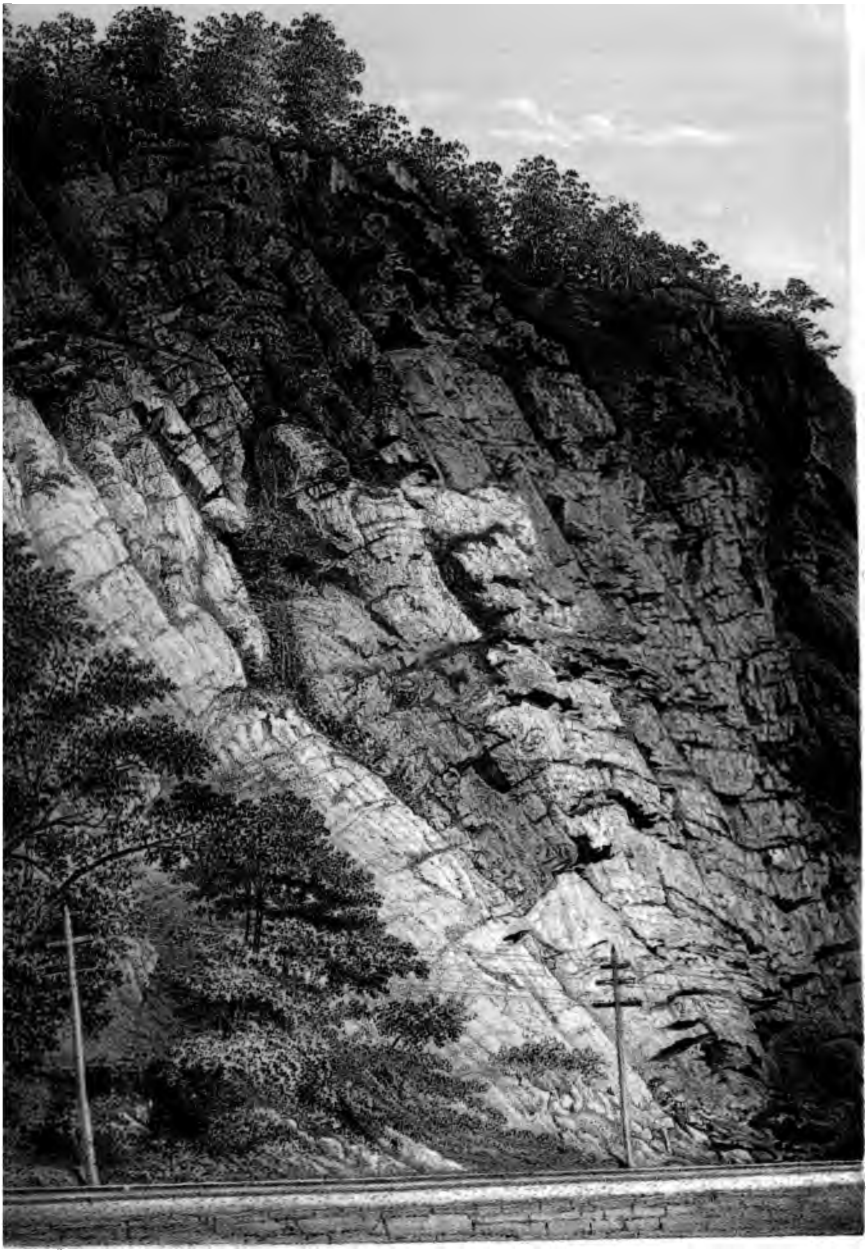
The first dip of Part 3 is about 300 ft. (91 meters) S. E. of the St. Charles Furnace and along the R. R. track.

The hydro mica slates which are very generally the concomitants of the limestone proper, come in between the tunnel and the first exposure of crushed limestone; in this (as in so many other cases) forming the ground or bottom layer of the limestone. The margin of the limestone when it first appears south of the St. Charles Furnace is much broken as in almost all cases at the margin of this formation, as for example north of Cabin Branch Run and West of the town of York. The dips are as follows:

=600 ft. (193 meters) S. E. of St. Charles Furnace.	Crushed limestone	N. 15° W.—44°.
	Rubbly limestone	S.—78°.
	Limestone schist	N. 20° W.—82°.

2nd Geol. Survey of Pa.

GENERAL V



E CHIKIS ANTICLINAL.

	Junction of limestone and slates	**Vertical Strike E. 10° N.**
	Argillite	S.—60°.
	Hydro-Mica Schist	N. 25° W.—78°.
	Limestone schist	S. 6° E.—78°.
640 yds. or meters S. E. of St. Charles Furnace, (=2100 ft.)	Rubbly limestone	W. 20° N.—68°.
	Limestone	S. 15° E.—64°.
	Limestone	E. 35° N.—55°.

There is a short gap here of 400 ft. (122 meters) which may represent a narrow anticlinal, as a calcareous sandy slate dips S. 5° E.—60°. Doubtless the curves are not actually as represented in these minute folds, since it is likely that limestone, slate, &c. will prove continuous over such short distances, but it would be a matter requiring very great power of imagination and ingenuity to so continue them as to present a plausible sequence in what is inextricably bound together. And after such a thing were done, the scale is too small to allow these differences to be of importance, and besides this, there is no certainty that the structure would even then be absolutely right.

I have preferred to consider both these slates and the accompanying limestones parts of one great formation, (as they most probably are,) and where such great variation occurs in short distances to turn the curves into each other in the form most probable in itself, but where the limestone schists and slates fill up large areas without a trace of true limestone, as in the case soon to be considered, I have assigned to them in the map a color of their own.

From this last recorded dip to the next following on the line of the section is a little over one kilometer (3600 ft.= 1097 meters) to Bogle's Grist Mill, near the foot of a small street called Lawrence St., in the town of Columbia. This dip is taken from the interior of a culvert over which the R. R. tracks run, just before the present track of the Reading and Columbia branches off from the line of the Pennsylvania R. R.

This space barren of dips occupies the most populous and busiest part of Columbia, and though well searched, no sufficient exposures were found, owing to the debris with which such a place soon covers its streets and shore line, and also from the fact that the rocks here are deeply overlain with clay. It is most probable that this space is filled by a synclinal of limestone corresponding to that on the other side of the river at Wrightsville, and of which the great bridge between the two places lies approximately in the axis.

Two characteristics in which the sections of these two synclinals of limestone agree are, 1st, in *shape*. The moderate dips and the more gently sloping side of the synclinal is the N. W. side; and second, in the thickness of limestone, as indicated by each section separately, which is about 3000 ft. (914 meters).

The axis of this basin seems to cut the Columbia shore about 1600 ft. (488 meters) S. E. of the Columbia bridge.

This dip in the culvert is in finely laminated limestone, which stands about vertical and strikes east and west.

About 800 ft. (244 meters) S. E. of this spot is another exposure of limestone near the Gas Works dipping S.—78°.

Another dip in limestone at the upper end of the Susquehanna Rolling Mill is N. 12° W.—87°, which may as well be regarded as vertical.*

On the S. E. bank of Strickler's Run, and ±76 yards (70 m.) from the stream, a quarry has been made in heavy compact calcaroid slates, containing small scales of pyrite, many of which are stained copper—reddish brown on the surfaces. Dip N. 12° W.—87°.

This is the commencement of the first high bluff of rock S. E. of Columbia on the left bank of the Susquehanna.

A cut 163 yds. (150 meters) wide and 38 yds. (35 meters) high, has been made (Detweiler's quarry). The bedding is very obscure. Two planes which seem to be most prominent are S. 10° E.—74°, and E. 12° S.—76°.

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* Just south of the Susquehanna Rolling Mill the surveyors of the Columbia and Port Deposit R. R. have established their zero, and as the stations of 100 ft. were marked on the rails all the way down the river, these stations formed the easiest and most reliable method of locating exposures. The plot of the road was afterwards obtained through the courtesy of the Penna. R. R., and the very marked kindness of Mr. Hutchinson, the superintendent of that division, and these observations located upon it.

It will, therefore, be understood hereafter when a number is given as R. R. station number so and so that it is that number of hundred feet down the river along the C. & P. D. R. R. from their initial point at the Susquehanna Rolling Mill.

In a second smaller quarry (Upp's) close to this one the plates of slate become thicker and the bedding more apparent.

Distinct lines of junction are seen between the slates and the limestones on the S. E. side of the quarry. The slate beds are noticeable in their lower members by an efflorescence which covers them in blotches, and resembles the similar blotches which disfigure very many house fronts in Philadelphia.

The limestone at the base of which this efflorescence first appears dips S. 14° E.—58°.

The curved form of the plates of slate near the top of the hill (22 yds. or 20 meters above the track) seem clearly to indicate the arch of an anticlinal, which is corroborated by the diminishing steepness of the dip. Other considerations lead one to consider Strickler's run nearly in the axis of an anticlinal of which the first three dips, noted above, mark the slightly overturned N. W. side, and those of this quarry the naturally placed S. E. sides.

Many of the slates on the N. W. side of the quarry are filled with concretions of quartz. For about 100 yds. (or m.) S. E. this limestone continues, its broad surfaces, pitted and rounded and so broken and crushed as to present the appearance of a conglomerate. Here the dip is S. 12° E.—60°.

Over this lies a drab, sandy limestone of pinkish color.

These dips and observations may be put in concise tabular form as below.

Opposite R. R. Sta. 6, a blue laminated limestone dips S. 10° E.—80°.

A short distance N. E., on a road which debouches opposite R. R. St. 9 and 10, are calcareous slates and argillites containing large crystals of pyrite, dipping vertically and with about E. and W. strike.

The slates here divide into two kinds. One with rhomboidal fracture and earthy lustre, and argillitic smell, not effervescing at all; and leaves of intercalated matter with large pyrite effervescing briskly.

At a small quarry on the S. side of Strickler's Run, and about opposite to R. R. Sta. 16, a broken rubbly calcareous slate, effervescing feebly, dips N. 20° W.—88°.

Opp. nearest R. R. Survey Station.	*Character of Rock, Dip, &c.*
18	Sandy, calcareous slate, dipping N. 10° W.—85°. Effervesces feebly; more strongly on basset edges.
19.5	Calcareous slate. North end of Detweiler's great quarry. Effervesces feebly. Dip, N. 10° W.—88°.
21	Calcaroid* slate. Dip, vertical. Strike, E. 20° N. Contains limestone with pyrite, and effervesces.
23	Calcaroid slate. S. 15° E.—82°. Location of anticlinal axis.
25	Calcaroid slate. S. 25° E.—81°, S. end of Detweiler's quarry.
27	Arenaceous argillite and calcaroid slate. S. 15°E.—83°.
29	Arenaceous argillite. S. 20° E.—80°.
31	Sandy slate. S. 20° E.—81°. N. end of Upp's quarry.
32.5	Impure limestone. Effervesces. "Iron ore was found in this quarry" (Mr. Knight). S. 15°E.—60°. S. end of Upp's quarry.
34	Limestone. Commencement of Droom's quarry. S. 15° E. to—S. 20° E.—62°.
	NOTE.—50 ft. (15 meters) back from this first exposure occur other planes of cleavage, some of them very marked. One in particular dips N.—32°.
	There is a gap here of 900 ft., (274 meters,) or to R. R. Sta. 43, in which the axis of a sharp synclinal has been supposed.
43	Sandy decomposed crystalline slates containing numerous pits and stains of pyrite. Dip, S. 20° E.—82°.
45	Sandy crypto-crystalline argillite. S. 18° E.—72°.
48	Arenaceous argillite and decomposed hydro-mica schist. S. 15° E.—77°.
50	Hydro-mica-schist. S. 15° E.—70°.
51	Hydro-mica-schist. S. 15° E.—82°.
52	Hydro-mica-schist, with pyrite. S. 20° E.—74°.
53	Hydro-mica-schist, much weathered. S. 20° E.—78°.
64	Hydro-mica-schist. S. 18° E.—80°.
	Between these last two exposures I have supposed an anticlinal, which will alone explain the lithological differences further on, and bring the first exposure of limestone met with in the town of Washington into its supposed proper place at Droom's quarry.
	This last dip of S. 18° E.—80°, and another one near R. R. Sta. 70, render this anticlinal impossible to draw as a simple anticlinal, but render a collapse in its centre most probable.

* *i. e.*, Resembling limestone.

The foregoing, from Strickler's Run to the N. W. end of the town of Washington, is a very important belt, and the question of the existence or non-existence of rocks contemporaneous with the lower Silurian limestone has an important bearing on the structure of the rocks and the origin of the Susquehanna water course. In Rogers this strip is considered primal and so colored, although there is nothing in the hydro mica schists which come in near Wortz's house to distinguish them from those which very generally accompany the true limestones.

The direction of the strike across the river is towards Wilton's Cove, just S. E. of which the enterprise of quarrying for roofing slate was undertaken.

The strike of these rocks would bring them south of the great synclinal of the York county side, whose axis very nearly intersects the end of the bridge in Wrightsville (marked "f" in Section 1, Report C for 1874).

The old State geological map makes here an area of "Primal Slates," which crosses the river from the enormous mass constituting the whole of lower York county, and stands as a peninsula in the limestone which reaches otherwise unbroken from Columbia to Turkey Hill. Lithologically, it has been above stated, these schists do not differ from those which alternate with the limestone beds north of Columbia, and from that portion of the Siluro-Cambrian formation which abuts upon the hill through which the R. R. tunnel is driven.

But stratigraphically there is still less justification for this hypothesis, for the direction of strike of the limestones and of the slates which succeed them is nearly enough alike to warrant the assumption that there is no want of conformity here, while the observed dips would appear to admit of no other structure than that of the above mentioned synclinal, which brings the limestones of the quarries south of Strickler's Run between great thicknesses of slate or schists, which are free from calcareous matter.*

* If this hypothesis be correct, the appearance of the map when colored suggests a thrust of between four and five miles (6 to 8 kilometers), which seems to have distorted the original position of things by pushing the left bank bodily that distance to the south (or the right bank to the north) before the New Red Sandstone was laid down (since there are no signs of this thrust in the line of continuity of that formation).

In this view the northern end of Turkey Hill would be once the continuation northeastward of the Creitz Creek Hills of York county; while the moderately straight line of the southern edge of the Lancaster county limestone, which passes north of Turkey Hill through Willow Street and to Gap Station, might have been originally continued southwest by the southern margin of the now well known limestone of the Codorus valley.

The narrow patch of limestone [of which the shape in the map of the old survey is calculated to mislead the eye as to its true relation to its

There is a prominent ridge of these calcareous slates in a vertical position extending from the mouth of Strickler's Run nearly to the Lancaster and Marietta turnpike. The Pennsylvania R. R. follows the base of this ridge for a part of the distance from Columbia to Lancaster. A short distance E. of Mountville this ridge was traversed to Hershey's Mill and the same light colored argillaceous hydromica schist was discovered dipping vertically. The ridge itself which is there the boundary between West Hempfield and Manor townships is not more than a couple of hundred yards or meters broad, and is followed by such rapid alternations of slate and limestone belts as to defy any attempts to separate the farms into slate and limestone farms, each farm containing a good deal of each.

Near the house of Samuel Schultz, which is not far from the N. W. boundary of the borough, the schists last noted gradually give place to a calcareous slate which composes the banks of the river to below Washington.

The bank of the river is lined with large boulders of trap seemingly brought down by the ice from the dykes above Bainbridge, and in all probability more massed at this point than at others, owing to the conformation of the bank or the backing up of ice floes by the interruption of Turkey Hill and the numerous islands just south of Washington.

About 98 ft. (30 m.) south of the school house in Washington and on the river bank a hydro mica schist dips S. 25° E.—50°.

Again just below, the slates dip S. 16° E.—64°.

About 492 ft. (150 meters) further on limestone appears in place dipping S. 24° E.—50°.

Opposite Jacob Ohmit's Susquehanna Hotel, limestone dips S. 20° E.—60°.

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congener on the Lancaster county side], and which was noted near Harris Wilton's Cove, through Prospect and around the old Margaretta Furnace; would join itself most naturally to the narrow thread of limestone which descends the Conestoga and debouches upon the river between cliffs of the older rocks. There are reasons, however, for not accepting this view at present.

It is enough for the present to assume that the slates between Washington and Columbia are all of Lower Silurian age, and belong to the limestone with which they are interbedded.

Just S. E. of the Hotel large masses of limestone resembling the Ocoe slates dip ?—45°.

492 ft. (150 meters) N. of Staman's Run very micaceous soft hydro mica schist dips vertically and strikes E. 14° N.

This soft rock alternates to limestone to within 50 m. of Staman's Run. The dip is very steep sometimes inclining to S. E. and sometimes to N. W.

This makes a clear synclinal between Staman's Run and the upper end of Washington, the h. m. schists forming the river bank of this town seeming to be the same which make the beds of problematical age on their vertical rise in the northern outskirts of Washington and their more gentle descent throughout its southern part.

About 150 meters S. E. of Staman's Run a banded limestone dips S. 14° E.—60°.

Near David Herr's property the limestone (which averages a nearly vertical dip) becomes more and more micaceous.

For about 200 yards or meters N. W. of the Grist Mill no rock in place is visible. At the mouth of the Grist Mill Run limestone appears almost vertical.

Between these last two dips there is every reason to suppose another synclinal, but if so the measures are rising above the present level and the limestones first noticed in the beginning of this Part, rise and do not reach the surface again between this point and the fault with which it ends.

These exposures of limestones continue for some distance dipping from 80° to 90°. The variations occur over short distances.

Limestones appear 55 yards (±50 m.) S. E. of O. Strickler's house dipping about S. 35° E.—±80°.

In the middle of the tangent next before the curve of the R. R. around Turkey Hill a limestone dips N. 30° W.—74°.

130 yards (120 meters) N. W. of the Station, Limestone dips N. 20° W.—60°.

The Turkey Hill Station is just at Wistar's Run. 33 yds. (30 meters) S. E. of Wistar's Run limestone dips N. 18° W.±88°. This dip is repeated several times and almost to the end of the tangent where a dip in calcareous slate pitted with iron holes gives N. 10° W.—nearly vertical.

At the very extremity of the tangent, *i. e.* where the Turkey Hill Rocks jut out from the shore into the river, a dip in Chlorite Slates entirely free from calcareous matter gives S. 14° E.—60°.

No pause has been made to note the locally and rapidly changing position of the rocks during the last few noted dips. It is entirely analogous with similar exhibitions elsewhere, and especially in the section across the River (No. 1 of Report C. 1874) that in the vicinity of a fault such as this at the end of the R. R. tangent on Turkey Hill seems clearly to be, the measures are almost invariably crumpled like a piece of soft paper when the opposite edges are pressed.

A specimen of limestone was taken from the last exposure S. E. of Turkey Hill Station on Wistar's Run for closer examination. Under a Stanhope lens it seems to be composed of fine flakes of mica in contact everywhere except in certain streaks and spots where they are held together by calcareous matter. This rock evidently corresponds with a similar exhibition near Bull's Run on the opposite side of the river and about 5 miles (8 kilometers) south of Wrightsville. In both cases proceeding from the north to the south (the limestone valley of Cabin Branch Run on the York Co. side and of Staman's Run or Washington on the Lancaster Co. side) the per cent. of $CaCO_3$ in the rock decreases by imperceptible gradations while the micaceous character of the rock increases at the same time, and the pyrite commences to appear in separate and well formed crystals.*

Part 4. Turkey Hill to Safe Harbor. Direction of Section Line S. 24° E.

There were long stretches of road where the R. R. station marks seem to have been obliterated, or at least were not found.

* Another fact which might be cited to confirm the supposition of a southerly displacement of the left bank. Candor compels the addendum, however, that all that it certainly proves is that in certain layers (probably near the lowermost) these physical peculiarities are continuous over wide areas.

At Station 250 from Mill in Columbia (=25000 ft. from the same) at the end of Part No. 2 the rocks are compact hydro micas of greenish color frequently noticed on the opposite side of the river.

Dip N. 20° W.—65°.

On a point of the curve near Station 260 the slates dip S. 14° E.—60°.

These slates become more chloritic without losing their character of hydro-micas.

These rocks are much convoluted from this point around the curve. The average strike is E. 10° to 20° N.—vertical.

Before reaching the first knob below Turkey Hill a huge mass of rock dips N. 18° W.—89°.

At the point of greatest bulge, chloritic slates with quartz dip N. 45°W.—63°.

A culvert for the passage of a beautiful cascade is found about 546 yds., 500 meters, from Turkey Hill. It is solidly built upon the chloritic schist, which here all dip ±N. W. ±45°.

At R. R. Station 342 the dip is still the same.

From the dip N. 18° W.—80° the succeeding dips seem to belong to the S. E. side of a synclinal of gentler slope than the vertical N. W. side; but, if the seven dips here considered are properly placed, indicate a basin formed of nearly 976 ft. (297 meters) of slates.

The seven dips referred to are as follows:

Chlorite Schist, N. 18° W.—80°.
Chlorite Schist with quartz, N. 45° W.—63°.
Chlorite Schist, N. 45° W.—45°.
Chlorite Schist, N. 45° W.—45°.
Chloritic Hydro-mica Schist, N. 25° W.—60°.
Chlorite Schist, N. 20° W.—45°.

The rocks on the inland side of Turkey Hill are hydro-micas, similar to those found along the river. The tops of the hills are cultivated, and seem to be flourishing farms. The soils are occasionally red.

There follows here a space of about 437 yds. (400 meters), in which the rocks do not furnish outcrops near the river, from which the hills, covered with underbrush, slope back.

At Station 383, S. E. of Turkey Hill, the dip is W. 40°

N.—80°. 15 yards further on this changes suddenly to N. 40° W.—62°, and 30 yards further on N. 25° W.—64°.

This and the following twelve dips have very nearly the same inclination, and less than the first named by 18° to 20°. Under these circumstances, and without light as to the structural causes of this phenomenon, it is embarrassing and somewhat hazardous to draw these as component parts of an anticlinal, and to consider the first of these as a mere local deviation ; yet nothing else can be done, for the least of them is as much larger than the average dip of the N. W. side of the anticlinal.

These measures imply a perpendicular thickness of 3600 ft. (1097 meters), or fill up a horizontal distance of 5600 ft. (1707 meters), namely, from R. R. Station 383 to R. R. Station 433.

These dips are as follows:

R. R. Survey Station.		
±383	Chlorite Schists, ...	W. 40° N.—80°
15 paces further S. E.	" "	N. 40° W.—62°
30 paces further S. E.	" "	N. 25° W.—64°
386	Finely laminated slates studded with pyrite, ...	N. 35° W.—67°
390	Mouth of small stream, forming cascade and cutting rocks. Non-pyritiferous slates, ...	N. 30° W.—61°
395	. . . .	N. 25° W.—52°
402	Middle of tangent, ...	N. 20° W.—62°
405	. . . .	N. 25° W.—62°
410 to 422 inclusive.	. . . .	N. 25° W.—62°
422	. . . .	N. 20° W.—58°
424	Dark green soft chlorite band, ...	N. 25° W.—54°
430	. . . .	N. 20° W.—64°
About 433	Pyrite in large and small crystals, not thickly strewn, ...	N. 18° W.—60°

No exposures are noted from this point to nearly 454, a distance of 1500 ft., (457 meters,) and this fact, together with the diminished steepness of the next group of dips, might at first sight suggest the placing of the axis of the synclinal between these two points, but the structure given appears better grounded.

At about 458 is the last of the clearly chloritic rocks, and the lower limit of this formation has therefore been placed here.

The measures seem to rise in the air from this station, (R. R. 465,) and though broken by a doubly collapsed anticlinal near the Grubb ore banks, to continue to ascend till opposite McCall's Ferry, when the lowermost rocks of the section at water level appear.

This necessitates a perpendicular thickness, measured from this point between Turkey Hill and Safe Harbor, (R. R. Sta. 465), of very nearly 2 miles (to be exact, 1.86 miles, or 3 kilometers) of mica schists.

A description of these rocks and dips here follows:

R. R. Survey Station.	*Character of Rock, &c.*	*Dip.*
454	. . . .	N. 18° W.—48°
457	Near Sour's Ferry, ...	N. 20° W.—40°
459	. . . .	N. 25° W.—50°
468	Mica schist with pink and white quartz.	N. 20° W.—58°
476	Mica schist, ...	N. 10° W.—54°
485	. . . .	N. 30° W.—51°
488	. . . .	N. 25° W.—41°
494	. . . .	N. 20° W.—58°
499	. . . .	N. 18° W.—58°
503	. . . .	N. 25° W.—40°
516	. . . .	N. 18° W.—42°
530 (about 200m. N. W. of Conestoga Creek.)	Compact hard mica schist with intercalated quartz, ...	N. 8° W.—52°
About 539	Conestoga Creek, S. E. side of mouth of creek, ...	N. 10° E.—24°

Part 5. Safe Harbor to Ladder Rock. Direction of Section Line. S. 21° E.

One hundred and nine yards (100 meters) southeast of the bridge over the Conestoga bridge, gneissoid mica schist with seams of quartz dip N. 15° W.—48°. The rocks S. E. of Conestoga bridge become rapidly solid, heavy bedded, compact gneiss, containing a small quantity of pyrite.

R. R. Survey Station.	*Character of Rock.*	*Dip.*
542 (about 100m. from bridge)	Gneissoid hydro-mica-schist, ...	N. 15° W.—48°
600 ft. (183 m.) further S. E.	Compact gneiss, ...	N. 8° W.—45°
300 ft. (91 m.) further S. E.	Gneiss seamed with quartz, ...	N. 14° W.—45°
553	Gneiss, ...	N. 14° W.—45°
555	Gneiss, ...	N. 10° W.—45°

Between these last two dips occurs a trap dyke which intersects the bank of the river. It is distinguished from the surrounding rocks by the dull, earthy, yellow color which its decomposition imparts to the soil, as do the most of those dykes whose natural position is among the rocks of the New Red Sandstone.

The N. W. side of this dyke consists principally of broken fragments or prismatic blocks of this earthy color on exposed surfaces. Higher up the hill, where the rock is intact on the S. E. side, and along the course of a small stream whose lower part coincides with this dyke, the blocks are larger, of a dull brick reddish color and presenting externally the shells with furrows which have been often noticed before.

A gneiss on its S. E. side dips as above stated N. 10° W.—45°. The line of the dyke through the hill is approximately the line of this small mountain stream which here empties into the Susquehanna. The appearance of the sudden break in the continuity of the hill is very peculiar as is also the opening at Safe Harbor through which one looks through a narrow river of hills of the older slates into a gentle rolling limestone valley.

The gneiss from the Conestoga to this point is very thickly seamed with quartz, very much foliated and very rich in mica, which latter determining, and lying parallel with the bedding, does not show where the edges of the rock are exposed.

Many cuts made in the construction of the C. & P. D. R. R. have revealed a stone which would be of value for masonry—a massive bluish heavy bedded gneiss.

R. R. Survey Station.	*Character of Rock, &c.*	*Dip.*
558	Gneiss, ...	N. 15° W.—40°.
568	Gneiss, ...	N. 10° W.—33°.
578	Gneiss, ...	N. 8° W.—45°.
586	Gneiss, ...	N. 8° W.—45°.
590 (Just S. E. of J. Boatman's house.)	Gneiss, ...	N. 18° W.—68°.

The color of the gneiss at this part of the section shows a tendency to become more greenish and the rock less quartzose.

The dip becomes shortly afterwards again about 45° in strength and planes of cleavage occur which are very confusing, but the fact that the convolution or curling is very great while the general dip is about 45° may be seen on close inspection.

The last dip above recorded therefore may be caused by a subordinate anticlinal of very short scope, or may be the result of the waving of the beds so often referred to. In neither case can it have any very important bearing on the structure.

In the river about quarter of a mile (0 .4 kilom.) below the mouth of the Conestoga Creek the trap dyke crosses at a distance of about 150 meters (163 yds.) S. E. of the sculptured Indian Rocks. In the middle of the river this dyke is about 10 meters (11 yds.) broad and seems to strike about E. 20° N. very nearly with the strike of the rocks which it has penetrated.

The evidences of the continuation of this dyke inland exist in the shape of loose fragments of dolerite lying N. E. of the Safe Harbor school house a little over half a mile (820 meters) N. of its exposure on the river front. This dyke may continue further up the Conestoga to Millerstown and connect with the traps exposed there as indicated in the map of the first survey, but no evidence of this could be obtained.

The Indian sculptured rocks are, as stated above, just above the line of this dyke in the river. The rock seems to be a mica schist dipping about N. 30° W.—30°.

On the road leading to Colemanville and near a house marked above Witmer's on the county map was an old ore mine known as Good's bank.

R. R. Survey Station.	*Character of Rock, &c.*	*Dip.*
596	Gneiss, curling and wavy, ...	N. 18° W.—45°
600	Ditto	Ditto.

A gap of 1600 ft. (488 meters) occurs here with no exposures. The next one at R. R. S. S. is N. 25° W.—50°. Perhaps the amount of steepening here was too little to warrant the structure given (*i. e.*, an overturned anticlinal with axial plane dipping N. W.), but in any case it cannot make very much difference in the positions assigned to the strata, but would add 1600 ft. (488 meters) to their thickness.

At R. R. S. S. 638 a coarse gneiss dips N. 25° W.—18°. The rock here is so hard, compact and massive that it is almost entitled to be called a granite.

A distance of 2200 ft. (670 meters) here again intervenes between this and the last dip, but here the rising of the measures to the S. E. is clearly shown by the low angle of inclination. This is very near the terminus of C. B. Grubb's ore R. R. on the river bank.

The Conestoga ore mines of C. B. Grubb & Co. lie about ¾ mile (1.2 kilom.) N. E. of this point.

At R. R. S. S. 650, 1200 ft. (366 meters) down the river from the last dip, is another dip in compact gneiss of N. 25° W.—23°, evidently conformable with the last. There are no signs of plications between the two.

At about R. R. S. S. 657 the gentle dipping lower side of an anticlinal commences to be felt by a dip of E. 25° S. —38° in gray heavy bedded gneiss with biotite and pyrite, which seems to be continued for 1400 ft. (427 m.), and at the end of that distance, or at R. R. S. S. 672, is repeated. At R. R. S. S. 682, near the mouth of the Pequea Creek, the steepness increases, while the direction remains constant, in a dip of E. 25° S.—60°. At R. R. S. S. 684 a gentle dip of S. 25° E. is visible, and this is followed by one at R. R. S. S. 704 of S.—24°.

There is clearly an anticlinal here which, though gentle, breaks the uniformity of the N. W. slope, which if continued as drawn from N. of Safe Harbor, would have 2400 ft. (732 meters) more of rock than it shows at present.

The anticlinal comes in between R. R. S. S. 650 and 658, and affects the stratigraphy for about 4800 ft. (1463 m.) along the line. The S. E. descending dips are as follows:

R. R. S. S.	*Character of Rock.*	*Dip, &c.*
672	Bluish gray, heavy bedded gneiss, containing biotite, ...	E. 25° S.—38°
683	Rocks in the river and beach, ...	E. 25° S.—60°
684	N. side of Pequea Creek, ...	S. 25° E.—gentle
704	On R. R., ...	S.—24°

Here the northwesterly dip is again renewed, and continued to the culmination of the great anticlinal near McCall's Ferry, or from R. R. S. S. 717 to R. R. S. S. 840. This distance along the rails is 2.3 miles, (3.7 kilometers,) and along the line of section it is but little short of this.

The following is the list of this group of dips:

R. R. S. S.	*Character of Rock.*	*Dip.*
717	. . . .	W. 20° N.—20°
730	. . . .	W. 40° N.—14°
744	. . . .	N. 10° W.—34°
747	. . . .	N. 10° W.—18°
754	. . . .	N. 40° W.—18°
763	Weathered brown mica schist, ...	N. 40° W.—28°
783	Brown weathered mica schist, ...	N. 45° W.—33°
788	. . . .	N. 45° W.—24°
796	Mica schist, ...	N. 35° W.—25°
800*	. . . .	N. 30° W.—32°

*** At this point the N. W. dip seemed to the observer to be so uniform, and continued over so long a distance with such gentle slopes, that he sought an explanation in the "sagging" of the exposed ends of the soft gneissic and mica schistose strata which were exposed along the river. A similar exhibition of long continued N. W. dip is seen along the Schuylkill River above Philadelphia, though at no very great distance from either bank the appearance is not at all that of monoclinal structure. These hypotheses were, however, believed to**

Part 6. Ladder Rock to Cutler's. Direction of Section Line. S. 23° E.

R. R. S. S. *808.*	*Character of Rock.*—At this point the mica schist seems to be more than usually studded with a brown mineral resembling garnet. The quartz seams (which are abundant, and which are disposed alongside the schist, just like the quartz seams in purely chloritic slates,) are also full of cavities, the latter sometimes of rhomboidal form, containing brown fragments as the result of the decomposition of the mineral which once filled them. When the mineral is not entirely changed to this dust, or iron ochre, it appears to have adamantine lustre, and to cleave in definite planes with ease.	*Dip*,—N. 20° W.—34°.

R. R. S. S.	*Character of Rock, &c.*	*Dip.*
811.5	Mica Schist, ...	N. 30° W.—12°.
818	Chloritic Mica Schist, ...	N. 10° E.—18°.
821	Chloritic Mica Schist, ...	W. 20° N.—18°.
823	(Small Creek,)	
834	Chloritic Mica Schist, ...	W. 30° N.—18°.
840	Chloritic Mica Schist, ...	N. 18° W.—12°.

Here is the axis of the great anticlinal a stratigraphical feature so important and apparently so far reaching in its effects as to entitle it to the separate name of the Tocquan Creek Anticlinal. The axis passes through the lower part of the larger island, and its course is for a short distance nearly parallel to that of the Tocquan Creek at its entrance into the Susquehanna.

The rocks which are visible at this point are clearly of the gneissic series and the lowest exposed within the limits of the State of Pennsylvania on the Susquehanna River, the Peach Bottom Slates being separated from this horizon

be unnecessary to account for the facts after a larger amount of territory had been studied, and especially since the dips of the section had been plotted on an accurate and sufficiently large scale. It is generally the case, that under this latter circumstance the proper structure plots itself, as it were, leaving comparatively little room for varying the lines of bedding.

Structure which does not thus suggest itself, when aided by lithological and other helps, is seldom to be much relied on for accuracy.

by 14400 ft. (2.7 miles or 4 .3 kilometers) perpendicular thickness of rock. The position and direction of this anticlinal as well as the lithological character of the rocks along which its course would be marked, agree well with the same features in the Archæan belt which extends down from the neighborhood of Phœnixville through the Gap Hills and Mine-Ridge. Martic township, which with a part of Providence township separates this outcrop on the river from the Georgetown Hypozoic belt near New Providence (as given on the State geological map of the first survey) is famed for the "Martic" hills, which take up nearly its entire area. About half a mile or 0 .8 kilometer N. E. of the mouth of the Tocquan and near the Bethseda P. O. road, Pulpit Rocks 100 ft. (33 meters) high are noticeable. The rocks noted between here and Martic Forge on the Pequea Creek and Mount Nebo P. O. are bluish and otherwise colored mica schists dipping gently and steeply in abrupt alternations.

Deposits of "gravel" were remarked in several places between Mount Nebo and the mouth of the Tocquan, but the rocks were not certainly proved to have been transported from any remote points.*

The localities S. W. of Mount Nebo and two northwest of Bethseda P. O. are marked on the township map as localities of this gravel. Another point of resemblance between the Georgetown belt and this one is the principal and most distinguishing characteristic of the former and its congeners, the Welsh Mts., viz: the abundance of fragmentary rocks, bearing the appearance of having been rolled. Wherever rock in place was observed (as on the Marticville road between Bethseda and Rawlinsville) it was found to be either mica schist or crystalline schist.

For these reasons it is rendered probable that the rocks of this anticlinal are continuous with the Georgetown belt.

From the axis of this anticlinal there is an unbroken series of S. E. dips, bringing to view ever newer horizons

* A sub section along a part of the southern side of the Tocquan anticlinal several miles N. E. of the river will be found further on.

over a distance even longer than that which formed its northern limb.

These follow here:

R. R. S. S.	*Character of Rock, &c.*	*Dip, &c.*
866	Chloritic Mica Schist, ...	S. 15° E.—12°
873	Gneissoid Mica Schist, very much convoluted, ...	E. 15° S.—38°
891	Mica Schist, less contorted than usual. Forms a heavy bluff at the narrowest part of the river, which is here not over 300 yards wide, ...	S.—38°
892	. . . .	S. 5° W.—22°
905	. . . .	S.—24°
909	. . . .	S. 10° E.—30°
911	Gneiss and Mica Schist. Very much convoluted, ...	. . . .
—	McCall's Ferry, ...	. . . .
923	Mica Schist, ...	S. 20° E.—34°
925	" "	S. 15° E.—25°
927	" "	*S. 12° E.—30°
935	" "	" "

This dip is continued for 984 ft. (300 meters) S. E. of McCall's Ferry.

R. R. S. S.	*Character of Rock.*	*Dip.*
953	Weathered fine grained mica schist, .	S. 25° E.—42°
979	. . . .	S. 20° W.—75°
981	. . . .	S. 20° W.—gentle.
994	200 m. N. W. of Cully's Station, . . .	S. 20° E.—40°
1009 to 1030.	The measures are frequently interspersed with ferruginous bands, . .	. . . .
1030	Ferruginous Mica Slate, ...	S. 20° E.—43°
1042	. . . .	S. 25° E.—57°

The last dip is in a heavy cut, and is assumed in the structure to indicate a small crumple in the strata, though the inclination of the strata at the two places is just sufficient to make either interpretation equally likely. This being the case, the natural tendency is to reduce the thickness of the measures as much as the observation will permit.

* As at first recorded, these dips were S. 10° to 20° W.; on close examination, however, it was found to be a mistake. It is true that this dip is frequently found among the exposures of the edges of the strata, but these instances are to be considered those of "sagging," or due to excessive convolution.

From this station 4800 ft. (1464 meters) below Cully's Station and 1600 ft. (488 met.) N. W. of Muddy Creek to a point 1200 W. (366 met.) N. W. of Fishing Creek, the measures dip in one direction and with tolerably uniform gentleness. The following is a list of dips:

R. R. S. S.	*Character of Rock, &c.*	*Dip.*
1059 opposite middle of large island.	Gneissoid Mica Schist, ...	S. 20° E.—32°.
1063	Mica Schist, ...	S. 20° E.—42°.
1068	(Muddy Creek mouth), ...	S. 15° E.—44°.
1084	Hard mica schist with large pyrite, . . .	S. 20° E.—40°.
1095	. . . .	S. 15° E.—34°.
1106	Quartzose Gneiss, ...	S. 25° E.—43°.
1112	. . . .	S. 20° E.—44°.
1120	(Phite's Eddy Point), ... Banded Gneiss and mica schist, containing much Quartz, ...	S. 30° E.—40°.
1130	Compact gneissoid mica schist, ...	S. 25° E.—38°.
1153	Hard mica schist, (white in strong light), ...	S. 40° E.—48°.
1178	Quartziferous Mica Schist, ...	E. 40° S.—62°.

Part 7. Cutler's to Maryland Line. Direction of Section Line S. 40° E.

Five Hundred feet (152 met.) from this exposure and 1100 ft. (334 m.) from Fishing Creek is another single N. W. dip which it was also assumed was the result of a curl of the measures. These suppositions are made according to the weight of probability, but they would be hazardous conjectures were they of great importance in the general structure. In such a case, before attempting to draw them, a careful examination along the strike line of the solitary dip would be necessary.

As it is, this is not of sufficient importance to warrant the labor; and as the effect is to diminish the almost incredible thickness of the beds, it is inserted.

At R. R. S. S. 1183 (±70 paces N. W. of G. W. Sweigart's house,) coarse mica schist with layers of quartz dips W. 35° N.—30°. There is some doubt however whether this outcrop is in place.

At R. R. Station 1190 (close by the mouth of Fishing Creek) brown sandy slates dip E. 35° S.—78°*.

This exposure marks the re-commencement of the chlorite slates interrupted for nearly eleven miles (17.7 kilometers) by the intrusion of the gneisses and mica schists.

No exposures of rock in place were observed from here to Station 1214, so that the question of the conformability or non-conformability of these measures here is not capable of being settled by actual demonstration. This gap in the section covers a belt of about 547 yards (half a kilometer) southeast of Fishing Creek.

There is, then, an absence of exposures for about 547 yards (half a kilometer) southeast of Fishing Creek.

The first is at R. R. S. S. 1224, near E. Sweigart's barn, where a chloritic rock with quartz dips E. 35° S.—24°.

At about R. R. S. S. 1246, 2200 ft., or 661 meters further along, and near J. Carr's saw mill, the same rock gives a dip of S. 45° E.—70°. There is hardly room to doubt that the axis of a synclinal traverses this gap of 2200 ft., more especially since there is the lack of outcrops usual to the exposed portions of a synclinal in soft rocks. There is about the same distance between the exposure on Fishing Creek and that near Sweigart's barn as between the dip near Carr's and the next at about R. R. S. S. 1280, or nearly opposite the head of Caldwell's Island. This latter dip is in quartzose chloritic hydro mica schist, in which many chloritic layers are interbedded. It is E. 35° S.—68°. This rock is a relation of the Peach Bottom slates, to which the section has now very closely approached.

At R. R. S. Sta. 1286 the same rock dips E. 30° S.—80°, and at R. R. S. Sta. 1290, E. 20° S.—64°. These dips, with other considerations connected with the general structure, make three tight folds here quite possible.

As just stated, at R. R. S. S. 1286 (nearly opposite the southern end of the "mount," *i.e.*, Mount Johnson, or Caldwell's Island), quartzose chloritic hydro-mica schist dips E. 30° S.—80°. At R. R. S. S. 1290, or about opposite a point

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* **Fishing Creek Station is about R. R. Sta. 1204.**

on the Island, 100 yards, or meters, south of the Mount, Chloritic Slates dip E. 10° S.—64°. Between these two a subordinate anticlinal has been placed.

At R. R. S. S. 1299, or nearly opposite the middle of Mount Johnson Island, a very green wavy chlorite slate dips S. 35° E.—78°.

At about R. R. S. S. 1314 a chlorite slate with quartz dips E. 35° S.—74°. (This latter dip is opposite a point near the end of the Island.) Between this and the next dip, at R. R. S. S. 1323, another subordinate anticlinal has been placed. There are two dips together at 1323 and 1324, which give respectively E. 35° S.—58° and S. 25° E.—62°. These two are situated but about 109 yds. (100 m.) N. of the slate factory. The rock in which the dip was observed resembles the genuine marketable slates in many features, but it is greener, more chloritic, and very much convoluted (as the disagreement in the strength and direction of two exposures so near together sufficiently shows). In fact, by passing slowly along the line of the R. R. and examining the texture of the rocks, the conviction gradually gains favor that there is an insensible alteration of the more chloritic hydro-mica schists into the dark purple black Peach Bottom slates, and the belt of true roofing slates is so narrow and so unique that it appears probable that the cause of this alteration must have been an essentially local one.

The slate ridge comes in here abruptly, and covers in several narrow belts (of a few yards or meters each in width where the really valuable slate is found) a stretch of river of, more or less, 400 ft. (122 meters).

A description of the quarries will be found elsewhere. A dip of a large exposed face in the quarry gives S. 20° E.—80°. Two other dips in the same slates near by are E. 10° S.—58°, and S. 20° E.—50°.

About 164 ft. (50 meters) N. W. of Peters' Creek, and close by the slate works, an exposure in fine grained black slate gives S. 40° E.—64°.

Just N. W. of R. R. bridge over Peters' Creek a heavy cutting in massive quartz slate shows dips of S. 20° E.—55°.

The indications that this is the southern side of a rock arch here are strong, but if so it must be an overturned rock arch since N. W. dips are here very rare.

In the near vicinity of these last dips, and still close by Peters' Creek bridge, a mass of crystalline schists intercalated with quartz dips S. 30° E.—52°, very slightly chloritic.

By this structure that part of the chloritic formation which lies between the southern slope of the great primordial belt and Peters' Creek is about 1600 ft. (487 meters) in thickness, of which the lower six hundred feet (183 meters) are, more or less, charatcerized by the properties of roofing slates, the lowest strata of all being actual roofing slates in the vicinity of Peters' Creek, perhaps made locally so through the presence of the trap dyke mentioned above.

At R. R. Station 1346 a chlorite schist dips S. 25° E.—45°. At 1348 the dip is S. 25° E.—55°. At 1349 a chlorite schist dips S. 45° E.—20°. At 1351 the same rock, with quartz, gives E. 30° S.—70°. In the bed of the river, off the mouth of Peters Creek, a fine grained black slate, whose lithological characters are not so easily noticed owing to the action of the water, gives S. 40° E.—64°.

A very interesting and curious quartz slate, interspersed with mica, occurs at R. R. Sta. 1352, and near to Peter's Creek bridge. The dip is S. 45° E.—58° to S. 30° E.—52. It is this massive rock which was referred to above as indicating by thegraceful curve of its bedding an overturned anticlinal, of which it seems to have formed at one time the sheath.

There is another importance to be attached to this quartz rock, and that is, that it seems to overlie the valuable roofing slates to the south, as far as the latter could be examined, or for some six miles southwest over the corner of York County, and down into the State of Maryland.

This same quartz rock occurs on the other side of the river, a few hundred yards, or meters north of McCall's house at the canal basin below Peach Bottom, York County.

After passing the mouth of Peter's Creek, the first objects that attract attention are the fragments of trap lying on the south shore, and along the bed of the creek towards Wick's mill.

Two exposures of trap in place (one of them definitely proven to be the continuation of the great eastern dyke) occur but a few thousand feet from the river, one close against the roofing slate near McClanahan's, and throughout Jos. Stubb's property, and the other (a line discovered and pointed out to me by Dr. C. H. Stubbs) running apparently from Geo. Harlan's to Geo. Hewes, a distance of about one mile, (or 1 .6 kilometers,) and entirely separated from the main dyke.

While, therefore, the accumulation of trap boulders on the flat southern shore of Peter's Creek would by itself have little significance, in connection with the above facts, it has the very greatest, because it is the only point at which the writer has been able to fix the probable traverse of the river by this rock.

The structure supposed in the section will not assign to this rock contemporaneity with the Chikis Quartzite, nor former continuity with the Quartzites to be noted further down the river. But the correct interpretation of the stratigraphy here is of the greatest difficulty, and the results are submitted with modesty as simply the best that the author can give in the absence of fossils, and in a region of such great disturbance.

These Peach Bottom Slates near Peter's Creek appear on the section as near the very base of the chloritic series, and, therefore, separated from the Chikis Quartzite (if the Turkey Hill measurement may be relied on) by not less than 3600 ft. (1097 meters).

