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GEOLOGICAL SURVEY OF NEW JERSEY.

ANNUAL REPORT

OF THE

STATE GEOLOGIST,

FOR THE YEAR 1873.

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1873

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STATE GEOLOGIST,

GEORGE H. COOK, - - - - New Brunswick.

*To His Excellency Joel Parker, Governor and ex-officio President
of the Board of Managers of the State Geological Survey:*

SIR:—In accordance with the law authorizing the Geological Survey, I have the honor to submit my annual report on the progress and present condition of the State Survey, for the year 1873.

With high respect, your obedient servant,

GEO. H. COOK,
State Geologist.

RUTGERS COLLEGE, New Brunswick.
December 30, 1873.

REPORT.

The act of the Legislature authorizing the present Geological Survey of the State was passed at the session of 1864.*

A supplementary act authorizing its continuance was passed at the session of 1869.†

At the session of the Legislature of the present year, and in accordance with the recommendation of the Board of Managers another supplementary act was passed providing for its further continuance.

Under this authority the work has been continued through the past season, and the following persons have been engaged in different branches of the Survey :

PROF. JOHN C. SMOCK, *Assistant Geologist*, has been in active duty a part of the year, during which he has visited many of the iron mines, has pursued studies of the rock structure of the Highland Range of Mountains, and more especially of the rocks, ores and minerals of the Jenny Jump and Marble Mountain ranges.

EDWIN H. BOGARDUS, *Chemist*, has been constantly engaged in the laboratory analysing ores, minerals, rocks, soils and fertilizers, and in testing mineral substances sent by citizens, or collected for purposes of inquiry and investigation.

PROF. EDWARD A. BOWSER, *Engineer and Surveyor*, has been occupied a part of the season in making a topographical map of the country in which Jenny Jump and Marble Mountain lie, and in completing an examination of the monu-

* The results of the Survey under this act were published in annual reports for 1864, 1865, 1866, and 1867, which were printed by the Legislature and distributed with the legislative documents and the Geology of New Jersey, an octavo volume of XXIV and 899 pages with a portfolio of 8 maps, which was published in 1869 by the Board of Managers of the Survey. See descriptive list of publications of the Geological Survey at the end of this report.

† The results of this continuation of the Geological Survey have been given in the annual reports of the State Geologist, printed by the Legislature in 1869, 1870, 1871, and 1872, and distributed with the legislative documents.

ments marking the boundary between New Jersey and New York. Wm. A. Chapman and Elbridge Van Syckel, Jr., graduates in the engineering department of Rutgers College, have assisted Professor Bowser in surveying and mapping the mountains, and James K. Barton, another graduate, has assisted him in surveying and mapping that portion of country about the Great Meadows of Warren county.

My own time has been taken up with the miscellaneous work of the survey—the drainage projects, the examination of the northern boundary line, the various departments of laboratory, field and surveying work, and in answering numerous and pertinent letters of inquiry. I have found great satisfaction in visiting some of the new iron mines, and in tracing out with Professor Smock the lines of division between several well marked belts of the Azoic rocks.

There is a great increase in the number of applications for information in regard to mines, minerals, mineral waters, ores, building stones, clays, sands, marls, and other natural products, which we answer as far as the time and means at our disposal will allow.

The work done is given in detail under the following heads:

1. The Drainage Works.
2. Survey of the Northern Boundary.
3. Subdivision of the Azoic region into four oblique belts, with a map of Northern New Jersey, and a Topographical Map of Jenny Jump Mountain, with its Iron Mines.
4. List of Mines of Magnetic Iron Ore, with notes.
5. Searching for Iron Ore.
6. Zinc and other Ores.
7. Building Stones.
8. Clays and Sands.
9. Limestones.
10. Marl.
11. Graphite.
12. Infusorial Earth.
13. Roads and Road Material.
14. Soils and unimproved Lands.

Drainage of Lands.

The law to provide for the drainage of lands, which was passed by the Legislature of 1871, put the plans for draining tracts of wet and marshy land under the direction of the Board of Managers of the Geological Survey. It required them, "on the application of at least five owners of separate lots of land included in any tract of land in this State, which is subject to overflow from freshets, or which is usually in a low, marshy, boggy or wet condition," to examine such tracts, and if they judged it for the public interest, to survey, and make a plan for the drainage of the tracts, and to submit the same to the Supreme Court and ask for the appointment of commissioners to carry out and execute the works of drainage, and to assess, collect and pay the expenses incurred. Under this act your Board has prepared plans for the drainage of the tract of land subject to overflow, bordering the Passaic river, between Chatham and Little Falls, in Morris, Essex, and Passaic counties; and for the tract of land on the Pequest, in Warren county, between Vienna and the Sussex county line. Commissioners were appointed for each of these works, and they have entered upon their duties. These enterprises involve the interests and rights of a large number of persons, and the mode of proceeding to carry them out is new and untried. Hence the Commissioners have thought it prudent to proceed with great care—which of course, has required time. The securing titles to the lands and property which have to be taken for the widening of streams, the deposit of excavated material, or the lowering or removal of dams, has been the first work of the Commissioners; on the Pequest this work is done, and on the Passaic it is in progress. The work of clearing the streams might have begun this fall, but the financial difficulties of the country compelled them to defer it. They are of the opinion that the expenses of the work will be least burdensome to land owners, if instead of being assessed for full payment at once, they can be divided and paid in several yearly installments—and the Commissioners have prepared the draft of a bill for the purpose, and ask this Board to recommend its passage.

The completion of these works of drainage will add largely to the productiveness and wealth of the State, and will remove fruitful sources of insalubrity and sickness; and while a just compensation must be made for any property taken or injured, the expense will be so provided for as not to be burdensome to the land owners.

II.

The Northern Boundary Line.

The division line between New Jersey and New York is marked by monuments on the line, at the distance of one mile from each other. Some of these monuments have been destroyed, others are said to have been moved for fraudulent purposes, and it was judged expedient by your Board to have the line examined, after which, if found necessary, the State of New York can be asked to join in restoring it to its true place, and in establishing permanent and easily verified monuments upon it. The first thing to be done in this examination is to determine the true latitude and longitude of Carpenter's Point—which is the extreme western end of the boundary, and then to compute the precise bearing of the straight line from the western end to the monument at the eastern end, which already has its latitude and longitude determined. By running this line through with the proper bearing, the true condition of the monuments will be found.

In accordance with the directions of this Board I applied to Professor Pierce, Superintendent of the United States Coast Survey, to determine these particulars, viz., the latitude and longitude of Carpenter's Point, and the azimuth of the division line, for us, and have great pleasure in reporting that Professor Pierce consented to have the work done by the officers of the Coast Survey, and directed it to be begun at once. An assistant was sent to Carpenter's Point where he established an observatory, set up the necessary instruments, and spent almost the whole of May and June in taking observations from which to make the proper computations. The work of computation is still in progress at the office of the Coast Survey in Washington,

and we are informed that it will be completed and reported to us by the close of the year. The enlightened liberality shown in doing this very nice and expensive work for us is worthy of high praise, and it is but just to give this public expression of it.

By the next meeting of the Board I hope to be able to report the condition and place of the monuments in relation to the straight division line.

III.

Subdivision of the Azoic Region into Belts; with a Map of Northern New Jersey.

The Azoic rocks of New Jersey are nearly all included in the mountainous district of country which lies in the northern part of the State, occupying the northwestern parts of Bergen, Passaic, Morris, Somerset and Hunterdon counties, and the southeastern parts of Sussex and Warren. Ramapo, Trowbridge, Mine and Musconetcong mountains, mark its southeastern, and Pochuck mountain, Pimple Hill, Jenny Jump and Marble mountain its northwestern border. This whole belt of mountain ridges is part of the chain of mountains which is known in New York as the Highlands, and in Pennsylvania as the South mountain.

The extreme length of this region from the Delaware on the southwest to the New York boundary line, on the northeast is sixty miles; its breadth at the Delaware is ten miles, and at the New York State line is twenty-two miles, and its area is about nine hundred square miles, exclusive of several tracts of country which though included in the above boundaries are underlaid by newer rocks.

In this whole region very little bare rock is to be found. Almost everywhere it is covered with a heavy body of drift earth, and much more than half of it has the surface thickly strewn with loose rocks and stones. This condition of the surface has rendered it much more favorable for the growth of wood, than for cultivation; and a large part of it is in forest.*

* That portion of the Azoic region embraced within the limits of Sussex, Passaic and Bergen counties, and that part of Morris county north of the Morris and Essex Railroad has 83 per cent. of its area in forest. Morris county south of the same road and Hunterdon county north of the Central Railroad of New Jersey have 39 per cent. in forest. Warren county and that part of Hunterdon south of the Central Railroad have 45 per cent. in forest. Taken together the area covered by forest is a little over 60 per cent. of the whole.

On this account it has been found extremely difficult to make any clearly defined and easily understood subdivision of this formation. The difficulty is still further increased by the peculiar circumstance that while the whole belt or strip of Azoic rocks crosses our State in a general direction of north fifty degrees east, the *strike* of the rocks, which is only the direction of the upturned and exposed edges of the strata is about north forty-three degrees east. So that any natural subdivision of the Azoic formation of our State must be into narrower belts which cross the whole formation obliquely and come to an end in the blue limestones on the northwest border of the region, and in the red sandstones on its southeastern border. The Hudson river cuts through the Azoic formation from Stony Point to Cornwall, and the rocks are finely exposed for study, but if one were to examine them with the expectation of learning the character and structure of New Jersey rocks of that age, he would be entirely at fault; for the Hudson river section mainly exposes a single one of the four belts into which we now divide our Azoic rocks. In the same way the Delaware cuts through the formation, but it only exposes two of the four belts into which the rock is divided.

BELTS.

For convenience of reference, the following provisional names have been given to these belts; and they are put down in the order of their occurrence beginning with that on the southeast and, going on to the northwest; and in any descriptions of a single belt, the southwest points are named first, and those farther towards the northeast in succession.

1. The Ramapo Belt.
2. The Passaic Belt.
3. The Musconetcong Belt.
4. The Pequest Belt.

1. *The Ramapo Belt* begins near Peapack, in Somerset county, and extends on in a northeast direction by Pompton to the State line, and in the State of New York to and beyond the Hudson.

It is about two miles wide at the southwest end, and at the State line its width is five miles. Mine mountain, Trowbridge mountain, Watnong mountain, the isolated low mountains between Denville and Boonton, the mountain ridge extending from Boonton to Pompton, and the Ramapo mountains are all in this belt. Its southeast border is characterized by its meeting the red sandstones and conglomerates of the Triassic Formation, and its southwest end is likewise in these rocks. Its northwest border is marked by a characteristic white crystalline limestone containing serpentine in grains, large masses, and fibrous forms as chrysotile. An outcrop of this limestone is to be seen at the Sanders property, a mile from Mendham, on the right of the road to Morristown; another is a mile and a half north of Montville, where there are quarries of limestone; still another is about two miles northeast of Bloomingdale, and a half mile west of the Wynokie road, on the DeBow property; farther on, limestone crops out at the west foot of Windbeam mountain at the roadside, near G. Monk's house; and again on the side of the road from Boardville to Greenwood lake, and a half mile from the former place; further on, in the tunnel to the Old Blue mine, at Ringwood a bed of limestone is cut across; and near the State line and just west of the road from Ringwood to Sterling limestone is found in small quantity; further on, in New York, in the extension of the same line, it is found a quarter of a mile east of the northeast end of Truxedopond. Other outcrops of limestone are seen east of the road at Wynokie, on Mr. Rhinesmith's land, and at Boardville, near the dwelling of J. W. Schermerhorn. But after examining the country, it was thought best to draw the division line along the most westerly of these outcrops of limestone, and to consider it all as belonging to the Ramapo belt. The line is drawn on the map between these outcrops, according to the best of our judgment now, though further examination may lead to its being slightly changed.

The Passaic Belt is the next belt on the northwest, and the line just described, is its southeast boundary. It begins at Clinton, in Hunterdon county, at the southwest, and extends on by

Dover and Ringwood to the State line, and beyond to Stirling and Turner's Station, where it ends. Its breadth is nearly uniform, and about five miles. Its surface is high and undulating, but it has no conspicuous mountain ridges or elevations, and its hills have only local names. On its southeast border from Peapack to Lebanon, it is bounded by the Triassic sandstones and conglomerates; nearer Clinton, it is limited by the Magnesian limestone; and at its southwest end, at the valley of the South Branch of the Raritan, and of Spruce run, it is lost from sight under the Triassic rocks. Its northwest border is defined by a continuous valley through its whole extent. This valley begins at the Spruce run, above Clinton, where its first eastern branch comes in, and follows up the valley of that branch, and over the depression of the ridge at its head, into German Valley; and up that valley to Naughtrightsville, Bartleyville, Flanders, Succasunny, Berkshire Valley, Longwood Valley, Petersburg, Newfoundland and West Milford, to Greenwood Lake and the State boundary. Beyond this it continues on, by Bellevalle to Monroe, in New York. This valley contains Potsdam sandstone, magnesian limestone and Hudson river slates, throughout its whole length: and, from Flanders on to the northeast, it is characterized by extensive ridges of Green Pond mountain conglomerate. No crystalline limestone has been found in this belt, but it is remarkable for its rich mines of magnetic iron ore.