In point of fact the structure to be next described would separate this heavy bedded quartz slate from the two quartzites further south (which can be connected in time, with reasonable probability) by over 4000 ft. (1219 meters) of perpendicular chlorite schists.

South of Peters Creek there is a broad flat ground over which repeated observations failed to bring to light any rock in place which could guide the geologist in continuing the structure from this point to a point about 4000 ft. (1220 meters) down the river.

Under these circumstances the author was at first obliged to make a gap here, and reluctantly abandoned the attempt to make the hypothetical structure continuous to the State line.

As a last resort the bed of the river, which is here shallow, was examined by drifting down the stream in a canoe and anchoring over a ledge till its approximate dip was obtained and a specimen procured. For giving the structure this expedient proved excellent, ledges being found which were apparently covered up by soil for long distances from the river, but the lithological peculiarities of the rocks were found to be so greatly changed that it was almost impossible to depend upon them. This was partly owing to the fact that specimens could only be obtained with difficulty and those most easily obtained (the looser) were less reliable owing to the greater action upon them by the water. This latter disturbing element reduced the strata to arenaceous rocks which on fresh fracture seem but little colored and showed evidences of great internal decomposition.

The first of these dips was at R. R. Station 1367 in what appeared to be the remnant of a chloritic rock with a dip of S. 40° E.—45°.

This is about the position of the old Peach Bottom Ford.

Nearly opposite 1370 and about 300 yards or meters from the shore a chlorite schist seems to dip S. 40° E.—30°.

Nearly opposite 1380 and about the same distance from the shore a massive ledge of rocks appears which is not traceable at the bank at all. It appeared to be a chlorite schist dipping about S 20° E.—54°.

Opposite 1393 a chlorite schist dips about S. 10° E.—50°.

At R. R. S. S. 1396+ an exposure is seen in chloritic hydro-mica schist very much convoluted. General dip—zero.

About R. R. S. S. 1400 a most curious instance of folding is exhibited on the side of the R. R. where the flanks have been cut through. The chlorite slates dip about E. 30° S.—53°, apparently perfectly conformable for some distance, yet a closer inspection of the rock seems to make it likely that the beds are, in fact, pressed back on each other absolutely flat. Layers can be selected exhibiting marked peculiarities from the distribution in them of quartz and other foreign minerals, and these layers can be followed around an acute angle and be traced with the same bedding but a few feet below their upper exhibition with apparently identically the same bedding. This is a most striking illustration of the kind of plication to which these rocks have been subjected.

The extent of this plication is too small and its abruptness too great to be shown on the section, more especially since a re-examination has left the main fact in some little doubt.

At R. R. S. S. 1410 arenaceous white laminated quartzite dips S. 25° E.—37°. This rock has on occasional planes thin deposits of mica.

At 1411 leached out chloritic mica schist dips S. 25° E. (?)—45°. At 1413 a dark green chloritic schist dips S. 25° E.—50°.

At R. R. S. S. 1415 the same or a heavy bedded quartzose sandrock exhibits what appears to be the dying out end of an anticlinal which the R. R. cut has entirely removed, and which probably did not extend above water level more than 6 or 7 meters, or yards, further to the W. 15° N., in which direction it appears to be subsiding ; but this is a delusion, caused by a curved plane of cleavage, the real dip being S. 35° E.—60°.

At R. R. S. S. 1419 arenaceous chloritic finely laminated Slate honey combed with seams of quartz dips E. 35° S.—50°.

At 1418 a heavy bedded quartzose sand rock dips ±S.—±50°.

At R. R. S. S. 1422 Greenish sandy slates very much convoluted dip S. 28° E.—15° to 70°.

This extreme convolution, the sandy texture, and dull green color of these rocks form their salient characteristics in this portion of the section.

At about 1427 massive chlorite schist dips S. 35° E.—50°. Rocks convoluted, twisted and filled with segregated quartz.

At R. R. S. S. 1432+immense boulders of massive rock rise like "pulpit rocks" ±131 ft. (40 meters) above the level of the track, but some distance back from it. Their dip seems to be±N. W.±45° (?)

At 1434 Williamson's Point stands vertically 150 ft. (46 meters) above the track. The rocks consist of a layer of light bluish green quartzose sand rock and very hard, on the side of which come in softer and more micaceous layers filled with quartz. The average dip is S. 24° E.—±64°.

At 1435 then comes in a lenticular vein of trap occurring in such a way as to resemble very much a fine thread of dolerite.

It narrows to nothing at the level of the R. R., and widens to 3 to 4 inches (8 or 10 c. m.) at 8 yards or meters above the track.*

The cleft which it fills is not made between separate layers of bedding, but intersects these, as may be seen in specimen 1760, which is a very fine exhibition of the vein in its gangue. For part of its course it lies in contact with the hard laminated arenaceous rock on one side and with a dark green chloritic mica schist on the other.

The dip of the dyke is about E. 35° S.—75°. Some ten yds. or meters above the level of the R. R. track it may be seen to fork and extend one tongue through the rock for a short distance at an acute angle to the direction of its main mass.

The rock is very wavy, but the dip assigned to the vein is very nearly that of the bedding, though not exactly, as it cuts through the crests of some of the little wavelets.

At R. R. S. S. 1442 bluish hard quartzose compact sandrock dips E. 40° S.±60°.

The rock contains mica and lenticular masses of quartz.

At 1446 heavy chloritic Pulpit Rocks dip S. 30° E.—45°.

The rocks on the side of the hill in this vicinity are full

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*A photograph of this dyke will be found among the illustrations; and elsewhere an analysis by Dr. Genth, and the results of a microscopical examination by the author.

NARROW VEIN OF TRAP ON THE COLUMBIA & PORT DEPOSIT R.R.

of holes from 8 to 12 inches (2 to 5 decimeters) in diameter made through soft green slaty layers.

At about R. R. S. S. 1454 the dark green strata are much contorted and waved. They contain seams of quartz and dark serpentine like matter intercalated. The cleavage planes of the latter being perpendicular to the walls between which it lies.

At R. R. S. S. 1461 occurs a light green micaceous sandrock with enclosures of milk quartz. Dip S. 35° E.—10°.

At R. R. S. S. 1479 appears hard, compact quartz slate with intercalated quartz the former very much convoluted.

At R. R. S. S. 1488 is observed a greenish chloritic schist with intercalated quartz. Dip S. 30° E.—80°.

One place here offered a most singular example of the intrusion of the quartz.

The layers of softer micaceous rock dip about S. 15° E., but appear to have spread in all directions from a piece of imbedded triangular quartz as crystals of salts spread outwards from the salient points of the foreign bodies introduced into the solutions. This form was doubtless due to the crumbling and disjointing of the strata following the general crush of which this portion of the section offers so many evidences ; and the entrance of the quartz was subsequent to this event, the angular character of the fragment alluded to having been caused by a fracture and removal of the greater portion of the seam near this place.

At R. R. S. S. 1492+are these laminated chloritic slates interbedded with quartz and with about the same dip, viz: S. 30° E.—80°.

At R. R. S. S. 1493 a sandy slate in part friable but in part compact dips S. 25° E.—50°.

The same rock occurs in huge masses at 1494 .6 which is the crossing of the Maryland-Pennsylvania State line by the C. & P. D. R. R.

Rocks back on the hills have the pulpit structure and are 200 ft. (61 meters) high.

To sum up the structure between Peter's Creek and the Maryland line, according to the best evidences available for that purpose, we have the chloritic series descending and bringing newer strata to the surface for about a mile (1.6 kilometers) south of that creek, when a quartzite comes in between the inverted folds of a sharp synclinal. The chlorites immediately underlying this quartzite (near Brown's Run) appear to be the uppermost layers exposed in this southern part of the section, and their thickness to the Peach Bottom Slates is about 5000 to 5400 ft. (1524 to 1646 meters).

They are very much convoluted wherever their structure can be seen on a sufficiently large scale to allow this feature to become apparent.

Near Brown's Run they are capped by a quartzite which is much more likely to be the representative of the Chikis Quartzite than that which occurs near Peter's Creek, and which is separated from it by almost the entire thickness of the chlorite measures.

From this point to the Maryland line the folds are frequent, but there is no addition to the thickness, and at the Maryland line the horizon is but a few hundred feet below that of this quartzite. The prominent deflections of the river at Williamson's and Frazer's Points seem thus to be due to the entrance of the harder and less decomposable quartzite into its place among the measures.

Frazer's Point is in Maryland, about a mile below the State Line, but the section was not prolonged that far, although it was visited. The statement, therefore, so far as regards Frazer's Point, is made with reservation.

There is little doubt, however, as to the lithological cause of the topography at Williamson's Point, and the same rocks have every appearance of re-appearing at Frazer's.

It would thus appear that throughout the range of rocks exhibited along the banks of the Susquehanna, in Fulton township, chlorite seems to be the distinguishing characteristic. There are a few places very much isolated and very narrow where the rocks might be assigned to the lower Eozoic horizon were it not for their observed relationships to the over and underlying strata. There are a few other localities where a substantially quartzose rock appears, but in every instance but one a construction of the strata is

HUNDREDTHS OF ONE MILLIMETER.

Thin section of Trap from Williamson's Point,
Lancaster Co. Pa.
Magnified 400 Diameters.

possible, which brings this quartzite above the series, and into the position supposed to be occupied by the Chikis Quartzite (whether the latter be Potsdam or not).

But this one exception is an important one, as it is a prominent indication of the proximity of the roofing slates. In York County, on the opposite side of the river, and, indeed, wherever this quartz slate has been seen, it seems to contain thin layers of hydro-mica, much of which is chloritic, so that even here the fundamental character on which a differentiation of two great series has been attempted, is not entirely lacking.

This rock under the Stanhope lens showed, besides quartz grains, blebby rounded granules of silicates of very minute botryoidal structure along with thin hydro mica scales, which were seen sometimes entirely absent and sometimes in large quantity.

On the Maryland line the heavy bedded hard greenish gneiss is overlain by highly lustrous chloritic hydro-mica schist, enclosing much milk quartz in segregations.

In view of the importance of this structure, another possible explanation must not be omitted. It has been said that proofs of the excessive folding of these strata are not wanting when the two limbs of an anticlinal or synclinal lie in parallel planes.

With this fact in view, and the other additional observation of the re-placement of the chloritic by hydro-micaceous habit in the exposures between Peters' Creek and Williamson's Point; it would be possible to imagine the quartz slate which covers the Peach Bottom Slates on the Lancaster county side subjected to all the local irregularities of dip between the above mentioned points, and to a tight inverted synclinal fold; which would bring it up above Williamson's, the entire thickness of quartzose strata between stations 1410 to 1418 being taken to represent the thickness of the quartzite or its representative. All the exposures of this rock would then form a continuous stratum, and the hydro-mica schists in the basin of the first synclinal would be the lower limestone slates or hydromica schists.

There is enough to warrant attention to this view, but not enough, it seemed to the writer, to justify the introduction of another color into the map at this point, however tempting the symmetry of such a graphic delineation might be.

The main objections to it are:

1st. That the quartzite is not visibly more than ±50 ft. (15 m.) thick just north of Peters' Creek (though its entire thickness does not show), whereas this hypothesis would require it to be about 400 ft. (122 m.) thick near Williamson's Point.

2d. The prolongation of these supposititious, hydro-micas of limestone age would carry the belt over a broad area up the line of the narrow guage Peach Bottom R. R., and up the valley of the Conewingo; whereas many observations in this part of Fulton township away from the river unite in fixing these as distinctly chloritic, though sometimes hydro-micaceous.

3d. It would be natural to expect to find calcareous matter among some of these lower beds of limestone slate as it occurs in the slate belt north of Washington. But no such occurrence could be found.

4th. It would be likely that some of the hematite deposits which almost everywhere characterize these measures should be found within this area.

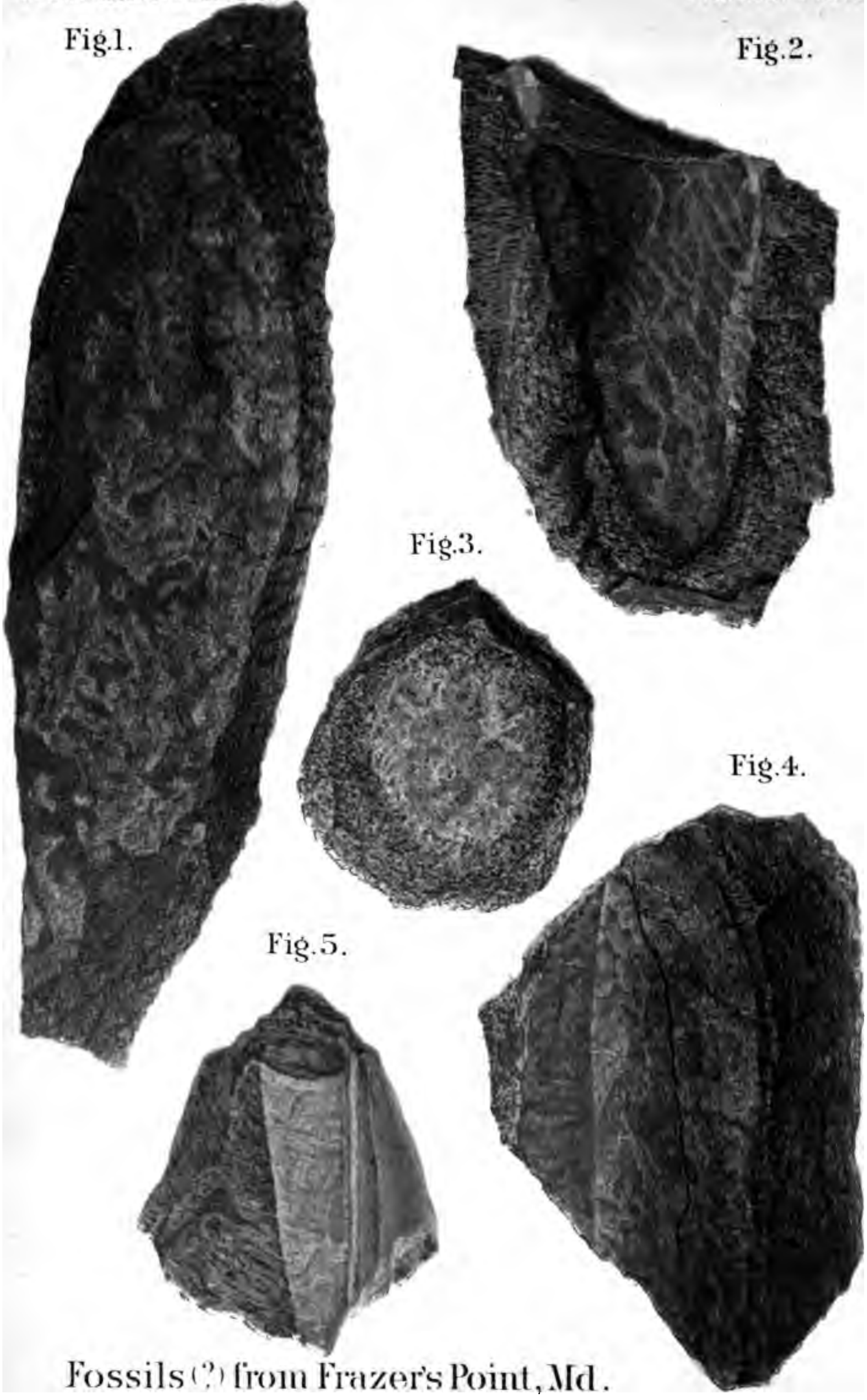
There are several indications of iron ore, red soil. &c., here, but no hematite has yet been proved.

5th. This structure would reduce the thickness of the chlorite series from 3600 ft. (1097 meters) to 1600 ft. (488 meters).

It will be observed that none of these objections are strong ones, were there other evidences of this later age of these strata.

For as to the first it may be said that rapid changes of thickness within comparatively short distances are not uncommon in precisely this formation; and besides this the *real* thickness at Peter's Creek may be 100 or 150 ft. instead of 50 ft. which are all that is visible.

As to the second; many of the limestone hydro micas are



Fossils (?) from Frazer's Point, Md.

Susquehanna River, near the Penn^a. State Line.

chloritic and difficult to distinguish from the South Mountain Chlorites.*

In reference to the third objection it must be admitted that it is not everywhere that the lower 1600 ft. of the limestone slates show limestone *e. g.* they do not in the Columbia-Washington Section. Neither is the objection based upon the non-occurrence of hematites in these measures conclusive; for these slates are apparently barren over quite extensive areas, and, in addition to this, the territory in question has not been properly exploited and might contain some hematite as yet undiscovered.

The objection on the ground of the diminution of the thickness of the Chlorite Series in the fifteen miles or so that intervene between this place and their appearance in Turkey Hill will operate in both directions. For if the rocks under discussion be not limestone slates but true chlorites, and monoclinal between Peter's Creek and Williamson's Point; then they have increased in thickness from 3600 to 5400 ft. (or about 1800 ft.): whereas if the upper margin of the chlorites be supposed to lie in contact with the Peter's Creek Quartz slate they have diminished in thickness from 3600 to 1600 (or 2000 ft). There is here a margin of 200 ft. thickness to the advantage of the former hypothesis if great weight be laid upon the doctrine that uniformity is the test of accuracy.

Fossils are said to occur in the rocks at Frazer's Point of which the determination will doubtless throw much light on this subject, if it can be had before the final publication of this report.

In the absence of such determination, or of other guides, the structure first assigned will be adhered to as being, on the whole, the most satisfactory.

Sub-Section along Fishing Creek.

Direction of Section Line, S. 10° E.

A subsection over a portion of the southern half of the Tocquan anticlinal, a little over a mile from the river, confirms the structure given in Section No. 1.

* See Sections in Reports C. and CC. in York and Adams Counties.

The first dip was obtained just west of the sharp elbow in the road west of Mr. J. F. Steinman's.

Mica schist dips here S. 15° E.—55°.

On Fishing Creek, (distant about half a mile S. E.,) and about 200 meters above crossing of the creek by the road south of Steinman's, mica schist, in bed of stream, dips S. 15° E.—17°.

It was the intention to make this the first of the dips in the sub-section of Fishing Creek, but its position with reference to the other dips on the creek, and its distance from them were both strong objections against doing so.

This small section then begins with the dip first given of S. 15° E.—55° in mica schist.

At Hutton's mill a large exposure of mica schist dips S. —37° to 47°, the rocks being laminated like gneiss.

A few score yards (meters) below this exposure the same rocks dip S. 15° E.—32°.

About 164 yards (150 meters) below this place the same rock dips S. 5° E.—32°.

328 yards (300 meters) below this the same mica schist dips S. 5° E.—42°, followed within a very short distance by S. 15° E.—42°.

In the bed of the stream, just below this, thin bedded gneiss seems to dip with tolerable constancy S.—±30°.

Pursuing Fishing Creek further south, large fragments, and even long ledges of rotten gneiss and mica schist are encountered, but none of them appear to be in their original places.

Just above Penrose's dam (218 yds., or 200 meters,) mica schist intercalated with quartz dips S. 20° E.—58°.

At the first crossing of creek and road below this, mica schist dips S. 15° E.—38° to 40°.

At Penrose's (now Hess's) mill, mica schist dips S. 10° E. —50°. This rock is a greenish mica schist with spots of decomposed feldspar.

Just below Hess's house a large exposure of mica schist dips S.—60°.

About 218 yards (200 meters) north of the second crossing of Fishing Creek below Hess's mill, a thinly laminated, sandy mica schist dips S. 25° E.—72°.

It is thus seen that these dips all belong to the south limb of the great Tocquan anticlinal, and agree with those on the river.

Lancaster Section.

Section from Neffsville through Lancaster to Marticville. Direction of section from the average of seventy-three observations, S. 12° E.

The object of this section was to ascertain the approximate thickness of the limestone which covers the larger part of Lancaster county, and more especially of this rock under the city of Lancaster.

For this purpose it was not thought necessary to include the entire belt in a north and south line, which should traverse the arm of Mesozoic by the village of Manheim and the Ephrata basin. An appropriate starting point was found at Neffsville, where the lower limestone slates along with broken fragments of Chikis quartzite come to day.

The first dip is in a quarry in a field north of J. Dutt's house, and west of the house of J. Groser, in the village of Neffsville.

It lies on the eastern slope of the northernmost of two ridges, which rise about 100 ft. (30.5 meters) above the general levels, on whose summit the quartz fragments ascribed to the Chikis are visible.

The quarry is Eshleman's, and the space between it and Neffsville is filled with hydro-mica schists of rhomboidal fracture.

The dip here is N. 30° W.—38°.

800 ft. south on the line of the section is the point of projection of the south end of Neffsville, and the junction of the limestone and lower slates, mixed with quartz and some quartzite.

Six hundred feet (183 meters) further on, or 1000 ft. (305 meters) from the initial point of the section, is the south margin of this slate area.

On the turnpike, between Schreiner's house and the road to Fruitville, the débris by the roadside, which is not due to the ballast of the turnpike, shows an unusual preponderance of quartz.

A limestone quarry occurs about 250 ft. (76 meters) south of the southern slate margin, and a ledge of limestone crosses the road about 1600 ft. (488 meters) south of the same line, the latter striking about E. The dips of neither of these exposures were obtained. About 1¼ miles (2 kilometers) from the starting point, and about 600 ft. (183 meters) north of Mr. J. A. Keller's house, an old abandoned limestone quarry gives a dip, in a rock paler than usual, of S. 20° E.—6°.

There are several planes of jointage and cleavage in this rock, two of which are as follow:

S. W.±80°.
N.—80.°

A lime kiln is built on this quarry.

Another quarry, close by Mr. Keller's house, gives in dark blue limestone S.—20°.

About 500 feet (152 meters) W. by S. of P. Hottenstein's house, a roadside exposure of limestone gives ±N.±20°.

About 500 ft. (152 meters) S. of this last exposure a limestone exposure in the gutter at the roadside dips ±N. W. —steep (*i. e.*, ±60°). This was a poor exposure.

An old digging by the side of the road north of D. M. Mayer's house a clay, from the decomposition of the limestone strata mixed with fragments of limestone, dips N. 20° W.—24°.

At Myer's quarry, off the Litiz turnpike, a limestone occurs, colored light blue to drab, and very much broken, and cleft with the upper layers slaty.

A seam of quartz seems to be intercalated with the bedding which, if this be true, gives a dip of N.—18°.

The measures have heretofore shown the gently sloping northern side of a flat anticlinal, and there is here a break in the continuity of dips of about 3500 ft. (1066 meters) in which no exposures were noted. This absence of dips from this part of the section is, however, of slight importance since all the evidence is in favor of gentle dips which do not add greatly to the thickness of the limestone in considerable distances over the surface.

The next dip is in a limestone on the side of the Reading and Lancaster R. R., in the village of Dillerville. It is S. 15° E.—38°.

This is the commencement of the southern side of the flat anticlinal.

Another dip, of which the projection falls on the same point of the section line, gives S.—44°.

The next exposure, in the S. E. corner of Dillerville, gives S.—50°.

Another, near the point of divergence of the P. R. R. and Reading R. R., gives S. 25° E.—35°. A short distance south, S. 15° E.—80°.

Between these last two dips there seems clearly to be a synclinal which extends over the boundary of Manheim, and into Lancaster township.

One more dip occurs in Manheim township on the R. R., and about 300 ft. (91 .5 meters) north of the township line, of S. 15° E.—75°.

About the same distance south of the north boundary of Lancaster township, on the Manheim turnpike, about 300 ft. (91. 5 meters) N. W. of its intersection with North Prince Street, the last dip occurs in the construction of the synclinal just mentioned. It is S. 15° E.—80°.

Here is the innermost side of a slightly inverted anticlinal.

The first dip on the southern, or gentle side is found about 500 ft. (152 meters) south of this exposure. It is ±S.—±30°.

At a cut near the crossing of the P. R. R. by the Reading and Lancaster R. R., the limestone gives a dip of S. 15° E.—70°.

In the cutting just east of the station of the P. R. R. in Lancaster, the limestone dips S. 15° E.—67°.

For a space of 500 ft. (152 meters) through the northern half of the city of Lancaster no exposures were discovered.

At the intersection of the Lancaster and Quarryville R. R. and Vine Street a light colored limestone in thin curved plates, blotched with white, dips S. 5° W.—70°. This continues for about 54½ yards (50 meters), or less, to Mr. H. Miller's Soap Factory, becoming gradually a very curved and convoluted calcareous hydro-mica schist.

This is corroborative evidence of a fact indicated by the stratigraphy; *i. e.*, that the lower measures of the limestone formation are here coming to the surface. Near the intersection of the Lancaster and Quarryville track and Conestoga St. thin bedded slaty limestone schists dip S. 10° E.—88°.

Between Conestoga and Hazel Streets, about 158 yards (145 meters) north of R. R. bridge over Gas Run, a finely laminated and very much twisted limestone holding seams of quartz dips S. 5° E.—74°.

At about 219 yards (200 meters) below this bridge about the same dip was observed.

On the Willow Street turnpike, about 163 yards (150 meters) north of the bridge over the Conestoga, a limestone hydro-mica schist dips S. 10° E., varying from 60° to 85° (74° was assumed as about the true average dip).

Close to the south of this last on the turnpike an arenaceous variety of the same rock dips S. 10° E.—50°, also waving. This continues for 33 yards (30 meters) further south, the rocks exhibiting pyrite and dipping S. 10° E. from 50° to 60°.

About 109 yards (100 meters) north of the carriage bridge over the Conestoga, a large exposure of rock shows N. 10° W.—32°, followed by large waves, of which the direction (measured by that plane passing through their nodes) was S. 10° E.—±20°.

At about 38 yards (35 meters) north of the carriage bridge a large quarry exposure of limestone schist, filled with pyrite in large crystals, of which those near the surface are completely transformed into Ferric Hydrates, dips in shallow waves S. 10° E.—80°.

The dip alongside the bridge on the south bank of the Conestoga is about the same.

The dips just described seem to require one complete synclinal and one and a half anticlinals between the northern township border and the Conestoga, and also to suggest the axis of the lower anticlinal at the point marked B on the section.

An analysis of these dips here follows:

Limestone,	S. ±30°	For the northern half of the synclinal.
"	S. 15° E.—±70°	
"	S. 15° E.—±67°	
Light colored limestone,	S. 5° W.—70° to vertical.	Southern side of synclinal.
Thin bedded limestone schists,	S. 10° E.—88°.	
Convoluted limestone, holding quartz,	S. 5° E.—74°.	
Limestone hydro-mica schist,	S. 10° E.—60° to 85°.	North side of anticlinal.
Arenaceous ditto	S. 10° E.—50°.	
Ditto with large pyrite,	S. 10° E.—50° to 60°.	
Limestone, (local curl), . .	W. 10° W.—32°.	
"	S. 10° E.—80°.	

The N. W. dip in the middle appears to be properly observed, but is of slight influence on the thickness of the measures as it is tightly compassed by opposite dips.

It will be very inconvenient to particularize the locality whence each dip here following was obtained, nor will it be necessary. The two lines along which observations were taken were both sides of the Conestoga and (when the strike and position permitted, all roads and other places in the township not too far away from the chosen line of section.

Before leaving this part of the section it may be as well to call attention to the fact that if the structure assigned in this section be not incorrect there are two points in the city at which the limestone is of minimum thickness, viz: Just south of the northern border, and between Conestoga and Hazel streets.

What the actual thickness is at these points it is at present impossible to say, owing to the paucity of exposures, the vertical position of the beds, and the consequent difficulty of ascertaining precisely how far a vertical shaft would follow the same bed.

It will be noticed in all close plications that the upper strata suffer much more disturbance than those underlying, and even in the southern parts of this Lancaster section instances can be found where a high loop of measures bends back upon itself with almost the same dip (C on section).

The result of this is a slipping of the upper on the under strata and a consequent accumulation at certain places of very much more than the true thickness of these upper strata.

To give an instance of this. If the horizon *d* and *e* (See *c* on Section) be supposed to be at a constant distance apart and the plication of *d* is so violent as to produce a tightly pressed anticlinal *f*, then since the thickness *d e* must be kept constant no part of *e* can be drawn inside of the anticlinal loop.

In this case the thickness *f g* will perhaps be many times greater than the thickness *d e*.

To apply this to the present case. It cannot be pretended by this method of making sections to give the actual thickness within 10 or 15 per cent., especially when the dips are few in number. But 10 per cent. of the supposed thickness of the limestone in this vicinity would be 300 ft. The addition of 300 ft. to the actual thickness of the measures would require 600 ft. to be introduced into any given anticlinal or synclinal, and in any tightly folded sharp, curve like A or B, it is easily seen that to preserve the constant distance of the lower plane of the supposed 300 ft. from the present lowest plane would throw the lower horizon of the whole formation very far below the assigned position of the anticlinal on the surface.

In B, the addition of 300 ft. to the measures beneath the apex of the anticlinal would add 100 ft. to the theoretical thickness at that point without allowing for the 500 ft. or more throughout which the lower horizon is bent back so nearly on itself that nothing but fragmentary limestone could be anticipated in intervening space.

If the addition were 400 ft., the least actual depth from B on the surface to the lowest limit of the limestone under it would be 800 ft. For an addition of 500 ft. to the measures, the depth would be 1300 ft.

It will be understood, therefore, that great caution must be observed in dealing with problems of this kind.

All that it is safe to say is, 1st, that the total thickness of the limestone measures before erosion and hence when near the actual thickness now in the vicinity of the P. R. R. Station in Lancaster was not less than 2700 ft. (823 meters). 2d. The points within the city of Lancaster, where there is the greatest likelihood of penetrating it in the least distance, are either 500 to 1000 ft. south of the northern limit of the borough; or somewhere between Conestoga and Hazel Streets, and not far from Queen St.

On the south side of the Conestoga and near the bridge a dip of S. 10° E.—80° has been recorded. From fifty-five yards (50 meters) to 219 yards (200 meters) south of the bridge a very much waved limestone dips N. 10° W.—20°.

Close by this is a limestone of which the strike is E. 10° S.—nearly vertical.

From this point for a distance of two or three hundred feet (61 to 91 meters) a dip of S. 10° E.—±20° was obtained. This waved and gentle dip continues to a point opposite the mouth of a little stream (nameless) in the right bank of the Conestoga where for a short space the exposures cease to be so prominent following down the bank of the stream. But some little distance back from the stream on the township road and about equally distant with the line thus far described, and on the opposite side, from the location of the section line, some dips occur which fill up this gap.

These dips are on the county road near Joseph Myers, and are identical in value with those near their points of projection on the section line, though the distance apart of the exposure is nearly 2½ miles (4 kilometers). Of course had there been any discrepancy between these two sets of dips they would not have been associated together in the same section, but the uniformity of the variation of this piece of limestone over wide areas is not the least interesting part of its study, and has an important bearing on any dynamical theory to which such study may give rise.

Opposite the toll house and on the left bank of the Creek the dip is S. 10° E.—75°.

This steep dip seems to continue to the curve in the stream where it is S. 10° E.—80°.

All the exposures on the road before mentioned down to its crossing of a lower curve of the Conestoga give dips N.

10° W.—very steep to vertical. They need not be therefore specially mentioned again.

Abreast of a point between the limekiln and the toll house and on the opposite side of the stream there is an appearance of a small anticlinal in the side bank.

Just south of the latitude of this limekiln a limestone dips north very sharply for about 58 yards (50 meters) where a flattening occurs for two or three yards or meters. South of this the rocks dip S. 10° E.—almost vertical.

On the right bank or the opposite side from that on which the above observations were made, the dips in the vicinity of the toll house seem nearly vertical as also at the fork of the road just south of these. At about 109 yards (100 meters) south of the toll house this vertical dip is replaced by one of S. 15° E.—30°, which is maintained for upwards of 22 yards (20 meters).

142 yards (130 meters) south of the toll-house the dip is N. 15° W.—30°.

At about 175 yards (160 meters) south of the toll house there is a strong flowing spring which apparently marks the position of another anticlinal.

The rocks to the north of this spring dip N. 10° W.—30°; and to the south S. 10° E.—80°.

The dip of S. 10° E.—80° is carried about 164 yards (150 meters) further south when a crush occurs very similar to one noticed on the opposite side of the creek, and mentioned as opposite a point between the limekiln and the toll house; when after a steep North dip a flattening occurs for a few yards or meters and this is succeeded by an almost vertical S. 10° E.—dip.

The steep dip of S. 10° E.—vertical, is maintained here to the lime kiln, or about 820 ft. (250 meters) north of Levan & Co.'s Mill.

Here it becomes gentler (*i. e.*, ±70°), to about 590 ft. (180 meters) north of Levan's, where the dip is N. 10° W.—85°.

On the left bank, opposite Levan's Mill, another crush occurs with much flattening and twisting.

The position of one of the two crushes in the right bank falls about 109 yards (100 meters) north of the point at which the similar crush on the left bank would intersect it by projecting the strike of its rocks. This looks somewhat like a fault and thrust up this stretch of the Conestoga. But no such fault can have had great influence in determining the direction of this stream, whose course is very tortuous.

The limestone alternates from N. 10° W.—45° to N. 10° W.—88° on the narrow peninsula between Mill Creek and the Conestoga, between a point opposite Hoover's house, and the bridge over the former stream; but the preponderance of the dip seems to bear towards gentle.

The point we have now reached seems to end the first series of subordinate waves (though really the series is continuous throughout), and furnishes us with a picture of the convolution of these measures entirely consistent with observations made elsewhere, but affording the best opportunity within the writer's knowledge of studying the effect on these weak and brittle limestones of such undulation as the eastern Appalachian belt has endured. It is readily understood why in the last Survey no attempt was made to make continuous structure across a limestone belt, for continuous structure would have been impossible except in the rare instances when dips could be obtained every few yards (or meters): conditions which happened to be fulfilled here.

From the crossing of the Conestoga for 1200 ft. (183 meters) there seems to be what remains of a wide and gentle synclinal, the position of whose southern side is no longer ascertainable with certainty; but could not well have been further south than the margin of the sand and clay which marks the area of no exposures in Pequea township; and seems likely, from the hypothetical structure (which, however, may be all wrong), to have been somewhere near them.

After the slight curving of the strata had resulted in these even and gentle basins of limestone, subsequent movements seem to have still further contracted them and forced the overlying limestone into a series of complicated curves, not unlike the upper outline of a cluster of soap bubbles blown above the surface of the liquid in a basin by a pipe inserted therein. Among the many contortions to which such a contraction of space gives rise are naturally to be found many anticlinals, but seldom such a large and comparatively symmetrical complex anticlinal as that shown in the section.

After Mill Creek was reached, along the line of the Conestoga, the road whence dips were obtained was that through New Danville and Marticville.

Those between the Mill Creek projection and the house of David Harnish will be found grouped together below in tabular form:

Character of Rock.	*Dip and Remarks.*	
Limestone,	N. 10° W.—88°	S.
Limestone,	N.—50°	N.
Limestone,	N.—70°	
Limestone and argillite,	N. 20° W.—60°	N.
Limestone,	N.—80°	S.
Limestone,	N.—50°	N.
Limestone,	S. 20° E.—45	S.
Limestone,	N. 20° W.—52°	N.
Limestone,	N. 25° W.—60°	
Limestone,	N. 10° W.—85	S.
Sandy limestone,		N.
Limestone,	N. 10° W.—58°	
Limestone,	N. 20° W.—35° to vertical	
Limestone,	N. 10° W.—50°	

The letters N. and S. placed opposite these dips, or groups of them, indicate the parts of subordinate anticlinals, to which they appear to belong. They are about five in number, the measures rising towards the south, where at the plane of the last recorded dip no more limestone is seen (nor other rock in place) for about 4400 ft. (1341 meters) south along the section.

The position of this gap is near the middle of Pequea township, and is remarkable for the absence of roads and houses on the township map, as it is for the absence of rock in place in actual fact. Mr. Martin B. Herr's house is near the middle of this blank area.

The surface consists of clay mixed with quartz, and some argillite fragments, the whole strewn with mica, as if from the débris of the schists which cannot lie very far beneath. At this part it is not possible to project dips from portions of the township contiguous to the east, because by reference to the general map it will be seen that an irregular patch of limestone is torn away which extended into West Lampeter township, and leaves a ragged edge to mark the division between it and the exposed underlying Eozoic rocks.

This gap has therefore been left unfilled, and no attempt has been made to connect the limestone horizons north with those south of it, though it is probable that the lower limits of the newer formation which rise in the air at the northern edge of this lacuna and are now washed away, descend somewhere near where the first dip in limestone to the south is recorded.

In resuming the section south of this gap a long series of dips in limestone and mica schist or gneiss were recorded alternating with each other so rapidly as to demand the most careful scrutiny before they could be plotted. The very first dip opens the series with a most difficult problem; on the solution (or supposed solution) of which the structure given to the remainder depends.

This exposure is found near a cross roads a little south of Mr. G. Harnish's house.

The northernmost dip is in a ledge of limestone which appears to give N. 10° W.—89° (*i. e.* Strike E. 10° N.—vertical).

In contact with this is a mica schist dipping S. 10° E.—89°. From these two it would be inferred that the two rocks were conformable to each other. Pursuing the line to the south, four more dips in mica schist or its equivalent are obtained, viz:

Mica Schist { N. 15° W.—80°. / S. 15° E—80°. } together.
Bluish Gneiss N. 15° W.—40°.
Rotten Gneiss N. 10° W.—61°.

These seem to form a collapsed anticlinal and in the absence of information to the contrary the limestone has been drawn over them conformably because they seemed conformable at this first contact.

About 800 ft. (244 meters) south, on the Section, a limestone dips N. 25° W.—60°, and another still further south N.— 62°.

So far the relative positions of the two formations seem to be properly maintained.

200 ft. (61 meters) further on, the first of two dips in the lower measures is obtained. It is in Bluish Gneiss S. 20° E.—20°, and very shortly followed by one in Mica Schist of N. 23° W.—82°. An inverted anticlinal seemed more probable here than a synclinal, because the latter would have involved the necessity of putting the next following limestone beneath these crystalline rocks, where every experience teaches the writer they do not belong. Besides this these two sets of measures appear here normally unconformable, the two dips in Eozoic being in planes which would intersect the horizon plane in a line about E. 21° N.; whereas the contiguous limestones lie in a plane which would intersect it in a due east and west line.

The next exposure of limestone dips N. 15° W.—40°., and the Rotten Gneiss underlying it has almost the same dip, N. 15° W.—58°.

The reasons assigned for this apparent conformability within short curves will be given further on.

The next dip in limestone 400 ft. (122 meters) further south, again resumes the limestone's normal direction of N.—60°.

The following dips filling a space of about 5000 ft. (1524 meters) can be best given in tabular form:

Limestone,	N.—60°	S.
Limestone,	N. 10° E.—60°	
Sandy limestone,	N. 25° W.—32°	N.
Limestone,	N. 10° W.—50°	
Limestone slate,	E. 25° S.—20°	S.
Limestone slate,	S. 10° E.—65°	
Limestone,	N. 40° W.—35°	N.
Limestone,	N. 30° W.—30°	
Sandy limestone slate,	E. 40° S.—28°	S.

Pequea Creek.

Limestone, ...	N. 10° W.—80°	N.
Sandy limestone slate, ...	N. 10° E.—70°	
Sandy limestone slate, ...	N. 15° E.—46°	

At this point, or rather 800 ft. (244 meters) from the last mentioned dip, a gneiss occurs, dipping vertically and with the somewhat abnormal strike of E. 10° S.

For the next 1½ miles (2.4 kilometers) there are but four recorded dips—a quite insufficient number to permit of an accurate delineation of the stratum.

Below this in Martic township the northern slope of the Tocquan anticlinal is reached with its usual gentle dips, and south of this no more limestone appears.

In viewing this latter part of the Lancaster section it will not escape attention that the strata are crumpled and convoluted very much, as they are in the northern part. One important difference between the two, however, is found in the occasional recurrence of mica schist and gneiss between these tight folds. In justification of the method of representation here adopted the following may be advanced:

Wherever a contact between limestone and mica schist can be followed for some distance their strike lines are found not to agree. That is to say, there are axes in the Mica Schist which cannot be traced through the limestone series.

Evidence seems to show, however, that the movements which contributed to the present structure of the Eozoic beds did not stop at the completion of that series nor until after the deposition of the limestone.

However the dip of the overlying limestone might result from crust movements subsequent to its deposition, the culminations of its waves would necessarily be above those of the formation on which it rested and which shared in these movements.

In a section the dips in a single vertical plane are considered and those which were not observed to lie actually in that plane appear (if plotted to the observed strength) flatter than their projections in nature ought to appear.

Consequently when the curves are short, however irreconcilable the structure of the two formations may be, they will seem to be conformable, whereas it may easily be that in wide synclinal basins of the lower formation a number of convolutions of the upper may be included.

It is probable that this is the case with the rocks in this section, but it cannot be established without information which would give us the position of the Eozoic beneath the limestone.

Many of the lower layers of the limestone in the southern part of this section are interleaved with mica, and the portions corresponding to the hydro mica schist horizon seem frequently to be partly composed of the debris of the gneissoid strata.

Neither this circumstance however nor the puzzling alternation of the two formations was considered to afford sufficient justification for interstratifying them as if these crystalline rocks were of limestone age: nor could any view be found which seemed to render this probable.

Mill Creek and Quarryville Section. Direction of Section Line S. 20° E.

The object of this section was to describe the appearance of the rocks in their rapid alternations near the town of New Providence, and to offer at least a possible graphic explanation of the structure.

Mill Creek joins the Conestoga a very short distance north of the north eastern limit of Pequea township, and the description of rocks may properly commence here.

Just at the south end of Mill Creek bridge a limestone dips N.—75°. Twenty-two yds. (20 meters) south of this dip and along a space of 87½ yds. (80 meters) a fine exposure dips S. 25° E.—25°.

At the abrupt bend in the R. R. to the E. a thinly bedded limestone dips N. 20° W.—80°.

820 ft. (250 meters) south of the bridge a limestone dips N. 10° W.—89°. Trap boulders are numerous here, all the fragments lying in the dirt which covers the limestone edges being of that character.

From the last outcrop for 492 ft. (150 meters) the dips succeed each other with changes very rapidly.

First there is N. 15° W.—70°, then within 50 ft. (15 meters) S. 15° E.—70°, and finally at the crossing of the road N. 15° W.—30°.

The rocks by Harnish's Station are limestone schists. Under the Station and along the County road they are seen to dip N. 10° W.—89°.

The weathered ends near Mr. Jno. Harman's house, dip N. 10° W.—64°.

Two hundred and eighteen yards (200 m.) north of a long cut in the R. R. a calcareous argillite gives a dip of N. 20° W.—89°, and 164 ft. (50 m.) further on limestone and calcareous argillite dip N. 20° W.—82°.

In the cut the dips are N. 25° W.—60°.

Between these there seems to be a synclinal axis.

Further along, a poor exposure in sandy limestone with washed out furrows dipped N. 15° W.—40°.

Just north of R. R. bridge a limestone dipped N. 15° W.—44°.

Along the course of the next R. R. cut, which is about 109 yards (100 meters in length) the dip is N. W.—gentle, and a very ferruginous stratum (almost an ore) comes in with a strength of 50°.

A short distance from West Willow Street village a blue finely laminated limestone much intersected by white crystalline quartz dips N. 15° W.—89°.

The land immediately around the Station at West Willow Street is destitute of exposures to about 327 yds. (300 meters) towards Lancaster, where the last dip was taken.

South of West Willow Street both white and colored quartz in profusion were remarked as occurring in the gulleys between the station and a slate quarry.

About 100 ft. (30 meters) north of the south end and nearly at the north end of a R. R. cut, hydro mica schists commence to come in pitted all through with minute excavations.

Not much further to the north a very massive mica schist shows a dip of S. 25° E.—85°.

On the R. R. and just north of the small stream which crosses it above Baumgartner's, argillite slates dip N. 25° W.—30° and immediately afterwards N. 25° W.—89°.

On account of the numerous planes of cleavage and the capriciousness with which this or that one is assumed by these rocks it is somewhat hazardzous to assume an anticlinal just at this point especially as the gentle slope is on the opposite side from that which is usual here, nevertheless the appearances certainly bear out this structure.

Just below Baumgartner's Station a light buff crystalline limestone dips N. 15° W.—81°. This is closely followed by a slaty blue limestone having the same dip.

The next important object intersected by the section lines was the Mylin Ore Banks, which lie between Baumgartner's and Linesville and about ¼ mile (400 meters) south of the M. E. Church. No dip was obtained here and the bank is described elsewhere.

Near Abm. Martin's place the limestone dips±N. W.—±20°.

Between the last two exposures, other dips serve to conform the existence of a synclinal.

About 164 yards (150 meters) W. by S. of Pequea Station and S. by W. of Snively's house is an excavation in great part filled up but which appears to have been a quarry.

The stone is of a buff or drab color and seems to be dipping N. 10° W.—35°.

About 109 yards (100 m.) West of bridge over creek a decayed mica schist and limestone dip±N.—±60°.

About 218 yards (200 m.) southeast of this bridge a soft mica schist with a great abundance of white quartz dips N. ±70°.

No limestone is apparent here.

Exposures in rock are not frequent from here until a cut in the R. R. about 55 yds. N. W. of Lime Valley Station is passed. The cut is 100 meters long and the middle portion is in blue clay.

Fifty feet (15 meters) east of the Green Tree Inn there is a bank of very much weathered mica schist which dips N. 25° W.—80°.

The rock is decayed almost to a sand.

About 218 yards (200 m.) N. W. of the crossing of Beaver

Creek by the Lancaster & Quarryville R. R. limestone and mica schist dips vertically with a strike of about E. 15° N.

Just at the crossing of this creek (N. W. side) a dark fine grained gneiss with many seams of quarts dips N. 15° W.—80°

This hard compact gneiss is about fifty feet (15 meters) thick and just 20 ft. (6 meters) west of it a calcareous gneiss and micaceous limestone dips S. 30° E.—60° to 80°. The best interpretation which could be given to the structure here makes a suspiciously regular, deep, U shaped trough in which the single abnormal dip in gneiss is neglected.

At John Strohm's where the road and R. R. intersect obliquely, a hard gneissoid rock containing limestone seems to dip N. 30° W.—gently. The dip, however, is not so certain as the strike which seems clearly to be E. 30° N.

The next objects of importance are the apparent dying anticlinal in limestone, and the ore bank at Amos Herr's.

At the limestone quarry of Mr. Herr ±218 yds. (200 meters) W. 30° N. of crossing of R. R. and county road, a compact light blue limestone dips S. 30° W—18°

At the north end of the R. R. curve near J. Stoneroad's a micaceous limestone dips S. 25° E.—20°.

About 327 yards (300 meters) west of New Providence Station is a R. R. cutting through a clay bank filled with fragments of milk quartz.