3. *The Musconetcong Belt*, is northwest of, and adjoining the Passaic Belt. The valley just described is its southeast boundary, as far as it goes to the southwest. From the Spruce run to the Delaware, it is bordered, principally, by red sandstone rocks, or as at Little York by magnesian limestone, or as at Amsterdam by quartzose rock. The southwest end is at the Delaware, where it descends to pass under the river, and in Pennsylvania it extends on to near Reading. Its northwest boundary is marked, as it runs from the Delaware by Lower Harmony up Harker's Hollow, and over the mountainous divide near Mount No-More to Oxford Furnace; thence, up the valley of the Pequest to Vienna, and then up Bacon's creek to War-

renville and Allamuchy; along the east foot of Allamuchy mountain, and east of the Cranberry reservoir, and the Roseville iron mine, to the high dividing ridge between the streams running into the Musconetcong, and those running into the Wallkill; from this divide it descends into the Wallkill valley, and follows along the east border of that valley by Franklin, Hamburg, Vernon, and on to the State line. Musconetcong, Pohatcong, Schooley's, Hamburg, Wallkill and other mountain ridges are in this belt and a large portion of it is an elevated table land. It continues quite across our State and ends near Newburgh, in New York, and near Reading, in Pennsylvania. In breadth it is from six to eight miles, including several long and wide valleys underlaid by magnesian limestone. No crystalline limestone has been found in it, in which respect it differs from the belt next adjoining on the northwest.

4. *The Pequest Belt*, includes all the Azoic rocks northwest of the boundary just described. It extends quite across the State, but on the northeast it passes only a few miles beyond the State line, and in Pennsylvania it ends a few miles northeast of Bethlehem. Its northwestern edge is everywhere overlaid by Palaeozoic rocks. Scott's mountain, Marble mountain, Jenny Jump, Pimple Hill and Pochuck mountain are in this belt. It is very irregular in width, being entirely lost in some parts of its length, and widening out to three miles or more in others. Crystalline limestone is very abundant in this belt, and it is also characterized by its rich zinc mines, and by its iron ores containing manganese.

AGE OF THE ROCKS.

In this division into belts, we have not been able as yet, to find any means of identifying our Azoic rocks with either the Laurentian or Huronian rocks into which the Canadian geologists have divided theirs.

The rocks of the Pequest belt have most resemblance to the typical Laurentian rocks of Canada, and the Green Pond mountain conglomerates have many characteristics in common with the

Huronian rocks of the Canadian geologists. There is a peculiar bluish gray slate which crops out in the bed of Ringwood river, just on the upper side of the bridge at Pompton, and has been found in one or two other places on the southeast border of the Ramapo belt, which is identical in appearance with the Huronian slates of Canada, but any positive conclusions would be unwarranted in the present state of our knowledge.

Structure.—The structure of the rocky materials of this formation has been given with many illustrations in the "Geology of New Jersey," and for full details reference must be made to that work. It is sufficient to say here, that all the rock of the formation is stratified; that the strata are not horizontal but are highly inclined, and in some cases vertical, that inclination which is called the *dip* is, with some exceptions, towards the southeast; that the direction of the edges of the upturned strata, called the *strike* of the rock, is northeast and southwest. The accompanying map shows the location and general direction of these rocks and their subdivision into belts, and gives at a glance what pages of text cannot convey.

Though the dip is usually in one direction, and that to the southeast, it has been found in mining explorations that the strata do not continue on downwards in the same direction of dip always, but that in many cases they bend round in a fold and return to the surface again; that in fact they are folds, and the parallelism of the layers is caused by the two sides of the fold being pressed powerfully together. The axes of these folds, or the lines about which they have been bent are not usually horizontal, but are much inclined from twenty-five degrees to fifty degrees to the horizon. This inclination of the axes of folding is always downwards in the direction of the strike towards the northeast. This inclination is, among our miners, called the *pitch*. The strata are not perfectly even and straight in their strike, but are commonly wavy, and instances are occasionally found in which the strike is changed from its usual northeast and southwest direction to one northwest and southeast, as if, in addition to being compressed on the sides, the strata had also been subjected to a powerful compressing

force between their two ends, which had caused them to shorten in their length by bending sidewise around vertical axes and forming a curve somewhat like the letter S. In addition to these folds and bends, the rock is broken across in various directions by vertical cracks or *joints*, and it is not uncommon to find that the rock layer on one side of a joint has been moved away from the corresponding layer on the other side, and that they are now separated by an interval or *offset* of greater or less extent, amounting in some instances to a hundred feet or more. The direction of these offsets does not conform to any known law, but is in some cases in one direction and in others directly opposite.

The beds of rock are not uniform, some being very thin and others thick and massive. Sometimes the same bed is found to vary much in thickness, being many feet thick in one part and thinning out to almost nothing in others—this is specially true of the iron ore beds.

Rocks.—The greater portion of the Azoic rock is *syenitic* gneiss, being composed of crystalline grains of quartz, feldspar and hornblende, like syenite, and being stratified like a true gneiss. Mica is found in it in some parts, but it is not abundant, and in many layers of the rock it can not be found at all. Feldspar, which is the most abundant mineral in the rock, varies much in color; in some strata it is white, in others flesh colored, and in others bluish or grayish white, and it imparts its own shade of color to the whole rock. It varies remarkably in its power of resisting decomposition. In some places the rock appears solid and incapable of decay, while in others the feldspar has decomposed, and become chalky in appearance, and soft and earthy in its substance.

Hornblende is very abundant in some beds of the rock, and imparts its own characteristic black color to the mass, and in some cases it has been mistaken for iron ore by explorers. It has been fancied that this kind of rock has some connection with the beds of magnetic iron ore, but its true relation in that respect is not yet demonstrated. Like the feldspar it is found

much decomposed in some places, and the material produced by its decomposition is remarkable for its deep reddish yellow color.

In some localities the stone splits freely and can be dressed well under the hammer, while in others the rocky mass is too hard and stubborn to be worked to any advantage. Localities of this rock can be found along any of the railroads crossing it, and great quantities are taken out of some of the iron ore mines. Quarries have been opened at Bloomingdale, Charlotteburgh, Franklin, Dover and Port Murray. Some beds of the rock are so peculiar as to be identified in hand specimens; but generally there is so much uniformity that hand specimens from the different belts and from different localities cannot be locally identified.

White crystalline limestone is found in the Ramapo and Pequest belts. That in the latter is in large quantity, and is interesting for its many and useful applications in agriculture and the arts, as well as for its rare and beautiful minerals. It is in such extensive beds that it is marked on the accompanying map by color, and it has been fully described in the "Geology of New Jersey." The white crystalline limestone of the Ramapo belt is not so well known, and is in much more limited quantity. It is remarkable for containing serpentine everywhere, and in some localities in such large proportion as to be almost worthless for making lime. The localities at Montville and at the De Bow property near Winokie are interesting to the mineralogist on account of the beautiful specimens of fibrous serpentine or chrysotile found in them. The massive serpentine is also very pure and handsome. Montville has long been famed as a locality for these minerals, but Winokie has not been heretofore noticed for them, though it has specimens quite as fine as those at the former place.

Magnetic iron ore is also found in regular and conformable beds between the layers of gneiss or limestone. The only difference between this ore and the other rocks among which it is found, is, that its beds are limited in extent, either thinning out or gradually changing in character until the ore is entirely replaced by rock—though this may not occur in hundreds or

even thousands of feet. The mineral is easily recognized by its being attracted by the magnet, and some specimens are themselves magnets. Its powder is black and it has the color and lustre of iron. In some beds the ore is granular and crumbles so much as to be called shot ore, while in others it is extremely tough and hard. It contains some rocky impurities mixed with it in variable but small quantity, such as quartz, hornblende, feldspar, phosphate of lime, titanitic acid, iron pyrites, &c.

Origin.—The rocks of this formation are now conceded by all geologists to be of sedimentary origin. They were originally deposited from water as sand, earth, clay, shells and corals or marl, and oxide of iron. Under the influence of pressure and heat, long continued, these deposits hardened to stone or rock. Under the prolonged and powerful influence of the same agencies the rocks were forced from their original horizontal position, turned up, bent and folded as we now find them, and the material of the rocks separated into distinct minerals, and changed from its earthy appearance to the crystalline structure which it now has. Examples to illustrate the possibility of these different changes might be cited, but they would hardly be in place in this report. In regard to the iron ore however, it may be said that we have in New Jersey deposits of yellow oxide of iron now going on; that they are in wet places, and are limited in the areas they cover. I have, in one instance at least, had a fossil from the northern part of the State of which the centre was red oxide of iron and the outer and main part was magnetic iron ore. Along our own shores too, we are having changes of level decided enough; and we have only to imagine them continued long enough to put our present level grounds in just as inclined positions as the Azoic rocks now have.

Description of the Geological Map.—This map is prepared specially to show the crystalline or Azoic rocks of the State, and the location of the different belts of those rocks, and the ranges of the iron ore mines. But it is also of general interest, and a short account of what it shows is accordingly presented. It is on a scale of two miles to one inch, and all the cities, towns and villages of the northern part of the State are on it, also the

roads, railroads and canals. There is no attempt at shading the hills or mountains, but the high and low surfaces are to some extent shown by the location and direction of the streams, which, of course, must always be on the lowest ground, and their small branches must always descend from the higher to the lower places. The colors on the map are mostly lithological in their indications, some approaching the true colors, and others being only conventional. The crystalline or Azoic rocks are indicated by the crimson lake, gneiss being colored full, serpentine with horizontal bars, and limestone of a purple color, made by crimson underlaid by blue. The iron mines are full black. The sandstones and quartzose conglomerates by a brown or umber color, numbers being used to designate those of different geological ages, and a much deeper shade of the same being used to show the trap rocks. The limestones by a cobalt blue color, and of different shades for those of different ages. The slates are of a gray color, and are also shaded to show different ages.

The columnar section on the west side of the map shows the different geological epochs of the New Jersey rocks, arranged in order, the oldest being at the bottom, that next to it immediately above, and so on to the topmost, which is of the present time. The rocks in their natural places are not, however, as level and regular in their order as this section would seem to show, but are found lying at all the different angles of elevation, and in some places many of the rocks in our series are wanting. The Azoic rocks are the oldest in our series, and the sandstones, limestones and slates which occur on the northwest side of them, are of the palaeozoic age, being the oldest of the fossil-bearing rocks. Those nearest the Azoic are the oldest, and those farther off are newer, the rocks dipping to the northwest. The rock on the southeast side of the Azoic is of the mesozoic or secondary age, in the series of fossil-bearing rocks. The dip of this rock is towards the northwest. The other rocks shown on the columnar section do not occur in Northern New Jersey, but are found in the middle and southern parts of the State.

From this it will be seen that we have rocks of all ages,

except the coal bearing or carboniferous. The accompanying section across the State, from Dingman's Ferry, on the Delaware, to Jersey City and the Hudson river, exhibits all the large rock formations found in Northern New Jersey, in the same relations to each other in regard to location and direction of dip, which they really have. The elevation of the country above the sea level is also shown. The iron mines are marked upon the map in their proper places. The location of these is very interesting to those looking for new mines. The exhibition of the tracts in which no mines are marked, together with the ranges of those now in operation, must stimulate to greater and better directed efforts to explore the, as yet, undeveloped districts. The color of the limestone marks the localities of that rock plainly, and the lines of railroad show how both iron ore and limestone can easiest find their way to market.

IRON MINES.

The iron ores of the Azoic region have been mined almost ever since the English settlers came into the State. Governor Robert Morris had iron works at Tinton Falls, Monmouth county, in 1685. The Dickerson mines at Succasunny, Morris county, were bought in 1710; and a forge was in operation at Whippany, in the same county, in 1716. There was also a forge in Upper Freehold, Monmouth county, in 1716. The Oxford furnace, in Warren county, was built in 1742; and furnaces and forges near High Bridge, Hunterdon county, in 1754. Ringwood furnace, in Passaic county, was built in 1762; and those at Charlotteburg and at Long Pond, in the same county, in 1763. Numerous other forges and some furnaces were in operation before the Revolution. The amount of iron made must have been small, though no statistics of the production are now at hand. Morse's Gazetteer for 1821, says that two thousand five hundred tons of iron were then made yearly in New Jersey. Gordon's Gazetteer, in 1831, puts our annual product at one thousand six hundred and seventy-one tons of pig iron and three thousand tons of bar iron. At that time

the iron was reduced from our ores by charcoal made in the vicinity of the works. With the application of anthracite coal to the reduction of iron ore, which began soon after this, and the opening of canals and railroads to furnish abundant and cheap transportation, the mining of our iron ores increased rapidly. Dr. Kitchell, in 1855, estimated the whole amount of iron ore mined in northern New Jersey that year, at one hundred thousand tons. In 1864, the estimate made for our annual report was two hundred and twenty-six thousand tons. In 1867, the estimated product was two hundred and seventy-five thousand tons. For 1871, the estimate was carefully prepared, and its result was four hundred and fifty thousand tons. The amount of iron ore mined in northern New Jersey in 1872, according to the returns obtained, was six hundred thousand tons. The amount mined the present year, as estimated from information furnished by the transportation companies and by individuals, is:

423,682	tons	carried on the	Del., Lack. and Western R. R.
196,000	"	"	" Morris canal.
13,970	"	"	" N. J. Central R. R.
27,000	"	mined and worked at	Oxford.
5,000	"	"	" Ringwood.

665,652 tons total product of New Jersey mines in 1873.

The value of this ore at the mines is not less than \$5 a ton, or \$3,328,260.

LIST OF IRON MINES, WITH NOTES.

The description of new mines and notes upon the older ones as here given are not complete in any of the features enumerated, but only notices of the mining operations of the past few years, particularly since the publication of the "Geology of New Jersey" in 1868. An attempt is made to mention all the new mines and ore localities, and to note any important changes in the development and working of those described in that report. This enumeration is necessarily incomplete, owing to

the extent of the field to be traversed and the large number of localities to be visited. As here given this is two hundred. To collect personally at all of these the data necessary for a detailed and accurate description, is not possible in a single season of field work. The plan pursued has been to study a district or belt, rather than attempt to go over the whole. This will explain the degree of fulness in some of these notes and the brevity in others. Wherever the localities have not been visited within the past two years, the needed information has been sought from persons acquainted with those points. And the description wherever based upon such information states the fact, so that in most cases it will be possible to discriminate between what has been obtained personally on the ground, and what has come from others. It is believed that this enumeration includes all the localities which can be properly styled *mines*, and nearly all the points at which much work has been done in searching for ore. In the notes on the working of our mines, the stoppages owing the late financial disturbance, are not given, but only those due to lack of transportation, quantity of ore, or other causes more properly belonging to such geological notes, rather than to a business directory. Nor has it been within the scope of this report to make full notes on the mineralogical features or lithological characters of the rocks, in consequence of a lack of time just now for the preparation of such descriptions, and because of the difficulties attending the whole subject of rock classification. The results of such a study will be reserved for a future and final report on the Azoic formation of the State. The geological features have been made prominent almost to the exclusion of the mineralogical. These statements will explain any errors and some omissions incident to such brief notes. They are put before the public in the hope that together with the accompanying map they may help to solve some of the perplexing questions of iron mining or searching for ore, or suggest new lines and localities that may develop into working and profitable mines.