About 218 yards (200 meters) N. E. of the Merchant's Hotel in New Providence in a limestone quarry of Mr. J. Hildebrande the limestone dips W. 30° N.—±30°.

This limestone is blue, somewhat crystalline, and very full of mica. The soil above it is colored deep red.

Near the southern edge of the town of New Providence in Peacock's Ore bank back of H. Groff's barn the rock fragments indicate a ferruginous mica schist and streaks in the bank seem to imply a dip of ±N. W.—gentle.

A limestone quarry by Geo. Witmer's house gives a dip of S. 25° E.—40°.

Close by (so close as to render it impossible to draw the curve as if affecting the rocks to any considerable depth) a limestone dips N. 20° W.—15°, and a mica schist under it the same.

A few score yards further S. E. a calcareous gneiss dips N. 40° W—18°.

Another dip in gneiss is N. 20° W—45°, of which the projection falls (on the line of section) just a little south easterly of the southern house marked on the map as Geo. Witmer's. This dip is in the peninsula which connects the Georgetown and Susquehanna Eozoic.

Near J. H. Lefevre's, on the Eden-Providence township line, a very much twisted calcareous gneiss dips N. 40° W. —20°.

Between the exposure, which of course is ascribed to the limestone series, and the last, the southern edge of the above arm of Eozoic rocks comes in.

Another limestone dip is S. 15° E.—60°, and still another in the limestone quarry of Milton Hess and others is N. 40° W.—20°.

Finally, just S. E. of the house of Daniel Lefevre is a dip in limestone of W. 30° N.—30°.

A tabular statement of these dips from New Providence here follows:

Place.	*Character of Rock and Dip.*
New Providence (S. end), ...	Mica schist, ± N. W. 18°.
Geo. Witmer's, (northwesternmost house of that name,)	Limestone—S. 25° E.—40°.
Limestone quarry, ...	N. 25° W.—18°.
Gneiss and limestone, ...	N. W.—gentle.
Short distance S. E. of above, . .	Limestone—N. 20° W.—15°.
" " " . . .	Mica schist, N. 20° W.—15°.
" " " . . .	Calcareous gneiss, N. 40° W.—18°.
±300 yds. S. W. of the southeastern house marked G. Witmer, . . .	Gneiss, N. 20° W.—45°.
±200 yards west of J. H. Lefrvre's house.	Very much twisted calcareous gneiss, N. 40° W.—20.
Limestone, ...	S. 15° E. 60°, also S. 30° E.—gentle.
Limestone, ...	N. 15° W.—gentle, and ore N. 35° W.—steep.
Near J. W. Lefevre's house, . . .	Black micaceous gneiss, N. 20° W. —45°.
Near J. E. Lefevre's house, ...	Thinly laminated mica schist, N. 20° W.—30°.
Limestone quarry of Milton Hess and others, ...	N. 40° W.—20°.
D. Lefevre's limestone quarry, on edge of Quarryville, ...	W. 30° N.—±30°.

From this point there is an unbroken line of limestone as far as the Chester Valley extends.

CHAPTER IV.

Mining Industries, etc.

Among the most important mining industries of Lancaster County will naturally come that which for so long a time was unique in this country, viz: a mine and furnaces by means of which nickel was produced regularly and on a large scale. The history of this enterprise will be found further on, given by the intelligent superintendent, Capt. Doble.

The mines are situated on a prolongation of the same Eozoic belt which makes the Gap Hills and Welsh Mountain and have been heretofore considered under the name of the Georgetown series. The area thus referred to is almost surrounded by limestone, the broad Lancaster limestone bounding it to the north, and the Chester Valley limestone to the south.

As will be seen in the excellent map, for permission to re-produce which in this report I am indebted to my friend Mr. Wharton, the great dyke mentioned often before cuts the S. E. corner of the hornblende mass which carries the ore.

The following is a history of the prosecution of work in this mine since 1718, made by Captain Doble for the annual report of the Secretary of Internal Affairs of the Commonwealth, in 1875:

"According to authentic history, the Gap Mines had been worked for their copper prior to the year 1744, and from traditions of the neighborhood, they were first discovered about the year 1718. For eighty or ninety years after their discovery, they were worked at intervals by four or five different companies, but none of those companies ever found sufficient copper to pay expenses, and consequently they would work them at a loss for awhile, and then abandon them, and let them stand idle, until new parties would take hold of them, and start them up again.

"In 1849, after those mines had been standing idle for thirty or forty years, a stock company was formed under the name of Gap Mining Company, to work them again for copper. They worked them on a rather larger scale than the previous companies; put up a twenty-five-horse power steam engine, for pumping and hoisting; employed a number of miners and laborers, and found considerable copper ore, which they sold to copper smelters in Boston and Baltimore, but there was not nearly enough to pay the expenses of working the mines. Nothing was known here at that time about nickel; although in mining copper, large quantities of nickel were mined along with it, and thrown away as worthless. It was called by the miners "Mundic," (sulphuret of iron,) a very plentiful and nearly worthless mineral.

"In the beginning of 1852, the present superintendent of those works came to the Gap Mines to work as a miner. He immediately discovered, and made known that what was termed Mundic, and was being thrown away as refuse, was not Mundic, but some other mineral—what mineral he could not tell. This led to samples of it being sent to chemists in Boston and Baltimore, but their analysis proved unsatisfactory. Finally, in the latter part of 1852, or the beginning of 1853, a sample was sent to Prof. F. A. Genth, a celebrated chemist of Philadelphia, who made an analysis of it, and pronounced it nickel, and gave the percentage of pure nickel contained in the ore. Thanks to Dr. Genth.

"At this point the "Gap Copper Mines" changed to "Gap Nickel Mines." The Gap Mining Company then mined the nickel ore and sold it to a separate company who smelted it for awhile in Philadelphia. A year or two afterwards another separate company erected smelting works about three quarters of a mile north of the mines. They bought the ore from theGap Mining Company and smelted it there, but the smelting of nickel proved unprofitable, consequently the smelting works changed hands several times with considerable loss to the owners. In 1859 the Gap Mining Company bought those smelting works and smelted their own ore, but in 1860, finding that neither mining, nor smelting, nor both together would come near paying expenses, they closed down the whole concern, mines, smelting works, and all. This finished up the Gap Mining Company's operations; they never worked it again. It remained idle nearly two years, the mines filled with water which ran out at the top of the shafts: engines and other machinery rusting out, furnaces and stacks which were nearly worn out before, now decaying and crumbling to the ground. Such was the condition of things when the present proprietor, Joseph Wharton, Esq., a Philadelphian, took hold of it in November, 1862. He, at that time, bought of the Gap Mining Company one half of the concern, and leased the other half for a term of years, but shortly after he bought the other half also, thus owning the whole concern—mines, smelting works, machinery and all. The whole, of course, costing him a large sum of money. He immediately commenced repairing the engines, blowing cylinders, &c.; pumped the water out of the mines; re-built the furnaces and stacks; and by the following spring, May, 1863, got into operation the mining, smelting and refining of nickel. Perhaps I ought to state here, that at the time Mr. Wharton bought the mines and furnaces, he also bought a large manufacturing establishment in Camden, New Jersey, and fitted it up for a nickel refinery. For be it remembered that when the metal leaves Gap furnaces it is not nearly pure, only a part of the dross, or worthless matter, has been taken out; in that condition it is called *matte*, and is thus shipped to the refinery in Camden, where it goes through a great many processes requiring much time, labor and skill to bring out the pure nickel. In fact, the processes of making nickel are so tedious and complicated that nearly a year elapse after the ore is mined before finished nickel is produced therefrom. Surely a man must have a great amount of courage, as well as capital, who, in the face of all this, undertakes such a gigantic concern alone, after seeing that so many strong companies have tried it before him and failed: but Mr. Wharton not only made the attempt alone, but stuck to it, and by sheer force of perseverance and expenditure overcame all obstacles, built up one of the completest nickel establishments in the world, and by vigor and economy made mining and making of nickel in America a successful industry, thus bringing many thousands of dollars every month into Lancaster county.

"The mines are situated in Bart township, and the smelting works about three quarters of a mile north of them in Paradise township. The original mine tract, bought by Mr. Wharton, of the Gap Mining Company, was 80 acres, since then he has bought 188 acres adjoining farm land. The original smelting-works tract was 9 acres. He bought in addition to this 74 acres, making total mine and smelting-works tracts 351acres. There is on those properties a large mansion-house at the mines where the superintendent of the works resides, a large country store and dwelling (White-Hall store) near the mines, 22 tenant-houses which are occupied by the workmen, 3 barns, stables, sheds, &c. A township school-house near the mines, and a commodious Episcopal church on the mine tract, erected in 1857, the Gap Mining Company donating the land for church and grave-yard. About 30 horses and mules are owned and employed about the works hauling ore, matte, fuel, &c. An hundred hands are employed at the mines, 50 at the smelting-works, and 100 in the refinery. The mines are opened out on the vein in length by shaftsand tunnels about 2,000 feet, and the deepest point attained is 235 feet. There are 6 shafts ranging from 100 feet to 235 feet deep, and a few others from 60 feet to 80 feet deep. All the shafts are vertical. The ore is rarely found in paying quantities nearer than 50 or 60 feet to the surface. There are 2 steam engines at the mines, one a low pressure Cornish pumping engine, 100 horse power, for pumping the water out of the mines, and the other a 25 horse power, high pressure, for hoisting the ore and rubbish out of the mines.

"The veinstone, or rock matter mixed with the ore, is a dark colored highly crystalline hornblende, considerable quantities of which has to be mined along and hoisted with the ore. The ore, after it is mined, is brought through the tunnels to the hoisting shafts in small railroad cars, carrying about a ton each, it is then hoisted to the surface in large iron buckets, carrying about 1,000 pounds each, or in square wooden boxes (skips) working in guides, carrying 2,000 pounds each. After the ore is brought to the surface, it is prepared for the smelting works by breaking up the large lumps with heavy sledges, and picking out the rock or refuse matter from it, washing and hand picking the middle size, and jigging the fine, (jigging is a process of separating the rock matter from the ore in water by the difference in their specific gravity). After it is prepared it is hauled to the smelting works, where it is first put through Blake's rock-breaker, then into large roasting kilns, and set on fire to drive off a part of the sulphur it contains. When once on fire, it burns 4 or 5 weeks without other fuel. After cooling, it is next put into the smelting furnaces and melted. This smelting does not bring out the pure metal, only a part of the worthless matter is taken out by it. The product of the furnace is a kind of a concentrated ore, called matte. The matte comes out of the furnace in a liquid state, and is ran into pigs in sand moulds, similar to pig iron from an iron furnace. This pig matte is next put through the rock breaker, then through a powerful Cornish crusher, by which it is reduced to a coarseish powder, into barrels, which is filled (1,000 pounds in a barrel,), and shipped to the refinery in Camden.

"There are two 25 horse-power steam engines at the smelting works. One drives the blast cylinders which give blast to the furnaces, and the other drives the rock breaker and Cornish crusher. There are three blast furnaces, but only two in blast at a time. There are also there a cooper shop, a blacksmith shop and a wagonmaker shop. We mine and smelt 636 tons of ore per month. The ore when it leaves the mines contains from one to three per cent. of pure nickel. It also contains cobalt, copper, iron and sulphur. Pure nickel is worth from $2 to $3 per pound. The refinery is called the 'American Nickel Works,' and its products are pure nickel, nickel oxide, nickel alloys, nickel castings, nickel salts, pure cobalt, cobalt oxide, cobalt alloys, cobalt castings, cobalt salts, copper, blue vitriol, &c.

Yours truly,

CHARLES DOBLE."

Oct. 2, 1875.

The following is a summary of details presented by Captain Doble for use in this report, and prepared by him for that purpose, (with Mr. Wharton's permission), September 22, 1877.

In answer to the appended printed list of questions, Captain Doble sent the replies which follow.*

1. Name of bank?
2. By whom leased, and since when?
3. How long in operation?
4. Character of ore?
5. Amount procured per day?
6. How many workmen employed, and in what manner?
7. What horse-power engine employed?
8. Cost and quantity, and kind of fuel consumed?
9. Description of important pieces of machinery?
10. Proportion of wash and lump ore?
11. Distance to shipping station, and cost per ton per mile on road?
12. Teams owned by company, or private?
13. Who uses the greater part of the ore, and for what purpose?
14. Is there too much or too little water?
15. Is it got out by cart or inclined railroad?
16. How does it lie in its bank?
17. What is its character, and dip of the foot and hanging rock?
18. Dip of all neighboring rocks, and distances from bank?

* These questions are embodied in a circular printed by me shortly after the commencement of the Survey, in 1874, for the use of my aids and to give an idea to bosses of mines, &c., of the kind of information which we required. As the mines were exclusively iron mines in the district in which I was then working, the last two questions refer to it specifically, but the circular is equally convenient for any other product.

19. What kind of iron is made, and how sold?
20. The analysis of the ore, and of the iron made from it?

Prof. PERSIFOR FRAZER, Jr.:

DEAR SIR: I herewith send you a few items in relation to Mr. Wharton's nickel works:

1st. Gap Nickel Mines and Furnaces.

2d. Owned and worked by Joseph Wharton, of Philadelphia, since 1862.

3d. . . . .

4th. Nickel Ore (Nickel Pyrites). Contains from one to three per cent. of pure nickel; it also contains Cobalt, about one twentieth, and copper, about one third as much as the nickel.

5th. From January 1st, 1876, to January 1st, 1877, mined and smelted 7632 tons—636 tons per month.

6th. Number of workmen employed and wages paid, in 1876:

First class Miners, ...	16,	at $1.60 per day.
Miners' Helpers, ...	30,	" 1.25 "
Surface Laborers, selecting ore, &c.,	20,	" 1.05 "
Boys, washing, jigging, &c., . . .	20,	" 45 cts. to 70 cts.
Engineers and Mechanics, ...	7,	" $1.50 to $1.80
Total Force at the Mines, . . .	93	
Furnace hands at smelting works,	12,	at $1.44 per day.
Engineers and Mechanics, " "	7,	" 1.50 to 1.80
Common Laborers, " "	31,	" 1.05
Total Force at smelting works, .	50	
Teamsters and Farm hands, . .	18 at $1.30	
Total workmen employed, . .	161	

On April 1st, 1877, reduced the working force about one third, production about one third, and wages about fifteen per cent. In consequence of the existing stagnation in business, the force has since then been further reduced, and a complete stoppage of all operations is now contemplated.

The ore vein is perpendicular, (*i. e.*, *vertical*,) and is from

4 feet to 30 feet wide (and in some places is even wider than 30 feet). About two thirds of all the stuff mined goes to the furnaces, and about one third is waste. The gangue is hornblende, and the rock, for two or three hundred feet north of the vein is also hornblende, pieces of it, and also pieces of the south side rock I sent you.

The mine is opened out on the vein in length by shafts and tunnels, about two thousand feet, and the deepest point attained is 235 feet. There are eight shafts, ranging from 100 feet to 235 feet in depth, and two or three others from 60 to 80 feet deep.

All the shafts are perpendicular, (*vertical,*) and all made secure by cribbing. The ore is taken to the surface through those shafts either by skips or buckets. The skip is a square wooden box, working in guides, and takes up about a ton at a time. The buckets are made of $\frac{1}{4}$ inch boiler plate, and take up about 1200 pounds at a time. A 25 horse-power, high pressure steam engine, with a $\frac{5}{8}$ inch wire rope, does the hoisting from all the shafts.

A 100 horse-power, low pressure Cornish engine does the pumping. This Cornish engine has an unequal beam—8 feet stroke in the cylinder, and 6 feet stroke in the shaft. Cylinder, 3 feet diameter. Is calculated to run ten strokes in one minute, or one stroke in ten minutes, according to the amount of water to be lifted. It pumps from two shafts 550 feet apart, one shaft 6x11 feet, 175 feet deep—13 inch diamater plunger pump, 6 feet stroke; the other shaft, 10x 13 ft., 235 feet deep—12 inch diameter plunger pump, 6 feet stroke. At present two strokes—153 gallons—per minute keep the mines clear of water. Consumes 1000 pounds No. 1 anthracite coal in 24 hours. Delivers just the right quantity of water for washing the ore, jigging, &c.

The ore is rarely found in paying quantities nearer than 50 to 60 feet from the surface. The mining is done by shafting, tunneling, and stoping. The tunnels, or galleries, are generally about 60 feet below each other, and the vein between is taken out by stoping. The stoping is done either upwards or downwards, whichever is the most convenient. The rock and vein, to the depth of 60 or 70 feet from the surface, is very rotten and decomposed, and it requires a great deal of heavy timbers and planks to keep the sides and top from caving in. Below that point, the rock and vein are very hard and firm, and have to be all blasted out.

The mines are situated in Bart township, 3½ miles south of Kinzer's station P. R. R., and the smelting works ¾ of a mile north of the mines in Paradise township, 2¾ miles from Kinzer's station.

At the smelting works there are 11 kilns for roasting the ore, which hold 100 tons each. It takes about 1½ cords of wood to fire a kiln. When once on fire, a kiln will burn 5 or 6 weeks without other fuel than its own gases. There are 4 smelting furnaces, 2 in blast at a time. Use limestone and quartz for fluxes. There are also two 25 horse power steam engines at the smelting works, one drives a 9x15 Blake rock-breaker, and a powerful Cornish crusher, and the other drives the blowing cylinders. Three blowing cylinders 32 inches diameter and 24 inch stroke. We have no pressure gauge, but we regulate the amount of blast according to the requirements of the furnaces.*

The works have also two blacksmith shops, a carpenter shop, a cooper shop, and a wagon-maker shop.

The original mine tract that Mr. Wharton bought with the mines in 1862 was about 100 acres. Since then he has bought 350 acres adjoining farming lands to it, which now makes one connected tract of 450 acres, of which 380 acres are farming land.

Yours, truly,

CHAS. DOBLE.

Sept. 22, 1877.

At the date of the visit to the Gap Nickel mines by the author, Aug. 29, 1877, the following notes were made, which will be found partly to embody the information given above by Capt. Doble, but partly also to refer to other matters.

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*The matte made here was for some years mainly sold to England and Germany, but now is sent to Mr. Wharton's refinery, at Camden, N. J., (the American Nickel Works,) where metallic nickel, cobalt oxide, and blue vitriol are the principal products. All these articles are of the first quality, the two latter are consumed entirely in this country; the nickel being of latter years, in excess of the consumption of this country, has been in part exported

The Furnaces.

The furnaces were under the management of Mr. Rupp in Capt. Doble's absence.

Of the four furnaces here but one was in blast. The blower was driven by one 25 horse-power engine, and the rock-breakers and Cornish crusher by a 25 horse power engine. The pressure at the tuyeres was about 1½ lbs. per sq. inch, (=1.0545 kilograms to the square centimeter.)

The ore at the mine is worked over with sledge hammers. The larger stuff is treated in the Blake crusher No. 9, which will take a rock 9″x15″ (22.8x37 5 centimeters), and the smaller stuff is washed and hand-picked, and the fine jigged.

From here the coarse stuff goes into the roasting kilns, and the fine stuff is cemented together into brick shaped lumps and goes into the smelting furnace.

The ore for roasting is broken coarse, 2″ to 3″, the limestone and flint (or quartz) for flux is broken finer. The matte is crushed in the Cornish crusher and is then barreled and shipped to Camden.

The rates of wages paid the hands at the above date here follow:

		$ cts.
(50) Fifty surface hands,	per day,	0.90
(6) Six furnace "	"	1.25
(15) Fifteen miners,	"	1.40
(25) Twenty-five miners' laborers,	"	1.10
96 men, at per day,		101.00

The fine stuff was washed at the mine, and cemented together at the smelting works by means of lime water. About 15 p. c. of all the ore mined is fine, and is thus treated.

A number of mechanics, engineers, carters, masons, carpenters, blacksmiths, &c., &c., are employed on the surface in numbers varying with the necessities of the mine.

Of these the engineers and mechanics get from $1.50 to $1.80 per day.

After the ore is thoroughly washed, it is charged in certain proportions, depending upon circumstances, into the furnaces and smelted.

There is a spring in the valley below the slag banks from which the water necessary for the boilers, brick-making, &c., was drawn, but it has so deteriorated within the last few years by the infiltration of waters, containing free sulphuric acid from the slag banks, that the necessary water is now pumped by a water-wheel in Wolf Rock Hollow, quarter of a mile away, which lifts it 102 ft. vertically.

There are eleven roasting kilns, each of 100 tons (101.6 tonnes) capacity.

On the average eight or nine kilns are kept in operation at once, and burn about five or six weeks.

The roasting is such that assuming the ore to have 25 p. c. of sulphur when put in, it comes out with about 5 p. c.

The ore, which is principally Millerite, (or Nickel Sulphide,) occurs principally as the lining to a hornblende rock, which lies like a huge "horse" in the coal regions. This rock is lenticular in shape, and strikes nearly east and west, averaging about 300 ft. (92.4 m.) in width. No ore of any consequence is found in the interior portions of the rock, but the main supply occurs as a contact vein between the surface of this hornblende gangue and the walls of the schist against which it rests.

The main shaft is nearly 240 ft. (73 meters) deep, and the hoisting is done on skips or in iron buckets, as described in the previous portion by Capt. Doble.

It is about 60 ft. (18.3 meters) from the mouth of the shaft to the top of the ore in the first drift.

The power for pumping the western mine is transported about 500 feet (152.4 meters) by a wooden shaft, commonly called by miners "flat-rods."

The consumption of coal used to be about 800 lbs. (363 kilograms) in 24 hours to pump for one mine alone. With this long connection the expenditure is only 1,000 lbs. (453.6 kilograms) per 24 hours, for pumping both mines, so that the expenditure of 200 lbs. (90.7 kilograms) frees the second mine of water. A 25 horse power engine does the hoisting.

When running at full blast, (as was the case May, 1877,) the average yield was about 600 tons (609.3 tonnes) per month, but as appears by Capt. Doble's statement above, 636 tons have been produced in this time.

At the time of this inspection about 300 or 400 tons were being got out. There are about 10 or 12 shafts altogether, old and new.

About 80 gallons of water per minute discharged from each of the two working shafts, free the entire mines from water.

Its water-making average is therefore about 160 gals. (605 liters). per minute.

E. 20° S. is about the average strike of this mass of hornblende, but this can only be said in a general way of a line which should be so placed as most nearly to divide the mass horizontally into two equal parts. The outside surface is very irregular and has only been ascertained as a result of the extensive exploitation and mining which has been done here.

At the west pump shaft the hornblende rock is about at its narrowest point.

Eastward from this west pump shaft the richest ore is found on the south side of the hornblende, and westward from the same point, on the north side. This renders it probable that this hornblende mass is cleft, or at least penetrated by the deposit under this pump shaft.

About 164 ft. (50 meters) southwest of the main shaft an opening 65 ft. (20 meters) N. E. & S. W. and 33 ft. (10 meters) wide and 40 ft. (12 meters) deep [originally 130 ft. (40 meters) deep] the ore comes nearest to day. The country rock on the S. E. side, supported by timbers, is a green mica schist. The hornblende lies to the N. W. The ore comes to within 16.4 ft. (5 meters) of the surface, and was wrought to 130 ft. (40 meters) in depth.

The country rock is generally a red ferruginous decayed mica schist.

The width of the slope varies from 6 ft. to 20 ft. (1.83 meters to 6.1 meters). It is well timbered and the timber is in good condition. Near the eastern extremity of the drift a slope is cut, exposing the foot wall which (*in the mine*) seemed to be a kind of hydro-mica slate.

At 170 ft. (51.81 meters) from day in the East side of the main shaft the vein seems to be about 35 ft. (10.66 met.) thick. A large chamber is cut out on the N. W. side (i. e. north side of the hornblende dyke).

The north shaft enters an end of this northwest chamber which is about 20 ft. (6.1 meters) wide, the vein being vertical.

About 500 ft. (152.4 meters) west of the main shaft the vein narrows in to about 8 feet (2.4 meters) thick. The mica slate (which shows indications of the proximity of trap) dips N. 15° W.—75°, but seems to get more vertical above.

Rock in the cross cut at 110 ft. (33.8 meters) dips N. 15° W.—80°. The rock is a very arenaceous decomposing mica schist.

In the breast at the north-west heading on the 110 ft. (33.8 meter) level and about 200 feet (60.95 meters) from the west pump shaft, the men were driving in a vein about 40 ft. (12.19 meters) thick. Many so called boulders or detached masses of hornblende exist in the solid ore. Some of these are each 1 yard (or meter) in diameter. Some times but not always the contact surface of the boulder and surrounding ore is richer.

About 159 ft. (35.6 meters) north from this shaft on the sixty foot (18.29 meters) level is a very rich pocket of ore. The Millerite usually coats the upper or lower surface of fissures or cracks in the vein, the nickel being carried in solution along the cracks.

Stalactitic structure is often noticed leading from one wall of a cleft to the other, or connecting mammillary concretions.

Near the heading on the slope from the 60 ft. to the 100 ft. level (where the richest ore is at present* found, and which was just now referred to), 20 to 35 foot timber stulls were being put in, of which one end is yet in solid ore.

* Sept. 4, 1877.

The actual thickness of the vein here exposed is about 35 ft. (7.6 meters).

The plunger of the force pump is 13 inches (30.5 centimeters) and six feet (1.83 meters) stroke.

The map of the mine and adjoining lands, made by Mr. W. M. Cooper, of Christiana, for Mr. Joseph Wharton, the proprietor, and kindly furnished the Survey by the latter gentleman for publication, will give the relative positions of the trap, ore, and schist better than any mere verbal description.

The irregular wedge shaped mass is the hornblende lying completely insulated in the mica schist.

The course of the portion of the great Point Airy—Peters Creek dyke through this map is seen in the right hand lower corner.

Mining Localities of Fulton Township.

The products of Fulton township obtained by mining are essentially of three kinds.

First, the chloritic argillites which form the roofing slates on the borders of Drumore, and which are extensively mined on the York County shore of the river, and still more extensively a little over six miles (or some ten kilometers) across the S. E. corner of York County, in the State of Maryland.

Second, the Serpentine belt, from which Chromite and Magnesite are obtained, and manufactured into magnesia salts for the drug trade, and chrome colors.

Many years ago Isaac Tyson, of Baltimore, followed up the Serpentine range which crosses the Patapsco northwest of that city, for the purpose of securing all the available magnesite mines which occur principally in connection with those rocks. In this manner he located many tracts for future mining in Lancaster County, amongst which several have become famous to collectors of cabinet specimens of minerals. Although Magnesia was the product originally desired, these explorations opened up in the same localities large quantities of Chrome ores, which afterwards obtained great mercantile value.

This manufacture gradually increased, and usurped the place of the other, until at last it became the principal product of the firm. Business considerations led to the endeavor to monopolize the raw product, until the heirs of Mr. Tyson find themselves in possession of the principal chrome mines in this country, some of those from which the chief source of ore is obtained being on the Pacific slope.

The principal chrome mines (now entirely abandoned) in Fulton township were the Line Pit,*(so called because it is astride Mason & Dixon's line,) "Low's Mine," "Jenkin's Pit," and "Brown's Mine," the latter on "Soapstone hill."

The "Line Pit" is situated on the Maryland-Pennsylvania line, about mid way between Rock Spring P. O., in Maryland, and Dr. Wood's Mill. The State line divides the pit into two parts, of which the Pennsylvania part belongs to the Tysons. Many of the minerals obtained from here are stated in Dana to be from "Texas, Penna.," which is two miles N. E.

Zaratite, Brucite, Magnesite, Chromite, and Williamsite, or Precious Serpentine, occurred here.

This mine was never entirely in the possession of the Tysons.

There are two openings here which have filled with water, one of which is the "Low Mine," and the other the "Line Pit."

Sixty-five and a half yds. (60 meters) S. W. of these openings, there appeared to be (July 10, 1877, at 11, A. M.) about 7° Magnetic Deviation E.

* Andrew Low and Benjamin Gibson opened a mine of "*chrome*" near the State line, and obtained a large quantity of the mineral, realizing considerable wealth therefrom. The Line Pit was opened and worked by other parties with success. The Jenkin's Mine, and all others where the surface indications were favorable, fell into the hands of the Tysons, and were wrought at different times, with varying success. At present, all these mines in Fulton township have been abandoned.* The only mine now in operation, as it is the largest and most productive ever opened in this part of the State, being Wood's Mine, across the Octoraro, in Little Britain township.

About 382½ yds. (350 meters) east of the Line Pit is situated one of the five-mile stones of Mason & Dixon's line.

These stone are curiosities, from the fact that they were carved in England

†Dr. C. H. Stubbs, Oxford *Press*, Feb. 9, 1870.

About 218½ yds. (200 meters) southwest of Rock Springs Church is the Jenkins Chrome Mine, opened by Isaac Tyson, and allowed to fill up again. It was re-opened in the last fifteen years, but no large quantity of the mineral was extracted. This mine never paid, although a deep shaft was sunk, and much money expended.

The Fulton township Chrome Mines are as follow: The "Line Pit," the "Wet Pit" (half way between the Line Pit and the next following), the "Jenkins Pit," and "Brown's Mine." The shafts of the "Wet Pit" have all fallen shut.

Magnesite Mines.

Among the most important mining industries pursued in Fulton township was the mining of this rock for the manufacture of Epsom Salts in Baltimore.

"An important locality of this mineral occurs on the property of McKim, Sines & Co., of Baltimore, adjoining the land of the late Joel Jackson. It was quarried and manufactured by this firm into sulphate of magnesia (epsom salts). These gentlemen have succeeded in making a purer salt at a much less price than it can be imported, which has entirely excluded importation, and the United States are now almost entirely supplied from this establishment.

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out of oolitic limestone, and shipped to this country. Relic hunters have nearly defaced all that were easily accessible on the eastern part of the line. The stones are vertically fluted, and those which mark every fifth mile bear the escutcheon of Lord Baltimore on their southern, or Maryland side, and that of William Penn on the Northern, or Pennsylvania side. The edges of the stones seem to have been truncated, and fluted horizontally.

In 1762, Chas. Mason and Jeremiah Dixon were employed to run the line of which these stones were intended to mark every even mile. Blocks of oolitic limestone, 7 ft. long, were placed at these intervals, with "P" on the north side, and "M" on the south side. Every fifth mile stone had the armorial bearings of the two original possessors engraved, each on his own side.

It may be well to add in this place the meanings ascribed to the names of places and streams most frequently met with in this part of the country.

"Susquehanna" is said to mean "Great Island River."

"Octoraro," "the place where money and presents were distributed."

This latter is so suggestive of the French word "*Octroi*," as concession, grant, or toll, as almost to suggest that this word was orginally derived by the Indians from the French.

"Conowingo" means "in the Rapids.

Five hundred tons of magnesite have been obtained from this locality." (*Mombert's History of Lancaster County*, p. 377). The above is placed under a topographical description of Little Britain township by the author * * although it belongs in the article on Fulton.

"Magnesite was obtained in considerable quantities on the "Boyce farm," but of late years the pits have not been worked. We are of the opinion that the mining of magnesia, like that of chrome, has been for the present discontinued."*

Roofing Slate Quarries of Lancaster County.

Just north of Peter's Creek the rocks are crystalline schists intercalated with quartz, which in the next 54½ yds. (50 meters) N. W. are replaced by fine grained black argillites with a dip of S. 40° E.—64°.

Brown's Old Slate Quarry.

This quarry, which is the nearest to Peter's Creek Station of the Columbia and Port Deposit R. R., has been in operation for more than 100 years. It has been in the possession of the Browns of Lancaster county for many years. Mr. Bonsall purchased it of the Browns, and Mr. Yard became afterwards interested in it, having bought it in at the assignees' sale. All the improvements belong to the Peach Bottom Mining Company, and half of the fee to the heirs of Brown. It has not been run in full force since last fall (1876).

Fifty men, two engineers, and three carts, the latter owned by the company, are employed.

Among the hands there are 6 splitters, 1 sawyer, 1 planer, and 1 dresser. The rest are quarrymen. The average quarry wages are $1.50. The engineer gets $40.00 per month, and the principal engineer, house rent and coal besides. The dresser gets $1.60. Helpers, $1.25. Laborers $1.00 per diem.

The dark, fine-grained slate gives place to the light colored schists first noticed just below the factory.

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* **Dr. C. H. Stubbs in article on the Mineralogy of Fulton township, Lancaster county. *Oxford* (Chester county) *Press*, Feb. 9, 1870**

One half the breadth of the cut is bony and unfit for the market.

Dip of large slate in the quarry is S. 20° E.—80°.

The cut is an open one about 85 ft. (26 meters) deep, measured from the level of the R. R. The shaft is irregular, but the width of the cut is from 12 to 20 meters(49 to 65.5 ft.)

One pulsometer clears the mines of water. The company paid $500 for the right to use the diamond drill, but at the time of inspection (May 29, 1877) no further inspections were being undertaken. The pulsometer threw 100 gallons per minute at 51 lbs. pressure. The boiler was from 16 to 18 horse power, while the engine was of ten horse power.

The quarry is getting too deep for profitable working.

Two more workings are being commenced.

One square (=100 sq. feet) of the slate can be produced for $3.75 when the full force of sixty men (60) are at work, and the machinery is in perfect order. On this (the Lancaster Co.) side of the river the sales price is $5.50 per square, on the other side it is $5.25.

The Navy yard and the Gas Works at Philadelphia are furnished from here. A blast is set in the bottom of the mine, and the large blocks thrown down bounded on one side usually by a joint, and weighing perhaps quarter to half a ton on the average, are hoisted up to the surface by a derrick or crane. They are then carted from the edge of the pit into the factory, where they are placed on an iron frame and sawed into lengths by machinery.

These sawed blocks are then put into the hands of the splitters, upon whose good judgment and long experience very much depends for making an economical use of the blocks. Slight differences of texture, that the most experienced mineralogist who had not learned this trade, would hardly observe, or if so, not connect with any serious deterioration in the stone, will suffice for these skillful splitters to expose a new face or, perhaps, throw a large part of the sawed block away. These Peach Bottom slates are not so smooth and black as some of those from Slatington and Chapman. They have a fine grain but are very liable to show incipient traces of blebby or bubbly texture, even in the finest parts of the best varieties.

In reflected sunlight they reflect a pinkish tinge, which proves them to be purple-black. Nevertheless they are of the finest structure, and seem almost ductile, so easily do they permit nails to be driven through them without splitting or breaking. They are not only smooth but soft to the touch and cut in the saw and shears like so much paper. Their weathering property is equally remarkable.

Mr. P. Maxwell's house next to Mr. Frazer's, on the road from Peters' Creek Station to the Maryland line, is said to have been among the first to be covered with these slates. If so, it must have been over 100 years ago, as the quarries have been wrought for at least that length of time. They not only have the power of resisting frost and sun, but they give a neatness and finish to a house quite different from anything attainable by shingles, and not the least attractive part of the landscape in these regions are the small and large roofs of barns, houses and dairies, which in the greatest distance present a clean, square cut outline and produce to the eye a pleasing effect.

On the other hand, they make small houses and attics excessively warm, owing to the high specific heat of the slates, which causes them to absorb enough heat during the day to radiate all night.

After the slates have been split to the required thinness, care being taken not to pass any shingle which shows signs of flaws, it is trimmed by the cutter to the desired size. The cutting knife employed in these works is a patent by Mr. Bonsall. It is moved by machinery instead of by the foot, like most of those employed on the other side of the river.

The saws are of various patterns, jig saws, &c., which, with the large horizontal wheel 7′ 7″ (2.4 meters) in diameter are mainly used for finishing the larger slabs for mantels, tombstones, &c., &c., and of which one here, a perfect stone without blemish, measured 6.13 feet (198 centimeters) in height, 3.05 feet (98 centimeters) in breadth, and 1.12 inches (3 centimeters) in thickness: which, assuming the lowest specific gravity of the stone (sp. gr. 2.6) would give it a weight of 363¼ lbs. (151.35 kilograms.)

Part of the enormous waste caused by the impossibility of separating the slate before hoisting, and most of which is dumped in huge piles along the R. R. is ground up into flour and sold for slating roofs, for graveling roofs, for cement and for paint.

Mr. Dawson Coleman & Co. is said to have paid $40,000 for two mines on the hill above this one, not now wrought.

The factory is 200 ft. (61 meters) by 50 ft. (15.23 meters.)

Peach Bottom Slates in York Co. and Md.

The principal part of the Roofing Slate industry is carried on in York county and Maryland, on the right bank of the Susquehanna.

These mines do not extend to the river bank, but after crossing from the slate factory of Brown, just described, are first met with about 3.6 kilometers (2.25 miles) S. W. from the river and near to Slate Hill P. O.

In passing from the town of York towards the present terminal station of the Peach Bottom narrow gauge R. R., in York County, a description of the rocks passed through up to the summit or Red Lion will be found in Report C for 1874, in Section 2. From here to Delta Station the scenery is wild and the hills precipitous along the banks of Muddy Creek, which has been chosen for the line of the R. R. The rocks belong to all varieties of the hydro-mica schists intersected here and there, and especially in the chlorite horizons, by veins of quartz.

An example of such a vein is to be found about half a mile (or 0.8 kilometer) N. E. of Woodbine Station, where a prominent ridge of white quartz 5 meters (5.4 yds.) wide strikes about north and south, and by its superior hardness has resisted weathering better than the adjacent soft strata and stands out boldly as a steep white comb of rock.

From here, further down, the continuations of the Martic Hills of Lancaster County are successively passed, the rocks being of similar nature, and the dips generally steep to the S. E.

MR. JOHN HUMPHREYS SLATE QUARRY, HALF A MILE EAST OF DELTA, YORK CO. PA.

About 0.6 miles (1 kilometer) N. W. of the site of an old church, said to have been erected about 1740, a dip of S. E. ±75° is recorded. [The site of this old church is near the abrupt elbow in Muddy Creek.]

1.3 kilometers (about 0.8 mile) S. E. of this exposure, on the line of the R. R., another dip is S. E.—steep (angle not recorded).

These S. E. dips are continued for over 1.8 miles, (3 kilometers,) wherever the rocks appear, to Delta.

The village of Delta lies on the N. W. slope of the Slate ridge, and about 0.5 kilometers (0.3 miles) S. W. of West Bangor, and perhaps 1.5 kilometers (a little less than a mile) west of Slate Hill P. O.

Description of Quarries.

Mr. John Humphrey's quarry is situated just E. of West Bangor, and about 350 meters from an old bank which ante dates the Revolution.

It lay idle until a few years ago, when it was wrought by Carmans.

There is still as good slate in this quarry as there is in the ridge, but the quarry got too deep, and the men became discouraged.

Mr. John Humphrey is one of the most intelligent of those interested in quarrying this slate, and all are remarkable for intelligence. The work is almost entirely in the hands of Welshmen, most of whom have worked in the slate quarries of Wales.

In 1849, the means at the disposal of the miners for getting out and dressing the slates were very limited, and chiefly confined to an ordinary crane or derrick. At that time the mines were not deep, but they shortly afterwards became so, and as the difficulties increased, the mine was abandoned.

Mr. Humphrey leased the mining rights from T. L. Williamson and heirs, who owned the property.

Besides these partners, all of whom worked actively in the mine, extra laborers were hired. For the first few years the profits afforded a bare living, but they persevered for a number of years, and were successful.

They afterwards sold out to Mr. G. T. Wierman.

The slate ridge just back of the town of Delta is neither high nor steep, but preserves a rather uniform outline as far as it can be followed by the eye from the valley below.

It is well wooded, the trees being in most cases oak, chestnut, and hickory.

The general strike of the slates is N. E. and S. W., (or, to judge by two exposures on the summit of the ridge, E. 30° N.,) while the dip is very nearly vertical, though usually they show a slight preponderance to N. W. dip, prominent in those chutes which are on the S., or rather S. E. side of the quarries (as most of them are).

The quarries succeed each other in the following order, beginning at the State Line, and proceeding S. W. into Maryland.

1. Kilgore & Co.'s Quarry, } both on the east side of the
2. James Perry & Co., } road.
3. Wm. E. Williams & Co. (west side of road).
4. Wm. C. Roberts.
5. John Humphrey & Co.
6. Thos. W. Jones & Co.
7. John W. Jones & Co.

But one quarry south of these has yet been opened, viz:

8. Hugh E. Hughes & Co.

The slates in this latter quarry are said not to have paid.

This last quarry is about 1.8 miles south (or 3 kilometers) of the State Line, on the strike of the ridge. This gives for the entire range of valuable slate from its northeasternmost occurrence in Lancaster county, above McClenahan's, to and across the Susquehanna, and down to the southernmost development in Maryland yet known, or length of about 8.7 miles (or 14 kilometers).

Nor is this entire length proved in every place. On the contrary the ridge is full of exploitation shafts and pits sunk apparently on the strike between the upper and lower productive quarries, but abandoned owing to the absence of indications of suitable stone. And even when the explorations have proved the existence of the finest variety of slate, and when extensive quarries have been in opera-

JOHN W. JONES & CO'S. SLATE QUARRY, HARFORD CO. MD.

tion for a long time, the strata of the merchantable materials are very frequently capricious, and in the deep or on the trend change so in character that the greatest perseverance and ingenuity on the part of the quarrymen are indispensable to avoid sustaining loss, and even spoiling the quarry by injudicious mining.

The ridge has been prospected for two miles further than the Hughes' quarry without finding any slates sufficiently valuable to justify the necessary outlays for opening up a mine.

Hugh E. Hughes Quarry.

This quarry, as has been stated, makes so far the limit of successful exploration towards the south west.

The general strike of the slates in this quarry is about N. 40° E., and the dips nearly vertical or slightly S. E. on the S. E. half and N. W. on the N. W. half.

The joints appear rather more numerously here than elsewhere. One of them showed a dip of S. 40° W.±50°, or very nearly in the direction of the strike.

This circumstance is favorable to the mining of slate, since it allows a more regular and cleaner cut to be made, and leaves the shortest possible breadth of overhang.

There are other planes of cleavage dipping in other directions, but none represent the direction of the planes of bedding with as much probability as the plates of slate themselves.

One important effect results from these many planes of cleavage, viz: The limitation of the amount of material which can be profitably manufactured. The wastage which is consequent on the intersection of two cleavage planes, which make an acute angle with each other, is very large, and only the smallest sizes of slates can be manufactured in such cases.

The John W. Jones & Co.'s Quarry

Is situated close by the former pit to the N. E. It covers, perhaps, ½ acre of the surface. It is about 52½ ft. (16 meters) deep. The strike of the slates is quite regular to N. 40°

E., and the dip nearly vertical. There are also planes of jointing or cleavage here.

One plane is about S. 40° W.—30°, or in the direction of the longer axis of the quarry and of the strike of the slate. It extends as a shelf from the north edge of the excavation to the extreme bottom of the quarry, thus affording the workmen ample facility for ascending and descending.

There is another plane dipping about W. 30° S.±80°.

None of these quarries were working to the fullest extent, and some of them were lying entirely idle on June 19, 1877.

The characteristics of the rock were the same as those mentioned in the previous quarry.

Thos. W. Jones & Co.'s Quarry.

This adjoins the last mentioned works, in the direction of the strike N. 40° E. It was opened in the Fall of 1870, and before those immediately in proximity to it, (i. e. the John Humphrey & Co. or the Jno. W. Jones & Co. work).

The full force, when at work on this quarry, numbers 25 or 30 men. The openings cover ⅜ of an acre. The mine is owned by Thos. W. Jones, John Perry and others. The owners of the mine are Thos. W. Jones, John Perry, Wm. W. Thomas, Catharine Jones and others.

Wm. Perry was also one of the partners in the enterprise until his death from an accident in July, 1876.

One engine of 25 to 30 horse power is employed, with a 35 to 40 horse power boiler. The hoisting is done by derricks either in car or by slinging large blocks in chains.

Quarrymen get $1.50 per day. Helpers get $1.10. Dressers $1.50. Engineer $1.50. Hours of work are from 6 A. M. to 12 M. and from 1 P. M. to 6 P. M. On Saturdays, work stops at midday, which is counted a full day.

The workmen are, almost without exception, Welsh, and most of them have worked in the Festiniag quarries in the north of Wales. The average production is eight "squares" per day, for which they obtain $5.00 to $5.25 per square.

One slab was produced which was 6 ft. long and 3½ ft.

broad, at 50c. per foot and 15 lbs. to the foot. It cost $10.50 and weighed 315 lbs.

Both hard coal and wood are used for the engine, for the former of which, as lump, $7.00 per ton is paid delivered here. Only four tons of coal are used per month.

Wood costs about $4.00 a cord, and 104 cords are used per year.

John Humphrey & Co.'s Quarry

Is situated close by and N. E. of the last. The strike of the slates is about E. 30° N.—vertical. Work was not being prosecuted during the time of the visit, and the north end was partly covered by water.

A jointage plane dips W. 20° S.—30°.

W. C. Roberts Quarry.

This mine is being wrought, like the others, in its S. W. end, but it is peculiar from the fact that there is here left a very large mass of overhanging slate, which has not been taken out.

The jointage planes upon which this work is proceeding downwards dips S. 40 to 45° W.—45°.

The slates here are not vertical, but in one of the best exposures gave N. 30° W—20°.

A small quarry between the Roberts and the Williams shows by the direction of its greater axis that the strike of the rocks is here E. 30° N.

Wm. E. Williams Quarry.

This Quarry is about 200 rods (1 kilometer) S. W. of the Maryland and Pennsylvania Line.

The strike is about N. 40° E. and the dip nearly vertical. The southwest end of this quarry is in arenaceous ferruginous chlorite slate, but the strike of this rock differs from that of the main workable part of the bank, and appears to be E. 10° N., the actual measurement of the dip giving N. 10° W.—88°.

This bank is in two parts, which are separated from each other by a thin dividing wall. The northern is the deeper of the two, being about 23 meters (about 75½ ft.) from the surface of the ground to the deepest part.

Part of the bank caved in during the time that the bottom was partly covered with water. Those who saw the result testify that for an instant the sky was obscured by the mass of mud and loose stones which were projected into the air. One man on the ledge between the two excavations was killed by a large boulder which fell upon him, and water and small stones fell in large numbers 984 ft. (300 meters) distant.

A smaller excavation to the N. E. of this quarry about 98.5 ft. (30 meters) deep.

A seam of chlorite slate and quartz mixed with manganiferous iron oxide was met with in streaks in this mine.

E. Davies Quarry.

It is a small excavation 65.6x39.3 ft., and 49.2 ft. deep (20x12 meters, and 18 meters deep.) The dip appears to be about S. 40° W.—87°. This is the first clear indication of a strike of the slate materially differing from the strike of the ridge.

Mr. McConkey reports of the whole ridge that the strike of the slate does not correspond with it.

Nevertheless, a lamination of the slate at right angles to the plane of deposition is so remarkable, that this single exhibition must, for the time, be assigned to the unexplained anomalies.