The order of arrangement in these notes is based upon the subdivision of the iron ore district into four belts, running

across the State from southwest to northeast. The boundaries of these subdivisions are given on a preceding page, and they can also be seen, together with mines and ore localities, on the geological map of Northern New Jersey accompanying this report. Beginning at the southwest end of the eastern or *Ramapo Belt*, the several mines are described in order, going towards the northeast to the State line. This is followed by the *Passaic Belt* in the same order, from southwest to northeast, and the grouping is geographical, by townships, rather than by ranges. The same order is observed in the description of mines in the *Musconetcong* and *Pequest Belts*.

MINES OF THE RAMAPO BELT.

SOMERSET COUNTY.

Bernardsville.—Ore was discovered and considerable digging done upon two or three farms near Bernardsville, Somerset county, in 1871. This was done by John Webb, of Chester. Since it was first opened but little has been heard of it, and it has not been visited a second time. The present lessees are parties in Dover. The New Jersey West Line Railroad, now running to Bernardsville, offers an easy outlet for ore.

Janes Mine on Mine mountain, has not been worked in many years.

MORRIS COUNTY.

Connet Mine.—This mine was opened in 1869 on an old tunnel near the Whippany river, on the farm of Stephen Connet, Water street, Mendham township, Morris county. The old adit or tunnel starting near the river penetrated the hill a distance of two hundred feet, and was probably driven in search of copper ores. In reopening the mine this tunnel was followed to the vein and then the latter was followed in a southeast direction about three hundred feet further, where the drifting was stopped in consequence of the ore diminishing so much in breadth that it was not profitable to work. Below this tunnel

a second drift has been worked in a southeast direction, on the course of the vein, and has reached a point nearly five hundred feet from the surface of the hill at the old adit-tunnel mouth. Throughout this distance the strike of the vein is southeast, the dip towards the southwest at an angle of forty-five degrees and the *pitch* of the *shoots* of ore is towards the southeast. In this direction of the strike and dip the vein is an exception to the usual mode of occurrence of ore-veins in this State. This unusual direction is probably of limited extent, and further openings may show a curve around towards the east, and ultimately towards the northeast, the usual strike of rocks and ore-veins in the Azoic formation. The width of the vein varies from four to seven feet, between rough and irregular walls. Near the surface the ore was very much altered by the decomposition of its constituent minerals, and hence had to be washed to remove the earthy matter. In places there is some hornblende and a little pyrite. The rock of the walls is a dark colored hornblendic gneiss with irregular masses of pyrite scattered through it. In the vein the pyrite is most commonly in the hornblendic portions. The tunnel serves for drainage and for the removal of the material mined. The product has averaged three to four hundred tons per month, and this has been shipped from Morristown for the Musconetcong Iron Works at Stanhope.

Taylor Mine.—On George Taylor's farm, near his residence, east of Mine Ridge and near Taylortown. This is an old locality which W. S. DeCamp reopened the past season. He found a vein from two to three feet wide of rich ore—striking nearly east and west. About fifteen years ago three hundred tons of ore were taken out and sent to Ringwood. None has yet been shipped from the last work done by DeCamp.

Kahart Mine.—In Pequannock township, east of the Bloomingdale and Boonton road and about three miles from Bloomingdale. The old mine-holes are close to the road leading to Pompton Plains and on the crest of a low ridge. The ore from these old workings is very rusty, and has a large amount of pyrite quite uniformly scattered through it. From these open-

ings a small vein of sulphurous ore can be traced northeastward following the trend of the ridge and near its crest line. The dip of the strata which crop out on this ridge shows everywhere a moderately steep dip towards the northwest. This direction of the dip is rarely seen in the gneissic strata of New Jersey, and this feature gives the locality more than ordinary interest, considered geologically. In addition, this locality merits particular attention as the first, and so far, the only place where the diamond drill has been used in searching for iron ores in our State. The work was done during the past summer by a drill from the American Diamond Drill Company, of New York, under the direction of J. W. Hussey, of Bloomingdale. Two veins were discovered; one, three feet thick, the other from three to six and a half feet. And on the latter a shaft sunk twenty feet found the thickness to average four feet. Further development of the property was stopped by the financial crisis in September last. Samples sent to the Survey Laboratory from this shaft were found to contain

52.34	per cent.	of metallic iron,
0.17	"	" phosphorus,
1.23	"	" sulphur,
1.40	"	" titanic acid,
21.20	"	" rock.

The percentage of phosphorous is low and that of the sulphur is not large.

Lanagan Mine.—About two miles northwest of Pompton Plains village and near the southeast border of the gneiss rocks, there are several shafts in which lean ore has been found. As there was no work doing when visited nothing definite was to be learned. Judging from the surface a great deal of prospecting has been done.

De Bow Mine.—South of the last mentioned workings and on the adjoining property, there is a long line of attraction, which was opened last year by De Bow and Barnes. The results of their work were not learned.

Jackson Mine.—(Pompton Mine of the "Geology of New Jersey"), one mile west of Pompton church and a few rods south of

the Bloomingdale road. This was reopened and worked during a portion of the past year by the lessees, Sutherland and Axtell. The vein is small and much disturbed by a coarse crystalline granitic dike which was struck in the main shaft. About five hundred tons of sorted ore had been mined when visited in July. The rock of this dike includes magnetite as one of its mineral constituents, together with feldspar and quartz. The attraction is strong over a wide area on the strike of the strata, which is towards the northeast. Over most of this ground, the south or negative end of the needle is affected.

The composition of average ore from this mine is here given,

Silica,	9.80
Magnetite,	73.15
Alumina,	9.48
Lime,	1.46
Magnesia,	0.72
Phosphoric acid,	0.54
Titanic acid,	4.40
Sulphur,	0.06
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	99.62
Metallic iron,	52.96
Phosphorus,	0.23

The unusually large percentage of titanic acid is noticeable.

Ryerson's De Bow Mine.—One hundred and fifty yards south of the Pequannock river and at the foot of the gneiss ridges, on the west side of the Plains. This, too, is an old mine locality, at which additional explorations have been carried on during the year by Martin J. Ryerson, of Bloomingdale. In a shaft about twenty feet deep the ore was found nine feet wide and dipping towards the southeast. With the ore a little pyrite was observed, but this is said to be rare in the ore at the bottom of the shaft. Hornblende also accompanies the ore, but not in sufficient quantity to make it at all lean. The attraction at the shaft and for one hundred feet on the strike of the vein is strong and positive. Two trial pits southwest of the shaft uncovered a lean ore. The Bethlehem Iron Company hold this property under a lease from Mr. Ryerson.