A quarry next northeast of this does not appear on the township map. It is a cubical opening of about 32.8x32.8x32.8 ft. (10x10x10 meters).

In this quarry also the rocks strike N. 40° E., and are nearly vertical. The intersection of certain cleavage planes on the N. E. wall of the quarry with the plane of excavation form straight lines.

In West Bangor, a view of the ridge (without any reference to the strike of the rocks composing it) gives N. 45° E. for its direction.

A house here, belonging to Mr. William D. Edwards, is covered on roof and sides with the product of the quarries.

It makes a sufficiently fire-proof house, so far as sparks and small flames are concerned, and is a pleasing object to the eye.

Williams & Co.'s Quarry,

Just east of West Bangor, is a large and deep excavation, from which, evidently, much slate has been taken. It is now nearly full of water. The upper slates, which alone are visible, seem to strike E. 30° N. to E. 35° N. The hole is about 98.4x82 ft. (30x25 meters) in area, and very deep. The engine house is new, and large piles of rubbish surround the place. It is not now in operation.

John Humphrey & Co.'s Quarry.

This is an excavation about 492 ft. long, (150 meters,) from 49.2 ft. to 68.6 ft. wide, (15 to 26 meters,) and of various depths.

The course of the excavation is about E. 35° N.

Mr. Humphrey thinks that 60 to 70 ft. will represent a fair average of the breadth, which it pays to work. Of this perhaps 40 or 50 ft. will make the best slate, but this breadth is the sum of a number of narrow benches.

Seen from the front of Mr. Humphrey's dressing house, the ridge trends E. 10° N. to Slate Point on the river.

The rock keeps its quality down to the bottom of the quarry, which is 53 meters (about 175 ft.) deep in the deepest part.

For the first 12 meters (40 ft.) from the surface, the quality of the rock alters, but below this it does not perceptibly change.

The amount of work performed naturally varies, but two men can make four squares a day, if the slate is good.

The system of joints in the southern quarries is somewhat different from that in the more northern quarries.

Thirty men are employed, and the product is 3000 to 3500 squares a year of the best quality slates, 100 tons of second quality slates (at 3½ squares to the ton).

NOTE.—A square is an amount of slates which will cover an area of 100 sq. feet, or 10 ft. square. The thickness and dimensions of the individual slates are different, but the price is usually the same for a given area.

Mr. Wierman sold out again to the same persons from whom he had bought the quarry two years before.

The whole ridge is slaty, and is about half a mile (0.8 kilometers) in width.

One specimen of the slate received from this quarry exhibits in the mass of a fine slate a fragment of unaltered mica schist.

Prof. Agassiz visited this quarry some years ago, and its stalwart owner remembers a saying of the great naturalist, which he repeated. "The Almighty," quoth the Professor, "might have made a more perfect fish than the trout, but he never did it." I say the same of the Peach Bottom slates, said Mr. Humphrey.

In the northern quarry the direction of the larger axis of the excavation (indicative of the line along which the best slates have been found) is E. 35° N.

In the old "Revolutionary Bank," not far from this working, and which is now full of water, the same trend is N. 40° E.

Jones & Co.'s Quarry.

Of this, which is the extreme north easternmost quarry on the York Co. map, no points (were observed) which would entitle it to any special notice. The conditions of the rocks were similar to those before mentioned, and the waste pile was as great or greater.

This accumulation of waste is a far more serious matter than the piling up of coal slack in the anthracite region, and is equally unsightly. For in the latter case there is a reasonable expectation that means of utilizing this slack will be found, but no such hope exists for the enormous piles of misshapen and glistening roofing slates which are the characteristic sight of Slate Ridge.

Serpentine Quarry, near Ramsay's Place, Harford County, Maryland.

The serpentine hills, which pass southwest of the slate quarries in Penn., cross a corner only of Lancaster County, barely touching York County, and continue into Maryland.

The slates which are found at road crossing of Broad Creek in Harford County, Md., nearly south of Delta, are arenaceous chlorite schists, dipping S. 35° E.—74° (on the north side of the creek).

Passing S. E. from Slate Hill (which one crosses between Peach Bottom Ferry and Delta) the Maryland line is traversed near the house of Mr. Glascow. A road to the left south of here brings one to Broad Creek. A rough partly corduroyed road leads up the hill, and up the stream. About 1.24 miles (2 kilometers) up the stream a ford is crossed, and 218 yds. (or a couple of hectometers) brings one to the mine.

Here there are first a few small openings. Higher up the hill is a horse winze, and a shaft well cribbed, and about 65.6 ft. (20 meters) deep; at least to the water, which partly fills the shaft.

The outcast of the shaft lies in large piles around its mouth. Part of this material is a dark green arenaceous chlorite, with plates of the exfoliated mineral upon it, but the main bulk of the rock presents to the eyes from a distance a light bluish color, and is in fact a serpentine with much steatite.

Some hard magnetite is also found among the fragments of this pile; and a larger mass of them lie in the east side of the mine as if in place.

The shaft is in good condition, and shows two lifts or stages of about ten meters each, with cribbing on the E. 40° S. side.

At the first landing from the top, massive rock is shown in the W. 40° N. face. The most important plane (perhaps of cleavage) dips±E.—±85°.

The lower portion is filled with water, and was therefore not observed.

From a small opening S. W. of the large shaft the serpentine shows a bedding of E. 40° S.—75°.

The fine specimens of Verde Antique exhibited in the

Maryland Department of the Centennial Exhibition is said to have been taken from these mines.

The rocks along the river just north of the Line Bridge on the tow path dip S. E.—80°.

At the first lock above the line the exposures of mica schist are good and extensive, and the dips are S. E. and steep.

Slate Point, which is about 654 yds. (600 met.) below Peach Bottom Ferry, shows these argillites dipping very abruptly S. E., but conformably to the adjoining strata.

Just below Slate Point are 33 yds. (thirty meters) of mica-schists which dip vertically.

About half a mile (or 0.8 kilometer) S. W. of Cooney's Hotel, Peach Bottom Ferry, and on the north side of the road and brook, mica schists dip S. 25° E.—62°.

The rock is very much intersected by quartz.

Wood's Mine. Little Britain Township.

In answer to questions as to the history of the Wood Mine, Mr. Glenn kindly forwarded the following:

"The Wood Pit was opened in 1828, and has worked to the present, except from 1868 to 1873. The total output has been about 95,000 tons of chrome iron ore. Of late years but a small force has been employed, producing 500 tons to 600 tons of ore yearly. The assay value varies as with other kinds of ore, but within smaller limits. Sample given Prof. Frazer in 1877 was 56 p. c. Cr_2O_3."

"The country rock is serpentine. The ore body as proved is almost 50 fthms. long at its greatest extension. Depth proved to 120 fthms. Pitch of the mine is from 40° to 60° under the horizon. The strike is nearly E. and W. at the outcrop and nearly N. and S. on lower levels. The width of the ore bearing rocks is from 10 to 35 feet, or may be taken generallyat 20 feet. In this space occur the chrome ore and gangue (mostly serpentine and magnesite) which shows a general attempt at stratification conforming to strike and dip of the mine. But occasionally a branch of ore will stand vertically and extend itself into the footwall—or it may be horizontal and do the same thing."

"The mine is worked by ordinary 10 fthm. levels, winzes, &c."

"The power for pumping and hoisting is taken from the Octoraro Creek, which is 180 fthms. from engine shaft. For hoisting, power is obtained from a 60 in. Turbine, under 10½ ft. fall and transferred by a 6 in. hawser cable to proper machinery at the mine. For power for pumps, a wooden breastwheel 16 ft. high by 18 ft. long, is used under 10½ ft. fall. The motion is transferred by 6″x 8″ wooden flatrod, 180 fthms. to the engine shaft. There are two Cornish plunger lifts in the mine, with 10 in. columns. The lower and third lift is a 6 in. drawing lift arranged for sinking deeper. The mine makes from 60 gals. to 110 gals. per minute—depending on the season."

"For business reasons, but a small force of men has been employed of late years. There is no reason to think they will not continue, as heretofore, to produce 500 tons to 600 tons yearly."

WM. GLENN.

9–16–'78.

"The above notes were prepared for Prof. Frazer of State Geological Survey."

This mine is famous throughout the whole civilized world for specimens of minerals which it has furnished to all cabinets. It lies in a great sweeping ox-bow of the Octoraro, in the extreme southern end of Little Britain township, separated by this stream from Chester County.

The mine was opened in 1828 by Isaac Tyson. The property was purchased in fee simple.

Mr. Isaac Tyson used the magnesian rocks which occur in the "Bare Hills," near Baltimore, and followed up the range into Pennsylvania, in his search for more raw material for his manufacture of Epsom salts, &c. This brought him into contact with the chrome ores which accompany the same rocks, and he was led into the manufacture of the chrome salts as pigments, &c.

These were traced through Maryland and into this corner of Pennsylvania, where the richest return was made.

The Wood Mine is now 120 fathoms (219.45 meters or 720 ft.) in depth. The first level from day is 34 fathoms, and from this downwards each successive level is 10 fathoms below the one above it. It has been steadily in operation from the time of its opening until 1869. From this time until 1875 the mine was flooded with water. The ore is thrown out almost pure and without admixture of gangue.

The chromic oxide in the ore averages about 48 p. c. 56.5 p. c. is the highest p. c. Mr. Glenn ever saw from the ore of this mine. A specimen from "*New Texas*" (?) (that much abused locality) mentioned in a paper by Mr. Edgar Smith in Vol. XVII, No. 100, (May to December, 1877,) of the Philosophical Society's Proceedings (p. 217), refers to a chromite which contains 62.66 p. c. Cr_2O_3. This same ore was analyzed by Mr. Garrett and reported to contain 63 p. c.

During the last three years Mr. Glenn has not had more than 35 men employed, and at the time of the visit (July 10, 1877,) only fifteen were occupied.

A steam pump was used to un-water the mine in 1875, but since then a simple water power pump has been operated which uses the water power of the Octoraro creek. The shaft which conveys the power from the creek to the pit mouth travels on friction rollers and is about ¼ mile (or 400 meters) in length. It works at present with a four-foot stroke, but with a five-foot stroke attachment.* At present the mine makes about 60,000 gallons of water (267.41 long tons=198998.4 lbs.=90.24 metric tons, 90.24 cubic meters, or 117.72 cubic yards of water).

The pump is equivalent to a 60 horse power engine.

About 5 p. c. of the ore is crushed and washed, the remainder being pure enough to ship without crushing. It is transported in wagons 5 miles (or 8 kilometers) to the Rising Sun Station, on the P. & B. Central R. R., at a cost of $1.50 per ton for the carting and $1.60 for the freight, from there to Baltimore. No siding is laid down, because the present state of the tract is not large enough to require a siding. The locality is nearly on the direct line between

*July 10, 1877.

Baltimore and Philadelphia, and about 50 miles (or 80.4 kilometers) from the former place.

The mine, Mr. Glenn states, at one time produced all the chrome in the world, and in busy times furnished 400 to 500 tons a month.

At present the heirs of Mr. Tyson get their ore from California, and the Wood Mine is used as a reservoir to offset the vicissitudes of so long a shipment.

Mr. Glenn has now in hand another chrome region which promises well.

The ore from the Wood mine is hoisted out by a horse whim, and also by a turbine and endless rope. The body of ore varies in thickness and strike, but is constant in depth.

The Serpentine which forms the "country rock" here is unstratified, and is about $\frac{3}{4}$ mile (or 1.3 kilometer) in breadth. The strike of the vein is about W. 12° S.

The sandy chloritic slates to the north of the mine dip S.—50°.

1.6 kilometers (1 mile) S. E. of the Wood Mine is a run, known as Black Branch Run, from which considerable quantities of stream chrome are obtained, containing about 38 p. c. Cr_2O_3.

The stream chrome ore from Wood's Mine contains about 46 p. c. Cr_2O_3.

Mr. Glenn reports that the rocks to the S. E. of the mine are hornblendic, and that a region of Syenite commences on that side of this Serpentine deposit.

A reference to the catalogue of specimens accompanying this report will show a number of most interesting species of minerals, some of which are rare, and becoming more so.

The Brucite from this mine was at one time unexcelled for the beauty of its crystals as it was for its abundance.

The production of Brucite has almost entirely ceased, and that mineral is nearly as rare as it is elsewhere. Mr. Glenn, however, gives the comforting assurance to mineralogists that he knows where a new "find" will be probably made, and intends to put a blast into the nest (or, let us hope, into the rock enclosure of it) before very long.

Deweylite and Magnesite are obtained here yet in considerable quantity. Very handsome specimens of each of these species were en-route to the Johns Hopkins University, in Baltimore, (July 10, 1877.)

Zaratite, Lancasterite (?), (now called Hydro-Magnesite,) and Chromite are met with in quite large quantity, and sometimes in specimens of rare beauty.

Within the narrow neck of land made by the closest approach of the sides of the horse shoe, into which the Octoraro is bent, a dip in slaty strata is found ±N. W., steep (say 70°+degrees).

Near Kinseyville (400 meters N. W. of that town) the rocks dip S. 20° E.—60°, while about the same distance south of Kirk's Mills, the N. W. dip is resumed, but its inclination is gentle. There are the traces of the same undulations noticed above in Chester County, in the vicinity of Pine Grove.

Bamford's Zinc Mine, Bamfordsville, 1 1-4 Miles (2 Kilometers) S. E. of Landisville, Lancaster Co., Pa.

The following are a few notes concerning the Bamford Zinc enterprise, taken during a visit in July, 1876.

A fuller description by Mr. E. G. Spilsbury follows, giving a resumé which includes all his own experience during the entire time that the industry was being carried on.

This mine was worked for white oxide of zinc twenty or thirty years ago.

Mr. Green, of Aberystwith, imported dressing machinery from Wales.

Mr. Bamford purchased it two or three years ago, and Mr. Tamlin opened it. At an exposure near the works, a limestone appears to dip N. 20° E.—32°. The limestone, rich from impregnation of blende with streaks of more or less argentiferous galena, is about 12 ft. (3 .7 meters) thick.

There are two openings, (designated No. 1 and No. 2) on different veins. The former is nearest the smelting works and railroad. No.2 is about 50 ft. (15 .2 meters) further off.

At the surface the dip appeared to be±N. E., but it changed about 13 ft. (4 meters) below the surface at a small winze shaft, and seemed to take a±S. W. inclination. At the date of this examination (July 26, 1876) it had not been followed to its junction with the vein in No. 2.

At the above date No. 1 shaft was down about 30 to 40 ft. (9 to 12 meters) vertically.

The depth of No. 2 was about 70 ft, (21.3 meters.)

A shaft was sunk in the outcrop of No. 2 vein north-east of both the above, and much calamine (perhaps 50 or 60 tons) was found.

The ore was crushed in a Blake's crusher, and afterwards in a fine crusher, and was dressed in six jigs and three buddles.

Two of the latter were fed from the crusher, and the other one by hand.

The coarse stuff was taken to four jigs from the crusher, and the other two were fed by hand.

The dressed ore was sorted by screens, and roasted and reduced by the Belgian process.

The engine, with a 13 ft. fly wheel, furnished power under an average pressure of 60 lbs.

About 80 men were employed, of whom five were engine men. The hauling was done by contract in three carts.

Anthracite coal dust for reduction was hauled from Landisville, at a cost of 50c. per ton for hauling, and one to two dollars for the material.

There were about twenty miners in all. All ore but the calamine was crushed in a Blake crusher.

The calamine was placed in a reverberatory furnace and roasted, after which it was crushed fine in a crusher used only for itself and for the clay employed for the manufacture of the retorts, &c.

After being placed in the store house, it was either treated with the blende or by itself according to convenience.

The retorts were 4 ft. 8 inches high, and 8¼ inches in diameter. The condensers (made also of retort clay) were conical, and about fifteen inches high. Coal dust and powdered ore were put into the retorts until full, and the latter were placed on shelves and heated by bituminous coal.

The coal employed for this purpose was from Clearfield county, and cost $4.25 per ton delivered at the furnace.

The general average daily yield of spelter was about 1,500 lbs. (710.85 kilograms.)

The average market price was 7.5 cents per lb., but as high as 11 cents has been obtained.

The wages paid the workmen were by contract, proportioned to the amount thus obtained, and amounted to from $1.50 to $2.00 per day.

Outside hands get about $1.35 per day; furnace men, $5.00 for a shift of 24 hours; engineers' wages were from $1 50 to $1.75 per day.

This spelter was put on the market the latter end of September, 1875. They were burnt out in November.

There are four zinc furnaces in one block, with fifty-six retorts and condensers to the furnace. At the date above given but three of them were in operation.

There were two double hearth and two single hearth furnaces. These were occasionally stopped for an hour or two by lack of ore.

The following brief statement of the history of the Bamford Zinc enterprise, near Landisville, is from the pen of Mr. E. G. Spilsbury, the able projector and superintendent of those works, till the suspension of work in 1877.

Sketch of the Bamford Zinc Mine, near Landisville, Lan caster Co., Pa.

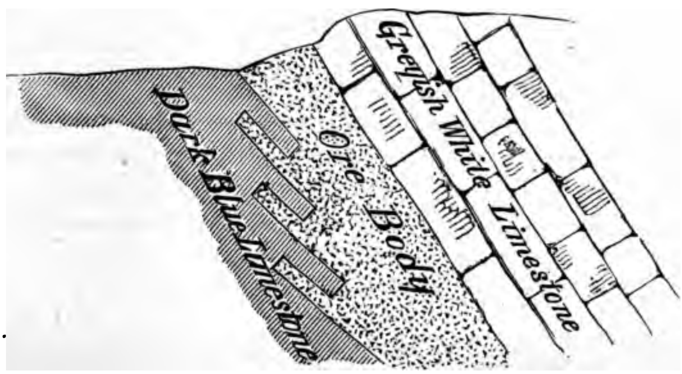
"This mine is situated in East Hempfield Township, on the line of the Pennsylvania Railroad, about five miles West of Lancaster."

"The deposit occurs in the form of two parallel bed-veins in the lower Silurian Limestones, near their line of contact with the shales of the same epoch, although so far as developed, the actual line of contact has always been found barren. In this respect the deposit differs from a very similar one in Sinking Valley, Blair county, where the contact lines between the shales and the Limestones are quite productive."

"The veins at the Bamford mine are most unmistakably "*bedded* veins, and not fissures or gash veins. They are conformable both to the stratification and dip of the enclosing rocks, their general course being about 74° 35′ east of North, and dipping at an angle of 18° from the vertical," (*i. e.* the dip is N. 15° 28′ W.—72°.) "The roofs or hanging walls are, in each case, well defined and regular, although the Limestone of the hanging wall has a decidedly brecciated appearance, is partially decomposed, of a whitish grey color and highly siliceous. It is full of seams and cavities, some of the latter attaining the dimensions of small caves, being from 15 to 20 feet long and equally broad, with a height of from 4 to 6 feet. All these seams and openings are completely filled in with a dark red sandy loam, differing in that respect from the Limestone caves of the Lead and Zinc regions of Missouri and Illinois, which are invariably filled with mineral. In none of of the cavities examined in this mine have I ever found a trace of mineral.

"This broken and dislocated appearance of the upper Limestone bed is not only apparent on the surface, but extends down at least so far as the bottom of the pump shaft, which is 110 feet."

"The foot wall, although having a generally regular dip, conformable to the hanging wall, is not so uniformly smooth, but has the appearance of a series of layers, between which the ore bearing limestone of the vein has been intercalated, sometimes to a depth of eight or ten feet. The annexed sketch will better explain this peculiar appearance:



"The limestone forming the foot wall differs very materially from that of the upper beds, being less siliceous, and of a dark blue, and in places almost black tint, and having a very close and compact fracture. I have noticed in places in it small druses lined with calc spar, and frequently filled with Oligiste iron ore," (specular.)

"The minerals contained in these veins are the sulphides of zinc and of lead. From the surface down to the permanent water level, a depth of about 18 feet, these minerals have been oxidised by atmospheric influences, and are replaced by calamines and carbonates of lead. The gangue is a limestone, slightly crystalline in spots, but generally very similar to that composing the foot wall. The Galena is chiefly found in bunches, or little strings, running along on or near the hanging wall, whilst the Blende thoroughly impregnates the whole of the vein matter in greater or less proportions. A remarkable feature in the Galenas from this deposit, is the vast difference between the percentages of silver they are found to contain. Specimens taken from one bunch or pocket, will run up to $2,000 of silver per ton, whereas adjoining pieces would perhaps contain only a couple of dollars to the ton. By the eye it is impossible to distinguish any difference between the two minerals, but nevertheless the difference is most probably due to the presence of minute crystals of Tetrahedrite. The average value in silver per ton may be taken as twenty-two dollars."

The Blende occurring here is of a bright golden color, known as rosin blende. It is very pure—the only impurities I have ever found in it being a slight trace of iron and cadmium, and mechanically mixed with it a small percentage of lead. The average of fourteen analyses, made at different times on these Blendes, gives:

Zinc	65.87 per cent.
Sulphur,	32.28 per cent.
Iron,	.81 per cent.
Lead,	.34 per cent.
Cadmium,	.07 per cent.
Total,	99.37 per cent.

The percentage of Blende in the vein varies considerably, "but the average of a year's working shows about 17 to 18 per cent."

"These veins have been traced on the property for a distance of about half a mile, and ore has been found in an excavation made on the side of the Petersburg Township road, just beyond the Pennsylvania railroad. About a mile and a half further north-east, another deposit of calamine was cut through in building the Lancaster Branch of the Reading and Columbia railroad. At that point considerable ore has been taken out, but owing to the desultory manner in which the mining was done, and also from the fact that there is no outcrop here, the soil being fully fifteen feet deep, it is impossible yet to form any correct idea regarding the extent or character of the deposit. It was at first generally supposed to be a continuation of the Bamford veins, but closer examinations prove it to be too far to the northward, and it must either belong to some other belt, or it may be an independent deposit."

"At the Bamford mine, both the veins have been opened upon and worked down to the 75 foot level, and the south vein has been cut at the 110 foot level."

"The north vein has been opened on a length of over 300 feet, had an average width of 12 feet, and has been worked out to a depth of 50 feet, and cut and explored on the 75 foot level. Below the 50 foot level, however, it was found everywhere to be perfectly barren."

"The south vein, which was the most regular and the most profitable, has now been worked out to the 75 foot level, and on a length of over 400 feet. The average width is from 14 to 18 feet. Although in some portions the ore was very rich, still the average amount of zinc in the vein never exceeded 12 per cent., and no ore was ever pure enough to treat without a previous concentration, excepting, of course, the surface deposits of calamine. The richest ore occurred at about fifty feet from the surface, and from there down to seventy-five feet. At the 110 foot level, although the vein is well defined, there is little or no ore in it, at any of the points where it has been opened, and what little ore is in it, appears in strings, and not disseminated, as above."

"These deposits were discovered as early as 1845, and have been worked off and on with varying successes since then. It was not, however until 1873, that the present extensive surface and underground workings were inaugurated. The property at that time changed hands for the enormous sum of $100,000 cash, and the purchasers at once set to work to spend another hundred thousand in building smelting works, before making any effort to develop the underground capabilities of the mine. In 1874 it became evident that no successful operations could ever be carried on here which were not based on a thorough mechanical preparation of the ores, owing to the fact, as stated above, that the whole vein mass was merely Limestone, impregnated with minute crystals of Blende. The present dressing floors were therefore erected on the Hartz system, and proved a most perfect success, and they are to-day, probably, the most complete and efficient in any of the Eastern States. The capacity of these floors is from forty-five to fifty tons per day."

"The calcining and smelting is carried on in furnaces of the Belgian style, adapted to the burning of anthracite coal."

"The cost of producing metal from such very low grade ores was necessarily high, though by very great care and economy the average cost for the year 1877 was not over five cents per pound. By the introduction of some more economical pumping machinery this might be lessened perhaps to 4¾ cents, but even at those figures there is no encouragement to resume operations, even if it were proved that the veins become again metalliferous at a lower depth. Subjoined is a detailed account of the cost of production, based on the capacity of the dressing floors for at least forty tons per day. Every item is from actual working, and taken off the books of the concern:"

Cost of Manufacture.

Mining 40 tons ore, @ $1.50,	$60.00
Hoisting and carriage to floors,	2.00
Dressing 40 tons, yield 26.63 clean ore,	20.00
Two engineers, @ $1.50,	3.00
Two tons coal for engine, @ $2.80,	5.60

Labor in roasting, $1.00 per ton,	26.63
Fuel for roasting 26.63 tons, @ $3.80,	101.19
Labor to reduce 24 tons calcined ore,	148.50
Fuel for reduction furnaces, 25 tons, @ $2.80,	70.00
Coal for reduction in retorts, 7½ tons, @ $1.50,	11.55
Fifty-four retorts, @ $0.72 each,	38.88
Condensers used, 180, @ $0.02,	3.60
	490.95
Add wear and tear, and management, 10 per cent.,	49.10
Total,	$530.05

The zinc produced, at the lowest estimation, would be 10,800 lbs., which, at 5 cents per pound, would equal $540, leaving a slight balance on the right side.

The spelter manufactured here was very pure, and acquired considerable reputation for its good qualities. Subjoined is an analysis of it:

Zinc,	99.687
Cadmium,	.034
Lead,	.262
Copper,	trace.
Iron,	.017
	100.000

E. GYBBON SPILSBURY.

Chestnut Hill Ore Banks.

The Chestnut Hill Ore is found in a tract which lies about three and a half miles (5.63 kilometers) north-east of Columbia, in a ravine—valley, on Chestnut Hill, which is a spur of Chikis ridge.

The excavations for ore cover an area of about 3350 feet (1 kilometer) east and west, by 1400 ft. (427 meters) north and south.

This area is sketched on the accompanying map, with boundaries approximatively correct.

Really, however, all the ores which lie above the Chikis Quartzite, from the mouth of the Chikiswalunga through Silver Spring and to the German Settlement and the works of the New York Company, should be included in this designation, for they are all parts of the same ore system.

There is practically no doubt that all these developments are made on the horizon immediately above the Chikis rock, and thus can be identified in age with the entirely similar deposits of Hematite in York and other parts of Lancaster counties.

Rogers considered the belts of rocks known in this report as the chloritic series, and the limestone schists, to be; the former, the *under;* and the latter the *upper* Primal slates; and speaking from this point of view, he designates these ores as upper primal ores.

It is not the intention here to assign any arbitrary limits to the formations, but rather to define the limits of the groups and belts of rocks; leaving to the final report their classification and arrangement under general names. But it cannot have escaped the attention of the reader of this report, that one great point of difference between the structure assigned by the writer and that given by Rogers, lies in the thickness ascribed to these several groups.

This "older slate" he makes 1200 ft. in Virginia, and "not ascertained in Pennsylvania." The "upper slate" "about 700 ft. in Pennsylvania."

The estimate of the thickness of these "lower slates," based on the measurement from Columbia to Turkey Hill, is 3600 ft., and the thickness of the "upper slates" in the same section, above Washington, at least 1600 ft.+

Nevertheless, the main fact that the horizon of these ores is in the hydro-micaceous schists, which separate the quartzite from the limestone, seems undisputed.

Before entirely leaving the general subject of age, it may be proper to explain why I have not accepted the word Primal Slates for those two groups, as a name and location given on very high authority, and universally recognized among geologists.

My reason for not wishing to unite the chlorites indissolubly with the Primal, is, that chlorites of apparently identical composition and habit are interstratified with rocks, in the South Mountain, which *may* be of Huronian age.

The objection to putting the nacreous hydro-micas (improperly called talco-micaceous in Rogers) in the Primal is still more cogent. In multitudes of cases these schists are interstratified with the Amoral limestone, and one seldom fails to find them apparently conformable to the base of that formation, wherever an extensive exposure is studied.* These schists seem to be inseparable from the limestone, but not from the quartzite or quartz-sandstone beneath them. But the question of which formation they belong to, can only be one of scientific and not of economical importance, for the relative positions of the series given by myself correspond with those assigned by the high authority to which I have referred.

Rogers says of this mine, Final Report, Vol. I, p. 182:

"This large mine is situated about three and a half miles northeast of Columbia on a high, trough-like valley or basin on the slope of Chestnut Hill a spur of Chiques "(sic)" "Ridge."

"The structure of the valley is apparently synclinal and the dips gentle and in the central portions nearly flat."

"The ore lies in the lowest layers of the Primal newer slates, the very same formation which contains the ore in the Cornwall, Jones' and Safe Harbor Mines. As the mine is now developed it is perhaps the clearest illustration the region affords of the geological relations of the Primal ore. It is worked by benching or open quarrying, the whole material enclosing the ore being in many parts cut down perpendicularly in steep banks. The depth in the center of the big mine from the soil to the bottom rock supporting the ore is about 100 ft., and ore of greater or less richness prevails throughout this entire thickness."

"The present excavation (1856) covers nearly the whole of the tract of ground belonging to this one estate—(namely about eleven acres)—but undoubtedly this is not the full extent of the ore-bearing ground."

"Indeed the existence of a rich large mine owned by

*Even in the case mentioned elsewhere of the contact of limestone with Chlorite and with Eozoic schists within a short distance along the east base of Turkey Hill, the nacreous schists are almost always present as intercalations of the lower limestone strata. Where this series was laid down on gneissoid rocks, of course the slates have a more coarsely micaceous character.

Messrs. Grubb almost half a mile to the eastward, shows that the ferruginous deposit has a wide range."

"The ore-embracing stratum has been dug through to the supporting rock in several places. In each such instance the floor is the upper surface of the Primal White Sandstone."

"In some places the first layers of this rock are a pale, yellowish, sandy slate; but penetrating a little further, the hard white sandstone invariably appears. It would seem, therefore, that the ore all lies within the first 80 or 100 ft. of the newer or upper Primal Slate."

"This slate throughout the upper 40 or 60 ft. or more—the thickness varying with the amount of the formation—is now in a thoroughly disintegrated condition, being in the condition for the most part of a bluish, yellowish, and white laminated unctuous clay; but it still retains more or less distinctly the stratification or intimate foliation of the original slate. Though approximately horizontal the layers display a wavy bedding, the result seemingly of an undulation of the strata primarily impressed and not a consequence of any washing of ore or clay deposits."

"Beneath this rather regularly bedded ore-containing slate there lies throughout a large part of the ravine an irregular deposit or bed of rich solid concretionary ore, extending under a variable thickness of ten, twenty, and thirty ft. down to the top of the Primal Sandstones."

"It is evident that this ore, which is a brown, cellular, fibrous hematite or limonite, has been derived from the filtration of the oxide of iron out of the ferruginous slates above, which show, in their condition of meagre clays, that they have thus been completely leached by water."

"The surface of the Primal sandstone is even now a water-bearing plane, for it is only here that water is met in sufficient quantities for domestic use, in and near the mine."

"Consolidated layers of the brown ore are seen overlying certain of the more impervious layers of the clay slate, as if this also at one time arrested the descent of the ferruginous particles."

"Possibly a part of the undulation of the strata may be due to the upward bulging action of the ore, as this was accumulating and concreting from above, such as we know took place in the gypseous strata of Western New York from the collection of great cakes of plaster on an impervious floor of slate."

"An interesting inquiry is here suggested as to what can have been the geological" (?) "atmospheric condition which produced the remarkable percolation which carried down so large an amount of ore out of their ferruginous beds. Was it tepid rain charged with carbonic acid, in an early Paleœozoic period? or could it have been a long filtration of surface waters such as now soak the earth? or are we to surmise an action of internal steam issuing upwards through crevices in the strata, in a period of crust movement and disturbance? I am inclined to the first conjecture."

"It is worthy of note that only in one spot in the mine do we meet with a crystalline magnetic ore. In the old or larger mine there is a band of this ore three or four inches thick containing small but beautiful octahedral crystals. Everywhere else the ore is the common brown peroxide of iron."

"From this it would appear that this Chestnut Hill deposit was invaded by a less energetic metamorphic action than that which attacked the Cornwall and Jonestown strata, where the crystalline and magnetic condition due to heat is the prevailing state, and not the exception."

"At what stage or period did this metamorphism take place?"

"Was the oxide of iron of the Cornwall and of the Jones mine primarily deposited as a part of the slate, and crystallized at the time of the metamorphism of all the Paleœozoic rocks? or did the ore originate from out of the ferruginous slate by a process of percolation, bringing together its particles, previously intimately diffused there, the heating, altering action arising afterwards?"

"I am disposed to think the ore was collected from the substance of the rock and then metamorphosed. But this is at present a somewhat obscure inquiry. Probably the Paleœozoic masses underwent more than one action of upheaval, undulation, denudation, and metamorphism; one perhaps at the end of the matinal age and a final one at the close of the Coal period."

Although not nominally the Sherk Ore Bank is actually a part of the Chestnut Hill Ore range and as it lies nearest to the river a desciption of these ores may most properly commence with it.

The Sherk Ore Mine

Lies about 3 miles east of Marietta and the same distance due north of Columbia and about ¼ mile (400 meters) south of the Chikiswalunga Creek.*

It was owned by Schönberger & Musselman for many years but has been held by Musselman & Watts ever since on a lease. The royalty paid is 50c. per ton. Sherk and his heirs own the property.

Mr. Peter Bradley reports the ore as having been less cold-short than that from Chestnut Hill.

For the first eight or ten years there were perhaps 8,000 to 10,000 tons a year taken out. Afterwards the production was diminished. An average yield of 25 tons may be said to have been produced from the mine.

The mine was started with twenty-five to fifty men. About ten regular miners are employed for underground work.

There were two engines and four engineers.

Of the former one was of 140 horse power and the other 120 horse power, for pumping, washing, and hoisting. Some anthracite and some soft coal (Broad Top) were used. The cost was not ascertained.

The washer was a single cutting Carter Washer fifteen feet long.

The pump was a force pump of the usual pattern.

At the beginning of operations there were obtained four tons of lump ore to one of wash; later in the history of the bank this was just reversed.

The whole deposit seemed to have been an exceptionally rich pot and the drifts and tunnels needed to be heavily timbered to resist the crush of the soft decayed slates. The

* The name is pronounced by the natives She-rick.

ore was hauled to Musselman & Watts' furnace at Marietta and used there.

Both company and private teams were used and, on the average, sixty cents (60c.) a ton was paid for hauling.

At first carts and roads were used for hauling, but afterwards "planes" were put in and the ore taken out by R. R.

There was more water than was needed for washing, but it could be always kept down with two pumps.

The deposit seems to have been an irregular one, the bottom about 80 ft. from the surface.

An estimate of the average per centage of iron in the ore was 40 to 48 p. c.

There is no rock in place in the mine except at a point 90 ft. from the top and ten ft. above the bottom of the deposit where limestone rock comes in.

The Iron made from the mine is said to have been excellent and used for merchant bar, for boiler plates, &c.

The metal from this ore usually fetched $1.00 more than the market price of similar grades.

The sides of the bank as in so many other cases consist of variegated clays. The opening covers perhaps one acre. There were about 35 ft. of water in the bank.

The work stopped in Sept., 1874.

Coppenhoffer's Bank

Is on the opposite side of the road. It was originally owned by H. Coppenhoffer. Jas. Myers had a lease on it about fifteen years ago and subsequently bought it. The ore is the same, but the bank is only about one quarter of the size of the Sherk Bank. It is owned now by Dr. Cottrell. It does not differ in position, horizon, or any important feature from that already described.

R. Garber's Mine

Lies N. E. of that of Sherk. It is small and does not present any novel or important feature. A large quantity of ore has been taken out.

John Hertzler's Mine

Lies about 878 yards (800 meters) across the creek, in Rapho township.

It was opened about ten years ago and has been mined by H. Gray. All the ore is taken to Chikis Furnace.

The mines thus far described (except perhaps the last) all lie along the margin of an extensive fault, which has cut off the western side of Chikis ridge and brought down the limestone to the level of the quartzite. Here is a fact which has some bearing on the question of where the ore bearing slates belong, *i. e.*, whether to Primal or Auroral.

The mine in Rapho township of Hertzler's last alluded to is outside of the influence of either Primal or fault in the middle of a district of limestone, yet this one resembles closely the ores procured along Chikis in occurrence.

The Chestnut Hill Mines.

The Chestnut Hill Mines proper are divided between E. B. Grubb's heirs (comprising about 14 acres); C. B. Grubb of about the same extent; and the property occupied by the Chestnut Hill Iron Ore Company.

Over all this area excavations in great number have been undertaken so that it is difficult to follow the property lines on the ground.

The height of the surface above the bottom of some of the pits is 80 feet.

The general appearance of the mine is that of those previously described in York county but on a much larger scale. The ore obtained is of two kinds: 1st. Wash ore which is distributed through the upper portion of the mine in planes, but without the regularity of a bed of sediment. 2d, concretionary masses lying usually low in the mine, hard and of massive texture, usually more dark and botryoidal than the ferruginous slates above.

Fragments of quartz are found everywhere sticking out of the bank, along with fragments of ore.

The ore seems to lie in beds or strings, often splitting and uniting again, and with these are mixed a number of hollow bombs, filled with water, and the inner skin lined with black iron oxide.

The Chestnut Hill Mine was opened over fifty years ago, by Mr. Grubb. The hill itself is of a horse-shoe shape.

Mr. Grubb sold the land, reserving only the mining rights. He afterwards bought the property back again.

The portion of the property now wrought by Chikis Iron Co. and E. B. Grubb's heirs was the first part opened.

This mine has furnished 114,121 tons to E. Haldeman and Chikis Iron Co. to date, but large quantities of ore had been taken out previous to 1868, the date of the commencement of this record.

Mr. C. B. Grubb controls the St. Charles and Henry Clay furnaces, near the mouth of Chikis, and uses all the ore he can mine for himself.

About three years ago a partition of the property by public sale was made, both parties in interest refusing to submit the case to a land-jury. The property was put up at sale, and bought (Chikis portion) for $100,000. The rest of it sold for $112,000.*

In the middle of the north side of the bank the preponderance of the dip appears to be gently to the north-west, but the layers exhibit every variety of inclination in a vertical plane; and their edges, owing to the irregular faces of the bank, every direction in azimuth.

Near the west end of the south side of tract No. 4 (see map) and under the office of C. B. Grubb, a drift has been driven in N. W. about 84 paces, and it continues tolerably straight in the same general direction altogether about 257 feet, (72.2 meters).

This drift has fallen shut now, but enough was open to show that layers of ore (beds) which were some feet above the bottom of the mine sank gradually in the walls of the nearly level drift, and disappeared in the sole.

This is the best possible evidence that the general dip is to the north in the northern part of the ore tract. It will be afterwards stated that in the medial portions the dip is about flat and these facts render the theory of one anticlinal or several of them exceedingly probable.

*** Mr. Chas. B. Grubb gives these figures at $140,000 and $100,000 respectively.**

The structure assigned by Rogers to the valley in his section (p. 182) differs from the section as made out here in that the hills to the south forming the boundary between Manor and West Hempfield are considered by him to be "Primal." But even regarding the hydro mica schists of which these hills are composed and from which the ore bearing clay strata have been weathered out, to be upper Primal; then instead of the dotted line (which in the section alluded to seems to represent the Primal sandstone or Potsdam) rising higher to the south and descending among the Manor Hills there seems to be only a slight interruption in the southerly descent of these slates which causes them to make a narrow basin for the Auroral limestone along the course chosen for the Lancaster and Columbia R. R. They rise and descend again to the south in Manor township bringing to view the Manor marginal hills and sink under the western part of the great Lancaster limestone. If this be true one would expect to find indications of abundant iron ore in these hills in positions more favorable to mining than at Chestnut Hill because at from 50 to 100 ft. higher above water level. Such indications are not wanting on the farms of J. H. Hershey, and J. F. and S. Bowers near the eastern end of this Manor-West Hempfield range as well as in the red soil so prevalent in the farm of J. Charles and in many other places westward along the south slope of this ridge.

But if exploitation demonstrated the absence of limonites in this belt one cause would at once suggest itself in the nearly vertical position of these beds which allows percolation of iron solutions to follow the strata to great depths.

It will not be forgotten that in the immense amount of water leaching and decay which the condition of the laminated clay in the Chestnut Hill Banks indicates, an impervious floor would be necessary to hold the dissolved and suspended iron particles which this process would detach from the upper layers. Rogers has suggested (see above) with extreme plausibility that owing to the joints and cracks of the clay leaves, this impervious floor was not found short of the Primal sandstone itself, except in detached masses where a clay horizon had been substituted. It is thus that he accounts for the existence of massive hard ore at the very bottom of the "upper slates" and in contact with the sandstone. The conditions of structure of Chestnut Hill, however, *i. e.*, gently rolling strata, would present the maximum of obstruction to the passage of chalybeate waters and each little basin would contain its own little ore deposit; the whole forming disconnected ore masses in more or less definite horizons. Here the reverse would be the case. These slates are exceedingly thin and when standing on edge the open passages for the descent of water are multiplied to such an extent that in the millions of years of washing which possibly have elapsed, scarcely any of the ore which was imbedded in these rocks would escape being carried into the deep.

What is topographically an advantage is, therefore, geologically a disadvantage in mining. But it is possible that at a great depth there may exist under these hills as large a deposit of the brown hematites as that which has given Chestnut hill its great reputation.

The drift which entered about N. W. put off a side drift or breast of about 28 ft. (7.6 meters), at 84 ft. from the mouth of the cutting.

50 ft. (15.24 meters) back on the straight gangway (±200 ft. from the mouth of the tunnel) a thin seam of ore was discovered about 10 inches (25.4 centimeters) to a foot (30 centimeters) under the floor.

The last bed of any importance was found in sinking about 10 feet N. W. of the breast.

From the mouth of the tunnel for about 50 ft. (15 meters) inwards, the dips are ±S. E., but it is evident from the sinking of the strata further N. W. that a very small flat anticlinal is made by the outside portions of the bank.

Indeed, in these soft yielding clays there is no violence done to sound speculation in supposing that this slight reversal of the average dip has been caused by the sagging of edges of the high vertical bank.

At the tunnel, on E. B. Grubb's and Haldeman's bank, a plate of limonite dips S. 15°, E.—40°. Observations on the probable change in direction and intensity of the dip will be found above. It was intended to prove the accuracy of the surmise that the measures gradually exchanged the southerly for a northerly dip, by sinking a shaft to find this bed of ore supposed to descend under the floor of the tunnel, but the latter was abandoned without any attempt being made to do this.

In a cut in the bottom of the mine near the tunnel a very well marked clay bed dips with some persistence (as indicated by the lines of its edges in the north and west walls). The former of these is about 3 ft. in 6, and the latter about 2 ft. in 16. This would make its average direction about W. 25° N.— 25° (?)

In the S. W. corner of E. B. Grubb's mine the layers of ore dip North through the hill which separates them. The whole series of strata seem to roll, but the preponderance of dip is to the North. A red paint clay in the south wall dips southward but this is also only a part of a roll, as the decayed and plastic clay laminæ dip in every direction.

In the "black bank" of the C. H. I. O. Co., at 80 ft. (24 meters) below the general level, a tunnel of 120 ft. (37 meters) was driven in, of which 100 ft. (30 meters) were through solid ore. The direction was about W. 10° S. In that portion of the bank furthest to the south and nearest to the Reading and Columbia R. R. the dip is southerly, thus confirming the structure heretofore made out. At the black bank it is northwardly. The axis of the tunnel was thus nearly along the strike of the small anticlinal.

At a point about 220 paces east from the office of Grubb, in the North Bank, layers of variegated clays are interspersed with lumps of rock, in many of them looking as if they had been detached and washed into their present position. The dip is S.—60°. Ten paces west of this, in the same bank, the laminæ change and dip N. or N. 5°E.—50°.

The north bank of the excavation in the E. B. Grubb property, shows small shallow waves, affecting the clay beds, underneath all of which is a broad band of white clay, which partakes of all these movements. Above this comes a broad band of mixed brown clay and ore. The average dip of the beds near the C. I. Co.'s tunnel is ±S. W.±45°.

For 100 ft. (30 meters) S. E. of the north bank, and just below, the measures seem to dip N.W. gently, and perhaps with one or two minor waves, at angles of 20° to 30°. At this point there is an anticlinal in gray clay, showing near the bottom of the bank the S. E. limb dipping in that direction, with about the same average angle.

At about 80 ft. (24 meters) N. W. of C. I. Co.'s washer layers of clay and ore dip E. 20° S—55°.

In the bottom of the sump, near A. and R. Garber's mine, are said to have been massive rocks, possibly quartzite, or its equivalent in horizon.

The Chestnut Hill Iron Ore Co.'s land joins the middle or C. B. Grubb tract to the west. From the engine house in a northerly direction the slope for the ore was sunk and a solid Hematite had at a depth of about 50 ft. (15.2 meters) of about 10 to 15 ft. in thickness.

The Company are not working their mine now (June 13, 1877). Their ground is very large and its exhibition of ore already taken out, interesting.

Over this ore lay about 30 ft. of *blue clay* and this circumstance is only important as showing that clay of this color does not always underlie the ore at least in this vicinity.

At an elbow where two deep lineal cuts join at right angles a drift was driven in thirty feet (9 meters) and a shaft was sunk striking a solid body of ore at 40 ft. (12 meters).

Another level drift was driven nearly north but no important developments by it are known to the author.

The right angled cuts referred to which runs northerly is narrow and seems to show in its sides nearly an equal quantity of wash ore and clay.

At a point marked on the map as "Rock Shaft" a shaft had been sunk about 70 ft. (21 meters) deep, allusion to which will be found elsewhere. It intersected numerous plates of quartz and quartz slate but no ore. It seemed to have been sunk on the crown of an anticlinal of which one limb dips about S. 20°—25° but getting steeper with the depth.

The mass of this dividing ridge upon which the rock shaft is sunk seems to be various forms of quartzose rock. In one part it is a quartz conglomerate of exceedingly fine grain, cemented together by a ferruginous matrix. In another place on the N. W. side of the unexcavated hill it resembles a quartz sinter.

On the top of this hill a small streak of magnetic ore was found.

In the N. E. corner of the same (Chestnut Hill Iron Ore Co.'s) property a band of rich red hematite occurs in a red clay.

The main trend of the Chikis range as viewed from this point seems to be about E. 10° N.

It has been stated that south of the C. H. I. O. Co.'s property and between it and the R. R. R. the rocks are the hydro-micas or "Upper Primal slates." Shafts sunk here have developed no ore. The Rock Shaft anticlinal may be a subordinate one and die very soon to the eastward.

Attention has also been drawn in a previous mention of these rocks to the shaft sunk against the Reading R. R. track. The depth was about 20 ft. the ore seeming to dip northwardly. Much of it thrown out of the shaft was mixed up with fragments of quartz into a coarse conglomerate. From a second shaft along with the multifarious hydroxides of iron was some Red Hematite and much quartz.