PASSAIC COUNTY.

Kanouse Mine.—This old mine, at the foot of Ramapo Mountain and east of Wynokie, has been reopened and worked within a year, but was not in operation when visited last summer. There are four shafts in addition to some surface diggings. The vein dips towards the southeast and the ore is very hard, compact, close-grained and mixed with a very white sulphide of iron—probably marcasite. A New York company own the property. The geological features of the locality are interesting, as close to the vein there is a crystalline limestone outcrop containing a large percentage of serpentine, and joining this, in immediate contact with it, and conformably stratified with it, is a greyish gneiss, traversed by numerous small quartz veins.

On the broad and elevated Ramapo Mountain range, belonging in this belt, the only mine which has been worked or which can be designated as such, is the *Butler Mine*. Local attractions are reported, but no explorations beyond the use of the compass have been made.

In this belt, beyond the State line, the following mines have been opened, viz.: *Hogencamp, Pine Swamp, Sure Bridge, Harris, Greenwood* and *Bradley*, near the Greenwood Iron Works, and the Forest of Deau Mine—all in Monroe township, Orange county, New York.

MINES OF THE PASSAIC BELT.

HUNTERDON COUNTY.

Large's Mine.—Round Valley, Hunterdon county, southwest of Lebanon and west of Round Valley, J. K. Large, of White House, has done much work in searches for ore. One shaft is ninety-five feet deep, showing a vein of mixed ore and rock six to eight feet wide, between walls which run east and west, but not ore enough for profitable mining. In some of the trial pits

on this property the strata were found having a northwest and southeast strike—the lines of attraction having the same course. The attraction is not, however, anywhere very strong. In several of these holes the ore was found to be in thin layers or strings which ran out below. At one point the ore appeared to be entirely replaced by black hornblende, while the walls continued their regular course and dip. In all of them the rock for several feet down was very much disintegrated and crumbling from the decomposition of the feldspar and hornblende.

High Bridge.—The old mines here have been steadily worked by the Thomas Iron Company, yielding several thousand tons of ore yearly. Southwest of the old workings a continuation of the vein was uncovered on lands of Mr. Creagor, and a considerable amount of ore taken out by J. K. Large, of White House. The mining was driven up to the old company's line. During the past year the High Bridge Iron Company has been at work here—mainly in the way of exploration.

Old Furnace Mine.—On the farm of H. H. Creamer, near Beaver brook, in Clinton township, about two miles east of High Bridge. A great deal of work was done here about a hundred years ago for supplying in part the old furnaces of this neighborhood. About four years since this vein was opened on the adjoining farm, belonging to G. N. Alpaugh, by J. K. Large and Isaac Hummer, and afterwards worked by the Union Iron Company of High Bridge. The vein was found to be large in fact no clean foot wall was reached. On the hanging wall there was a string of rich ore—in places widening to three feet. The ore contained a large percentage of sulphur. The main shaft was about eighty feet deep, and from this the vein was opened by several drifts, so that the surface was thoroughly tested.

Cokesburgh Mine.—On the farm of O. W. Farley, three hundred yards east of the village of Cokesburgh, Tewksbury township, Hunterdon county. The history of this mine is very similar to that of the Old Furnace mine, having been opened before the Revolution, and again, about ten years ago by Hummer, Large and Conover, and afterwards, in 1872, by the Union

Iron Company. Here the ore was very rich and with only traces of sulphur, but the vein was so small, (from ten inches to two feet wide when stopped), and the quantity of water to be pumped so great, that the mining was unprofitable. The ore was very much liked by furnace men and commanded the highest market price.

Fox Hill Mine.—This is of so recent a date, having been opened in November, that it may be premature to dignify it with the above title. The diggings are on the lands of Henry Fisher and George Sutton, near a tributary of the Rockaway creek, and about three quarters of a mile south southwest of Fox Hill M. E. Church. There are several holes on the Fisher property, but when visited a few weeks ago, these were so filled with earth and water that the extent of the ore was not made out. In an adjoining field on Sutton's farm a shaft then sinking had struck ore of very good quality. The attraction is said to be strong and steady for a long distance and a great breadth of ore is reported as having been uncovered in the Fisher openings.

Pottersville Openings.—In the vicinity of Pottersville three distinct veins have been worked within the past two years. The first to be described is on the lands of Potter brothers, about one mile west of the village and near the Fairmount road. Here a vein five feet wide, between hard and firm walls, and running east and west with the hill, has been opened about fifteen feet deep, and about one hundred tons of good ore taken out. As it is about two hundred feet above the brook the drainage by an adit at the foot of the hill will be easy.

Another opening in this vicinity is on lands of J. V. P. Bartles, about half a mile northwest of the village and near the Fox Hill road. This vein is said to be five feet wide and the ore of good quality. The locality was opened by S. W. Seals and others, and has recently been sold to other parties.

MORRIS COUNTY.

Northeast of Pottersville about half a mile, and near the

Chester road, the Dover Iron Company did considerable work on a small vein of very good ore. This was stopped about a year ago.

About two miles west of Pottersville a vein is reported by the Dover Iron Company, but its exact location is not known, nor the results of their explorations.

Rarick Farm.—About a mile southwest of Hacklebarney and a few rods east of the road leading to Fox Hill, parties are now digging and finding ore. The work is not far enough advanced to write more with any degree of certainty. Northwest of this road and west of the Rarick diggings, a line of attraction is being tested by L. W. Langdon, of Chester, on what has been known as the *Pitney Farm*.

Hacklebarney and Chester.—Since 1868 the mining operations between these two points have been very greatly expanded. The old mines have been vigorously worked, and discoveries of great extent have been made. Much of this increased activity has been due to the completion of the Chester Railroad and its extension southward towards the Hacklebarney mines. The building of the projected High Bridge and German Valley Railroad will offer another and more direct outlet towards the Lehigh furnaces, and no doubt stimulate to still greater production. The capacity of these mines is very great and with cheap transportation they can furnish an immense amount of ore, considerable of which is sufficiently pure to be used for Bessemer steel.

The mines of this district appear to be nearly all in two lines or on two more or less continuous veins. They are about one thousand feet apart and have a parallel course from southwest to northeast. Beginning at the southwest the eastern range includes an old opening on the Hacklebarney property south-east or east southeast of the old mine, the Skellenger or Samson mine, the Chester hotel property, the Collis shafts and the Swayze mine north of Chester. The western line includes the main Hacklebarney mine, the Gulick mine, Hedges property; Peach-orchard or Creager mine, Hedges mine, Dickerson farm, and the Creamer openings near the Congregational church, west of the

village. East of these lines the Budd and Woodhull mines, and the Child's openings may constitute a third range or vein.

Hardin Farm.—One mile south of Chester and west of the Peapack road. Some digging was done here in 1869 by Theo. P. Skellenger, of Chester, and ore in strings and thin veins found, but no further explorations have been made.