The hydro-mica slates in the R. R. cutting dip S. 20° E.—36°.

Near the house of Mr. Lewis Baker on the Marietta and Lancaster turnpike the road crosses a ridge.

There is a valuable deposit of sand near this point used for building purposes through the neighborhood. The rocks in this ridge are similar to those strewn on Chestnut Hill and the fragments consist partly of quartzite, and partly of a fissile, arenaceous mass with every appearance of having been a feldspathic rock containing quartz fragments from which the matrix had dissolved away.

Seams of white and colored quartz occur frequently intersecting this rock.

Heiss's Mine.

200 to 300 paces S. E. of a corner of the Chestnut Hill property is a mine lately belonging to Henry Heiss.

A shaft was sunk, and ore broken out. It is said to have been a small deposit, and to be now exhausted.

Silver Spring Mines.

About 656.18 ft. (200 meters) north of the large Grubb bank, is that of the Silver Spring Co., owned by Haldeman & McCormick, and E. B. Grubb.

The opening is not a large one, covering little more than an acre. The deepest level to which the excavation has been carried, is sixty feet.

It was commenced in 1863, and stopped in 1874, but the work was not prosecuted more than five years in all. A twenty horse-power engine and a washer are still standing.

A slush pond here covers seven acres of a previous mining excavation. From 1864 to 1871, 48,027 tons were taken out of the bank by E. Haldeman & Co. and their successors the Chikis Iron Co. In all about 75,000 tons of ore have been taken out of the entire Silver Spring property. The company owned the grounds.

In order to give a better idea of the way in which these banks are worked, Mr. Horace L. Haldeman, Treasurer of the Chikis Iron Co., has furnished the author with the following average weekly take of the three mines used by that Company for the years 1865, 1870, 1875, and 1878 (the latter to Sept. of this year):

Average No. of tons taken out per week from:

	Gamber Mine.	Grubb Mine.	Silver Spring.	Total Tons.
1865, ...	87	. . . .	71	158
1870, ...	5	289	45	339
1875, ...	19	284	. . . .	303
1878, ...	. . . .	213	. . . .	213

In reference to the total ore mined by E. Haldeman & Co. and the Chikis Iron Co. from the Gamber Bank the same authority furnishes the following statement:

Gamber Bank owned by Haldeman & Grubb. Mining commenced in 1846 and stopped in 1875. Mining resumed this month (Aug., 1877).

Total number of tons mined 45,472.

The following analyses of average samples of lump ore from the Chestnut Hill Mines were made by Mr. A. S. McCreath:

	C. B. Grubb.	Haldeman & Grubb.*
Iron sesqui-oxide (Fe_2O_3)	78.857	78.571
Manganese sesqui-oxide (Mn_2O_3)	1.302	0.657
Cobalt sesqui-oxide (Co_2O_3)	0.047	0.130
Alumina (Al_2O_3)	2.112	2.367
Lime (CaO)	0.210	0.170
Magnesia (MgO)	0.335	0.187
Sulphuric Oxide (SO_3)	0.095	Trace.
Phosphoric Oxide (P_2O_5)	0.581	0.847
Water (H_2O)	12.075	12.468
Insoluble Residue,	4.765	4.770
Total	100.379	100.167
Metallic Iron	55.200	55.000
" Manganese	0.908	0.457
Sulphur	0.038	Trace.
Phosphorus	0.254	0.370

Mr. McCreath adds: "Both samples consisted of lump ore exclusively. That from Chikis Iron Co. is the second sample analysed from their bank; the first one was ⅛ lump and ⅞ fine ore. All the phosphorus determinations in these Chestnut Hill ores have been made in duplicate.

The following two analyses were also made by Mr. A. S. McCreath:

No. 16. Chestnut Hill Iron Co.'s Bank, C. J. Nourse, Superintendent.

No. 17. E. B. Grubb and Paris Haldeman's Bank, from eastern series of workings:†

* Should be marked E. B. Grubb.

† Other analyses of the Chestnut Hill Iron Ores will be found in Chapter VI.

	16.	17.
Iron Sesqui-oxide (Fe_2O_3),	76.428	64.571
Manganese Sesqui-oxide (Mn_2O_3),	1.456	1.450
Cobalt Sesqui-oxide (Co_2O_3),	0.066	0.185
Lime (CaO),	0.230	0.054
Alumina (Al_2O_3),	1.260	2.633
Magnesia (MgO),	0.147	0.047
Sulphuric Oxide (SO_3),	0.008	0.008
Phosphoric Oxide (P_2O_5)	0.602	1.026
Water (H_2O),	12.773	10.970
Carbonaceous matter,	.....	
Insoluble Residue,	7.290	19.015
	100.260	99.959
Metallic Iron,	53.500	45.200
Metallic Manganese,	1.015	1.010
Sulphur,	0.003	0.003
Phosphorus,	0.263	0.448

In connection with the bomb shell ore it was thought that an examination of the contents of some of the bombs would prove of interest inasmuch as in some cases the shell of the bomb was an inch or two in thickness and all communication between the outside and the inside must have been cut off since the solidification of this shell. The water and solid contents of some of these bombs may therefore be the remnants of these substances of a previous geological age. A very compact bomb was broken open and the liquid and solid contents transferred to a glass bottle which was properly secured and labeled and sent to Dr. F. A. Genth for analysis.

The following is the result:

"The water contains 0.000116 p. c. of solid matter containing K_2O and a trace of Na_2O."

"The solid constituents contained principally damourite, quartz, and limonite, titanic acid and carbon."

"The analysis gave:

Silica (SiO_2),	47.42
Titanic Oxide (TiO_2),	2.00
Iron Sesqui-oxide (Fe_2O_3),	13.38
Alumina (Al_2O_3),	20.57
Manganous Oxide (MnO),	0.07
Cobaltous Oxide (CoO),	0.10
Magnesia (MgO),	2.33
Lime (CaO),	0.12

Soda (Na_2O),	0.02
Potash (K_2O),	6.06
Water (H_2O),	6.52
Carbon (C),	1.99
	100.58

Dr. Genth adds: "You will see from this analysis if we take the 6.06 K_2O and calculated from it the constituents of damourite nearly the whole of the alumina is taken up.

KO	— 6.06
Al_2O_3	—19.83
SiO_2	—23.16
HO	— 2.32
	51.37 per cent. damourite."
	24.26 = quartz.
	2.00 = rutite.
	15.04 = limonite.
	1.99 = carbon.

Average specimens of the ore worked by the Chestnut Hill Iron Co. were sent by Mr. C. J. Nourse to Mr. A. H. Sherred, chemist of the Lackawanna Iron & Coal Co. May 29, 1876, with the following results:

Silica (SiO_2)	18.20
Iron Sesqui-oxide (Fe_2O_3)	70.20
Metallic Iron	49.14
Phosphoric Oxide (P_2O_5)	0.95

C. B. Grubb's Ore Banks (Conestoga Township).

These banks are situated about half a mile (800 meters) from the river, and about twice that distance northwest of Colemanville.

The decomposed schists in which these ores are found dip, near the river, about N. 15° W.—72°.

Mr. Hopkins opened this bank about 40 years ago.

The bank is cut about 131 ft. (40 meters) into the face of the hill. The abrupt face of the bank (nearest the river (?)) is about 52 ft. (16 meters) high. The stripping on top seems to be about 6 to 10 ft. (2 to 3 meters) thick and the ore principally wash ore with varying amounts of large lumps. The ore itself is very like that of many mines in the hydro-mica belt both in York and Lancaster Counties. It is a concretionary, testudinous, partly manganiferous limonite consisting of the various brown hematite with occasional Göthite, &c.

The side of the bank is for the most part composed of clay which is, as usual, variegated in places.

Eighteen to twenty men in all were employed in this and the neighboring banks.

A compact finely laminated gneiss in a lane N. W. of this bank dips about N. 15° W.—72°.

The ore bank nearest the river was opened in 1875. It is a narrow cut 33 ft. (10 meters) broad. At the face being worked (July 31, 1877) the height above the bottom of the bank was about 82 ft. (25 meters). The stripping is about 10 ft. (3 meters) on one side and 100 ft. (30 meters) on the other. The cut is about 164 ft. (50 meters) East and West.

The dip is W. 30° N.—35°.

The schists in which this ore occurs are much decayed and very sandy, and the ore occurs in layers between the strata.

Much of the ore is lean and mixed with the gangue so that Mr. Grubb had the intention of jigging it before employing it in the furnace.

In the northernmost bank the ore in the then heading seemed to be solid and to give a dip of about N. 40° W. but the strata are much twisted. A line connecting together the three banks here in operation would run about N. 20° W., and its extremities would be about 656 ft. (200 meters) apart.

These pits seem therefore to be opened upon the successive waves of a generally ferruginous belt of strata.

There is a great deal of bombshell ore here, the interior of the geodes being, in many cases, of a light steel gray.

The northwesternmost pit contains the richest ore and there is a saying among the ore miners of this region that the northerly side of an ore deposit is generally richer than the other.

The following extract is from an analysis of ore from the C. B. Grubb portion of the Conestoga Ore Banks made by Mr. J. B. Britton and furnished me by Mr. Chas. B. Grubb:

	p. c.
Metallic Iron	53.59
Oxygen with ditto	20.42
Water	11.76

Siliceous Matter	10.08
Soluble "	0.66
Sulphur	None.
Phosphorus	0.44
Oxygen with Phosphorus	0.57
Alumina	0.64
Lime	0.22
Magnesia	0.04

Good's Iron Ore Bank

Lies about ¾ mile (1200 meters) east of the mouth of Conestoga and Safe Harbor.

It used to supply the Safe Harbor Iron Company with ore. It is now fallen shut and disused. In the neighborhood of its site a quantity of black magnetic sand is seen strewn along the road.

This appearance was also noticed near the foot of the hill by Colemanville where the soil was partly covered by a black sand of highly metallic luster.

Reeves & Co.'s Bank

Lies about 328 ft. (100 meters) N. E. of the first Grubb bank.

It was full of water and showed nothing at the time of its inspection. It has not been wrought since 1866.

Another bank above it has been likewise abandoned.

On the hill S. E. of the Conestoga and near the Safe Harbor School House a dark blue banded clay, similar to those associated with the iron ores, appears under a stripping of about 1 yard of soil.

At Doll's dam north of Safe Harbor a very much weathered and convoluted hydro-mica schist strikes E. 25° N. dipping vertically.

At the head of the next following dam (to the north) near Henry Gravin's saw mill a limestone dips N. 10° W.—44°.

M. R. Shenk Ore Banks.

This extensive mine was opened over forty years ago, on Mr. Buckwalter's land. It has not been wrought for two or three years.

The name above given simply indicates that these banks are situated near Mr. Shenk's house. A cross-road cuts a large ore deposit into four parts. Mr. Peacock is one of the owners.

The whole extent of ground uncovered will reach four or five acres, but the sides are everywhere covered, and nothing is showing but impure ferruginous strata, exhibiting foliaceous character. The ore is very impure and testaceous.

Traces of dip in the decomposed strata give N.15° W.—50°. The character of the country rock in the vicinage is that of a mica schist and hydro-mica slate.

An hydro-mica schist at Mary Gantz's house, but a short distance north-west, dips N. 15° W—60°.

Ore Banks in the Vicinity of Marietta.

An opening in the ground N. of Marietta shows large boulders of limestone and of ore. Of the latter, all which show on the surface are of plate-like structure, and of sandy texture.

Cooper Ore Bank, No. 1.

The largest of the two openings, about ½ mile (800 meters) north of Marietta, is separated from the smaller by an interval of two or three hundred feet (61 to 91 meters.

The excavation covers about one acre, and the depth of the lowest from the highest point is about 50 ft. (15 meters.)

The dip of the limestone, which protrudes in large pinnacles from the middle of the bank, is about E.—85°, though owing to the crushed condition of the rock, and the consequent multitude of planes of cleavage, it is very difficult to distinguish the true planes of bedding.

The sides of the bank are composed, as in so many other cases, of white and variegated clays, with much gravel and worn pebbles.

A great deal of ore has been taken out of this bank. It was worked up to within a couple of years ago, but the sides are now washed shut. Some water remains in the deepest sump.

The mine was opened in 1862. The ore was a sandy limonite, and was used by Musselman & Watts till they dissolved partnership, and afterwards by Musselman.

It was regarded as first-class ore. They took out about 15 tons a day, and employed about 20 men, and pumped water from Sohny's farm away for the washer. The fuel employed was anthracite. The character of the ore was chiefly wash ore, with very little lump. After washing it was hauled to the furnaces in wagons.

The teams used for this purpose were owned by the company, and all the product of the mine was used by the owners. No planes were employed, the ore being carted out of the bank. Foundry and mill iron were made from it.

There is still ore in the bank, but it could scarcely be depended upon to produce largely or long, from the observations which were possible at the time of the visit, June 5, 1877.

Duffy's Bank No. 1

Is situated nearest to Marietta and the Mt. Joy turnpike.

There are here large blocks of limestone apparently in place with a dip of about North.

On those parts of the sloping sides not overgrown the soil is red and the composition gravelly. In other parts and in the bottom there is a large growth of trees and other vegetation.

The apparent dip is N. $\pm 30^\circ$.

Duffy's Bank No. 2

Is situated furthest from the Marietta and Mt. Joy road. The excavation is about 60 ft. (18 meters) deep.

Within the bank are large masses of limestone dipping about S. 15° E.—62°.

The sides and bottom of the mine are all overgrown.

In one of the lowest sides of the bank is a large mass of milk quartz rocks. The soil is red and gravelly.

Another ore bank belonging to Mr. Duffy is situated just S. E. of his Park. It is a large and irregular excavation of which the sides show very little and are mostly overgrown but where bare they consist of red ferruginous gravel.

The tree growth of the interior of the excavation covering about four acres is principally locust.

The largest tobacco shed in Lancaster County is that belonging to Mr. Duffy, and situated opposite to this bank.

At the head of the trout pound in Mr. Duffy's Park a limestone dips S. 10° W.—80°.

Iron Ore Mines near New Providence.

Peacock's Mine

Is situated back of the barn of Widow Groff's Hotel, in the town of New Providence.

This mine was opened about 1874 on Saml. Stoneroad's land which was leased for the purpose.

The cut is about 66x47 ft. (20x14 meters) in area, and was originally 33 ft. (10 meters) deep but has now fallen shut.

All the ore taken out is said to be that which lies around the bank, and was extracted to comply with the terms of the lease. No rock in place is showing but streaks on the side of the bank indicate a dip of ±N. W.—gentle.

The ore is a very ferruginous mica schist or gneiss. A specimen looking like a fragment of laminated gneiss, on being struck with the hammer opened into a flat geode filled with gray micaceous dust.

Where the iron oxide is concentrated it is testaceous but without a trace of magnetism.

Mr. John Hildebrand of New Providence reports having opened a pit about half a mile (800 meters) N. E. of there in the hill and having obtained magnetic ore.

The material said to have been taken from there looks like a fine grained, somewhat heavy, dark-banded gneiss.

Geo. Mowrer's Mine

Is situated about 0.3 mile (half a kilom.) S. W. of New Providence. The mines were opened by their owner about ten years ago (1867).

The excavation is a long cut of about 492 ft. (1 50 meters) in a direction N. E. and S. W.

The average width is 66 ft. (20 meters) and the depth about 33 ft. (10 meters).

There were no planes at this mine nor any other machinery but a horse winze and a small double-cutter barrel washer, conveniently arranged.

The machinery is in good repair. The N. E. walls of the bank are covered with white clay which seems pretty much to surround the bank except in the middle and southern end of the S. E. face where the clay is red.

The ore is a more or less ferruginous gneiss with seams of segregated limonite. The country rock is a very quartzose gneiss the grains of silica remaining in skeleton form of the fragment after the other components of the rock (except some of the mica) had been washed out.

On the country road south of the bank some large lumps of good ore are seen, together with large fragments of milk quartz.

Eckman & Patterson's Mine.

The mine thus designated in the township map has been completely filled up, and no ore is showing. It is on the Shirley farm. The soil is of the same sandy micaceous character elsewhere noticed.

This mine also was opened about ten years ago or a little longer. Eckman & Patterson used the ore in their furnace at Port Kennedy, Montgomery county.

The opening now under consideration was not considered to produce such good ore as that of Geiger's and that of other openings in the vicinity by the same company.

Perhaps fifteen or twenty men were employed here at one time. The ore was hauled from here to Strasburg and shipped by rail from Strasburg to Port Kennedy. The wash water was pumped out of a deep well.

Limestone was struck in this well at 50 ft. (15 meters) from the surface.

A specimen of this limestone, said by Mr. Winter to whom the writer is indebted for most of the above information) to be from the bottom of the well, was highly crystalline and micaceous; streaks of the latter mineral penetrating it in various places.

Pit No. 2, Eckman & Patterson

Is situated about half a mile (800 meters) east of the last named. It is a much larger excavation than No. 1 and covers about an acre.

The banks in the southern end are about fifty ft. (15 meters) high where there is a large mass of ore in place, standing in the northern end. The dip is here about N. 15° W. — 35°.

The ore forms incrustations of about half an inch (1 or 2 centimeters) thick in the six faces of cleavage and bedding (the latter two faces nearly perpendicular to the others), thus enclosing prisms sometimes almost cubes of weathered finely laminated gneiss.

The character of this ore is testaceous, the geodes being usually filled with gray micaceous sand.

Geiger's Ore Bank

Is situated near Lively's farm, New Providence township. It was opened about 20 years ago and it has been over 10 years since Geiger worked it.

It was first worked as a mere ditch in removing the surface wash ore. Jacob Swinehart estimates its deepest part as about 60 feet (18 meters) but it is now full of water.

About sixteen men were employed and the output was about twenty tons a day. One plane connected the bottom of the pit with the washer. The latter was a double cutter of the ordinary size. As to the yield, there was about two thirds wash ore and one third lump.

It was taken by team to Lancaster at $2 50 per ton in six horse hired teams, as much as eight tons 900 ℔s. have been thus hauled.

The average was about five tons. The trip and return was made in a day. The fuel employed was coal.

The greater part of the ore was used in the furnace of the owner, in Lancaster, until the furnace passed into the hands of Peacock & Thomas, and even after this transaction the ore was still sold to the furnace. Water was in sufficient quantity for washing. A well was sunk in the north end of the bank, which furnished water for this purpose, and proved the existence of excellent ore.

In some places the latter was thick and compact, and in other places loose. The ore of this mine has a very good reputation among the miners and farmers in the neighborhood.

The engine, machinery, drums, boilers, &c., are in good condition. Mr. Geiger intended to start the mine in two or three weeks from the date of the visit to it, (July 13, 1877.) The miners' wages were to be 70 cents per day, for which plenty of laborers could be procured.

Cook, Wright & Co.'s Mine.

This mine was commenced before the Revolution, and the ore was reduced at the old Mill Valley Furnace. It was bought by Cook & Wright, about ten years ago. They took out about 20 tons of limonite per diem, and worked with a force of about twelve men when working full. The washer is driven by horse-power altogether.

The chief product of the mine is wash ore, with about one eighth lump.

It cost about $1.50 to ship to Strasburg, whence it was sent to Monocacy.

Peacock and Thomas used most of the ore in Lancaster. There was too little water for washing. Water was pumped up from the creek. The dip was ±N.35° W.—±60° to 65°. The ore by itself made a cold-short iron, like all the similar ores. 2¼ tons were required to make one ton of iron. Mr. A. W. Fisher thinks that Geiger's ore is "neutral."

* George Baer and Shenk's Mines adjoin the mine of Cook, Wright & Co. to the west, the Brooks, Montgomery Co., and Reading R. R. being still further off in the same direction.

The engine-house of Brooks, Montgomery, and R. R. R. was erected about 1861. About 40,000 tons were taken out from Geiger and Baer. The ore is pretty solid in the bottom. It is too solid to pick, and not solid enough to blast.

An important detail belonging in the notes on the township geology, is a dip of limestone near the grave-yard and opposite Christian Groff's house. A limestone quarry here

* Owned jointly by C. Geiger, Baer, and Shenk.

shows a dip of N. 15° W—gentle, which indicates a shallow synclinal in here.

The Montgomery Iron Co. used all their ore at Port Kennedy. They made gray forge. They had too little water, and hauled from the creek. The ore was got out by carts entirely. Its character was like that in neighboring banks.

B. B. Myers' Bank, (Eden Township.)

Mr. L. Hensell, of Quarryville, reports an iron ore enterprise undertaken by B. B. Myers on a place near the name of Hugh Donnelly on the Eden township map. About 400 tons of ore have been taken out and the remainder is lying about the bank. The bank was opened in 1870. Mr. Myers leased it and then purchased the lands. It was not in operation more than two years, and during that time was wrought in a very partial and unsatisfactory manner.

The ore was a ferruginous gneiss very testaceous and cold short.

The production is said to have been sometimes ten tons a day with six hands; but it is clear from the first statement as to the total ore extracted that this is above the average.

There was no machinery about the place.

The lump ore is estimated to have formed 60 p. c. of all the ore taken out though without a washer it is difficult to say.

The ore was shipped to Christiana on the P. R. R. distant seven miles @ $1 50 per ton at that time. (It would not cost now over $1 25).

Four teams were owned by Mr. Myers and the balance were private.

This mine belongs to those located among the hydro-mica schists of the South Valley Hill of the Chester Valley.

Stewart Smith's Ore Bank

Lies about half a mile E. 20° N. of the above. There has been some shafting done here with the result of developing very much the same kind of ore as that in Myers' Bank.

B. B. Myers' ore bank which has been closed for two years appears as a shallow pit of which the sides are principally gravel. The limestone is quarried just north of J. Montgomery's house and the Penn School House.

The ore is the usual ferruginous varieties of mica schist and gneiss, and the quality of that left seems to be very lean. The bank is full of quartz and micaceous fragments.

The dip is about S. 35° E.—48° judging from indications of the iron slates in the west end of the bank.

The height of the mine above water level (±85 ft. by barometer above Quarryville) will make it an easy mine to work provided that ore in it proves of average constancy.

About 437 yds. (400 meters) south of Myers' Mine on Collins' place a deviation of the dial compass amounting to 4° E. was observed. This was the greatest deviation observed in the investigation of the "non-standing" point of the magnetic needle: and a less deviation of the needle was found by experience not to be significant. The other deviations are respectively 2° E., and 3° E. at different corners of the property.

Daniel Lefevre's Bank

Is situated about half a mile (800 meters) north of Quarryville. Its name is Witmer & Lefevre's Bank. It was leased by H. H. Lefevre in 1873. It has been in operation about two years. The character of the ore is about the same as that of the banks heretofore described.

About twenty tons a day were mined when the industry was being pushed.

No engine was employed.

About 10 p. c. of the ore was lump ore. Most of the ore has been taken away since the Reading and Quarryville R. R. reached the latter place.

There is only about ⅛ mile to haul it, and 25c. per ton to put it at the cars. The freight to Birdsboro' is $1 55 per ton on the R. R. The Company owned its teams but hired some. E. & G. Brook use the greater part of the ore for making iron. There was too much water. The mine water was not used for washing.

Cabeen & Co.'s Bank.

Conowingo Ore Bank is situated just north of Camargo

P. O., Eden township. F. Cabeen leased this mine in 1873 from Cabeen & Co.

Up to 1865 it was owned by Jas. Hopkins and worked by him for about thirty years. From that time until 1873 it was wrought by Cabeen & Co. (J. G. Jones, Sup't).

Admiral Dalghren is said to have thought very highly of the iron manufactured from this ore in the Conewingo furnace for use in Naval ordnance.

At the last working the product was about 25 tons per day. It employed forty workmen for the last two years.

For the last six months it ran night and day.

The laborers' wages in 1876 were about $1.40 per day. An engine of about 50 horse power was employed.

Bituminous coal was first used as fuel but afterwards anthracite.

The coal cost $4 25 a ton at the bank. Five tons a day were used. The mine is about 75 ft. (23 meters) below the general level.

A fine steam pump manufactured in New York is there. The wash pipe is 8 inches in diameter and the water is kept constantly running. About 20 p. c. of the whole product is lump ore.

Under Mr. Hopkins' management it was hauled 5½ miles (8.8 kilometers) to Conewingo furnace. Under the Cabine management it was hauled to Strasburg and shipped from there to Danville.

Since the completion of the Lancaster and Quarryville R. R. (in May, 1875) a branch has been built from the mine to this road.

Under the last management no teams for hauling were employed.

The excavation is at least 1000 ft. (305 meters) long, and 100 ft. (30 meters) broad.

It is now filled with water.

Specimens of ore curiously septated by quartz were obtained at the bank.

B. J. Meyer's Bank, on Keen's Run, Eden Township.

Mr. L. Hensell leased this mine in 1873 and ran it two years. The quality of the ore was said to be the same as Cabeen's. It had the same structure and was only a short distance east of the latter. About 15 tons of ore a day were taken out and six men employed. No machinery was erected. The lump ore constituted 25 p. c. of the product.

It was shipped to Strasburg, a distance of five miles, and $1 00 a ton was paid for hauling it. The Montgomery Iron Co. took all of it.

The mine made too much water. The excavation was 20 ft. (6.9 meters) deep when work was stopped.

The extracting was done by cart.

It lay in the bank like the other ores in this group of mines.

It is said to have made No. 1 iron.

No analyses could be procured.

This mine was originally opened 40 years ago and run by Withers & Co., of Mt. Eden Furnace, 4 miles (6.4 kilom.) N. E. of Quarryville.

Peacock & Thomas' Bank.

The ore seems to be like the preceding.

It was hauled to the river and ferried across. John Baer of York Furnace which blew out in 1873 is said to have used the ore.

There is a plane in the bank.

The bank made much water.

Peacock & Thomas are said to have run but one fourth of this ore, but the iron was known in the tract as Conewingo iron and fetched one or two dollars a ton more than other iron.

Brooks Bank,

An old bank, is situated on the Hugh Donnelly place on the same range with the B. B. Myers ore and about a quarter of a mile west. It was probably called the *Brooks Bank* from Chas. Brooks of Black Rock Furnace 4½ miles (7.24 kilometers) S. W. of Quarryville.

It was opened about 40 years ago and was operated about 20 years off and on. The ore probably resembled that of

B. B. Myers which is near to it. The ore was all shipped to Black Rock Furnace.

Eckert & Co., of Reading,

Opened a mine on the property of J. Eckman about 1 mile (1.6 kilometer) E. of Quarryville.

They think that there are indications of magnetic ore. They have not taken out more than ten or fifteen tons altogether. Opposite Eckman's house in this pit a quantity of dark gray gneiss is showing, but without any discoverable traces of magnetic ore. It would not be surprising, however, if such ore should be opened further south or in the bank of B. B. Myers, as this location is close alongside the track of the great dyke so often referred to which penetrates the valley hills south of Quarryville.

About ¼ mile (400 meters) W. of Eckman's on the farm of David Keen, shafts have been sunk and ore found.

On the farm of Henry Keen about ½ mile (800 meters) N. of Quarryville Eckert is reported to have found ore.

Eckert & Hensell Bank

Is situated about 1½ miles (2.4 kilometers) N. N. E. of Quarryville and opposite the house of Mr. Jacob Myers, (of "Stony Hill," called so to distinguish him from another of the same name.)

It is an old bank and was opened forty years ago by Mr. Hopkins, (by whose name it has been designated in this report,) and was leased six years ago. They found ore, but the water increased too rapidly; and this combined with the depressed state of the market caused all work to be abandoned. Over this side of the valley, float ore is said to be turned up by the plough in large quantity. The lease has expired and Mr. Myers will not renew it.

Mr. Elliott Miller reports the indications of ore on Mr. Bossler's fields south of Keen's Run to be good.

The character of the rocks is siliceous and micaceous and entirely fragmentary from the edges of the limestone to Mt. Eden Furnace. Quite a large tract of land near the furnace is unfenced and barren. From the house of J.

Myers of Stony Hill, towards Georgetown, the micaceous character is subordinated and the quartzitic and quartzose predominates.

About quarter of a mile (400 meters) S. W. of Georgetown a dyke of trap is crossed.

Supplementary notes on Bart Township.

Some large boulders of trap and many small fragments are found due west of Georgetown, about half a mile (800 meters), and at the first jog in the road.

The field to the north of this place appears to have been an ore bank which has been partially filled up. It is wet and swampy and shows many traces of previous exploitation and work. The fragmentary rocks in and around it now are principally quartzite, though fragments of dolerite also abound.

At Mr. A. L. Baughman's farm the dyke is traceable by numerous fragments of dolerite.

Near Morrison's house the fragments are quartzose, felsites and quartzites proper; the former intimating a relationship to the Huronian felsites.

A conglomerate rock occurs near Morrison's, which seems to be an Adularia mixed with much quartz.

Near M. Wood's, about two miles S. W. of Georgetown, a coarse-grained gneiss dips S. 25° E.—66°.

The trap outcrop curves around by Mr. Baughman's and crosses the road just to the north of an abrupt hill made by the gneiss.

This coarse-grained gneiss is the North Valley Hill and on crossing it one is in the Chester Valley.

Supplementary notes on Eden Township.

Following the telegraph road, the long trap dyke passes over Mr. A. Scott's farm and strikes the main road at a place marked Henry Bushong's on the township map. Fragments of trap are seen along the road for half a mile (800 meters) and the bottom of the valley is said to be filled with it.

Hence this dyke may be traced a short distance south of

Hugh Donnely's, a short distance north of Jos. Montgomery's, and near Wm. Dungan's house, and from there to the S. W. corner of the township.

Midway between the Eckert Pit and a point on the edge of the woods the dial-compass showed a deviation of 7° east.

At the second pit it showed no deviation at all.

A pit about ten feet deep is said to have been sunk to solid rock. If so the dip is S. 15° E. gentle, indicating an anticlinal in the North Valley hills. The rock is gneiss.

On the farm of Mr. Jas. Collins, in a tract in Eden township, coming on B. B. Myers and J. Hildebrande, where it is said to have been an old tradition among Surveyors that the needle "would not stand." No deviation was observed with the dial-compass after due allowance had been made for the annual magnetic declination, and the difference between the local and Philadelphia mean time. Although it would have been natural to find some deviation, as before suggested, owing to the proximity of the trap dykes.

Amos R. Herr's Ore Bank

Lies about one mile (1.6 kilometers) west by north of the town of New Providence, just north of the Lancaster and Quarryville R. R.

It was opened about 25 years ago by Mr. Herr's father, who took some ore out and leased it to the Phœnix Iron Co., which wrought it about five years. It was lying idle for six or eight years. The ore resembles that of the Providence and Eden Mines just described. Only six or eight men were employed, who took out about 1,000 tons per year. The coal employed in the engine was anthracite and was shipped from Strasburg, whence the ore was returned. The teams used were private and the hauling was done by contract. The Phœnix Co. used all the ore. The amount of water collected in the sump was just sufficient to wash the ore.

A hole bored west of the ore mine found a solid mass of limestone. Limestone was also found a little south of the strike of the measures on the farm of Mr. Herr, with a southerly dip, so that it is extremely likely that this ore is found in the horizon under the limestones characteristic of so many of these limonite deposits. The quarry in which this limestone was found was a little over 656 feet (200 meters) W. 30° N. of the crossing of the county road and R. R. and exhibited a dip of S. 30° W.—18°.

As one reaches Mr. Amos Herr's property going west along the R. R. the hills become steeper 65 to 100 ft. (20 to 30 meters,) and show a trend of W. 15° N.—E. 15° S. The limestone exposures both from the gentleness of the dip and the gradual westing which the direction of the dip attains, suggests the dying end of an anticlinal.

At John Strohm's where the county road and R. R. cross obliquely a hard gneissic rock seeming to contain limestone strikes E. 30° N. with a probable dip of N. 30° W.—gentle.

Just across the Beaver Creek a cut in the R. R. in dark fine grained gneiss with seams of quartz dips N. 15° W.—±80°.

This hard gneiss is about 50 ft. (15 meters) thick and just six meters west of it a calcareous gneiss in micaceous limestone dips S. 30° E.—from 60° to 80°.

Mylin Ore Bank

Is situated close to the oblique intersection of a road and the L. & Q. R. R. in the S. E. corner of Pequea township, a little over a mile S. E. of Willow street. There is an extensive excavation with 7 inch pump pipes and machinery in apparently good order. The mine is not now in operation though the brick engine house and the appointments seem to be well cared for and comparatively new. The sides of the main excavation are covered by a wash of drab or lead colored clay, which in the N. W. end of the bank and near the surface are the decomposed edges of the former slates interbedded with ferruginous sandy strata. This wavy structure seems in the average to dip west at a low angle.

A pile of ore lying near the cylindrical screen resembles very much the limonites of the limestone slate in which this bank is situated.

A brilliant orange colored ochre is interspersed among other impure iron hydrates to a greater degree than in other similar dump piles. There is also a predominance of the anhydrous red oxide of iron and the lower hydrates of the iron series which is not common among the limonite mines.

These banks belong to the Hon. State Senator Mylin from this district.

Some notes on the Warwick, Reserve and Jones Mine, in Berks County, on the edge of Lancaster County.

It is not intended here to do more than record a few observations on the geology of the localities bordering on the my assigned district (Lancaster County) which cannot fail to have a bearing on the views of structure in the latter.

On the lands of the Warwick Reserve 2 miles (3.2 kilometers) S. E. of the Joanna Furnace and about 1½ miles (2.4 kilom.) east of Morgantown, and ½ mile (800 m.) south of the narrow belt of limestone which leaves the large Lancaster limestone tract and passes through Churchtown and Morgantown, in Berks County, is an exploitation for ore. The surface indications were good and the locality was on the strike of the Morgantown ore pits. A winze was put down about a month before the date of the visit (July 26, 1872). The material thrown out of the pit appears to be an altered mud rock alongside of which occurs ore very like that of Cornwall and some of that from Dillsburg.

At the intersection of the Welsh Mountain with the southern extremity of Berks County the Eozoic schists, the lower Silurian limestone series, and the Mesozoic strata come together and the disseminated iron salts of these strata (perhaps under the influence of the numerous trap dykes which here as elsewhere break out of the Mesozoic, have segregated to form deposits of superior ore.

The Jones Mine.

This large excavation covers 4 or 5 acres.

Wavy fissile quartz slates show in the west face of the bank dip W. 30° N—±40°.

Large masses of chloritic slates containing pyrite and some chalco-pyrite are also found cropping out on the sides.

In the vein which is being worked near the bottom of the pit about the middle of the west face, layers of decomposed chloritic schists and quartz slates are superposed and dip ± N. 20° W. ±30°. Part of the quartz slate is pinkish color and very full of pyrite and chalco-pyrite.

The rock which is permeated by copper and iron pyrites consists of feldspar and quartz sometimes in crystals large enough to be measured with a goniometer, and sometimes intimately mixed *as in the Orthofelsite of the South Mountain.*

These carry copper in both places and are interbedded with the chlorite schists which are in abundance here and and dip into the hill on the west side as if overlying the main mass of Orthofelsite.

Passing up the excavation made into the west face and above these chloritic schists occur large quantities of Kaolin quite pure but not absolutely white, and containing appreciable grit.

On the east side of the Jones Pit large boulders of dolerite are scattered about the ground indicating the presence of a dyke which in all probability cuts off the ore.

Three miles from the Jones Mine are the Hopewell and Middle Mines, then the St. Mary Mine (Warwick) and the French Creek (Elizabeth) in Chester County.

Hopewell Mine, &c.

The ore is a specular, craystallized ore and is said to be richer than that of the Jones Mine. It was discovered and opened about fifty years ago. It was then a forest farm which was offered to the Potts but refused. It was then offered to the Hopewell Iron Co. which took it. The Company had $\frac{4}{11}$ of $\frac{1}{8}$ of the Warwick Reserve which is mainly owned by the Phœnix Iron Co. The Potts family owned the 900 acres in fee and sold the mining rights.

The Warwick Reserve line runs close to the Hopewell or Middle Mines. The Jones Mine is in Berks. Middle, French Creek, and the Warwick Mines in Chester County.

The ore bodies in Middle and French Creek Mines are very large. A new "vein" six feet (2 meters) thick was discovered at French Creek last year.

The large veins at French Creek and at Middle Mine are each 40 ft. (12 meters) thick, but beside these there is in each case a parting of quarter of a mile (400 meters) of rock with steep dip separating the large vein from the overlying small ones. The latter contains very fine ore.*

Welsh Mountain Ores.

Shirk's Ore Bank

Lies about half a mile (800 meters) southeast of Churchtown on the upper northern slope of the Welsh Mountain.

The debris which covers these hills is, like that of the South Mountain, in main composed of quartzite but the fragments occasionally show that they were resolvable by weathering into grains partially held together by a decomposing matrix with angular quartz often assuming a pink color.

Five years ago (*i. e.*, in 1872,) Messrs. E. & G. Brooke leased this mine from D. Shirk. The Garman Bank and the Beartown mines were the only mines in operation at that time. Ore has been taken out of the mine for four years. The character of the ore is like that of most of these banks, a limonite but much red hematite is disseminated through it. There is also said to be red hematite found in the ridge which intervenes between here and the valley.

About 25 or thirty tons were got out per day by the labor of twelve miners, one engineer, and one boss.

The engine was of thirty horse power made by Schaber & Johnson of Franklin Iron Works, Reading.

The fuel consumed was pea coal anthracite at $3 00 per ton. About ten or twelve tons were consumed per month. It was shipped by Reading R. R. to Birdsboro'.

The washer was a Thomas washer (single cutter) 120 pad-

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* The information above respecting the Hopewell and French Creek Mines was mainly derived from Mr. Bently Smith to whom and to his brother Col. Smith the author is indebted for many courtesies.

dles in six rows. The shaft of the washer was 23 ft. (7 meters) long.

The pump was an 8 inch (20.3 centimeters) lift pump 3½ ft. (1.06 meters).

The wire rope for hoisting was ⅞ inch, and the pressure averaged 45 lbs. to 50 lbs. (22.5 kilograms).

The distribution of ore in the mine was about ¾ wash ore to ¼ lump. No veins at all were observed.

The ore was shipped at Joanna Station on the Wilmington & Northern R. R. at a distance of seven miles and a cost per ton of 90c.

The teams were private and there were three of them of six mules each. Each team can make almost two trips to the station a day. On a monthly average each team would make perhaps 1.75 trips per day.

Mr. E. and G. Brooke, of the Keystone Furnace, Birdsboro', uses the greater quantity of the ore.

The mine is not a wet mine and does not make more water than can be conveniently disposed of. The wash water is brought from a distance.

The ore is got out by a plane to the bottom of the bank and the stripping is done in two carts employed for that purpose.

The ore lies irregularly in its bank as in most of the analogous mines. It exists in a number of nests and pockets.

There is no rock in the bank but limestone slates. There is no limestone in the ridge which lies between the main range of the Welsh Mountains and the Churchtown valley, this being filled entirely with thin hydro-mica schists.

A drift driven 100 ft. (30 meters) due south into the Mountain, filled with water during Sunday. On Monday it was found that about 50 ft. (15 meters) from the mouth a hole had suddenly formed in the floor of the drift and the timbers had gone down on top of it. It is supposed by the mine boss from this that the limestone underlies this ore. If this were true it might be difficult to account for such structure, except by supposing an overthrow.

It is supposed that the ridge which skirts the Welsh

Mountain's northern base, is an anticlinal ridge and that its south side dips towards the mountain.

Foundry and Mill iron are made from the ore.

Squire McKay's Bank

Is a small opening which is situated about S. by W. of Shirk's Bank and is distant about half a mile. It was opened about two years ago.

The top only was opened out and two or three hundred tons were taken out. The other portions of the description of Shirk's mine which could be compared with the conditions obtaining in this bank, agreed very closely.

A little southwest of and on the same range there is an opening by Stolzfuss whence only a few tons have been taken out.

The ore is of the same kind.

There is no exposures of ore between this and the Beartown mines a distance of about two miles (3.22 kilometers).

Mr. Noble pays the following wages (Sept. 27, 1877):

Boss, ...	$40 00 per month.
Engineer, ...	30 00 per month.
Laborers, ...	0 90 per day.

Other employers in the neighboring mines are said to pay but 80c. per day.

Shirley's Bank.

The area of this bank, which lies not far from the Shirk Bank, is about two acres. The depth of the working below the average surface on the south side is about 59 ft. (18 meters.)

At this end there are about thirty feet of stripping of white and pink clay. In the bottom of the mine a parallelopipedon has been cut out like a cellar and the bottom of the cut shows dark brown and black ore similar to that found in the Chestnut Hill Bank immediately overlying the quartzite.

The traces of bedding are very obscure, but as nearly as could be made out there are two synclinals within the length of the excavation, and 1½ anticlinals.

It was not possible for the author to ascertain with exactitude how many feet the ferriferous ore seam is in thickness, but it is evident that so far as yet developed the bank shows an unusually large amount of dead work for the amount of ore obtained.

An 18 ft. (5 meter) pit was sunk which rapidly filled with water. Below this the drill was driven 30 ft. (9 meters) through dry black powdery ore. As in so many other places, so here the love of the marvellous has induced many persons to believe the story asserted by a usually careful man that "this ore when heated up in the blacksmith's forge *to melting* could be hammered out into iron."

40 c. royalty is paid here on the ore and 28 c. at Beartown.

At the first hill by the school house north of Shirk's Bank are intensely hard bluish limestone dips S. 10° E—20°.

Garman's Bank

Is 147 ft. (45 meters) in a direction E. and W. and 50 feet (15 meters) north and south. The dip as indicated by the clay in the sides is N. 10° to 20° W.—20°.

The bank is full of water.

A large amount of black lump ore stood outside the mine. It appears to be manganiferous and is said to be so. The soil is composed of clay and gravel the latter consisting mainly of quartz.

Levi B. Smith and Sons' Bank.

The excavation covers about 1½ acres. At the north side about 39 ft. (12 meters) from the top to the water level.

The bank is full of water.

The engine and machinery are standing and in good repair.

The plane is a steep one.

The appearances of ore are, wherever comparable, in all respects like those of the Garman Bank.

Both these mines and the Shirk are in the same position with relation the Welsh Mountain.

It is difficult to estimate the dip from the appearance of the sides which are much washed.

The apparent dip is into the mountain or northerly ±45°, but this statement must be received with great caution. In any case the dip here will have been modified by slipping of the soft strata.

Beartown ("Old Mine" or No. 1)

Was opened in 1861–62 by Nath. Williams, who sold it to Mr. Riley. Mr. Riley sold it to Levi B. Smith & Sons. It was sold by them to an iron company which finally disposed of it to Jas. Lannaghan.

The deposit is very nearly like that in the New Beartown Bank, so that the same description will in most cases do for both.

Beartown (New or No. 2 Bank)

Was opened three years ago. It was leased part by Mr. Brook and part by Mr. Yahn.

It was opened in the same way as those already described.

The ore was shipped from Beartown Station, Waynesburg branch of P. R. R.

It cost 15 c. per ton to put it in the cars. It is mined and put on the cars for $1.46 per ton. About 25 to 30 tons were produced per day.

Twelve men were employed.

There were two carts and a plane for getting the ore out.

The engine is of 15 horse power and was manufactured by Wood & Mann of New York.

The fuel was originally bituminous coal at $6.00 per ton, and about eight to ten tons a month were consumed.

The Reading R. R., the Wilmington and Northern, and the Waynesburg branch of the Pennsylvania R. R., are all available as means of transportation. Charges on the latter road were 30c. per ton for six miles.

All costs of transportation included amount to about $1.90. The cost of the steamboat coal used is about $2.00. Total for fuel, $3.90 per ton.

The wash and lump ore are almost evenly represented.

The cost per ton per mile is 15c. from the mine to Beartown.

Mr. E. and G. Brooke is the principal consumer of this ore. He is said to use $\frac{3}{8}$ Beartown ore, $\frac{3}{8}$ Shirk's ore, $\frac{1}{8}$ Cornwall ore, $\frac{1}{16}$ Jersey, and $\frac{1}{16}$ mill cinder.

The mine makes rather too much water.

The position of the ore in the bank is similar to that in the cases already mentioned.

No analysis of the ore or the iron made from it was obtained.

The stripping of Mr. Brook's Beartown Mine is done by six men, who get 11c. per cubic yard (.76 Ster.) and a team provided at 17c. per cubic yard, the workmen to furnish their own teams.

A cubic yard contains about three loads for the average one-horse cart. In the clay of this mine are very numerous quartz pebbles. The dip as indicated in the clay seams of the bank is S. 45° E.—30°.

The excavation seems to cover about $2\frac{1}{2}$ acres, and is 82 yards (80 meters) in length N. and S., and 55 yards (50 meters) E. and W. The S. E. dip in the south heading is shortly re-placed by a long gentle N. W. dip apparently continuing to the extreme northern end.

Similarly to the phenomena in the more western mines, the bottom of the excavation partially removed reveals loose dirt and ore of a dark *bruin-brown* and black color, but there were not very good signs of ore in the heading itself.

As in the Garman Mines these lie between the high ridge of limestone and the crest of the Welsh Mountain.

Sensenning Ore Bank

Adjoins the Beartown mine to the west.

Seyfert, McManus & Co. opened this mine about two years ago, and leased from Sensenning.

The ore is the same in kind as that just described.

The production was about 20 tons a day.

About 8 or 9 men were employed, and one engineer. The engine was of 25 horse power, using anthracite fuel.

The washer was a single cutter, and the ore about $\frac{1}{8}$ lump and $\frac{7}{8}$ wash.

The cost of transportation to the main freight lines is about the same as in the case just described.

Seyfert & McManus use all the ore. The mine is too dry, and does not furnish water enough to wash with.

A plane is used for getting out the ore. In other respects the conditions are the same as in the last mine.

Russel's Mine

Close by Sensenning's.

The mine was leased by and operated for Seyfert, McManus & Co.

It has been in operation for 7 years. About 25 tons per day were procured with the aid of six carts and one plane and the labor of twelve to fourteen men.

The fuel was anthracite.

One quarter was lump ore and the rest wash ore.

No ore has been shipped from this mine for two years, (i. e. since 1875). The shipments used to be via Waynesburg.

Enough water is obtained.

Garman's Mine.

Mr. Levi B. Smith leased this mine in 1875.

The ore is a limonite and 28 to 40 tons were procured per day.

It is not in operation now but twelve to sixteen men were employed in one of the banks, not quite so many in the other.

As to questions of fuel, machinery, &c., the facts stated in reference to the last mine will answer here as well.

About one quarter was lump. No ore was being shipped but it would probably now be shipped to Joanna Station, W. & N. R. R. There was just about enough water collected in the mine for washing purposes.

J. Keller's "Granite" Quarry, (Conoy Township)

Lies about midway between Collins and Falmouth Stations on the P. R. R. The rock quarried is a dolerite which crosses the river here and is mined extensively on the other side for building stone in the vicinity of York Haven.