Budd and Woodhull Mines.—These are on a line parallel with the Skellenger vein and about half a mile south of the village of Chester. The Budd mine was opened in 1867, and worked a short time by the Chester Iron Company. The Woodhull mine southwest of the Budd, has been pretty thoroughly tested by J. Webb, who worked it for the Musconetcong Iron Works at Stanhope. It is now idle. At one time the vein was eight feet wide, but deeper, the ore seemed to be replaced by what may have been a horse of micaceous gneiss, as the wall rocks continued their regular dip as deep as the workings went. The rock in these was dark colored and very largely made up of hornblende, differing very materially from the rock with the ore. The dip also changed from seventy degrees at the top to about fifty degrees near the bottom. This would indicate a *shoot* structure, the vein being *pinched* up by the *roll* of the walls. The ore is very firm, highly crystalline, and very rich. It was reported as making iron of excellent quality. The prismatic structure of the ore is very marked. Between the main shaft and the Budd openings the attraction and surface diggings show two faults or offsets, the one towards the southeast, and the second towards the northwest, and each throwing the vein about two hundred feet, so that the working shafts of the mines are on a line.

Proceeding towards the west, the most southern of the first or southeast range is an old mine hole on the Chester Iron Company's Hacklebarney property, about three hundred yards east southeast of the Open Cut Mine. This was going in the old forge times, since which nothing has been done in it.

Topping Farm.—In Chester, this belongs to the Union Iron Company of High Bridge, and both the ranges cross it. The only openings yet made were shallow trial pits on the south-

eastern range which crosses the property from the adjoining Skellenger shafts in front of the old dwelling. Ore was found in these, but the diggings were not deep enough to determine the extent of the ore outcrops. Southwest of these the compass shows a long and steady line of attraction, running towards the above mentioned old Hacklebarney mine holes.

Skellenger or Samson Mine.—This was opened in 1867, and had been going quite steadily up to the financial panic this year. The mining has been to remove the ore along the whole line rather than to penetrate deeply, and hence none of the shafts exceed one hundred feet in depth. A remarkable feature here, is the comparatively great extent of the changes which the ore has undergone through surface agencies. These are seen in the crumbling, disintegrated rock and rusted and desulphurized ore which are found quite to the lowest levels yet opened. The vein is said to be quite uneven, but to average five feet in width. The surface ore was washed before shipping. The compass shows frequent changes from positive to negative attraction which can be traced towards the northeast, crossing the road on to the Hotel Property. This mine is worked by the Samson Iron Company.

Hotel Property.—Here there are three shafts lately put down by A. N. Elliott, for the Lehigh Valley Iron Company. The vein has been thus opened, but nothing definite was learned of its size or of the character of the ore.

Collis Farm.—This property is held by the Coleraine Iron Company, and is now being tested by them. When visited in December, about seventy tons of wash ore had been sent away and a large pile on the bank had not then been washed. No blue ore had been found, although a shaft down forty-five feet on the dip of the strata had been driven some distance in a hard grey feldspathic gneiss. Between this and the Hotel Property a little ore was got from a pit on this line, on the Creamer farm. All these openings are to be regarded as explorations and not mines.

Swayze Mine.—A short distance north of the village, and worked by the Chester Iron Company. The openings extend

entirely across this property—a distance of three thousand feet, to General N. A. Cooper's line on the northeast. The first openings were made in 1870, and since that time it has yielded several thousand tons of ore. The attraction can be traced along on the line of the openings and thence on Cooper's lands for a long distance. As thus opened the vein varies from twelve to eighteen feet in width, including in places, a horse of rock three feet across, and dips about forty-five degrees towards the southeast. The rock of the walls is a greyish feldspathic gneiss. For forty feet down, the rock and the ore were much altered, the latter having a rusty appearance and so soft as to be got out without much blasting, thus resembling the surface ores in all the mines about Chester. The rottenness of the rock necessitated close timbering, making the extraction of the red ore quite costly. Beneath this the rock is firmer and the ore is bluish black, quite hard and contains some sulphur. According to an analysis of average samples sent to our laboratory the chemical composition is as follows:

Silica,	11.50
Magnetic oxide of iron,	81.79
Phosphoric acid,	0.18
Manganese,	trace.
Titanic acid,	0.00
Sulphuric acid,	0.31
Iron disulphide,	3.02
Sulphur,	1.59
Phosphorus.	0.08
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Metallic iron,	59.21

The lime and magnesia with the alkalies were not determined. These would probably fill up the deficiency between the total of these constituents given and one hundred.

Some of the sulphur exists in the form of iron sulphate, and is reckoned above as sulphuric acid, but the most of it is in combination with iron alone, as iron disulphide or pyrite or more commonly known as *iron pyrites*. While the sulphur percentage is quite high, that of the phosphorus is low. If this

should represent the ore mined here, it might be tried for making Bessemer metal.

On the western range or vein beginning at the southwest end, the *Hacklebarney Mine* is first to be noticed. The earlier work here for the supply of the forges was confined to shallow pits and open cuts, removing the red weathered ore within a few feet of the surface, and leaving the blue ore as undesirable for forge purposes. Since the preparation of the report on this mine in 1868 a vast amount of work has been directed towards the more thorough exploration of the veins on both sides of the Black river. The new shafts and extended open cuts show a wide vein or series of veins half a mile long, verifying the sanguine statements made in that report concerning the probable extent of the ore. On the hill west of the river the openings show at least two distinct veins which are traceable towards the northeast, down the hill, across two off-sets displacing them towards the southeast, to the open cuts on the east side and close to the stream. The amount of displacement is said to be about seventy feet at the river road, although from the line of strike in the open cuts on each side it would appear to be greater, over one hundred feet. The largest amount of work has been in the open cuttings, on the east of the stream. These show three veins, of which the most westerly has been followed about six hundred feet in an open drift running in a little above the level of the river, and removing the ore and its slight covering of earth and boulders to the present heading. The stratification is very distinctly seen, and the dip is towards the southeast, between fifty and sixty degrees. The average breadth of beds removed is about twenty feet; in places this amounted to twenty-five feet. But in this space some layers of rock (horses) were included. A true hanging wall is not reached in this open cut, and but a few feet from this a second vein of lean ore is opened near the river, and a few yards further there is a third. As these last two have but just been uncovered, nothing can be said of their extent towards the northeast. Beyond the main open cut going northeast on the top of the hill, several shafts have struck workable thicknesses

of ore, so that altogether there is a great deal of ore *in sight* on this property. Pyrite is very generally distributed through the vein, but in larger proportion in some thin beds, so that by care in mining and a little sorting the amount of sulphur may be reduced much below the average of the whole. In the large open cut both the ore and rock are very hard, and but little weathered quite to the surface. In the southeastern openings there is more rock and a great deal of mica with the ore. The per centage of some of the constituents of this ore, represented as averages from the open cut and the river stopes is here given, viz.:

	Open Cut.	River Stopes.
Insoluble matters, - - - -	12.20	23.35
Metallic iron, - - - -	59.21	52.03
Sulphur, - - - -	3.78	2.33
Phosphorus, - - - -	0.08	0.03
Titanium, - - - -	0.00	0.00

Gulick Mine.—Ore was discovered on this farm some years ago, but not much was done until 1870 when it was again tested, and in 1872 the Union Iron Company leased it. A shaft sixty feet, with short drifts, has allowed the removal of some red ore which has been sent away. Very little work has been done in the blue ore. The surface ore contains considerable hornblende and mica in laminae alternating with the magnetite. The attraction is strong over a wide belt on the strike of the vein. At the southwest the line approaches the Hacklebarney road, and then crosses it, so running to the Chester Iron Company's property.