The rock resembles that used in Gettysburg from the Cemetery and Culp's Hill both in lithological features and in the manner in which it can be got out in slabs.

It is harder to work but much cheaper than marble.

The dressed stone in slab costs $15 a perch (25 cubic feet or 0.71 cubic meter or Stere).

Rough clipped (2d class) stone fetches $2.50 per perch.

Quarrymen received (June 12, 1877) $1.00 per day and about thirty men were employed, getting out about twenty perch per day.

John Musser's Brick Kiln

Is situated 3½ miles (5.2 kilometers) W. of Marietta, on the canal bank. It had been in operation since about 1871. The clay is found along the bed of the canal and R. R. and has been cut out in a large square from the former. Its color is blue. It is too sandy for Potter's clay and works like that of the Wrightsville brick works. The brick wears well as a paving brick. One hundred thousand can be put in at one heat. The bricks are all hand made in a double mould. One day's labor is equal to the manufacture of about 3500 bricks. There are five men in the gang. The temperer finds and mixes the clay and gets $1.75 for his work. The moulder get $2.50. The wheeler $1.25, and the furnace boys $7.00 per month. The boss gets $4.00 per thousand and hire and pays all hands. The bricks fetch $6.00 per thousand. The fuel employed is Pittsburg gas coal, principally slack at $4.50 delivered at the siding.

About 25 tons are made in eight days to finish an average heat, but sometimes with dry brick in six days. The kiln employed is the patent of Mr. Winegard, of Pittsburg.

The bricks are 9″x4½″x2¼″=22.8 cm.x11.4 cm.x 5.7 centimeters.

They are laid three and three on the long sides and then three across these. They are stacked thirty lengths of brick to a side in a square pile (22.5 ft. or 6.86 meters on the side, and forty bricks (short side=15 ft. or 4.5 meters) high. Most of these bricks are sold in Marietta to which place they are hauled by teams.

This clay deposit seems to be in thin belt of the same slates which hold the iron ores. They appear also to have suffered the same decomposition and kaolinization but have not been washed in the same way by iron solutions and therefore are so far as known free from ore.

CHAPTER V.

Some observations on the temperature of Spring Waters in Lancaster and other Counties.

During the prosecution of the geological work in Franklin and Adams Counties attention was directed to the temperature of various springs. It was thought that the variations exhibited by these different springs might have a bearing of more or less significance on the strata whence they issued, and in fact so far as these observations go, it would appear that the spring waters of the Mesozoic rocks are appreciable and constantly higher in temperature than those which are found on either the limestone series or the Eozoic measures.

The following notes were part of my report for 1876 which has not been published, and are introduced for the purpose of prefacing a number of observations on this subject in Lancaster county.

Notes on some Springs.

Near Monterey, (Franklin County.)

The ridges of the South Mountain in the neighborhood of Monterey furnish abundant springs, though there is none on the site known as the Monterey Springs hotel. The latter is supplied by a pump which (according to the account of Mr. David Miller the proprietor) never runs dry but furnishes an abundant supply in the driest season. He reports the flow of the spring supplying this pump at 182 liters (about 40 gallons imperial) per minute. The temperature of this water, as it ran from the spout at about 10 A. M. Aug. 11, 1876, was 50¼° Fah.

Mr. Burcher's spring, situated about ⅝ mile (1 kilometer)

N. of Clermont house, is a fine spring supplying a large spring house. Temperature at 9.45 A. M. on the same day 52½° Fah.

The Gum Spring heads up in the notch just north of Clermont House, and finds its outlet through the Maria Furnace Gap. It is just north of the fork in the Old Furnace road. Its estimated flow at 7 A. M. on the above date was 18 to 20 gallons imperial (about 409 liters) per minute. Temperature 51° Fah.

A large flowing spring in Tomstown at 1.52 P. M. on the same date showed a temperature of 55½° Fah.

Near Mont Alto, (Franklin County.)

The proprietors of the Mont Alto Furnace property have laid off a handsome park within the gorge, where the furnace is situated. This gorge was known as the valley of a thousand springs, and does in fact possess an unusual number of remarkably large and fine springs, which add very much to the attractions of the place, now a favorite pic-nic ground for the people of the neighboring counties.

August 18, 1876, some of these were examined as follows:

	Temp. Fah.
Indian Spring, 12.55, P. M.,	53°
Pearl of the Park,	51°
Big Spring,	52°

Springs in the vicinity of Chambersburg, August 18, 1876.

	Temp. Fah.
Sulphur Spring, about 1½ miles (2.4 kilometers) north of Chambersburg, 8.30, A. M., temperature,	58°
Chalybeate Spring of Bamstead, about 1.8 miles (3 kilometers) north of Chambersburg, 9, A. M.,	53°

An alum spring existed once in this vicinity, but all traces of it had disappeared at the time of this inspection.

Franklin County.

	Temp. Fah.
Spring of Hunter & Springer, Franklin Furnace, 3.45, P. M.,	55°

The Ainsworth Trout Farm

Is situated just out of Shippensburg, on a superb spring, which breaks out of the limestone rock in very great volume and at a low temperature. Mr. George B. Dykeman conceived the idea of raising trout for the market, and in order to get a place suitable for hatching and keeping this fish he made a series of investigations of all the large springs which abound in the valley, both in regard to strength of flow and temperature. Unfortunately he has not kept (or could not find) a list giving the results of his labors. The observations were made with the same thermometer, and at different seasons of the year and hours of the day.

He states in general terms that the temperature of all these springs in the valley is the same, viz: 51°.

There is not the difference of a single degree between summer and winter, nor can any appreciable variation be noticed before and after a heavy fall of rain.

The spring on the Ainsworth farm discharges about 1150 U. S. gallons (4353 liters) per minute.

The discharge of Boiling Springs is said to be even greater than this.

In reply to a letter requesting information as to his data Mr. Dykeman says: "* * Mr. Jas. Stephenson and my-"self traveled from Harrisburg to Hagerstown, Md., through "this valley for the purpose of finding a suitable place to "raise trout, and with the same thermometer took the "temperature of the various springs, in May, 1870, and "found all the same temperature, viz: 50° (except Boiling "Springs, four miles from Carlisle) which was 54°, but "found near the same spring a spring of 50°. We came "to the conclusion that Boiling Spring had from some near "source an inlet of surface water.

"We traveled by wagon, on foot, and by rail. As you "know, my spring here was 50° when you were here, so I "will put down from mem.:

"May 2d, 1870, Shippensburg Spring, 50°.

"May 25th, 1870, Boiling Spring, 54°.

"May 26th, 1870, Big Spring, Springfield, near Newville, "50°.

"These are all the mems. I kept, as all the other springs "were too small. We had some sites that did not suit us "or were not for sale, such as the Leter's, at Carlisle. "Green Spring, west of Newville, several out along the "South Mountain, at Papertown (Mt. Holly), and every "spring of any size we could hear of. The temp. was "taken with the same thermometer in each case. If the "above is of use to you I am re-paid.

"Yours,

GEO. R. DYKEMAN.

"P. S. Greensburg, Franklin Co., Spring, out of Chambersburg, and at Hagerstown, Md., 50°."

It will be observed from the above letter that the temperature assigned by Mr. Dykeman to all true springs in the Cumberland Valley (including his own) differs from the data which I noted down on a visit to his place. My notes make the temperature of his spring as given by Mr. Dykeman's own thermometer, 51°, which corresponds more nearly with the temperature which I have obtained independently in various parts of this region. Nor is it to be hastily assumed that 50° or any other number represents the normal temperature of all true springs in the Cumberland valley. Many large springs, as those around Chambersburg, those near Mont Alto and others, and Monterey and Graffenburg showed higher temperature and but few of them exactly the same temp. A number of trials of the Graffenburg Spring at different seasons gave as its mean about 51°.

In fact but one spring has been thus far discovered which gives a temperature lower than 51°, and that is D. Miller's pump water, at Clermont Hotel, Monterey.

It is highly improbable that any large number of springs so widely separated should give identically the same temperature and such has not been found to be the case.

Springs in Lancaster County.

A good spring back of the blacksmith shop of St. Charles Furnace flowed (June 4, 1877) several buckets per minute, but is reported to change its volume much with the season.

The main reservoir of water which supplies Columbia is on the hill back of it, distant about half a mile (800 meters.)

Time of observation about 10 A. M. Weather very warm.

Temperature of spring 56° Fah. (13.3° Centigrade).

A spring at the base of a foot bridge over the track N. W. of Henry Clay Furnace was examined about an hour later than the above observation was made.

Temperature 54° Fahrenheit.

As a means of comparison with these spring temperatures and to show how much water long exposed to the atmosphere was affected by the surface temperature of the earth, the water of the Susquehanna Canal was taken 1¼ mile (2 kilometers) W. of Marietta, on June 12, 1877, at 10.25 A. M. The day was cloudy and the temperature of the air 72° Fah. with an occasional fitful breeze.

The temperature of the canal water was 73° Fahrenheit, or one degree warmer than that of the air.

At the same time the water in the beautiful spring on Prof. Haldeman's lawn was 52.5 Fahrenheit.

A fine spring in the Ore Bank of Mr. C. B. Grubb, at Chestnut Hill, on June 15, 1877 (about noon), gave as the temperature 53°.5.

The temperature of the "Rock Spring" Fulton township near the Maryland line and on Mr. Jackson's farm is 62° Fah.

It is almost safe to say from this circumstance alone that it is much diluted with surface waters. It is also very subject to changes with various amounts of rain fall, and is probably not a true spring but the outflow of an area of surface drainage not far distant, together with some water perhaps which may have had a longer passage underground.

The Ephrata Springs.

These springs break out of the side of a hill of New Red Sandstone age near the town and in the township of Ephrata. One of them which is most used for bathing had on July 16, 1877, a temperature of 57° almost exactly that of the Gettysburg Spring. The water was conveyed some 50 ft. (15.2 meters) in an iron pipe.

The Black Barren Spring (*Fulton Township*)

Lies about half a mile northeast of Pleasant Grove and rises in the midst of a Serpentine ridge. It is said by its advertising circular to possess medicinal virtues.

It is a transparent, colorless, tasteless, and inodorous water which on July 5, 1877, at about 3 P. M. had a temperature of 52° Fah.

Spring in limestone quarry ±¼ mile S. E. of Quarryville, Eden Township.

A strong flowing spring fills an abandoned limestone quarry near Mr. Elisha Hammill's house.

The temperature of the water near its source at about 6 P. M., July 18, 1877, was 52°.25 Fah.

Litiz Spring, *Warwick Township.*

This spring has been celebrated for years. It is one of those strong springs (like Boiling Spring, that at the Ainsworth trout farm, &c., in the Cumberland Valley) which find a subterranean passage through the limestone and break out at great distances from the areas whence they derive their supply. It rises in large volume through a number of small apertures in a beautiful park maintained by the Moravian church.

Its temperature at one of the principal mouths of issue was on August 4, 1877, by repeated observations during the day 51° Fah.

Spring on M. McClure's Farm, *Bart Township.*

The temperature of a spring on the above place on the eastern and about a mile from the northern boundary of Bart township was at about noon, Sept. 4, 1877, 55°.75 Fahrenheit. The rock whence this spring issued was mica schist in the neighborhood of a trap dyke.

Pump Water of Mansion House of the Gap Nickel Co.

The pump water here, after freeing the pump stock of the water which had been there for some time, showed a temperature (about 12.30 P. M., Sept. 4, 1877) of 55° Fah.

Chapter VI.

Analyses of Ores, Rocks and Minerals.

Part I. Analyses of ores, etc., collected in previous years, but of which the analyses have but just been received.

The following were analyzed by Mr. A. S. McCreath:

No. 1. Ore Bank, ⅛ mile E. of York road station, Han. Junc. R. R., Bauman's farm, York Co., (*See Report C p. 63 and CC p. 203*).

No. 2. Forney's Bank, York Co., ½ mile S. of Hanover, (*C—p. 42*).

No. 3. Mickley's farm, York Co., 1 mile N. E. of Smith's Station Han. Junc. R. R. (*C—page 37*).

No. 4. Stoner's farm, York Co. (*C—page 47*).

	1.	2.	3.	4.
Iron Sesqui-oxide (Fe_2O_3),	60.857	38.571	62.428	36.428
Manganese Sesqui-oxide (Mn_2O_3),	2.638	3.165	0.992	0.051
Alumina (Al_2O_3),	1.912	1.499	2.024	1.908
Lime (CaO),	0.160	0.040	0.020	0.040
Magnesia (MgO),	0.407	0.263	0.237	0.313
Sulphuric Oxide (SO_3),	0.057	0.075	0.100	0.077
Phosphoric Oxide (P_2O_5),	2.691	1.571	0.698	1.014
Water (H_2O),	11.560	8.210	11.826	6.218
Insoluble Residue,	19.115	46.155	21.795	53.790
Loss,	0.603	0.451	....	0.161
Excess,	....	....	0.120	
	100.000	100.000	100.000	100.000
Metallic Iron,	42.600	27.000	43.700	25.500
" Manganese,	1.837	2.204	0.690	0.036
Sulphur,	0.023	0.030	0.040	0.031
Phosphorus,	1.175	0.686	0.305	0.443

No. 5. Bollinger's Farm, Kaufman's Siding, ¼ mile E. of York Road Station H. Junc. R. R. York Co.

No. 6. Michael Good's Bank, 1½ miles N. W. of Fayetteville, Franklin County (*CC—page 248*).

No. 7. Mount Holly Bank No. 1, Cumberland Co., 1 mile N. E. of Papertown. (Not a good specimen). (*CC—page 241*).

No. 8. Eichelberger's Bank (?). York Co. (?).

(*Label lost and specimen not certainly identified.*)

	5.	6.	7.	8.
Iron Sesqui-oxide ($Fe_2 O_3$),	56.143	77.571	58.000	64.714
Manganese Sesqui-oxide ($Mn_2 O_3$),	0.201	0.103	0.342	0.155
Alumina ($Al_2 O_3$),	2.321	0.942	2.405	1.607
Lime ($Ca O$),	0.140	0.160	0.170	0.250
Magnesia ($Mg O$),	0.324	0.076	0.415	0.317
Sulphuric Oxide ($S O_3$),	0.073	0.040	0.040	0.067
Phosphoric Oxide ($P_2 O_5$),	0.616	0.185	5.795	1.559
Water ($H_2 O$),	6.286	10.874	12.788	12.045
Insoluble Residue,	34.330	9.775	19.670	19.410
Loss,	....	0.274	0.375	
Excess,	0.434	....	....	0.124
Total,	100.000	100.000	100.000	100.000
Metallic Iron,	39.300	54.300	40.600	45.300
Metallic Manganese,	0.139	0.072	0.238	0.108
Sulphur,	0.027	0.016	0.016	0.027
Phosphorus,	0.269	0.081	2,530	0.681

No. 8 was analyzed by Mr. D. McCreath, the others by Mr. A. S. McCreath.

No. 9. Limonite float ore on S. Wolff's farm, 2 miles N. W. of Greenwood. (*CC—page 247*).

No. 10. Thomas Iron Co's Bank, Cumberland Co., 1¼ miles from Pine Grove on Bendersville road. (*CC—page 246*).

No. 11. McCormick's bank, 1½ miles S. W. of Dillsburg, York Co. (*CC—page 228*).

No. 12. English's Ore Bank, Franklin Co., 2 miles S. E. of Greenwood.

No. 13. Thomas Iron Co's Ore at Pine Grove, Cumberland Co. (*CC—page 246*).

No. 14. Pond Bank, Franklin Co., 2 miles E. of S. of Greenwood, on Greenwood and Funkstown road. Limonite (poor specimen). (*CC—250*).

	9.	10.	11.	12.	13.	14.
Iron Sesqui-oxide ($Fe_2 O_3$),	81.857	44.142	71.714	56.286	45.000	43.142
Manganese Sesqui-oxide ($Mn_2 O_3$),	0.233	0.578	0.288	1.839	0.485	0.310
Alumina ($Al_2 O_3$),	0.623	6.523	4.089	4.316	1.279	1.398
Lime ($Ca O$),	0.050	trace.	0.250	0.030	0.120	
Magnesia ($Mg O$),	0.050	1.239	0.216	0.612	0.504	0.216
Sulphuric Oxide ($S O_3$),	0.105	0.070	0.077	0.052	0.092	0.052
Phosphoric Oxide ($P_2 O_5$),	2.710	5.915	3.007	1.268	0.361	0.180
Water ($H_2 O$),	11.490	12.430	14.700	10.892	8.110	7.595
Insoluble Residue,	2.155	28.575	5.685	23.960	43.230	46.300
Sum,	99.273	99.472	100.026	99.255	99.181	99.193
Metallic Iron,	57.300	30.900	50.200	39.400	31.500	30.200
Metallic Manganese,	0.150	0.403	0.201	1.280	0.338	0.216
Sulphur,	0.042	0.028	0.031	0.021	0.037	0.021
Phosphorus,	1.185	2.583	1.313	0.554	0.158	0.079

No. 12 was analysed by Mr. A. S. McCreath. The others by Mr. D. McCreath.

No. 15. Trone's farm, York Co., ⅛ mile W. by N. of Smith's Station, H. J. R. R. Limonite from shaft in field. (*C—page 36.*)

No. 18. Sprenkel's farm, ½ mile West of Mengis's Mill Station, Short Line R. R. Limestone from N. W. shaft. (*C—page 39.*)

No. 19. Ditto. Limestone from alongside of ore in main shaft.

	15.
Iron Sesqui-oxide (Fe_2O_3),	68.143
Manganese Sesqui-oxide (Mn_2O_3),	0.183
Alumina (Al_2O_3),	1.698
Lime (CaO),	0.180
Magnesia (MgO),	0.212
Sulphuric Oxide (SO_3),	0.025
Phosphoric Oxide (P_2O_5),	1.679
Water (H_2O),	9.986
Carbonaceous Matter,	0.530
Insoluble Residue,	17.620
Sum,	100.256
Metallic Iron,	47.700
Metallic Manganese,	0.128
Sulphur,	0.010
Phosphorus,	0.733

	18.	19.
Lime (CaO),	36.816	38.500
Magnesia (MgO),	5.019	1.814
Ferrous Oxide (FeO),	2.443	2.228
Iron Sesqui-oxide (Fe_2O_3),	0.896	5.524
Iron Bi-sulphide (FeS_2),	0.065	0.041
Alumina (Al_2O_3),	1.138	1.930
Manganous Oxide (MnO),	0.321	trace.
Sulphuric Oxide (SO_3),	trace.	trace.
Phosphoric Oxide (P_2O_5),	0.132	0.050
Carbonic Oxide (CO_2),	35.550	31.632
Water (H_2O),	0.350	1.055
Insoluble Residue,	16.650	18.210
	99.385	99.984

The above analyses are by Mr. A. S. McCreath.

No. 20. Mine Bank, Altland's lease, 2½ miles S. W. of Wellsville. Analysed by Mr. A. S. McCreath. (*CC—page 235 to 237 inclusive.*)

No. 21. Price & Hancock's Ore, 1½ miles East of Dillsburg, York Co. Analysed by Mr. D. McCreath. (*CC—page 219.*)

No. 22. E. L. Cookson's farm, eight miles East of Dillsburg, York County. Analysed by Mr. D. McCreath. (*CC—page 237.*)

No. 23. McIlwee's farm (Altland's lease) 4 miles S. E. of Dillsburg. Analysed by Mr. D. McCreath. (*CC—page 233.*)

No. 24. Coal from the New Red Sandstone, York County. B. Gross's place on the Liverpool road, ¾ miles North of Liverpool, on the Little Conewago. Analysed by Mr. A. S. McCreath. (*C—Catalogue of specimens, No. 239.*)

	20.	21.	22.	23.
Insoluble Residue,	3.373	3.840	25.280	1.910
Phosphoric Oxide—(P_2O_5),	0.291	0.113	0.027	0.160
Sulphuric Oxide (SO_3),	0.010	0.047	0.002	0.132
Alumina (Al_2O_3),	3.425	4.752	2.066	1.819
Iron Sesqui-oxide (Fe_2O_3),	88.357	72.214	45.142	91.214
Manganese Sesqui-oxide (Mn_2O_3),	0.016	0.296	0.668	trace.
Ferrous Oxide (FeO),	2.121	15.364	7.457	3.021
Lime (CaO),	1.290	0.460	18.290	0.270
Magnesia (MgO),	0.479	1.448	0.198	0.187
Water (H_2O),	0.551	1.485	1.230	1.770
Sum,	99.913	100.019	100.360	100.483
Metallic Iron,	63.500	62.500	37.400	66.200
Metallic Manganese,	0.011	0.230	0.518	trace.
Sulphur,	0.004	0.019	0.001	0.053
Phosphorus,	0.127	0.050	0.012	0.070

	24.
Water,	4.310
Volatile Organic Matter,	18.482
Fixed Carbon (by loss),	74.358
Sulphur,	0.528
Ash,	2.322
	100.000

According to the system proposed in a paper read before the American Institute of Mining Engineers, and subsequently prepared as part of my report for 1876, this coal would have a fuel ratio of

C : Volatile Hydro Carbons : : 80.1 : 19.9

$$\text{Fuel ratio} = \frac{\text{p. c. Carbon}}{\text{p. c. Volatile Hydro Carbons}} = 4$$

In other words this coal takes its place among the *bituminous* coals which are those of which the fuel ratios range from 5 to 0.

No. 25. McClure's Mine, York Co., Pa., 2 miles East of Dillsburg. Sample 30 ft. from the outcrop. Analysed by Mr. A. S. McCreath. (*CC—page 212.*)

No. 26. The same. Sample sent by Mr. King. Taken 110 ft. from outcrop. Analysed by Mr. A. S. McCreath.

	25.	26.
Silica ($Si\ O_2$),	20.330	17.780
Phosphoric Oxide ($P_2\ O_5$),	0.107	
Sulphuric Oxide ($S\ O_3$),	1.105	
Alumina ($Al_2\ O_3$),	3.775	
Iron Sesqui-oxide ($Fe_2\ O_3$),	47.859	
Ferrous Oxide ($Fe\ O$),	13.821	
Manganous Oxide ($Mn\ O$),	0.036	
Copper Oxide ($Cu\ O$),	trace.	
Cobalt Oxide ($Co\ O$),	0.040	
Lime ($Ca\ O$),	5.604	
Magnesia ($Mg\ O$),	4.129	
Iron Bi-sulphide ($Fe\ S_2$),	1.605	
Water ($H_2\ O$),	1.140	
Sum,	99.951	
Metallic Iron,	45.000	43.000
Metallic Manganese,	0.028	
Sulphur,	1.298	1.230
Phosphorus,	0.047	0.028

No. 27. Ore from Sprenkel's farm, 1½ miles West of Mengis's Mill, Short Line R. R. Analysed by Mr. A. S. McCreath. (*C—page 29.*)

No. 28. Ore from McIlwee's farm, Altland's lease, York Co., Pa. (*CC—page 233.*) Analysed by Mr. A. S. McCreath. (*CC—page 233.*)

No. 29. Geo. Cole's specular ore, 1½ miles from Newman's, on the road through Cole's Valley. Analysed by Mr. A. S. McCreath. (*CC—page 249.*)

	27.	28.	29.
Silica ($Si\ O_2$),	. . . .	1.700	25.660
Insoluble Residue,	16.310	. . .	
Phosphoric Oxide ($P_2\ O_5$),	0.154	0.029	0.007
Titanic Oxide ($Ti\ O_2$),	. . . .	0.330	
Sulphuric Oxide ($S\ O_3$),	trace.	0.020	0.017
Carbonic Oxide ($C\ O_2$),	14.170		
Alumina ($Al_2\ O_3$),	2.528	2.642	0.999
Iron Sesqui-oxide ($Fe_2\ O_3$),	46.000	66.780	72.357
Manganese Sesqui-oxide ($Mn_2\ O_3$),	. . . .	. . . .	0.031
Ferrous Oxide ($Fe\ O$),	3.985	27.964	0.321
Manganous Oxide ($Mn\ O$),	trace.	0.280	
Lime ($Ca\ O$),	15.250	0.410	0.240
Magnesia ($Mg\ O$),	1.333	0.259	0.133
Iron bi-sulphide ($Fe\ S_2$),	0.046	0.009	
Water ($H_2\ O$),	0.330	0.371	0.224
Sum,	100.106	100.794	99.989
Metallic Iron,	35.300	68.500	50.900
Metallic Manganese,	trace.	0.217	0.022
Sulphur,	0.025	0.013	0.007
Phosphorus,	0.068	0.013	0.003

No. 30 is an ore from Jacob L. Smith's house three miles south of Wellsville, from a shaft in the woods.

Analysed by Mr. D. McCreath. (*CC—page 233*).

Silica ($Si\ O_2$),	17.560
Phosphoric Oxide ($P_2\ O_5$),	0.297
Sulphuric Oxide ($S\ O_3$),	0.050
Carbonic Oxide ($C\ O_2$),	0.483
Alumina, ($Al_2\ O_3$),	10.416
Iron Sesqui-oxide, ($Fe_2\ O_3$),	56.428
Manganese Sesqui-oxide, ($Mn_2\ O_3$),	0.206
Ferrous Oxide ($Fe\ O$),	1.285
Copper Oxide ($Cu\ O$),	0.868
Lime, ($Ca\ O$),	8.260
Magnesia ($Mg\ O$),	0.990
Alkalies and loss (by deduction),	1.355
Water ($H_2\ O$),	1.802
	100.000
Metallic Iron,	40.500
Metallic Copper,	0.692
Metallic Manganese,	0.144
Sulphur,	0.020
Phosphorus,	0.130

The following is an analysis by Mr. J. B. Britton of the "Fry" ore from a mine near the crossing of the Wrightsville—York R. R. and the turnpike about ¾ mile from York:

Siliceous matter,	15.00
Titanic Oxide,	(doubtful)
Phosphorus,	0.01
Sulphur,	0.03
Pure Iron (all as Fe_2O_3),	57.66
Oxygen combined with same,	25.48
Alumina,	0·50
Lime,	(trace)
Manganese,	(trace)
Water,	1.05
Total,	99.73

"A comparison of this ore with Lake Superior Ore was made by three assays of each in the furnace. The result was 60. p. c. reduced metal for the latter and 61.08 for the former. The buttons of each ore were tested in the socket mortar. The Lake Superior button flattened a little and broke with three strokes, showing a dark gray and fine grained iron. The button from the Fry ore was completely reduced and showed the same peculiarities."* It is clear that either there must be an error in the above analysis or else that the specimen tested in the dry way was much richer than that of which the analysis was given, as there is always loss by this method.

A sample of Heavy Spar from Franklin County near Waynesboro' which was sent to the laboratory of the Survey by Mr. Burgess was analyzed by Mr. D. McCreath with the following results:

Barium Sulphate ($BaSO_4$),	98.650
Strontium Sulphate ($SrSO_4$),	—
Alumina and Iron Sesqui-oxide (Al_2O_3 & Fe_2O_3),	0.140
Lime (CaO),	—
Magnesia (MgO),	trace
Silica (SiO_2),	1.110
Water (H_2O),	0.200
Sum,	100.100

The following analyses were furnished from the labora-

* For the above statement I am indebted to Mr. Nourse of the Chestnut Hill Iron Ore Co.

tory of the University of Pennsylvania by Dr. F. A. Genth, Professor of Chemistry.

No. 1157. Quartzite. One and a half miles south of west of the burned saw mill on the Conococheague.

No. 1167. Laminated Orthofelsite ¼ mile S. E. of Caledonia Furnace.

No. 1055. Orthofelsite ¼ mile N. of road to Lerew's store.

No. 822. Feldspathic Mineral from vein in Trap at Kidd's Mill, 2 miles S. E. of Krallstown, Bermudian Creek, York Co., Penn'a.

	1157.	1167.	1055.	822.
Quartz ($Si\,O_2$),	84.130			
Silicic Oxide (combined) ($Si\,O_2$),	7.870	75.570	75.920	57.800
Titanic Oxide ($Ti\,O_2$),	0.145			
Phosphoric Oxide $P_2\,O_5$),	0.205	0.190	0.190	0.120
Alumina ($Al_2\,O_3$),	4.210	11.940	12.400	22.390
Iron Sesqui-oxide ($Fe_2\,O_3$),	1.800	3.830	2.950	0.080
Lime ($Ca\,O$),	0.040	....	trace	*10.670
Potash ($K_2\,O$),	1.160	5.250	6.490	0.690
Soda ($Na_2\,O$),	0.160	3.010	2.320	7.650
Ignition,	0.960	0.270	0.440	2.190
	100.680	100.06	100.71	101.59

Trap from McClure's Farm 4 miles S. E. of Dillsburg.†

No. 452. (Average)

Silica ($Si\,O_2$),	53.32
Phosphoric Oxide) $P_2\,O_5$),	0.22
Titanic Oxide ($Ti\,O_2$),	1.00
Alumina : ($Al_2\,O_3$),	13.87
Iron Sesqui-oxide ($Fe_2\,O_3$),	3.12
Ferrous Oxide ($Fe\,O$),	7.17
Manganous Oxide ($Mn\,O$),	0.47
Lime ($Ca\,O$),	10.42
Magnesia ($Mg\,O$),	7.57
Soda ($Na_2\,O$),	2.05
Potash ($K_2\,O$),	0.73
Lithia ($Li_2\,O$),	faintest trace
Ignition,	0.69
	100.63

* Trace of Manganese.

† The numbers at the head of each analysis refer to those in the catalogues of specimens included in reports C and CC.

No. 1265. Epidote Rock, 2¼ miles of Mont Alto Furnace. (Marked in Catalogue "Greenstone.")

Silica ($Si O_2$),	48.02
Phosphoric Oxide, ($P_2 O_5$),	1.45
Alumina ($Al_2 O_3$),	17.84
Iron Sesqui-oxide ($Fe_2 O_3$),	11.61
Ferrous Oxide ($Fe O$)	0.98
Lime, ($Ca O$),	18.25
Ignition,	1.50
Sum,	99.65

No. 477. Syenite from Harman's blacksmith shop, 6 miles East of Dillsburg, York Co., Penn'a.

Silica, ($Si O_2$),	52.91
Phosphoric Oxide ($P_2 O_5$),	2.74
Alumina ($Al_2 O_3$),	15.61
Iron Sesqui-oxide ($Fe_2 O_3$),	9.76
Ferrous Oxide ($Fe O$),	*5.22
Lime ($Ca O$),	4.39
Potash ($K_2 O$),	3.05
Soda ($Na_2 O$),	4.27
Ignition,	1.24
	99.19

The amount of magnetite deducible from this percentage of Fe O on the supposition that all of the ferrous oxide was present in that form is, ... 16.82

Actual weight of both oxides together, ... 14.98

Weight of magnetic oxide calculated from the ascertained weight of $Fe_2 O_3$, ... 14.15

It is certain therefore that some of the ferrous oxide (0.83 p. c.) exists in other combinations.

No. 478. Amphoterolitic† mineral from the Syenite.

Silica ($Si O_2$),	49.56
Phosphoric Oxide ($P_2 O_5$),	6.92
Alumina ($Al_2 O_3$),	3.66
Iron Sesqui-oxide ($Fe_2 O_3$),	12.30
Ferrous Oxide ($Fe O$),	16.36
Lime ($Ca O$) (trace of $Mn O$),	8.79
Ignition,	2.20
Sum,	99.79

* The 5.22 p. c. Ferrous oxide is the average of two determinations.

† Silicate of "heavy" and "light" metal bases.

No. 478. Feldspar from Syenite Rock. Harman's blacksmith shop, six miles East of Dillsburg. Reddish and white mixed, and cannot be separated.

Silica ($Si\,O_2$),	62.26
Phosphoric Oxide ($P_2\,O_5$),	0.10
Alumina ($Al_2\,O_3$),	22.96
Iron Sesqui-oxide ($Fe_2\,O_3$),	0.75
Lime ($Ca\,O$),	4.13
Potash ($K_2\,O$),	3.27
Soda ($Na_2\,O$),	5.66
Ignition,	1.83
Sum,	100.96

No. 478. Magnetic portion from Harman's.

Silica ($Si\,O_2$),	37.25
Phosphoric Oxide ($P_2\,O_5$),	0.31
Titanic Oxide ($Ti\,O_2$),	1.26
Alumina ($Al_2\,O_3$),	2.77
Iron Sesqui-oxide ($Fe_2\,O_3$),	22.95
Ferrous oxide ($Fe\,O$),	20.15
Manganese Oxide ($Mn_3\,O_4$),	0.71
Lime ($Ca\,O$),	4.61
Magnesia ($Mg\,O$),	7.34
Ignition,	1.74
Sum,	99.09

No. 493. Contact of fine grained and coarse grained Trap, McElwee's, 4 miles S. E. of Dillsburg.

Silica ($Si\,O_2$),	52.14
Titanic Oxide ($Ti\,O_2$),	1.04
Phosphoric Oxide ($P_2\,O_5$),	0.04
Alumina ($Al_2\,O_3$),	17.41
Lime ($Ca\,O$),	9.21
Magnesia ($Mg\,O$),	3.72
Iron Sesqui-oxide ($Fe_2\,O_3$),	4.94
Ferrous Oxide ($Fe\,O$),	6.42
Potash ($K_2\,O$),	0.85
Soda ($Na_2\,O$),	2.95
Ignition,	1.59
Sum,	100.31

No. 1100. Finely laminated Orthofelsite, half a mile west of Cole's Saw Mill, on the Shippensburg road.

Silica ($Si\,O_2$),	75.81
Titanic Oxide ($Ti\,O_2$),	0.41
Phosphoric Oxide ($P_2\,O_5$),	0.05

Alumina ($Al_2 O_3$),	12.96
Iron Sesqui-oxide ($Fe_2 O_3$),	3.05
Potash ($K_2 O$),	3.15
Soda ($Na_2 O$),	5.11
Ignition,	0.61
	100.65

No. 1243. Orthofelsite containing Epidote, from 11¾ miles West of Gettysburg.*

Silica ($Si O_2$),	48.93
Alumina ($Al_2 O_3$),	15.42
Iron Sesqui-oxide ($Fe_2 O_3$),	14.71
Manganous Oxide ($Mn O$),	0.54
Lime ($Ca O$),	18.16
Magnesia ($Mg O$),	2.78
	100.54

No. 555. Analysis of a coarse grained Syenitic Granite from Geo. Heiges's, 3½ miles S. E. of Dillsburg.

a. Analysis of finely comminuted and carefully averaged sample of the entire rock.

Silica ($Si O_2$),	49.28
Titanic Oxide ($Ti O_2$),	2.59
Phosphoric Oxide ($P_2 O_5$),	0.17
Alumina ($Al_2 O_3$),	13.01
Iron Sesqui-oxide ($Fe_2 O_3$),	6.50
Ferrous Oxide ($Fe O$),	10.94
Lime ($Ca O$),	4.88
Magnesia ($Mg O$),	6.15
Manganese Oxide ($Mn_3 O_4$),	0.29
Potash ($K_2 O$),	0.83
Soda ($Na_2 O$),	2.76
Ignition,	1.80
Total,	99.20

No. 555. Coarse grained Syenitic Granite, from Geo. Heiges's place, 3½ miles S. E. of Dillsburg.

b. Analysis of the Hornblendic portion.

Silica ($Si O_2$),	50.26
Titanic Oxide ($Ti O_2$),	0.70
Alumina ($Al_2 O_3$),	3.34
Iron Sesqui-oxide ($Fe_2 O_3$),	11.60
Ferrous Oxide ($Fe O$),	11.31
Lime ($Ca O$),	6.91

* Analysed by Henry Trimble.

Magnesia (Mg O),	12.04
Manganous Oxide (Mn O),	0.47
Alkalies by loss,	1.71
Ignition,	1.66
Total,	100.00

No. 555. Coarse grained Syenitic Granite, from Geo. Heiges's place, 3½ miles S. E. of Dillsburg.

c. Feldspathic portion of the rock.

Silica ($Si\ O_2$),	55.38
Alumina ($Al_2\ O_3$),	25.80
Iron Sesqui-oxide ($Fe_2\ O_3$),	2.36
Lime (Ca O),	9.47
Magnesia (Mg O),	0.29
Potash ($K_2\ O$),	1.05
Soda ($Na_2\ O$),	5.07
Ignition,	0.79
Total,	100.21

No. 450. Trap from M. Porter's farm, on the Gettysburg road, half a mile S. W. of Dillsburg.

(Silica ($Si\ O_2$),	56.13
Titanic Oxide ($Ti\ O_2$),	1.98
Phosporic Oxide ($P_2\ O_5$),	0.44
Alumina ($Al_2\ O_3$),	12.32
Iron Sesqui-oxide ($Fe_2\ O_3$),	5.86
Ferrous Oxide (Fe O),	6.15
Lime (Ca O),	5.52
Magnesia (Mg O),	1.54
Manganese Oxide ($Mn_3\ O_4$),	0.49
Potash ($K_2\ O$),	0.17
Soda ($Na_2\ O$),	5.88
Ignition,	3.78
Total,	100.26

No. 607. Trap. Half a mile from Rossville.

Silica ($Si\ O_2$),	52.48
Titanic Oxide ($Ti\ O_2$),	1.15
Phosphoric Oxide ($P_2\ O_5$),	0.15
Alumina ($Al_2\ O_3$),	15.27
Iron Sesqui-oxide ($Fe_2\ O_3$),	2.39
Ferrous Oxide (Fe O),	8.22
Lime (Ca O),	10.28
Magnesia (Mg O),	7.35
Potash ($K_2\ O$),	0.45
Soda ($Na_2\ O$),	2.05
Ignition,	0.38
Total,	100.17

No. 497. Chloritic Mineral containing Chloritoid. McElwee's farm, 4 miles S. E. of Dillsburg.

Silica ($Si O_2$),	58.08
Alumina ($Al_2 O_3$),	15.56
Iron Sesqui-oxide ($Fe_2 O_3$),	0.93
Ferrous Oxide,	14.20
Magnesia ($Mg O$),	5.64
Potash ($K_2 O$),	0.10
Soda ($Na_2 O$),	0.15
Ignition,	5.48
Total,	100.14

Slaty Rock from 9 miles S. W. of Dillsburg.
(*The catalogue number is uncertain. Perhaps 527(?)*).

Silica ($Si O_2$),	53.66
Alumina ($Al_2 O_3$),	22.18
Iron Sesqui-oxide ($Fe_2 O_3$),	7.11
Ferrous Oxide ($Fe O$),	1.46
Lime, ($Ca O$),	1.99
Magnesia ($Mg O$),	2.79
Potash ($K_2 O$),	4.56
Soda ($Na_2 O$),	4.12
Ignition,	2.55
Total,	100.42

No. 977. Variegated Chlorite Schist with chlorite (?). Half a mile N. E. of Pine Grove.

Silica ($Si O_2$),	37.03
Titanic Oxide, ($Ti O_2$),	4.05
Phosphoric Oxide ($P_2 O_5$),	0.51
Alumina ($Al_2 O_3$),	24.13
Lime, ($Ca O$),	0.21
Magnesia ($Mg O$),	1.44
Ferrous Oxide (?) ($Fe O$),	19.83
Potash (trace Soda),	8.93
Ignition,	3.54
Total,	99.67

No. 1262. Purplish Slaty Orthofelsite from a locality 1½ miles S. E. of Mont Alto.

Silica ($Si O_2$),	52.82
Titanic Oxide ($Ti O_2$),	1.92
Phosphoric Oxide ($P_2 O_5$),	0.21
Alumina ($Al_2 O_3$),	20.73

Lime (Ca O),	0.23
Magnesia (Mg O),	2.03
Potash (K_2 O),	6.68
Ferrous Oxide (Fe O) (?),	10.72
Ignition,	4.28
Total,	99.62

No. 567. Dolerite from E. Hoffman's farm, 6 miles East of Dillsburg.

Silica (Si O_2),	51.88
Titanic Oxide (Ti O_2),	1.01
Phosphoric Oxide (P_2 O_5),	0.21
Alumina (Al_2 O_3),	13.73
Iron Sesqui-oxide (Fe_2 O_3),	2.79
Ferrous Oxide (Fe O),	8.05
Manganous Oxide (Mn O),	0.42
Lime (Ca O),	10.68
Magnesia (Mg O),	7.86
Soda (Na_2 O),	2.32
Potash (K_2 O),	0.61
Lithia (Li_2 O),	trace
Ignition,	1.10
Total,	100.66

No. 844. The following analysis by Henry Trimble is of an Orthofelsite from a cut on the Turnpike 5 miles N. W. of Petersburg, Cumberland county.

Silica (Si O_2),	76.76
Iron Sesqui-oxide (Fe_2 O_3),	2.63
Alumina (Al_2 O_3),	12.64
Lime (Ca O_2,)	0.11
Magnesia (Mg O),	0.16
Titanic Oxide (Ti O_2),	0.68
Phosphoric Oxide (P_2 O_5),	0.11
Potash (K_2 O),	6.15
Water (H_2 O),	1.53
	100.77

PART II. *Analyses of specimens from Lancaster County.*

The following analysis of the Peach Bottom Slates which cross a portion of Lancaster and York counties was made by Mr. Andrew S. McCreath. The specimen is from J.

Humphrey & Co's Quarry, half a mile East of Delta, York county.

Silicic Oxide ($Si O_2$),	55.880
Titanic Oxide ($Ti O_2$),	1.270
Sulphuric Oxide ($S O_3$),	0.022
Alumina ($Al_2 O_3$),	21.849
Ferrous Oxide ($Fe O$),	9.033
Manganous Oxide ($Mn O$),	0.586
Cobaltous (Oxide $Co O$,)	trace
Lime ($Ca O$),	0.155
Magnesia ($Mg O$),	1.495
Soda ($Na_2 O$),	0.460
Potash ($K_2 O$),	3.640
*Carbon (C),	1.794
Water ($H_2 O$),	3.385
Iron bisulphide ($Fe S_2$),	0.051
Total,	99.800

The following analyses of ores were furnished by chemist, Mr. A. S. McCreath:

Current field number of specimen.	
No. 1739, . . .	Micaceous Iron Ore (magnetic) six paces S. E. of "Rock Shaft," Chestnut Hill.
No. 1729, . . .	Magnetic iron ore Limestone Hill near John Haldeman's near trap dyke, 5 miles (8 kilometers) W. of Marietta.
No. 1741, . . .	Micaceous (slightly magnetic) ore, from ridge dividing the property of the Chestnut Hill Iron Co.

	1739.	1729.	1741.
Iron Sesqui-oxide, ($Fe_2 O_3$,)	39.181	62.857	87.571
Ferrous Oxide, ($Fe O$,)	15.171	19.285	5.528
Iron bisulphide, ($Fe S_2$,)	0.050		
Manganous oxide, ($Mn O$,)	0.102	. . . . .	0.155
Manganese Sesqui-oxide, ($Mn_2 O_3$,)	. . . . .	0.232	3.217
Lime, ($Ca O$.)	0.040	1.010	0.050
Magnesia, ($Mg O$,)	0.396	1.396	0.252
Sulphuric Oxide, ($S O_3$,)	. . . . .	0.007	0.007
Phosphoric Oxide, ($P_2 O_5$,)	0.039	0.082	0.109
Water,	0.350	1.896	0.950
Insoluble Residue,	43.350	10.670	2.260
Total,	100.169	100.667	100.099

*Average of three determinations.

Further resolution of the compounds above given:

	1739.	1729.	1741.
Magnetic Oxide,	45.84	62.14	17.81
Surplus of Iron Sesqui-oxide over that required by the Magnetic Oxide,	5.46	20.00	75.28
Metallic Iron,	39.250	59.00	65.60
Metallic Manganese,	0.079	0.180	0.108
Sulphur,	0.027	0.003	0.003
Phosphorus,	0.017	0.036	0.048

No. 1705. Analysis from Dr. Genth's laboratory of a Mica Schist, with imbedded crystals, from half a mile N. W. of Cully's Station, Columbia and Port Deposit R. R.

Silica ($Si\ O_2$),	59.01
Titanic Oxide ($Ti\ O_2$),	1.34
Phosphoric Oxide ($P_2\ O_5$),	trace.
Alumina ($Al_2\ O_3$),	17.02
Iron Sesqui-oxide ($Fe_2\ O_3$),	7.76
Ferrous Oxide ($Fe\ O$),	2.64
Manganous Oxide ($Mn\ O$),	0.96
Lime ($Ca\ O$)	2.08
Magnesia ($Mg\ O$),	0.07
Potash ($K_2\ O$),	2.63
Soda ($Na_2\ O$),	2.44
Ignition,	4.42
Total,	100.37

A note at the bottom of this analysis states that the proportion of quartz and of magnetite varies in the different parts of the rock.

The following analyses are by Mr. A. S. McCreath.

1. Haldeman's limestone quarry, near Chikis. Middle of Quarry. Best Specimen.
2. Ditto ditto. Worst specimen.
3. Ditto. Extreme north end of quarry. Sandy Layer.
4. Haldeman's South Quarry. Best Blue limestone.

	1.	2.	3.	4.
Calcium (Carbonate $Ca\ CO_3$),	55.104	53.517	50.339	54.750
Magnesium Carbonate ($Mg\ CO_3$),	43.602	43.522	41.143	44.204
Iron oxide and Alumina ($Fe_2\ O_3$ and $Al_2\ O_3$),	0.304	0.869	0.731	0.517
Sulphur (S),	0.023	0.021	0.030	0.011
Phosphorus (P),	0.016	0.014	0.029	0.010
Insoluble Residue,	0.847	1.926	7.699	0.436
	99.896	99.869	99.971	99.928

The following analyses by Mr. J. B. Britton are from limestones about ½ to 1½ miles South of Manheim, along the track of the Reading R. R. and near county bridge:

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Insoluble Siliceous Matter, ...	3.38	3.42	7.12	1.45	1.62	5.60	4.52	4.08	2.28	6.25	13.96
Sesqui-oxide of Iron and Alumina,	4.51	2.88	1.51	0.54	0.29	0.44	0.64	0.58	0.40	0.44	3.36
Water, ...	0.48	0.42	0.28	0.36	0.36	0.28	0.32	0.56	0.52	0.20	0.52
Calcium Carbonate, ...	52.28	54.23	74.42	86.50	93.34	89.17	88.77	90.64	93.24	87.75	57.43
Magnesium Carbonate, ...	39.35	39.05	16.67	11.15	4.39	4.51	5.75	4.14	3.56	5.16	24.73
Total, ...	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Strickler Limestone Quarries.

Various parts of a limestone quarry half a mile East of the intersection of Strickler's Run with the Lancaster and Columbia R. R., have been analysed by Mr. Britton, with the following results:

	1.	2.	4.	5.	7.	8.	10.	11.	13.	14.
Insoluble Siliceous Residue, ...	0.40	0.32	0.08	0.29	0.72	0.78	0.32	0.24	0.12	0.12
Iron Sesqui-oxide and Alumina, ...	2.24	2.18	0.64	2.14	2.04	1.44	0.53	0.31	0.40	0.20
Water, ...	0.32	0.44	0.72	0.36	0.32	0.48	0.20	0.25	0.32	0.24
Calcium Carbonate, ...	56.81	53.29	53.28	53.17	53.19	68.22	86.24	88.67	83.46	90.89
Magnesium Carbonate, ...	40.23	43.77	45.28	44.04	43.73	29.08	12.71	10.53	15.70	8.55
Total, ...	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The following analyses by the same person were of a limestone about 300 yards N. E. of the Strickler quarries:

Insoluble siliceous matter,	1.61	1.38
Iron Sesqui-oxide and alumina,	0.84	1.18
Water,	0.36	0.48
Calcium Carbonate,	92.53	90.81
Magnesium Carbonate,	4.66	6.15
	100.00	100.00

Calcium Carbonate,	86.89
Magnesium Carbonate,	5.36
Insoluble Silicates,	4.03
Iron Sesqui-oxide and Alumina,	2.40
Water,	0.49
Solid carbonaceous matter,	0.09
Manganese,	trace
Loss,	0.74
Total,	100.00

Two specimens of Millerite of which the analyses by Dr. Genth appear in his Report on the Mineralogy of Penn'a, 1875, are as follows: (See B, p. 17).

	Millerite.	Partly altered to Chalcocite.
Sulphur,	35.14	33.60
Nickel,	63.08	59.96
Cobalt,	0.58	
Iron,	0.40	1.32
Copper,	0.87	4.68
Gangue,	0.28	0.54
Total,	100.35	100.05

A series of determinations of the Nickel and Cobalt, and Copper in the Gap Nickel Ores, furnished by Mr. Joseph Wharton is here appended.

	1.	2.	3.	4. p. c.	5.	6.	7.
Nickel and Cobalt,	4.23	3.16	4.81	4.25	4.32	2 80	1.53
Copper,	2.26	0.96	0.10	0.05	0.05	1.10	
Sulphur,							17.67

Some analyses of the Nickel Ores from the New Caledonia Nickel Mines are of interest in connection with those from the Gap Mine. In the "Comptes Rendus de la Societé des Ingenieurs Civils" of 1877, are found the following three analyses:

	I.	II.	III.
Nickelous Oxide ($Ni\,O$),	3.50	8.50	18.50
Ferrous Oxide ($Fe\,O$,)	5.18	2.50	3.50
Lime ($Ca\,O$),	2.20	17.28	2.65
Magnesia ($Mg\,O$),	26.65		15.75
Silica and Insoluble matter ($Si\,O_2$ &c.),	41.75	57.50	50.00
Water ($H_2\,O$),	21.25	14.50	10.00
Total,	100.53	100.28	100.40
Metallic Nickel,	2.75	6.60	14.62
Metallic Iron,	4.03	1.94	2.45

Apparently no Millerite is found.

Trap.

The following is an analysis by Dr. Genth of the thin vein of trap which intersects the chloritic rocks at Williamson's Point. A photograph of the locality and a colored thin section of the rock will accompany this report:

Silica ($Si\,O_2$),	50.79
Titanic Oxide ($Ti\,O_2$),	0.70
Phosphoric Oxide ($P_2\,O_5$),	0.15
Alumina ($Al_2\,O_3$),	14.19
Iron Sesqui-oxide ($Fe_2\,O_3$),	3.84
Ferrous Oxide ($Fe\,O$),	7.44
Manganous Oxide ($Mn\,O$),	0.48
Lime ($Ca\,O$),	9.75
Magnesia ($Mg\,O$),	7.88
Potash ($K_2\,O$),	0.95
Soda ($Na_2\,O$),	1.89
Ignition,	1.95
Total,	100.01

The trap dyke which cuts through the hard quartzose and chloritic rock at Williamson's Point is peculiar in its isolation from known rocks of igneous origin, in the manner in which it is foliated transversely to its contact planes and in its disappearing on its under side in a feather edge. Its upper continuation is now obscure from the denudation of the rocks which it intersects but as far as it can be followed it widens in an upward direction and the uneven facade of rock against which it appears gives it the semblance of being dislocated in places but this is a deception of the judgment. The picture of its outcrop represents it in the black line line seen on the right hand, but the view has been displaced in transferring it to stone, an error which can, however, be easily corrected with the knowledge that the mile post marking 28 miles to Columbia should be perfectly vertical.

The rocks are here twisted in a most extraordinary manner and this twisting is more remarkable just beyond the limit of view in the right foreground than in the part presented. A very fine specimen of a portion of this vein with both walls distinct and attached on one side to the rock which it intersected is No. 1760 in the collection.

An examination of this specimen will reveal the fact that the fissure has not been exactly along planes of lamination but truncates the tops of several small waves into which the strata have been forced.

A specimen of this trap was obtained and reduced to a thin section of which a representation as seen under a power of 400 diameters and in polarized light has been very faithfuly made by Mr. Faber.

It was not found expedient in this drawing to imitate exactly all the details in any one field of view, but the more characteristic exponents of the minute crystals were brought together from all parts of the slide and substituted for those less perfectly formed; due regard being had always to the proportions in which the several constituents of the mass manifested themselves.

In the centre of the field is a large double—or rather multiple—columnar crystal of labradorite, to the bottom, and the middle of which other smaller crystals are attached —(whether accidentally in contact or an offshoot in the former case is not certain.)

In the upper left hand portion of the field a curious instance of the splitting of labradorite may be observed. It was at first thought that the apparent divergent curvature of the two branches of this crystal might be an optical delusion and that in reality two independent individuals were thus accidentally in contact at one extremity. Under higher powers than here given, however, it proved to be an actual ramification of the mass from one common stock like the growth of twigs from the same branch.

The other labradorite crystals will be easily distinguished by the eye, and as usual are characterized by their tendency to separate into two or more parts colored respectively light brown and pale blue.

The four masses of pyroxene are equally distinguishable by the peculiar net work of clefts which covers their surfaces which in polarized light present usually one of the tints here distributed among them. It is often the case when a thin slide has been carefully and evenly made that at a certain position of the analyser all the labradorite divides itself into its two characteristic colors depending upon the postions of the optical axes of a pair or a series of the twins. With Pyroxene it is different. The fragments (in these traps at least) rarely show definite crystalline form and in any given position of the analyser there may be found specimens exhibiting any of the indefinitely large number of gradations in color between bright green and dark violet which accompany the rotation of the analyser through the angle which separates the projection of their optical axes.

Only a single hexagonal section is given in the picture but these figures are distributed, though not profusely, throughout the mass. This is probably a minute column of Apatite, and the low percentage of Phosphoric Oxide in the accompanying analysis sufficiently explains why these forms are comparatively rare.

A number of these hexagonal forms having been examined it was found that when most symmetrical they exercised no influence on polarized light and were therefore sections perpendicular to the optical axes of uniaxal crystals: therefore of hexagonal crystals since the basal plane assumed this form.

But where the hexagon was distorted or in the frequent cases where it was covered by a film of vitreous pyroxene or by labradorite, the extinctions were more or less those of bi-axial crystals, though not regular. One of the quasi hexagons measured 0.048 millimeters between the parallel edges.

The comparatively large rhombic figure is in all probability a section of calcite parallel to one of the planes of the rhombohedron. Several of these figures were measured and examined. One of them was 0.11 millimeter in the longer axis. The angles as measured were 81° 03′ and 98° 36′ respectively. This crystal showed four positions of maximum transparency and four positions of extinction alternating with each other at distances of 45°*. It therefore was not a basal section of a rhombic crystal.

Another and the largest similar section which was measured showed a longer axis equal to 0.25 mm. An examination under the improved Füss's microscope with a magnifying power of 275 diameters gave

Acute angle,	80°30°	180°
Obtuse angle,	99°30°	

In this case there was no general extinction of light during one revolution with or without the quartz prism.

The modifications of light at a few points seemed to be caused by impurities.

A small rhomb examined in the Füss instrument under a magnifying power of 275 diameters gave

Acute angle (imperfect,)	73°30′	172°
Obtuse " "	98°30	

A profusion of small black specks distinguished the face of the crystal which was apparently therefore not homogeneous. It showed four extinctions.

A third rhombus at 275 diameters showed

Acute angle,	72°	173°
Obtuse "	101°	

Neither of the above angles were perfect.

This crystal also showed four extinctions.

The ground mass is composed of minute bodies very often stellate in structure among which are probably small col-

* The microgoniometer having been set at zero when the Nicols were crossed the succeeding positions of extinction were very nearly 0°, 90′ 180°, and 270°.

ulmnar masses of rutile, as the Titanic Oxide in the analysis suggest. They are exceedingly small and except here and there do not indicate any definite order, or arrangement.

This ground mass is not certainly determined. The tufts are sometimes flat and *frayed* at the ends like a piece of worn cloth.

They polarize feebly within different shades of brown. Under a magnifying power of 900 diameters these small objects unresolvable under lower powers are for the most part resolved into small blades of labradorite with perhaps some Apatite and Rutile.

Herewith are presented side by side average analyses of labradorite and of Pyroxene both calculated from the data given in the last edition of Dana's System of Mineralogy (Fifth Edition, 1877). The former is based upon forty analyses of labradorite and the latter on 18 analyses of pyroxene from eruptive rocks.

	Labradorite average of 40 analyses.	Pyroxene average of 18 analyses.
Silica ($Si\,O_2$),	53.00	49.35
Alumina, ($Al\,O_3$),	27.96	5.79
Iron Sesqui-oxide ($Fe_2\,O_3$),	1.33	—
Ferrous Oxide ($Fe\,O$),	—	8.30
Magnesia ($Mg\,O$),	0.93	13.88
Lime ($Ca\,O$),	10.88	20.86
Soda ($Na_2\,O$),	4.09	—
Potash ($K_2\,O$,)	1.08	—
Manganous Oxide ($Mn\,O$),	—	0.27
Water,	0.84	0.19
	100.11	98.64

In the following table the percentage of each constituent in Dr. Genth's analysis of this trap is doubled and the result compared with a column showing the sums of the percentges of the average labradorite and the average pyroxene:

	Sum of Labradorite & Pyroxene.	Double percentage of Dr. Genth's analysis.
Silica ($Si\,O_2$),	102.35	*102.43
Alumina ($Al_2\,O_3$),	33.75	28.38
Iron Sesqui-oxide ($Fe\,O_3$,)	1.33	7.60
Ferrous Oxide ($Fe\,O$,)	8.30	14.88
Manganous Oxide ($Mn\,O$),	0.27	0.90
Magnesia ($Mg\,O$),	14.81	15.76
Lime ($Ca\,O$),	31.74	19.50
Soda ($Na_2\,O$),	4.09	3.70
Potash ($K_2\,O$,)	1.08	1.90
Water ($H_2\,O$,)	1.03	†3.90
	198.75	199.17

* 0.70 p. c. $Ti\,O_2$, and 0.15 p. c. $P_2\,O_5$ included in $Si\,O_2$. † Ignition.

It will be seen that the two columns agree remarkably well in most particulars, which is the same as saying that the composition of the rock is very nearly what the chemical analysis of a mixture of one molecule of labradorite and one molecule of pyroxene would show.

In report "C" a number of similar traps were discussed and analyses given amongst others of one from "West Rock" Connecticut, and one from Beeler's farm, York County.

The composition of the former like the one here considered agreed more nearly with a distribution of labradorite and pyroxene molecules in the proportion of one to one while the "Beeler" trap corresponded more nearly with the mixture of two molecules of labradorite with one of pyroxene. In the present case tables of comparison were made on the basis of 2 L+P, and 3 L+P,* but none agreed so closely as the two first made and presented above.

It should be mentioned that a slight error is due to the counting of all the Titanic oxide and Phosphoric Oxide as part of the Silicic Oxide, neglecting at the same time to make the necessary allowance for the quantivalential, and atom-weight differences, but the amount of these substances was so small that the error will be entirely inappreciable.

The same is true of the method here followed which is simply to compare the ascertained percentages of the compounds instead of reducing the analysis to percentage weight of the elements and striking a balance between the electro-negative and the electro-positive elements. This latter method is much more exact but is too delicate and no better for the purpose than the rough and ready system here followed. A comparison of the same bodies given above in their percentage values would be as follows:

	P. c. composition. 1 L.+1 P.	Analysis of trap.
Silica ($Si\,O_2$),	51.50	*51.64
Alumina ($Al_2\,O_3$),	16.95	14.19
Iron Sesqui-oxide ($Fe_2\,O_3$),	0.67	3.84
Ferrous Oxide ($Fe\,O$),	4.17	7.44
Manganous Oxide ($Mn\,O$),	0.13	0.48
Magnesia ($Mg\,O$),	7.45	7.88
Lime ($Ca\,O$),	16.00	9.75
Soda ($Na_2\,O$),	2.55	1.89
Potash ($K_2\,O$),	0.55	0.95
Water ($H_2\,O$),	0.52	†1.95

*Including $Ti\,O_2$ and $P_2\,O_5$. †Ignition.

It will be observed that the theoretical composition requires more Alumina and Lime than are given in the analysis. The alkalies are about equivalent in both, for there is a little less soda and a little more potash in the rock, which contains also more iron as both sesqui-oxide and protoxide.

Manganese is too small to consider as is also the slight difference in the per cent. of Magnesia.

The analysis thus considered tells us that the actual composition of the rock though near 1:1 of labradorite and pyroxene is not quite that, being slightly deficient in Alumina and Lime (labradorite) while the excess of the two oxides of iron remind us that we are not to forget one of the most generally distributed constituents of these dolerites ? e. g. Magnetite, though really under the microscope this mineral is not at all prominent.

The study of the microscopic section having led to the suspicion of Calcite in the rock a great number of specimens were tested for effervescence and all showed it in a prominent degree. As the above analysis of Dr. Genth gave no car-

*L stands for one molecule of labradorite. P stands for one molecule of Pyroxene.

bonic Oxide on inquiry he writes: "The rock is full of cracks and these are lined with a minute quantity of calcite. The portion of which I sent you the analysis was as nearly as possible selected from that which did not show this coating. * * * Still some of the 'Ignition' may be Co_2," &c. &c.

It is clear from the position of these calcite crystals that they cannot all be due to infilbrated solutions of calcium carbonate through cracks in the rock, because the individual crystals are isolated from each other.

Their occurrence is peculiar and will be made the subject of future study.

Three determinations of loss by ignition made at different times and with different portions of the rock gave respectively 3.65, 3.40, and 3.88 p. c. (average 3.643 p. c.)

An average of three determinations of carbonic Oxide gave 1.49 p. c. though this may be slightly too high as one of the samples appeared to be abnormally rich in calcite. It appears reasonable to assume 1 p. c. as the proportion of $C\,O_2$ which would give 1.65 p. c. of calcite.

It may be stated that an investigation of the results of this analysis render it probable that 45.88 p. c. of the Silica recorded is present in the form of an ortho-silicate or $M'_4\,Si\,O_4$ and 4.91 as a mono-meta silicate or $M'_2\,Si\,O_3$.

Chapter VII.

Catalogue of Specimens added to the Collection by the parties of Adams, Franklin, Lancaster, &c., during the season of 1877.

1. Specimens collected by the Assistant Geologist in charge in Lancaster (and adjoining) Counties.

Nos.	Character.	Locality.
1700	Ferruginous slate, with efflorescence,	Slate quarry, one mile south of Columbia bridge.
1701	Slates,	Commencement of curve below Turkey Hill Station, C. and P. D. R. R., $5\frac{1}{2}$ miles S. of Columbia.
1702	Pyritiferous calcareous slate, in limestone slates,	2d quarry, S. E. of Strickler's Run.
1703	Limestone. Dip nearly vert. N. 10° W.,	30 yards S. E. of Turkey Hill Station.
1704	Limestone,	Quarry 1 mile [1.6 kilometer] N. from Safe Harbor.
1705	Mica schist with imbedded crystals,	Half a mile N. W. of Cully's Station, C. and P. D. R. R. (See analysis),
1706	Hard siliceous mica slate with seams of quartz,	Peach Bottom Quarry, Lancaster Co.
1707	Gneiss,	S. E. border of trap dyke, 20 meters above R. R., $\frac{1}{4}$ mile S. E. of Safe Harbor.
1708	Mica schist, with imbedded crystals,	2 miles N. W. of McCall's Ferry.
1709	Much decayed fissile, siliceous mica schist,	0.6 mile (1 kilometer) north of Safe Harbor.
1710	Trap intersecting mica schist,	328 yards S. E. of mouth of Conestoga.
1711	Chloritic hydro-mica schist,	$\frac{1}{2}$ mile N.W. of Peach Bottom quarry.
1712	Mica schist enclosing brown mineral,	Near Cully's Station, C. and P. D. R. R.
1713	Calcaroid hydro-mica slate,	55 yards S. E, of Strickler's Run, (1 mile S. E. of Columbia.)
1714	Gneissoid mica slate enclosing black crystals,	Cully's Station, C. and P. D. R. R.
1715	Trap boulder,	Opposite Mr. Seiple's house, Washington town.
1716	Quartzose slate,	98 yards S. E. of School House, river bank, Washington town, Lanc. Co.
1717	Impure limestone,	Half mile west of 3d mill dam, N. W. of Safe Harbor.
1718	Manganiferous (?) limonite,	$1\frac{1}{2}$ mile S. E. of Safe Harbor, Grubb's bank.
1719	Peach Bottom slate,	Peters' creek, Lancaster Co.

1720	Quartzite with white plates of quartz and small veins of limonite, ...	85 yards S. E. of Chikis furnace.
1721	Quartz with imbedded crystal,	Taken from Chikis anticlinal, by Prof. S. S. Haldeman.
1722	Clay from Musser's brick clay bank, ...	109 yards S. E. of Shock's Mill Station, P. R. R.
1723	Brick from clay, ...	Musser's brickyard. (As above.)
1724	Ripple marked calcareous slate,	One mile S. E. of Bainbridge.
1725	Trap from dyke on R. R., . .	Just N. W. of Keller's trap quarry, half a mile from Collins', and the same from Falmouth Station, P. R. R.
1726	Trap, ...	Keller's quarry. (See preceding.)
1727	Trap, ...	Outcrop on R. R., just N. W. of Collins' Station, and S. E. of Keller's quarry.
1728	Hard rock resembling limestone in the quarry, ...	Falmouth Station, 4 miles N. W. of Bainbridge.
1729	Magnetic Iron Ore, ...	Limestone Hill. near Jno. Haldeman's, close by trap dyke, which forms its nucleus, 5 miles N. W. of Marietta.
1730	Indurated sand rock, ...	Falmouth Station, 50 meters E. of same, (195½ miles from Philadelphia.)
1731	Botryoidal stalactitic iron ore,	E.B.Grubb, and Haldeman's (Chestnut Hill) ore bank.
1732	Stalac. Limonite, and Göthite,	C. B. Grubb's Mine, Chestnut Hill, Lancaster County.
1733	Bomb of limonite, ...	C. B. Grubb's Mine, Chestnut Hill, Lancaster county.
1734	Red clay (strike about E.,) . .	C. B. Grubb's bank,
1735	Hollow kidney shaped nucleus of bomb 9 inches in diam., .	C. B. Grubb's ore mine.
1736	Göthite, etc., and Glance Iron Ore, ...	C. B. Grubb's bank, Chestnut Hill ore bank.
1737	Bombs of limonite, ...	C. B. Grubb's Chestnut Hill bank.
1738	Quartz slate, ...	Bottom of 70 ft. shaft, "Rock Shaft," Chestnut Hill.
1739	Magnetic micaceous iron ore in place, ...	6½ yards S. E. of Rock Shaft, Ch. H. Min. Co.
1740	Hydro-micaceous quartz slate from Rock shaft, ...	Ch. Hill Min. Co.'s bank.
1741	Micaceous slightly magnetic ore, ...	Dividing ridge, (Ch. H. M. Co.'s bank.)
1742	Red Iron Oxide (Float Ore,) .	South of middle part of Ch. H. M. Co.' bank.
1743	Float Ore, partly red hematite,	Middle part of Ch. H. Min. Co.
1744	Friable brown quartz sandstone, ...	Dividing ridge Ch. H. M. Co., in same hillas Rock Shaft, and 109 yards from N.
1745	*Scolithus linearis*, ...	Chikis Rock, Lanc. Co., Pa.
1746	Specular Iron Ore, in quartzite,	Chikis Rock, (Prof. S. S. Haldeman.)
1747	Milk quartz with fragments of calcareous slate with some Pyrite, Specular iron ore, and some copper ore associated with trap dyke,	Sent to Prof. S. S. Haldeman by Mr. Wylie, of "Haldeman's Riffles."
1748	Best limestone from middle of Haldeman's,* N. quarry.	Haldeman's N., quarry, Chikis.

* See analysis in preceding chapter

1749	Worst limestone from middle of Haldeman's N. quarry,* .	Haldeman's N. quarry, Chikis.
1750	Limestone, blue and hard, Specimen of best,*	Haldeman's South quarry, Chikis.
1751	Sandy limestone,*	N. end of N. quarry, Chikis, (Haldeman's.)
1752	Massive slate of best quality,*	Jno. Humphreys' quarry, York Co., Pa.
1753	Mica schist intersected with quartz veins, ...	Half mile N. W. of Cooney's hotel.
1754	Chloritic slate, Quartz and Margarite, ...	Williams & Co.'s slate quarry, one mile S. W. of Delta, York county, Pa.
1755	Serpentine, ...	Quarry just S. W. of main shaft, Harford county, Md., 5 miles S. E. Peach Bottom Ferry.
1756	Magnetite occurring with Serpentine, ...	N. E. of Serpentine quarry, 5 miles S. E. of Peach Bottom Ferry.
1757	Serpentine and Steatite, . . .	Harford county, Md., Quarry 5 miles S. E. of Peach Bottom Ferry.
1757*a*	Serpentine and Steatite. .	Excavation S. W. of main shaft.
1758	Magnetic Iron Ore, (siliceous, Bi-polar,)	Mouth of Serpentine quarry, 5 miles S. E. of Peach Bottom Ferry.
1759	Smallest size Peach Bottom, slate,	E. of West Bangor, York county, Pa., Jno. Humphrey's slate quarry.
1760	Trap with the enclosing rocks,	Williamson's Point (Wm. M. Lee,)
1761	Serpentine, Steatite, Magnetite &c.	W. H. Spence's farm, 3½ miles E. of Peters' creek, Fulton T.
1762	Magnetite in quartz from loose specimens in the field, . .	Near Grand Templars' Springvale Lodge, Drumore township, Lancaster County.
1763	Magnetite found loose in field,	2 miles W. of Buck P. O.
1764	White hydro-micaceous sandy slate adjacent to Peach Bottom slate ridge, ...	109 yards S. E. of McClenahan's slate quarry.
1765	Green, sandy mica schist, . . .	Penrose's (now Hess's) mill, Fishing Creek, Lancaster county.
1766	Göthite, ...	Eshleman's house, 2 miles west of Buck P. O.
1767	Green mica schist, Fuchsite (?) chlorite schist, ...	Eshleman's farm, 2 miles W. of Buck P. O.
1768	Wavy argillaceous slate, . . .	McClenahan's (Peach Bottom) slate quarry, near Fairfield.
1769	Pyrolusite (?) and limonite. Surface specimen, ...	G. Lamborn's place, ⅛ mile E. of N. of his house.
1770	Hematite, ...	Eshleman's farm, 2 miles W. Buck P. O.
1771	Green mica schist with decomposed feldspar,	Penrose's (Hess's) mill, 1½ miles W. of Chestnut Level.
1772	Serpentine, Steatite, &c., . .	A. Flaherty's opening, 2½ miles S. E. of Peters' creek.
1773	Serpentine, Mamillary Quartz, Steatite, Magnetite, &c., . .	Boyce's farm, 1½ miles E. of S. of New Texas, Fulton township, Lancaster County.
1774	Testaceous and sandy Limonite,	Eckman and Patterson's mine, Providence township, Lancaster County, 1½ miles S. of New Providence.

* See analysis in preceding chapter.

1775	Ferruginous Gneiss and geodes containing gneiss dust, .	Cabeen's mine, 1½ miles N. W. of Quarryville, Eden township, Lancaster Co.
1776	Ferruginous mica schists, geodes with mica dust inside,	New Providence village, (Prov.tp.,) back of Merchants' hotel.
1777	Ferruginous mica schist, limonite,	New Prov. village, (Prov. tp.,) back of hotel.
1778	Conglomerate of limpid quartz in brown limestone, ·	Opposite Joseph Hopkins' house, half mile E. of Comargo P. O., Eden tp.
1779	Testaceous limonite and ferruginous gneiss from dump pile alongside bank,	Mowrer's farm, 1 mile S. W. New Prov., Prov. tp.
1780	Micaceous crystalline limestone from pit 50 ft. below surface,	Eckman & Patterson's mine, alongside barn of Silas Winters, 1½ miles S. of New Prov.
1781	Ferruginous mica schist limonite,	Peacock mine, behind barn, New Prov. village.
1782	Limonite and septated and laminated quartz,	Cabeen's mine, 1½ miles N. W. of Quarryville, Eden tp.
1783	Limonite, ferruginous, gneiss, etc., and geodes. Septated ore,	Cabeen's mine, 1½ miles N. W. of Quarryville.
1784	Picrolite, ...	Wood's mine.
1785	Brucite, ...	Wood's mine.
1786	Magnetite, ...	Wood's mine.
1787	Williamsite, ...	Wood's mine.
1788	Brucite on Chromite, ...	Wood's mine.
1789	Minute mamillary Zaratite, . .	Wood's mine.
1790	Chromite, ...	Wood's mine.
1791	Chromite and Zaratite, ...	Wood's mine.
1792	Serpentine, Brucite, &c., . . .	Wood's mine.
1793	*Missing*, ...	Wood's mine.
1794	Brucite, ...	Wood's mine.
1795	Brucite, ...	Wood's mine.
1796	Chromite, ...	Wood's mine.
1797	Chromite, ...	Wood's mine.
1798	Zaratite and Chromite, ...	Wood's mine.
1799	"Lancasterite" or Hydromagnesite;	Wood's mine.
1800	Chrome sand, ...	Black Bottom Branch, near Wood's mine.
1801	Picrolite, ...	Wood's mine.
1802	Serpentine, Mangetite, Steatite, Zaratite, etc., ...	Line Pit and Low's Mine.
1803	Pebbles of Oneida conglomerate, (?) (drift), (?)	Blake's graveyard. Fork of roads between Griffin Stubbs and Louis Haines, Fulton Tp.
1804	Banded Jasper, ...	Bed of Rock Spring run, Fulton Tp.
1805	Rock out of which Rock Spring issues. Rotten Serpentine, .	Rock Spring, Fulton township.
1806	Trap,*	Williamson's Point, 1¼ miles N. of State Line, Col. and Pt. Dep. R. R.
1807	Trap cutting off ore, ...	West face of Grassy Hill, Cornwall.
1808	Trap, ...	N. W. bounding wall of Middle Hill. N. bounding wall 185 feet above water level. Cornwall, Leb. co.
1809	Trap, ...	Trough cut of Middle Hill. Dyke in middle of ore. Cornwall, Leb. co.

* See preceding chapter.

1810	Fine grained trap, ...	First bench of Big Hill, (in midst of ore) Cornwall, Leb. co.
1811	Limestone, dipping ± N. W. and intersected with small veins of ore,	Sand slide south of Middle Hill. do.
1812	Dendritic markings on limestone, ...	Cornwall ore bank, among ore.
1813	Limestone, ...	?
1814	Crystalline limestone.	Cornwall ore mine,
1815	Serpentine in limestone, . .	Cornwall ore mine.
1816	Specimen of No. 1 ore. Free from S. and usually soft, . .	S. W. of Middle Hill, and 54 yards E. of hole No. 4.
1817	Seam of impure limestone with crystals of magnetite,	Sand slide south of Middle Hill.
1818	Chalcocite in ore, ...	Big Hill, Cornwall.
1819	Coarse grained trap boulder, .	In front of office, Cornwall.
1820	Filamentous limestone and coating, ...	New heading of Middle Hill.
1821	Asbestus in place, ...	Near level between Middle and Grassy Hills.
1822	Rusty filamentous limestone with efflorescence, ...	Near level between Middle and Grassy Hills.
1823	Serpentine in limestone, . . .	Ravine between Middle and Grassy Hills.
1824	Concretionary quartz from clay bank, ...	Cut near west base of Middle Hill.
1825	"Nigger head" ore, . .	E. face of Grassy Hill.
1826	Chloritic rock with slickensides,	N. face of E. base of Middle Hill.
1827	Coarse grained dolerite, . . .	N. W. face of Middle Hill.
1828	?.	
1829	Trap, ...	Island of Rip Rap in middle of river, ±875 yards below Safe Harbor.
1830	Trap, ...	Island of Rip Rap in middle of river, ±875 yards below Safe Harbor.
1831	Trap, ...	±437 yards S. of S. W. tavern, in Millersville.
1832	Hard crystallized gneissic rock,	=1.2 kilometers (¾ mile) S. of New Texas, banks of Conewingo.
1833	Vein matter intersecting the sculptured rocks,	Miles Island, 800 meters (½ mile) S. E. of Black Friar Hotel; middle of Susquehanna river, Md.
1834	Anthophyllite (?) slate, . . .	J. Bowman's island, near Sculptured rocks in Susquehanna river, 875 yards S. E. of Bald Friars, Md.
1835	Anthophyllite (?) with pits containing iron oxide,	2d island in Rip Rap from Cecil county, Md., shore, 875 yards (½ mile) S. E. Bald Friars.
1836	Anthophyllite (?) vein intersecting the pictured rocks, .	Miles' Island. (As above.)
1837	Steatite intercalated between rocks, ...	White Rock, Little Britain township. Presented by Mr. Alexander, of Oxford, Chester county.
1838	Vein matter filling clefts, (slickensides).	Sculptured rocks, ±½ miles S. E. of Bald Friars.
1839	Anthophyllite (?) dyke on which are Indian sculptures,	Miles' Island, middle of Susquehanna river, 1½ mile S. E. of Bald Friars.
1840	Anthophyllite (?) rock, . . .	Island 219 yards from shore.
1841	Anthophyllite, ?	±875 yards (½ mile) S. E. of Bald Friars Hotel. Miles Island.
1842	Syenite, (?)	Miles Island, 875 yards S. E. of Bald Friars.
1843	Trap from one of large boulders,	± Half a mile E. of Goodville, East Earl township, Lancaster county.
1844	Trap from one of large number of fragments strewn around,	Brickerville, at first cross road N. W. of the village, Elizabeth Tp., Lan. Co.

1845	Trap, ...	Kurtz's limestone quarry, 437 yards N. W. of Salisbury P. O., Sal. tp., Lanc. Co.	
1846	Chloritic mica slate with pyrite and chalco pyrite,	Shaft on Maxwell's farm, ¾ mile W. of Gap Station.	
1847	Trap from large unweathered boulder,	219 yards N. of Pequea town mill dam, Salisbury tp., Lanc. Co.	
1848	Fragments of trap from dyke crossing,	±437 yards N. W. of Salisbury P. O., Sal. tp., Lanc. Co.	
1849	Hornblende, main shaft, 130 ft. below day,	Gap mine.	
1850	Hornblende rock, ...	Gap mine near main shaft, 130 ft. below day.	
1851	Trap, ...	Sam'l McClure's, Bart tp., N. E. of Gap mine.	
1852	Millerite, ...	Gap mine. Heading now wrought.	
1853	Mica schist, ...	From block taken from platform wall of engine house, main shaft, Gap mine. Said by Mr. Doble to have been taken from main shaft.	
1854	Quartz, Feldspar and chloritic mica schist,	1313 yards S. W. of Gap Station.	
1855	Limestone made crystalline from vicinity of trap,	±1 mile West of Gap Station.	
1856	Fragment of unweathered trap,	± ½ mile West of Spring Garden, Salisbury tp., Lanc. Co.	
1857	Copper and Nickel matte, .	Gap smelting works, Lanc. Co. Paradise tp.	
1858	Native copper, (rare), ...	Gap mine.	Presented by Capt. Doble.
1859	Pyrite, ...	Gap mine.	
1860	Hornblende, nodule and Pyrite in nickel ore, ...	Gap mine.	
1861	Hornblende from 60 ft. level, .	Gap mine.	
1862	Vivianite, Siderite, Chalcopyrite, and Nickel ore on hornblendic slate,	Gap mine.	
1863	Millerite, ...	Gap mine.	
1864	Millerite in hornblendic slate,	Gap mine.	
1865	Millerite, ...	Gap mine.	
1866	Millerite, (large specimen), .	Gap mine.	
1867	Siderite, ...	Gap mine.	
1868	Pseudomorph of quartz after Calcite,	Gap mine.	
1869	Mica schist, south wall of vein. 110 ft. level and 3 ft. south of vein,	Gap mine.	
1870	Hornblendic gneiss, south wall of vein. 110 ft. level and 30 ft. south of vein,	Gap mine.	
1871	Chalcopyrite, ...	Gap mine.	
1872	Nickel pyrite, magnetic, . .	Gap mine.	
1873	Hornblende with specks of ore in it from the 200 ft. level,	Gap mine.	
1874	Nickel ore, non-magnetic. Generally found near the wall or side rock, ...	Gap mine.	
1875	Pyrite. Hexahedra combined with octahedra and rhombic dodecahedra,	Boyce Farm, 1½ miles from New Texas, Fulton tp., L. Co.	
1876	Ripidolite, ...	Wood's mine, Little Britain tp., L. Co.	
1877	Hemitropes of magnetite, . .	Pleasant Grove. Presented by B. Haines.	
1878	Icosihedra and truncated hexahedra of pyrite,	Boyce Farm, 1½ miles from New Texas.	

1879	Fragment of oolitic limestone from mile stone of Mason & Dixon's line,	Near Line Pit.
1880	Chromite with Brucite and Aragonite,	Wood's mine.
1881	Brucite and Chromite, ...	Wood's mine. 2 specimens.
1882	Clinochlore on Chromite, . .	Wood's mine.
1883	Deweylite, ...	Wood's mine.
1884	Zaratite, ...	Wood's mine.
1885	Deweylite, (very pure,) . . .	Wood's mine.
1886	Brucite on Chromite, ...	Wood's mine.
1887	Hydromagnesite, Zaratite, . .	Wood's mine.
1888	Limonite and Göthite, . . .	Chestnut Hill. Mining Co.'s bank.
1889	Limonite, in part stalactitic and Göthite, ...	Chestnut Hill. Mining Co.'s bank.
1890	Limonite bomb with stalactites,	Chestnut Hill. Mining Co.'s bank.
1891	Stalactites with Göthite, . . .	Chestnut Hill. Mining Co.'s bank.
1892	Limonite, stalactitic and botryoidal, ...	Chestnut Hill. Mining Co.'s bank.
1893	Peach Bottom slates, largest sizes,	Brown's slate quarry, Peach Bottom, near, mouth Peter's creek Lancaster Co.
1894	Stalactites of limonite, ...	Chestnut Hill mines, Lancaster Co.
1895	Piece of oolitic limestone, . . .	Mason and Dixon mile stones.
1896	Magnetite in Chlorite, ...	Ramsey's serpentine mine, Harford Co., Md.
1897	Greenish quartzose sand rock,	Williamson's Point, $\pm 1\frac{1}{2}$ miles above Md. Line.
1898	Chloritic vein, ...	Intersecting quartzose, micaceous sandstone, $\pm$600 ft. N. W. of the State Line C. & P. D. R. R.
1899	Dyke of trap,*	Williamson's Point, $\pm 1\frac{1}{2}$ miles N. of Md. line, left bank of Susquehanna river.

*See preceding chapter.

2. Specimens collected in the South Mountain in 1875 by A. E. Lehman Topographical Assistant.

Nos.	Character.	Locality.
1900	Mountain Creek rock, ...	Rocky Ridge, $3\frac{1}{2}$ miles N. E. of Mt. Alto.
1901	Quartzite with Scolithus fragments.	Poke Hill, Franklin co., opposite Shippensburg.
1902	Fine-grained schist. Orthofelsitic (?).	Head of Raccoon creek, South of Caledonia.
1903	Greenish quartzose schist, fine-grained.	Rocky Ridge, 3 miles N. E. of Mt. Alto.
1904	Mountain Creek rock, peculiar weathering.	Stumps run. S. E. of Greenwood.
1905	Massive quartzite, ...	"White Rocks," 2 miles N. E. of Mt. Alto.
1906	Quartz conglomerate, ...	"White Rocks."
1907	Limonite, ...	Near Greenwood, East.
1908	Brownish quartzite, ...	White Rock Ridge, 2 miles South of Greenwood.
1909	Quartzose sandstone, ...	"White Rock" Gap, 2 miles S. from Greenwood.

1910	Float limonite ore, ...	White Rock Gap.
1911	Quartzite, curved fracture, . .	"White Rock" Gap.
1912	"Copper rock," (Epidotic Rock (?)).	Raccoon creek hollow, 3 miles S. of Caledonia.
1913	Orthofelsite porphyry, much weathered, with Quartz.	Raccoon creek, 3 miles S. of Caledonia.
1914	Weathered limestone, ...	In road to Pinch-Gut, 3 miles S. of Caledonia.
1915	Ferruginous rock, ...	Hosacks run, 2 miles North of Caledonia.
1916	Laminated quartzite, ...	Mouth of Deer Hollow, 3 miles N. of Caledonia.
1917	Ferruginous sandstone, . . .	1 mile N. of Graeffenburg.
1918	Limestone, ...	¾ mile S. W. of Mt. Alto.
1919	Float limonite, ...	¾ mile S. W. of Mt. Alto.
1920	Sandy ore containing grains of quartz.	¾ mile S. W. of Mt. Alto.
1921	Limonite, ...	Douglas' mine.
1922	White quartzose sandstone, . .	Douglas' mine.
1923	Argillite, ...	Foot of mountains East from Quincy.
1924	Quartzose sandstone, ...	In Hollow, 1½ miles East from Tomstown.
1925	Limonite, ...	Shaft of Douglas' mine.
1926	Quartzite with Scolithus, . . .	Antietam creek, 2¼ miles N. E. of White Mills.
1927	Limonite, ...	Douglas' mine.
1928	Mountain creek rock, ...	Antietam creek, 4 miles N. E. White Mills.
1929	Quartzite, ...	4 miles N. E. White Mills.
1930	Orthofelsite porphyry, ...	4½ miles N. E. White Mills.
1931	Chloritic rock with chloritoid,	Missing, ±6 miles N. E. White Mills.
1932	Schistose, "Green stone." (?) .	2 miles South West of Cold Springs, on Antietam creek.
1933	"Green stone,"	2 miles South West of Cold Springs, on Antietam creek.
1934	Soft sandstone, ...	3 miles S. E. of Mt, Alto.
1935	Ferruginous rock, ...	¾ mile S. E. of Tartown.
1936	Quartzose schist, soft, ...	2 miles S. E. Mt. Alto.
1937	Rippled limestone, ...	Quincy.
1938	Quartzose sandstone, ...	Old Forge, Antietam creek.
1939	Argillaceous mica schist, . . .	Mt. Alto Park, 2 miles ± E. of Mt. Alto.
1940	Milky quartz containing weathered chlorite slate.	Mount Alto Park, 2 miles E. of Mt. Alto.
1941	M. C. rock, with cap of milky quartz.	Buzzards Peak, 2 miles W. of Caledonia Springs.
1942	Milky quartz, ...	S. E. slope Buzzards Peak.
1943	Quartzite, with curved fracture,	Snowy Mountain, S. E. slope.
1944	Quartzose slate, ...	Buzzards Peak, S. E. slope.
1945	Orthofelsite, ...	Antietam creek, 5 miles N. E. White Mills.
1946	Fine schistose rock, ...	Buzzards Peak, 2½ miles S. W. Caledonia Springs.
1947	Brown, ferruginous, finely laminated sandstone, containing iron ore.	Foot of Mt. S. E. Tomstown ½ mile.
1948	Chlorite slate, milky quartz and Orthofelsite, (?), ...	N. E. slope Snowy Mountain, 2 miles E. Caledonia Springs.
1949	Orthofelsite porphyry, ...	1 mile W. of Caledonia Springs.
1950	Micaceous iron ore and milky quartz.	Baker's farm, ¾ mile W. Caledonia Springs.
1951	Porphyritic Orthofelsite, . . .	¼ mile S. W. from Caledonia Springs.
1952	Orthofelsite (?) containing small grains of micaceous iron.	¼ mile S. W. from Caledonia Springs.

1953	Coarse-grained M. C.* rock, .	Antietam creek, ¾ mile N. from "Old Forge."
1954	Quartzite and milky quartz with coating of iron ore.	1 mile South from Mount Alto.
1955	Red quartzose sandstone coated with a layer of quartz.	1½ miles S. of Mount Alto.
1956	Ore and sandstone conglomerate.	1½ miles S. E. from Tartown.
1957	Ferruginous slate, ...	1½ miles S. E. from Tartown.
1958	Limonite, ...	Hoves' farm, Antietam creek.
1959	Lean limonite, ...	1 mile S. W. of Old Forge.
1960	M. C. rock, ...	3 miles S. E. of Quincy.
1961	Fine-grained quartzite, ...	Peaceacres Gap, 3 miles S. E. of Quincy.
1962	Float limonite, ...	1 mile East of Quincy.
1963	Calcareous shale, ...	½ mile East of Quincy.
1964	Fine-grained quartzite, ...	1 mile West of Old Forge.
1965	Limestone, ...	Old Rolling-mill, Antietam creek.
1966	Limestone, ...	5 miles N. of E. from Waynesboro'.
1967	Limestone, ...	5 miles N. of E. from Waynesboro'.
1968	Quartzite and Chlorite with quartz,	5 miles East from Waynesboro'.
1969	Impure limestone, ...	4 miles S. E. from Waynesboro'.
1970	Red quartz, ...	1 mile S. from Waterloo.
1971	Cavernous arenaceous finely laminated slate.	Half mile S. E. from Waterloo.
1972	Fine-grained sandy slate, . . .	2 miles S. E. of Hopewell Mills.
1973	Quartzite in place, ...	2 miles S. E. of Hopewell Mills.
1974	Coarse-grained quartzite, . . .	2 miles N. W. of Monterey.
1975	Orthofelsite porphyry, ...	2 miles N. of Monterey.
1976	Orthofelsite porphyry, ...	2 miles N. from Monterey.
1977	Hydro mica slate, ...	2½ miles N. from Monterey.
1978	"Copper rock," (Epidotic Rock (?)).	4 miles N. E. from Monterey.
1979	Orthofelsite, ...	3 miles N. W. from Fairfield.
1980	Diabase, (?), ...	1½ miles N. W. from Fairfield.
1981	Chlorite slate, ...	1½ miles N. W. from Fairfield.
1982	Quartz containing micaceous iron ore.	1 mile N. W. from Fairfield.
1983	Decomposed Orthofelsite, . .	1 mile N. W. from Fairfield.
1984	Fine-grained quartzite containing iron.	1½ miles W. of Fairfield.
1985	Quartzgrains in epidotic matrix,	2 miles S. of W. from Fairfield.
1986	Porphyritic "copper-rock," epidotic.	2 miles S. of W. from Fairfield.
1987	Conglomerate limestone, . . .	3 miles S. W. from Fairfield.
1988	Sandy calcareous mesozoic shale.	3 miles S. W. from Fairfield.
1989	Triassic conglomerate limestone.	2½ miles S. W. from Fairfield.
1990	Sandy schist, ...	2½ miles S. W. from Fairfield.
1991	Fine-grained chlorite rock, . .	3 miles S. W. from Fairfield.
1992	Quartz conglomerate, ...	3 miles S. W. from Fairfiold.
1993	"Chloritic" rock, ...	2½ miles S. W. of Fairfield.
1994	Epidotic chlorite, ...	2½ miles S. W. of Fairfield.
1995	Chlorite slate, ...	3½ miles S. W. of Fairfield.
1996	Chlorite rock, ...	Mary's Hill, 3 miles N. W. of Fairfield.
1997	Argillite, ...	2½ miles N. W. from Monterey.
1998	Hydro mica schist, chloritic, .	2½ miles S. of W. from Fairfield.
1999	Sandy clay, ...	Mary's Hill, 3½ miles N. W. from Fairfield.
2000	Chlorite schist and Quartz (?),	Mary's Hill, 3½ miles N. W. from Fairfield.

"*Mountain Creek."

2001	Quartzose slate,	"Vineyard," 4½ miles N. E. from Waynesboro'.
2002	Medina sandstone, (?), loose fragments.	"Vineyard," 4½ miles N. E. from Waynesboro'.
2003	Medina sandstone, (?), loose.	"Vineyard," 4½ miles N. E. from Waynesboro'.
2004	Quartzose sandstone capped with milk Quartz.	"Vineyard," 4½ miles N. E. from Waynesboro'.
2005	Arenaceous chlorite slate, (?),	"Vineyard" Ravine, 4½ miles N. E. Waynesboro'.
2006	Quartzite containing a fine specimen of scolithus.	Antietam creek, "Vineyard" ravine, 5 miles N. E. of Waynesboro'.
2007	Laminated argillite,	1 mile S. W. of Cashtown.
2008	"Copper rock," milk Quartz and fibrous green Quartz.	4 miles S. W. from Cashtown at Poplar Spring.
2009	Orthofelsite,	4 miles S. W. from Cashtown at Poplar Spring.
2010	Epidote (?),	Poplar Spring, 4½ miles S. W. of Cashtown.
2011	Orthofelsite,	3 miles S. of Cashtown.
2012	Porphyritic Orthofelsite, bleached.	3 miles S. of Cashtown.
2013	Orthofelsite,	3 miles S. of Cashtown.
2014	"Copper rock,"	3 miles S. of Cashtown.
2015	Hydro-mica schist,	3 miles S. of Cashtown.
2016	Argillite,	3 miles S. of Cashtown.
2017	Quartz conglomerate,	2½ miles S. W. from Fairfield.
2018	Epedotic rock,	2½ miles S. W. from Cashtown.
2019	"Copper rock" containing milky quartz and epidote.	3½ miles S. W. from Cashtown.
2020	Float iron ore,	1½ miles S. W. from Cashtown.

Some further specimens collected by Assistant Geologist.

2021	Limonite bomb,	C. B. Grubb's bank, Chestnut Hill, Lanc. Co.
2022	Limonite bomb.	C. B. Grubb's bank, Chestnut Hill, Lanc. Co.
2023	Crystallized hematite,	C. B. Grubb's mine, Chestnut Hill, Lanc. Co.
2024	Testaceous limonite and ferruginous gneiss.	G. Mowrer's mine, ±1 mile S. W. of New Providence.
2026	Indian stone arrow heads,	Mt. Johnson Island, opposite Peach Bottom slate quarry.
2027	Stalactites of calcareous matter,	Viaduct "Tape Worm" R. R., 3 miles N. of Fairfield.
2028	Hydro-magnesite on Chromite,	Wood's mine.
2029	Deweylite,	Wood's mine.
2030	Garnets,	Underwood's mill, ±1 mile from Dillsburg, York Co.
2031	Native copper,	Near Bigham's house. Phila. Co.'s mine, ±3½ miles N. by E. of Monterey Springs, Adams Co.
2032	Lignite,	J. Liver's place, Mt. Pleasant tp., Adams Co.
2033	Concretion of slate,	Gotherd's tunnel, ½ mile N. E. of Franklin Furnace.
2034	Quartzite with white plates of quartz and vein of limonite.	Henry Clay Furnace, Lan. Co.
2035	Manganiferous(?) ochre,	½ mile E. by N. of Lamborn's house.
2036	Slaty limestone,	1700 ft. South of Susquehanna Rolling-mill, on C. & P. D. R. R.
2037	Limestone and slate,	1200 ft. S. of Susq. Rol. mill.
2037	Limestone slate,	2000 ft. ditto.
2038	Slaty limestone,	2100 ft. ditto.
2039	Limestone slate,	2900 ft. ditto.
2040	Slaty limestone,	3400 ft. ditto.

2041	Slaty limestone, ...	3250 ft. ditto.
2042	Limestone slate, ...	4550 ft. ditto.
2043	Hydro-mica schist, ...	5000 ft. ditto.
2044	Hydro-mica schist, ...	5200 ft. ditto.
2045	Hydro-mica schist, ...	6450 ft. ditto.
2046	Hydro-mica schist.	9060 ft. ditto.
2047	Chloritic mica schist beside mica schist.	Robt. Wood, Little Britain tp., Lancaster Co.
2048	Chloritic mica schist, ...	Crossing of Md. line by C. & P. D. R. R. line.
2049	Feldspar dyke, ...	Haines' land, ±1½ miles S. of Pleasant Grove, Lan. Co. In Maryland near Bald Friars.
2050	Chrysotile Picrolite and mica schist.	1 mile E. of New Texas.
2051	Quartz film on weathered rock,	Bald Hills, Haines' land, Md.
2052	Chloritic mica schist, ...	
2053	Chloritic schist, ...	1 mile west of Spring Hill, Little Br. tp.
2054	Dolerite, ...	"Fulton House," Lanc. Co.
2055	Chloritoid, ...	1 mile E. of New Texas, Sorghum Mill.
2056	Arenaceous chlorite schist, . .	Bed of Susquehanna river, opposite R. R. station 1394.
2057	Fine-grained quartzose sandstone,	⅜ mile South of Unicorn.
2058	Kyanite, (three specimens).	1 mile from Rawlinsville, Martic tp., Lan. co. (Presented by Dr. Stubbs.)
2059	Chrysotile and Picrolite, . . .	2 miles E. of Wakefield, Lan. Co. (Presented by Dr. Stubbs.)
2060	Feldspar, ...	1½ miles South of Pleasant Grove.
2061	Quartz Sinter with quartz films,	1½ miles South of Pleasant Grove.
2062	Chlorite, ...	½ mile N. of Md. line, C. & P. D. R.R.
2063	Dolerite, ...	Fulton House.

APPENDIX.

Some general notes on the occurrence of copper ores in a few well known localities in the United States.

The most extensive occurrence of copper in this country and in many respects the most remarkable in the world is in Lake Superior where enormous masses of argentiferous native copper have been laid bare. The junctions of igneous rocks with the sedimentary sandstones and shales appear to be the points at which copper is generally found, but this does not imply that all such planes of contact are cupriferous nor that any law has yet been established to show the true relations between the dykes and this metallic product. Sheets of copper have been uncovered which were estimated to weigh 200 tons,and crystals or grains of native silver have been noticed as accompanying it. Dana adds (Ed. 1875, p. 196): "The extent to which the rock and its cavities are penetrated and filled with copper shows that the metal must have been introduced by some process before the rock had cooled."

Under the head of Protozoic Rocks (Geol. Survey of Wisconsin, Iowa, and Minnesota, David Dale Owen, 1852, p. 53) it is stated that copper ore has been found between the Mississippi and the Kickapoo; not however in any connection with sandstone but on the contrary in a true magnesian limestone "possessing the characters usual in that formation throughout the lead and copper localities of the Mineral Point District yet belonging to an older division of the Protozoic rocks." It is light green, with waxy lustre and fracture, very brittle and disseminated through ferruginous earthy matter, composed principally of the brown oxide of iron.

The position of all these indicates that they were once included in a fissure of the magnesian limestone. Another copper mine similar to this was found three hundred yards north of the ore bed just described.

In Col. Whittlesey's portion of the same report (on the part of Wisconsin which borders the south shore of Lake Superior) some interesting remarks on copper veins are to be found from which the following excerpts are taken:

"In 1845 it was believed that the spar veins of the con glomerate were the most promising of any," (for copper).

"In 1846 the parallel veins were not known or if so, were not relied upon by explorers. The *perpendicular* or cross veins in the trap were then considered the only profitable sources of mineral. Most recently it has been ascertained that there were large masses of *unproductive* trap while formerly a location made on a trap range was considered good as a matter of course." * * * * *

"The indications that have attracted most attention from explorers are in the black trap next the conglomerate particularly at the Second Falls of the Montreal River, the Falls of the East Fork of Bad River and the Falls of Tyler's Fork. In Cornwall where veins pass from one rock to another the miner expects a rich deposit near the junction but here it is found not to be a hopeful sign." * *

"Copper doubtless exists in the quartz veins of the igneous rocks of the interior but as yet has been seen only in scattering specks."

Mr. Shumard in his report to Dr. Owen in the same work on the Barraboo river, etc., describes a locality of copper ore (Barry's copper diggings) about two miles N. W. of a ridge of "Siliceo-calcareous rock interstratified, containing green grains of silicate of iron; and on the top of which was a ferruginous pebbly sandstone" the whole making a cliff of three hundred and twenty-eight feet above Barraboo.

"The ore is an impure carbonate and silicate of copper with some copper pyrites very similar to that analyzed by Dr. Owen from Kickapoo," (which had 19.87 p. c. metallic copper).

Three miles from Adams the same observer finds the rock on this same river (the Barraboo) to consist of altered sandstones and quartzite the former passing from a coarse brown sandstone to a flinty quartzite. On the top of the ridge first mentioned in a ferruginous pebbly sandstone some fossils were discoverable but with the exception of a Bellerophon none were determinable.

This Bellerophon is a "Lower Silurian"* fossil, but until the relations between the copper veins and the rocks they intersect are known, it will be impossible to base any conclusion on the age of the latter, even if satisfactorily determined; for Prof. Dana hazards the conjecture that the copper which occurs so abundantly in this part of America, may have come up with the igneous rocks from some portion of the earth's interior. On the geological map accompanying this report the north shore of Lake Superior is represented as surrounded by a zone of alternations of schists, slates and sandstones with volcanic grits and other bedded traps and porphyries in which numerous dykes of greenstone (Diabase ?) occur so frequently as to give the whole formation a mottled appearance.

Copper Ores in New Jersey.

Copper is not an unusual companion of the iron minerals—usually as chalcopyrite or malachite—but in Pennsylvania, the principal horizons where copper is to be sought, are in the Huronian series, and the New Red Sandstone. This latter formation has furnished copper minerals very generally in the States where it occurs (Connecticut, New Jersey, Pennsylvania, etc.) chiefly as copper glance (or chalcocite), bornite (or erubescite), chalcopyrite (or copper pyrites), and malachite (Dana). Besides these Prof. Beck, of New Jersey, has published in Silliman's Journal other varieties which he has noticed.†

"*Native copper*, according to the last authority, is found in various places on the surface. Sp. gr. 7.553 to 7.842. One piece ploughed up near Somerville is more or less pure and weighs 78 lbs., and probably originally weighed much more.

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* Siluro-Cambrian. † Geology of New Jersey, 1868.

"A thin sheet of the metal is noticed in the City of New Brunswick in red shale. The thickness is $\frac{1}{16}$ to $\frac{1}{8}$ inch (about $\frac{1}{4}$ c m). An average specimen yielded 70 per cent. of pure copper.

"*Red oxide of copper* also occurs in the vicinity of New Brunswick, as well as near Somerville.

"A compound" (mixture?) of carbon and oxide of copper occurs at New Brunswick.

"*Gray sulphuret* is found, consisting of quartz and silica, copper and iron, from the altered shales of the new red sandstone; also chalcopyrite from the same locality."

Prof. Cook says of the copper ores of this formation:

"Copper is quite generally disseminated through the altered shales and sandstones along the trap ridges. Strings and pockets of ore are formed in the shales adjacent to the trap beds, occurring sometimes throughout the strata for a distance of several feet from the trap rocks. * * No regular ore beds or true veins have been found, the copper being irregularly diffused through the altered or indurated shales, instead of being confined by regular walls of rock, as is the case in true veins and ore beds."

Fourteen localities, apparently all in the Mesozoic sandstones, are mentioned by Prof. Cook, who adds that little copper ore has ever been discovered outside of this formation.

Some of the fissures in the Connecticut and New Jersey sandstones contain copper-glance, erubescite, and malachite. (See Dana, Ed. 1875.)

Copper pyrites, associated with the green and blue carbonate of copper (no doubt from the decomposition of the former mineral), has been found in the gneiss near Gardnersville, and on the east slope of the Jenny Jump Mountain.

The only other mine outside of the New Red Sandstone is the Pahaquarry mine, on the west slope of the Blue Kittatinny (our North) Mountain. The rock here is a light gray sandstone.

Dr. T. Sterry Hunt, in his chemical and geological essays, refers to a note of his on the copper deposits of the Blue

Ridge, which appeared in the *American Journal of Science and Art*, for October, 1873, in which the horizon of these deposits is placed among the White Mountain series. They are, therefore, disconnected from anything heretofore mentioned as occurring in Adams County, but have an important bearing on a series of copper developments shortly to be referred to. In this White Mountain series, Dr. Hunt places also the Ducktown copper mine.

As an occurrence of copper in No. 4 (or the Oneida or Shawangunk grit), similiar to that mentioned in Prof. Cook's Report of the Geology of New Jersey, may be mentioned the Ulster lead and copper mine near Redbridge, New York. The Ellenville and Shawangunk mines are similiar.

From the above citations it would appear that the horizons which alone have yielded copper in this country in profitable quantity, have been the Huronian (White Mountain), Oneida (No. 4), and Triassic beds. Of these but two are represented in Adams County, viz: the first and the last. Along with the hydromica slate upon which lies the Auroral limestone in York County, and in the southeast corner of Adams, frequent very pyritiferous horizons have been encountered, and along with the iron pyrites or pyrite, copper pyrites or chalcocite is not rare (see Report C, 1874, p. 15, etc.), but it is so sparsely distributed through any small area as not to be an object for profitable mining. These slates are probably of the same age as those which form a part of the South Mountain, and hence may perhaps be the analogues of the Ducktown and other cupriferous series in the Archæn rocks.

Mesozoic Copper Ore, Adams County.

The existence of copper in the shales and sandstones of the Mesozoic era has long been known, and many of the copper industries derive their material from such sources. The whole of the band of micaceous and specular iron ores which lies along the northwestern border of the New Red Sandstone is saturated with copper salts, and cupriferous strata are frequently found among the rocks of the central portions of the basin.

One of the latter recently discovered lies about five miles east of the town of Gettysburg, at the hamlet of Bonnaughton.*

About 300 yards south of Mr. Liver's house, in a field, is an excavation made in Sept. 1876. While cutting off the corn, numbers of outcrop specimens of malachite were observed strewn over the surface of the ground. The rocks here are very much broken. The most homogeneous of them consist of a red sandstone, which is hard and compact, regarded in large blocks, but the latter are intersected by innumerable cleavage planes.

The general dip is about N. W.—30°. The cupriferous strata are about one foot thick, while the clay and rocks both above and below this are much impregnated with copper. Some of the accompanying rocks appear to be calcareous, with small prisms of perfectly transparent quartz.

In the sandstone are pits showing the section of cubes of pyrite more or less hydroxidized.

The strike of these cupriferous measures seems to extend at least a mile on either side.

The portion which might be called a *bed vein* of copper ore was, as is said, about 1 foot thick. That is to say, that the decayed argillaceous material composing this foot was sufficiently green to render it worthy of being called an ore.

This seam was selected and averaged, and submitted to three determinations for the contained copper.

The following is the record:—

	p. c.
Insoluble siliceous residue,	79.73
Sesquioxide of iron present (over 5 p. c.),	not determined.
Copper by electrolysis,	2.65†

* Or "Bunnytown," as it is generally pronounced.

† While on this subject, it may not be inappropriate to say one word as to the readiest methods to determining copper. Of various methods of *indirect* determination, but one was selected (viz, that of Rose) for comparison with the results obtained by precipitation of metallic copper on a tared platinum dish. The results follow:

		p. c.	mean.
Cu	by Rose's method, *	2.55	2.53
	by Pfaf's method, †	2.40	
	by Luckow's method, ‡	2.65	

The difficulties experienced in the practical use of the second of these methods, when a large number of analyses are to be undertaken in a limited time, are very great. The solution of the zinc in a liquor strongly saturated with salts is slow and irregular; towards the close of the operation, small pieces of undissolved zinc are likely to be commingled with the granular copper, and not separated therefrom; if the solution be kept in contact with the deposited copper until the analyst is assured that the zinc is all dissolved, part of the copper is sure to go into solution.

For these reasons, one of the worst processes for rapid copper determination is the reduction of metallic copper by zinc in an acid solution. A modification, or rather a suite, to this process is that by Steinbeck, which, with another, took the prize offered by the Mansfield Copper Works.

It contains in dissolving the copper precipitated by zinc in nitric acid, and titring with cyanide of potassium.

For practical purposes, and whenever a battery is to be had, the electrolytic method seems more rapid and exact.

To recapitulate:

	1st.	2d.
Insoluble residue,	79.73	78.11
Iron sesquioxide,	over 5 p. c.	

Metallic copper, (Rose), 2.55; (Pfaf's), 2.40; (Luckow's), 2.65.

Mr. Mell's Copper Mine

On J. Baumgardner's property, about a mile and a half East by N. of Fairfield.

Within the filled up area once covered by the opening of a magnetic iron ore mine, which was used forty years ago for the Maria Furnace, there is a shaft sunk.

Within about two yards or meters of the foot of this shaft, in a drift extending about 26 ft.±S. 20° E. the hard and brittle sandstone dips N. 20° W.—22°.

The bed rock was struck about 3 ft. below the bottom of the present shaft. The deposit of cupriferous slates is about 18 inches thick at the bottom of the shaft.

The deposit lies more or less between the strata but there are strings of ore connecting the deposits together. Very little magnetite is now seen on the bottom.

At about 12 ft. above the bottom of the shaft another

* Precipitating in acid solution by sulph. hydric acid and igniting with excess of sulphur.
† Precipitating in acid solution by zinc. There was a slight loss of copper in this analysis.
‡ Precipitating by the battery in acid solution.

drift runs in S. W.±25 ft. on a slope. The entrance is on the west side of the shaft. There is at present a short slope of about 20 feet on the east side of the shaft and opposite the upper opening. This latter connects with an air hole.

In the upper drift is a quantity of magnetic iron ore in flaky masses.

About 40 ft. N. W. of this shaft is another shaft 40 ft. deep in which magnetic iron ore is passed through, but no copper is reached. Mr. Mell commenced work here about a year ago.

About 300 yards N. W. of this mine is a limestone quarry in limestone-conglomerate covered by shale. There appears to be little or no dip, the measures being here horizontal. But there is a slight indication of dip N. by W.

The deposit here seems to be similar to that at Mr. Liver's, and the specimens were principally impure masses of shales coated on the outside with malachite and more or less permeated with the salts of copper.

There is doubtless a connection between the occurrence of copper in the Mesozoic shales and the copper deposits in the adjacent Huronian series of the South Mountain, although there is now no conformity in strike lines of the two outcrops. It seems as if this deposit at least was among the upper or more recent layers of the Mesozoic series, both on account of its *apparent* position (*i. e.*, it lies on the north-western side of a basin in which the dips are throughout generally north-west) but also because of its proximity to the upper limestone conglomerate ("Potomac Marble"(?)), represented in a quarry only 300 or 400 yds. distant and of which the strata are nearly horizontal.

Musselman's Lower Mine

Lies on the side of the road which is the boundary between Hamiltonban and Liberty townships, and about 1½ miles S. W. of Fairfield.

The rock seems to be a green argillaceous sand rock. The dip is obscure, some indications being about E.—±48°(?) As in the last mine the presence of copper is indicated by the green stains on the cleavage and bed planes of the broken rock. It is not now in operation.

Between this exposure and the town of Fairfield which lies about $1\frac{1}{2}$ miles to the north-east there are several limestone quarries in the same conglomerate before noticed. One of these, a short distance S. W. of Fairfield, is a conglomerate of blue limestone and seems to dip E. 20°S—62°.

A quarry on the east fork of the road shows a dip of N. 20° W—80°. These dips are consistent with what has been elsewhere noticed of the structure of the Mesozoic strata, both on the N. W. and the S. E. margins of the space which it now fills. This structure is displayed in a series of dips more nearly vertical than those within the body of the formation, and, whatever their explanation, are excellent guides for placing those strata which form its upper or lower horizon.

These two copper ore localities lie nearly in a E. 30° N. line and about three miles apart. This line is very nearly parallel to the average trend of the South Mountain nearest adjacent to it and most likely marks the same horizon among the Mesozoic shales.

From the lower exposure of copper ore on the Musselman tract the road ascends steeply S. W. about half a mile over the neck of a promontory, which apparently connects the knob at its extremity with the main chain of the South Mountain to the west.

An old opening just over the Liberty township border is now almost entirely filled up, but the rocks seem to be composed of Orthofelsite, (both the finely laminated and the slaty varieties.) The prevailing characteristics being massiveness and the color purple.

Large quantities of dark green chlorite rock lie around but no rock is in place.

A couple of hundred yards south from this opening is the site of the old furnace which was dismantled forty years ago. Nothing satisfactory was observed of the cupriferous character of these rocks which, were it established, would entitle the deposit to be treated under the next following sub-heading.*

Huronian (?) Copper Ores.

But a far more interesting series of occurrences of copper ore is to be found inside the eastern bounding chain of the South Mountain, and extending from near Millerstown or Fairfield (Adams county) down to and beyond the Maryland line. This ore belt lies in the orthofelsite, which forms this portion of the chain.

This belt of cupriferous orthofelsites has not been extended further north-east at the present date (Nov. 1878) in continuous outcrop than the mines on the J. Musselman and Keilholtz properties, which lie within the South Mountain chain and about 2¾ miles W. 30° N. of the town of Fairfield.

Hence a practically continuous, and unusually well marked outcrop of these cupriferous strata extends through the valley and along the road connecting the properties marked on the Hamiltonban township map as D. B. Russell and J. Reed.

Here the line meets an abrupt knob which divides the valley into two branches, the one running out nearly due south as a ravine which heads up to the neck connecting Jack's Mountain with the main chain. The other passes into Franklin County and thence across its south eastern corner into Maryland.

A little south of the extreme point of this dividing knob and on the west side of the shorter ravine is the copper deposit of J. Bigham which is mentioned elsewhere.

About ⅔ mile east of south and near the summit of the aforementioned neck is the ore mine of J. Benchoff. In the extreme south-western corner of the township there are copper indications on the properties of W. Gladhill and W. Benchoff.

Further S. W. in the corner of the county, in a field east

* It may be incidentally noted here that specimens of galena are reported to have been found under the rocky débris in the eastermost ridge of the South Mountain, south of Fountaindale, on the property of Joseph Tressler.

of the Clermont Hotel, owned by Mr. David Miller, specimens of copper ore were obtained. The outcrop strikes the Maryland line on the farm of Mr. Chapman, passing through the Holmes' property.

The length of this outcrop above given is about six miles and its direction S. 30° W.

A short description of the principal localities where mining has been attempted here follows:

On the bed of the "Tape Worm" R. R. on Lewis Pittinger's place about ¼ mile N. E. from Washington Benchoff's house on the Emmettsburg turnpike the heading of an uncompleted rock cut displays a quantity of chrysotile. The rocks adjacent seem to be dark green argillaceous chloritic and epidotic masses of which the dip is E. 30° S.—20°. Quartz abounds in these rocks and the fibres themselves seem to be largely composed of it.

About thirty yards south of this exposure dark green chlorite schist with stains of copper dips S. 30° E.—45°.

This asbestiform exhibition is found to be one of the indications of copper belt and some of the numerous instances will be mentioned further on where they occur together.

At Lewis Benchoff's house chloritic and arenaceous rocks dip E. 30° S.—35°.

At the intersection of the county line by the turnpike green, arenaceous chloritic slate dips E. 30° S.—35°.

Washington Benchoff's Place.

At the upper of two localities visited an arenaceous sandy chloritic rock dips±S. E.—±48°.

The rock is deeply charged with salts of copper and appears to vary in character between serpentine and epidote, both of which seem to be represented here.

There are also numerous quartz veins between which and the country rock at the plane of contact are fine exhibitions of native copper in small nests.

Some specimens exhibit azurite and many of them chrysocolla.

About 300 yds. west of Mr. Gladhill's house and barn occurs epidotic rock saturated with copper.

John Benchoff's Place

Is on the elevated neck spoken of which connects the outlying spur with the main ridge. Many of the rock fragments strewn about over this place were of the usual epidotic character and others of a different appearance, viz: epidotic and sandy, but with blade like plates of quartz like the flat slabs of Labradorite ⅛ inch long by ¼ inch broad. Part of the component minerals were of translucent quartz. The ground character of the rocks here was chloritic and they were largely stained with copper salts.

A short distance south of the Maria furnace, Millerstown and Monterey Springs road, the "Mountain Creek Rock" or schistose conglomerate which forms the bulk of the South Mountain near the Maryland line, gives place eastwardly to a compact dark green chlorite schist, more or less streaked with white quartz, after which occur large fragments of blue orthofelsite porphyry streaked with small milk-quartz veins, and stained green by copper salts.

Joseph Bigham's Copper Mine.

Close to Joseph Bigham's house there is an opening for copper ore. The locality is 1¼ miles S. 30° E. from Daniel Snyder's farm, and ⅓ mile N. 30° W. of Christian Frizel's.

The excavation is about 13 ft. (four meters) square and 19.7 ft. (6 meters) deep following the slope of the rock.

The hanging wall of this mine is in orthofelsite porphyry stained with the salts of copper (chiefly malachite) and dips E. 20° S.—61°.

One cleavage plane dips S.±20°, and another on the opposite wall more steeply, or about±88°. The copper ore appears to follow down the joints.

Both foot wall and hanging wall are much weathered, and the continuation of the former on the strike shows the green copper stains for a considerable distance. Where foot and hanging walls are stained, the rock resembles, at a distance, eklogite.

A dip in an exposure to the west and in the strike of the middle of the deposit E. 15° S.—52°.

On the N. W. and south-east sides of the shaft the rock is an arenaceous quartzose rock containing slabs of feldspar and epidote. A jointage fracture seems to dip S. 20° W.—15°.

On the S. E. side of the shaft bedded green arenaceous rock with the appearance of porphyry dips about S. 45° E.—45°.

Forty years ago the mine was opened by George Thompson for the Philadelphia Company, of Philadelphia, who erected a furnace, extracted some ore, and smelted it. It was wrought about five or six months, and then abandoned. Since this nothing has been done. The old furnace was erected on 120 to 130 acres adjoining the former tract. As nearly as can be gathered from the description of the persons living near here, the furnace was a reverberatory.

Mr. Wm. F. Benchoff, of Franklin Co., cleaned out the excavation in the fall of 1876 to see the character of the rock. An analysis gave 4 per cent. of copper.

J. Reed's Farm, Pittsburg Co.'s Old Copper Mine,

Lies near an old saw mill and at the fork of Spring Run close by the fork of the road.

Forty years ago parties opened a shaft near J. Reed's house and saw mill. There is nothing visible to indicate the extent of the work then done. The rock is of the same general character as that examined.

Dr. Snively reports that veins of quartz intersect the rock and in the quartz small specks of native copper occur. Malachite stains also abound.

J. J. & D. Miller Copper Mine.

On the property of J. J. & D. Miller a shaft was sunk by a Pittsburgh company thirty years ago, but is now unworked. Mr. Wm. A. Tritel of Waynesboro' is said to have picked out a piece of native copper from the bottom of the pit as large as his head at 20 ft. below the surface.

In interpreting all comparisons of this indefinite nature great care must be exercised, but there is no inherent impossibility in the story if we assume this as indicating any ordinary size.

Mr. Joseph Watson says that his father had this mine first opened by Captain Ward for the Pittsburgh Company, which had opened a copper mine on the Snyder farm over thirty years ago.

The Snyder property was opened twenty-eight years ago; and Watson's, thirty years ago. The ore was taken out, boxed up, and sent to Gettysburg, whence it was forwarded to Philadelphia or Pittsburgh. It was actively wrought for about two years, when the lease ran out and the owner refused to sell.

There were two shafts; one about fifty feet, and another not quite so deep. A considerable quantity of ore was taken out, among which was distributed a great deal of pure copper. The ore was said to have been richest at about four feet from the bottom of the shaft.

Mr. D. B. Russel, of Waynesboro', has a copper mine about two miles N. E. of here, on the same part or the same ridge.

Parties are said to have followed the strike of this vein four miles S. W. from Russel's, *i. e.*, about two miles S. W. from here.

Some specimens of the green stained gangue have small crystals of native copper imbedded in them. Mr. Benchoff has found specimens of nearly pure copper weighing one or more pounds.

Mr. Russel bought about 500 acres of land, including the mine, in 1870; but has wrought it in a very imperfect and desultory way.*

Mr. A. Bechtel & Thos. Brown's Copper Opening,
(Examined Oct. 15, 1878,)

Is made on ground leased from D. B. Russell.

The dip seems to be E. 20° S.—40°.

Their opening is about 500 yards north of J. Watson's old house and was commenced July 1, 1878.

* Fall of 1876.

Mr. Bechtel commenced the excavation at the S. W. end of the present opening, from indications of Malachite and Red ore found on the surface. He ditched about 200 ft. east, thus crossing the measures.

The rock seems to be a dark green chlorite slate. The pit is down about six yards and three men are sinking lower by drilling.

The large blocks appear to be a sandy chlorite with epidote rock, of which the latter, according to Mr. Bechtel, contains 2 p. c. of copper.

Between the D. B. Russell and the Keilholtz properties is a hill known as Quartz Hill. The ground is covered with débris of milk quartz in large lumps.

Watson's mine is about two miles south-west of here.

Keilholtz & S. Musselman's Copper Openings,

At the old abandoned saw mill near the new copper opening on Keilholtz's farm an unctuous Orthofelsite dips S. 20° E.—32°.

The openings on this and the next farm have been made recently by a company in which Dr. Snively, Mr. J. M. Wiestling and others are interested. The place lies about a mile north of the Bechtel opening. In ascending the steep hill from the road large quantities of chrysotile are observed, and Dr. Snively reports that this outcrop can be followed to a cut on the Western Maryland R. R. on the widow Gladhill's property and immediately upon the Maryland line. The belt crosses also the farm of Mr. Elias Harbaugh, which is in Pennsylvania and just this side of the last named. Near the top of this hill a number of trenches have been cut in a north and south direction over the surface.

In the upper cut a green arenaceous clayey slate mass dips E. 20° S.—40°.

The purple color still suggests Orthofelsite here. In the heading there is much milk quartz and an intercalated small mass of dark green chloritic rock.

Mr. Douglass (of the Hunt & Doughlass Process) requested Mr. Middleton to try the effect on the dip needle of this locality, as he suspected or had observed disseminated magnetite. The result of Mr. Middleton's experiment is said to have been that the dip needle stood vertically.

The outcrop can be followed up the hill in a direction about N. 20° E., but these openings and those on S. Musselman's immediately adjoining are the last in that direction on this copper belt.

About thirty yards south east of the trench a shaft was sunk about 20 ft. and the mass thrown out was mainly chlorite with quartz, epidotic rock, and azurite, besides various silicates containing more or less copper.

In the heading of the 20 foot tunnel chloritic, sandy, orthofelsite dips S. 40° E.—50°.

Mr. J. M. Wiestling of Harrisburg sends the following notes which are of interest owing to the high authority from which they emanate and the hitherto comparatively unknown constitution of these ores:

HARRISBURG, PA., *Oct. 18, 1878.*

DEAR SIR: Inclosed I send you, pursuant to your request, a copy of Prof. Doughlass's analysis of the specimens of our copper, which Mr. Middleton says was a fair average of the ore which we have lying on the ground.

I am very truly yours, &c.,

J. M. WIESTLING.

To Prof. PERSIFOR FRAZER, Jr., *Geologist.*

PHŒNIXVILLE, *Aug. 24, 1878.*

W. A. MIDDLETON, Esq., *Harrisburg:*

DEAR SIR: The sample of ore from H. Musselman location that you gave me for examination weighed 305 grammes. Of this there remained on a fine sieve native copper with some adhering rock 58 grms.—18.8 per cent. of the whole. There passed through the sieve 247 grms.—81.2 per cent.

The lump of copper and rock I estimated to yield 90 per cent. of copper.

The fine ore yielded of oxyd and carbonate, ...	11 per cent.
and of native copper, . . .	14 per cent.
	25 per cent. of copper.
The copper contents of the sample are, therefore, 90 per cent. of 18.8 per cent.=	16.9 per cent.
25 per cent. of 81.2 per cent.=	20.3 per cent.
The sample contained, . . .	37.2 per cent. of copper.

There is magnetic oxide of iron in the sample.

Yours,

DOUGHLASS.

The distance from Millerstown or Fairfield, Adams Co., to the Maria Furnace, was 1¾ miles; that from the furnace to Watson's mine, 1½ miles; that from this mine to the toll-gate on the Waynesboro' turnpike, about three miles.

A certain Rudolph, from Lake Superior, 28 years ago, is said to have believed that copper was to be found in this locality in paying quantities. A fine specimen of native copper was presented to the survey by Mr. Benchoff, who found it loose about a quarter of a mile N. W. of the Philadelphia mine.

General Remarks.

It will be observed in glancing at the map that a belt of rocks belonging to the overlying, eastern flank of the South Mountain and consisting of decayed and stained chlorites and orthofelsites mixed with epidote, quartz and serpentine (or its representative in decayed chrysotile), passes down in a course generally parallel to the direction of the axis of the mountain and about half a mile in width between the extreme lines along which copper is found. It does not necessarily follow from the latter circumstance, however, that the entire mass within these lines is cupriferous; because either a synclinal or anticlinal structure might give rise to two lines of moderate width and this distance apart, in either of which cases the horizon of the two lines would be the same. A party of the Survey is now engaged in completing an elaborate map of this region, and when completed a discussion of the origin and relations of this area can be made with the assistance of much light which is as yet wanting.

The description of the Lake Superior ores above referred to is not quite appplicable to the rocks of that region of the South Mountain which we have been considering and yet there are some resemblances which must be more than accidental. Throughout the South Mountain range (viewed as a whole) from the Chambersburg turnpike to the Maryland line we have an area of trapezoid shape of which the longer side rests on the above turnpike and the shorter is near the State boundary.

The rocks of this region may be divided into two great series a western (underlying (?)) of which the characteristic strata are composed of quartzite, and of a nacreous schist containing quartz pebbles (Mountain Creek Rock of this and previous reports); and an eastern (overlying (?)), made up of hydro-mica and chloritic schists, and orthofelsite both porphyritic and unporphyritic. Both of these series show indications of having been penetrated by dykes of plutonic character in certain places within this area. The porphyry which carries the copper ore in this place shows no character of igneous origin but occurs in coarse and thin beds, more or less disintegrated and in certain localities reduced almost to the state of kaoline. Nothing which might correspond to the term sandstone was observed though all the above sediments are full of grit and hard sandy particles. No fossils of any kind were observed except *Scolithus linearis* which occurs on the north west flank of the mountains and imbedded in quartzites forming the surrounding walls of some of the westernmost ravines and glens, but not in such a position as to exclude the possibility of their belonging to a more or less wasted and denuded layer of Potsdam sandstone of which a few fragments are known to remain on the sides and in the folds of these mountains. The whole belt consisting of both series narrows rapidly from eight miles at the northern, upper, or long side of the trapezoid to a couple of miles on the southern side. There appear to be numerous horizons of crystalline schists on both sides of and intercalated between the Orthofelsites and even of the quartzites though here more sparsely.

It seems fair to conclude however that the region of the copper bearing rocks belongs to the Huronian cycle as do the similar porphyries in Missouri, and on Lakes Superior and Huron.

It will be observed that here in Adams County and within a few miles of each other occur lean representatives (it is true) but nevertheless representatives of the two great copper regions of this country: the one* in the Mesozoic and the other in the Huronian felsites.

One point not as yet entirely intelligible deserves comment viz: that both the formations from which the principal supply of copper is obtained, are in rocks which are generally penetrated by traps of various ages and characters.

It cannot be always as Prof. Dana suggests in reference to the great copper region of Keweenah Point in Michigan that "whenever the trap was thrown out as a melted rock the copper probably came up, having apparently been derived from copper ores in some inferior Archæan rocks through which the liquid trap passed on its way upwards," for the previous part of this same sentence informs us that "the copper occurs in irregular veins in both the trap and the sandstone near their junction," which suggests the subsequent origin of the copper, even were not the facts of the occurrence of copper in other localities in favor of this view. I make these remarks in all respect to the above opinions, for one can hardly divest oneself of the notion that there is an intimate connection, parental or fraternal, between the traps and the copper, when it is noticed that

* It is worth repeating a report of Mr. Riegel of Græfenburg Springs that copper ore had been found in an Orthofelsite ridge on the western side of the Mountains between Caledonia Furnace and Caledonia Spring. It is not improbable that under the Potsdam sandstone (if the patches of sand rock may be ascribed to that age) and above the Mountain Creek Rock this Orthofelsite comes to view on the West as it does on the East side of the South Mountain chain, and brings with it this amongst other of its characteristic minerals.

the rocks in which both abound are the same. But it does not follow either in theory or fact that the copper always occurs in or near trap. On the contrary, part of the Mesozoic copper deposit referred to in Adams County is on the eastern side of the red belt, i. e. where the trap outbreaks are least frequent, and so far as examination yet serves, is disconnected from any trap, ridge, or dyke.

The Huronian ore is also in a part of the mountain, where as yet no disturbance from igneous intrusion has been noticed.

But in general terms both these series are well known to be traversed by numerous trap ranges, whose roots may extend to the horizon whence the copper comes.

OUTCROP OF TRAP AT THE DEVIL'S DEN NEAR GETTYSBURG, ADAMS CO. PA.

INDEX TO CCC.

PART I.—Nominal and Geographical.

PART II.—Geological.

APPENDIX 2.

Examination of copper from the Wiestling & Snively copper mines near Monterey.

The following analyses were made by the writer of specimens of copper ore from the pits opened by Dr. Snively and associates, in the South Mountain, near Monterey Springs.

The first pieces produced were three lumps selected by the owners and shipped as a sample lot. These three lumps were pounded in an iron mortar and proved to contain many pieces of native copper. Two pieces of the latter after a long hammering which separated them from the grossest impurities and left them free from admixture of rock particles so far as the naked eye could observe, weighed respectively 105 grams and 55 grams.

A fragment from the smallest lump gave the following results:

	p. c.
Native copper,	97.547
Quartz grains and silica,	1.285
Alumina and iron sesquioxide,	0.332
Silver,	0.006
Ignition and undetermined,	0.830
	100.000

If this percentage of silver were to be assumed as constant every ton of pure copper would contain $2 40 of silver. The value of the silver in one ton of the *ore* would be equal to about 23 cts.

The included siliceous matter consisted under the Stanhope lens of small fragments of chrysocolla, yellowish green epidotic material and pure quartz.

Two other specimens of this native copper gave:

1. Native copper,	93.19
2. Insoluble silicates,	7.67

It may be assumed then that without other refining than such as occurs in the stamp mill, the native copper contained in such ore will average from 93 to 97 p. c. and the siliceous matter included within it 3 to 6 p. c.

Additional specimens taken by the undersigned himself were first weighed, pulverized, and passed through a fine sieve to separate the particles of native copper from their matrix. There were present 3.6 p. c. of native copper.

This native copper was found to vary between 93 and 98 p. c. of chemically pure copper. The impurities being in the first case mostly due to the mechanical mixture with the metal, of siliceous fragments which could not be detached by the simple means employed.

The rock, after separation from all visible particles of native copper, was next analysed, with the following result:

	p. c.		*p. c.*
Present as native copper,	3.6.	Pure copper,	3.34 to 3.52.

Separated Matrix.

	1.	*2.*	*3.*
Insoluble siliceous matter,	83.770	83.40	
Alumina and iron, sesqui-oxide,	6.320		
Lime,	1.570		
Magnesia,	0.150		
Sulphur,	0.250		
Lead,	0.150		
Copper (in combination),	4.700	4.69	4.35
Ignition,	0.650		
Oxygen, undetermined and loss,	2.440		
	100.000		

The numbers 1, 2, and 3, at the head of the vertical columns, refer to different determinations in the same lot of specimens.

Analysis of mineral waters in Lancaster county, by Dr. F. A. Genth.

Black Barren Spring, near Pleasant Grove, Fulton township, Lancaster county.

	Grains per gallon of 231 cubic inches.	Millionths or milligrams ℔ liter.
Calcium sulphate,	0.20460	3.503
Calcium phosphate,	0.01305	0.223
Iron carbonate,	0.03050	0.522
Magnesium carbonate,	2.68808	46.017
Calcium carbonate,	0.27093	4.638
Sodium carbonate,	0.22063	3.777
Potassium carbonate,	0.05585	0.956
Sodium chloride,	0.18368	3.144
Silicic oxide,	1.41884	24.289
Carbonic oxide,	2.19631	37.599
Total matter dissolved,	7.28247	124.668

This spring has been extensively advertised, if not extensively visited, and its waters are even now sold at many places throughout the United States, on account of their supposed medicinal virtues.

Analysis of water from Rock Spring, Fulton township, Lancaster county. Analysis by Dr. F. A. Genth.

	Grains per gallon.	Millionths or milligrams ℔ liter.
Calcium sulphate,	0.00945	0.162
Potassium sulphate,	0.41246	7.061
Sodium sulphate,	0.65467	10.207
Sodium chloride,	0.27244	4.664
Sodium carbonate,	0.44351	7.592
Magnesium carbonate,	7.24103	123.939
Iron carbonate,	0.03881	6.874
Phosphoric oxide,	trace.	trace.
Silicic oxide,	0.18462	3.160
Carbonic oxide,	1.81930	31.155
Organic matter,	trace.	trace.
Total matter dissolved,	11.07629	194.814

The Rock spring is situated a short distance from the

Maryland line; and near the old Rock Spring church, Fulton township, Lancaster county. It flows in a gentle current out of half a dozen cups scooped out of a serpentine rock by the aborigines: and had the reputation of a medicinal spring among the Indians.

It will be interesting to compare the total solid matter dissolved in each of these two mineral springs with the same factor in the Schuylkill water collected at various places specified below. The methods of analysis of the two being different, they cannot be easily compared, but it may be said that each of the samples contain in their dissolved material nitrites, chlorides, and sulphates. I am indebted to my friend, Mr. H. C. Humphrey, for the following data:

		Milligrams per liter, or millionths of solid inorganic matter in solution.
Schuylkill water at Philada.	Roxborough dam,	105.08
	Corinthian dam,	107.08
	Belmont dam,	79.05
	Fairmount dam,	109.07
	Spring Garden dam,	110.08
	River at Belmont, (Schuylkill,)	91.07
	Schuylkill at Flat Rock dam,	91.07
	Black Barren spring,	124.67
	Rock spring,	194.81

The following is an analysis by Mr. A. S. McCreath of samples of iron ore obtained by Mr. A. E. Lehman from Wyeth Douglas' mine near Mt. Airy, 1 mile N. E. of Quincy:

	p. c.
Insoluble residue,	25.570
Phosphoric oxide,	0.602
Sulphuric oxide,	0.087
Iron sesquioxide,	62.428
Manganese sesquioxide,	0.237
Cobalt sesquioxide,	trace.
Alumina,	1.500
Lime,	0.110
Magnesia,	0.395
Water,	9.392
Total,	100.321

Note to paragraph 2, on page 250, CCC.—On the afternoon of August 11, 1879, the spring in the cellar of the Monterey House, Monterey Springs, at 3, P. M., was 52° Fahrenheit.

The temperature of the water from the pump fronting the house, and separated from it by the public road, was 52° Fah. A quart of the water was distinctly colored by 0.33 cubic centimeter of chameleon solution of a strength of 0.01403, Grm. Fe. per. c. c.

This is equivalent to 5.5 c. c. of Sulphureted Hydrogen gas in one quart.

The pump situated in the stable yard of the same hotel, on the same date and at 3.45, P. M., furnished water at 50° Fah. This water had a strong smell of decaying organic matter, but gave no reaction with chameleon solution.

Establishment of a Meridian on the South Mountain, near the Maryland line, by Mr. A. E. Lehman.

It being thought expedient by Prof. Frazer, to make an observation of the magnetic variation at Monterey Summit in Franklin county, I went there on Nov. 14th, 1879, accompanied by Mr. E. B. Harden in charge of the instrument, and the late Mr. J. T. Fuller as aid.

The instrument, kindly lent to us by Mr. John Henry Harden, M. E., was a large new Transit-Theodolite made by W. F. Stanley, London. Its principal appointments were a telescope 10 inches long, erect and inverting eye pieces, vertical and horizontal limbs 6 inches in diameter, with verniers 180° apart divided on silver, and reading to 20 seconds. Needle 6 inches long, maximum swing 20°, (10° each side of telescope.) The instrument was also provided with illuminated diagonal eye-pieces. Upon testing its adjustment, it was found that the cross hairs were slightly out of collimation (about ½ inch in 50 ft.) but as it revolved truly in a vertical plane, and no back sights were to be taken, it was thought best not to disturb it.

The weather did not permit an observation until Nov. 15th. The point selected was the top of the hill in field S. E. of Monterey House, 1 mile North of Maryland line.

By observations made on Ursa Minor (Polaris) on Nov. 15 and 16 the declination of the compass needle from the astronomical meridian was found to be 2° 11′ 40″.

The work was performed as follows: A stout plug was driven into the ground at the point from which the observation was made; 400 ft. due North from this a horizontal bar was firmly erected 2 ft. high and sufficiently long to permit the swing of the telescope from the true North line to the magnetic line to mark accurately the sides of the angle produced, within the extreme ends of the bar. This was done by driving two small nails into the bar at the points thus located.

The instrument being erected accurately over the centre of the plug, Polaris was sighted and taken at its upper culmination. The time for right ascension of this star, Nov. 15th, 1879, was taken from American Ephemeris for 1880. This given in sidereal time was 1 h. 14′ 25″ at Washington, reduced to civil time and allowing for difference in longitude west from Washington made the time for right ascension of Polaris at this locality 9. 87. 59 P. M.

Time was ascertained from one of the best Waltham watch movements, a chronometer not having been provided for the purpose.

After placing the vertical cross-hair of the telescope carefully upon the star, the line was deflected down to the bar and marked as described. The magnetic line was marked by the needle upon the bar likewise and declination observed at daylight the following morning.

On the evening of November 16th another observation was made under exactly similar circumstance. The result of both observations was as follows:

DATE.	Time.	Declination.	Variation.
Nov. 15, ...	9. 38. 59 P. M.	41° 13′	2° 12′
Nov. 16, ...	9. 34. 03 "	41° 05′	2° 11′ 20″
Mean, ...	. . . .	. . . .	2° 11′ 40″

The weather during both observations was clear and cold, and the sky cloudless.

After obtaining a true meridian, it was established by placing two white marble stones, dressed, 8 inches square, 4 ft. long, 1100 feet apart: one by the cherry tree at the point of observation 930 ft. E. 33° 30′ S. from N. E. corner of main building of Monterey House; elevation above sea level 1420.18. The other stone was placed in a field 100 ft. north of turnpike, 3 ft. west of line fence between Monterey Hotel property and premises of Dr. Herman Groesbeck. Elevation at latter point 1380.00 above ocean level.

Had time and weather permitted I should have endeavored to prove the meridian obtained from Polaris by tests on some southern stars; those of less declination, larger orbit and more rapid movement than the North star being preferable for ascertaining magnetic variation, and allowing observation with greater ease and accuracy.

The latitude and longitude of Monterey not being known, no attention was paid to it, nor was it included as a factor in the above investigation. The geographical position of the nearest known point was Gettysburg 16 miles N. E. Lat. 39° 49′ 15″. Long., from Washington 0° 14′ 00″ West.

The declination at Monterey being less than was expected, and by comparison with the Magnetic chart of the U. S. Coast Survey less than some points further West, there is apparently some discrepancy to account for in the result here obtained. This variance is possibly not due so much to observation or instrumental errors as to local causes. An explanation admits irregularities in the distribution of Magnetism as well as direction of isogonic curves in this locality.

Mr. E. B. Harden rendered me indispensable service during the progress of the work.

AMBROSE E. LEHMAN,
Topographical Assistant.

Analyses of Limestones from "Welty's quarries" on the N. W. edge of Dillsburg.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Lime,	44.950	44.220	47.000	42.940	43.920
Magnesia,	5.275	6.403	3.845	3.045	2.929
Ferrous oxide,	1.179	.864	.585	1.098	2.304
Manganous oxide,	trace.	trace.	trace.	trace.	trace.
Alumina,	2.460	2.320	1.690	2.680	5.090
Sulphur,	.004	.003	.004	.003	.005
Phosphorus,	.011	.012	.003	.013	.031
Carbonic acid,	31.040	34.030	34.985	30.072	17.020
Water,	1.460	1.150	1.270	1.160	1.720
Insoluble residue,	14.010	10.890	10.460	18.580	27.010
	100.389	99.892	99.842	99.591	100.029

The "*ignited insoluble residues*" contain:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Silicic acid,	11.603	8.766	7.710	13.144	25.320
Ferric oxide,	.039	.148	.211	.126	.113
Alumina,	.236	.126	.231	.524	.205
Lime,	.838	.634	1.238	2.560	.433
Magnesia,	.666	.465	.819	1.777	.304

ANDREW S. McCREATH.

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