Creager or Peach Orchard Mine.—This is about a mile from Chester and a few rods south of the old Washington turnpike. The attraction here for six hundred feet on the course of the vein was positive, with a deflection of the dip needle of from twenty to seventy degrees, and constant over a breadth of seventy-five feet. Several shafts and drifts since made, have proved a workable vein, whose upper portion consists of the red, rusty looking ore so common to all the Chester mines, mixed with some earth and rotten rock, in which there is much

mica. This mine has been worked by S. W. George, of Chester, and considerable ore taken out of it.

Hedges Mine:—Three-quarters of a mile southwest of Chester and about one hundred yards northwest of the Hedges' farm house. Here the Union Iron Company, of High Bridge, has done a great deal of work, and in the first year's mining raised about ten thousand tons of ore. The workings consist of a wide open cut descending towards the northeast, which is about three hundred feet long, and at the heading, fifty feet deep. A few yards beyond, in a northeast direction, the vein is further opened by a vertical shaft and a level which has been driven each way out connects with the open cut. The foot wall is a greenish gray feldspathic gneiss, very firm, and dips sixty degrees towards the southeast. It is wonderfully regular in its dip and well defined, so that the ore comes off very readily. The ore as worked measures twenty-five feet to a horse of rock, which is about six feet wide; then there is another vein whose thickness is not yet known. As exposed near the surface it is at least five feet in width. Most of the ore taken from the open cut was got out with a pick and then hoisted by means of two steam derricks on to the bank. Very much of it had lost its sulphur, and was rusty and mixed with rotten rock, requiring washing before being shipped. In the hard blue ore from below there is some pyrite quite uniformly distributed through it. According to analysis of samples collected during the mining, the sulphur amounts to two and forty-six hundredths per cent., the phosphorus to forty-five hundredths per cent., and the metallic iron to fifty-three per cent. The ore is dumped into cars which run from the mine on a short branch railroad to the Chester Railroad extension. It is worked at Harrisburgh, Pennsylvania, into pig for the Pennsylvania Steel Works, where it is used for making Bessemer steel. From the shaft northeast the attraction is quite steady to the *Dickerson Farm*. On this farm there are two shafts out of which ore has been raised. It is lean, the magnetite being mixed with mica and a decomposed hornblende. The line of attraction from these shafts is said to run across the Topping and Hedges farms to the Chester road

near the Congregational church. North of this road, and west of the church, this vein is opened on the *Crear er Farm* by the Coleraine Iron Company.

From the character of the ore and the associated rocks and from the observations with the dip compass, these several points opened appear to belong to continuous veins, or if interrupted and broken, to a series of veins parallel to one another and comprised in a quite narrow belt. The compass would fail, unless the observations were much more carefully noted than is customary with practical ore hunters, to show breaks or offsets. Systematic and minute magnetic surveys would do much to settle the question and reconcile the discrepancies existing between the statements of those who are conversant with iron mines in this district.

De Camp Mine, on the farm of David S. De Camp, one mile northeast of Chester and near the road to Dover. This locality was opened in 1869, at three shafts, all within a few rods of the farm house. One of these was reported to be eighty feet deep. The ore seen on the bank is moderately fine crystalline and apparently of good quality, containing but little rock and very little pyrite. Judging from the dump materials, the accompanying rock is a grey hornblendic gneiss. The attraction observed was from fifteen to thirty degrees positive. No ore had been shipped at the time it was visited.

The Leake Mine has not been worked since 1869.

Daniel Horton Mine, in Chester township, about two miles northeast of Chester village, and a few rods southeast of the road leading to Dover. Although first opened in 1867, this mine was not fairly in operation until the following year. After about four thousand tons of ore had been mined it stopped in 1870. One of the slopes is one hundred and sixty feet down, dipping with the vein about fifty degrees towards the southeast. The ore varies in thickness from four to nine feet. A small percentage of rock, mainly quartz, occurs quite uniformly disseminated through the ore matrix. Some of it has been worked in Segur & Lewis' bloomery forge, at Shippenport, and is said to

have made a very superior iron. Between the two main slopes the stopes have not been worked out, so that there is a large quantity of ore *in sight*. At the bottom a *roll* of the hanging wall *cuts out* most of the ore. This may not continue very far, and deeper sinking may prove a wider and workable vein. From appearances, this ore is quite free of sulphur and phosphorus. Waterman & Beaver, of Danville, Pennsylvania, are the proprietors. Edmund Canfield directed the mining operations.

Barnes Mine, near the Dover road, three miles northeast of Chester. This was opened in 1869, and worked steadily for three years, under the management of E. Canfield, yielding several thousand tons of ore, which was sent to the Stanhope furnaces. The vein was opened more than five hundred feet in length, and some of the slopes went down about one hundred feet. The dip was sixty degrees towards the southeast, and the average thickness of the ore four feet. Three offsets, about the width of the vein, were found in the progress of the mining. Accompanying the magnetite there is considerable quartz and a little hornblende, making the ore rather lean.

RANDOLPH TOWNSHIP.

David Horton Mine, in Randolph township, about three miles south-southwest from Dover, and a short distance south of the Walnut Grove and Succasunna Plains road, Edmund Canfield, lessee. Here there are three small veins within a few yards and dipping steep towards the southeast. The mining operations are carried on through four shafts, of which the deepest is down one hundred feet. Some of the ore, as seen on the bank, is very rich and fine-grained, but the greater portion of it is mixed with a little rock, occasionally masses of pyrite and small, greenish grains of apatite. The rock coming from the walls is a hard, light gray laminated mixture of brownish mica, glassy quartz and orthoclase.

An average of the ore on the bank, at the time of our visit, was analyzed, with the following result, viz :

Silica, - - - - -	16.15
Magnetic Oxide of Iron, - - - - -	68.48
Alumina, - - - - -	3.34
Lime, - - - - -	4.87
Magnesia, - - - - -	1.94
Titanic acid, - - - - -	1.09
Phosphoric acid, - - - - -	3.01
Water, - - - - -	0.40
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Total, - - - - -	99.28
Metallic iron, - - - - -	49.57
Phosphorus, - - - - -	1.30

The per centage of phosphorus comes from the apatite granules in the ore, and when it is remembered that some of our best New Jersey ores contain this mineral, this analysis need not appear as disparaging to the character of the mine.

DeHart Mine:—Northeast of the *David Horton Mine* and north of the Walnut Grove and Succasunna Plains road. The report in 1868 speaks of the attraction here as very strong, but the searches had up to that time been unsuccessful. Later explorations have discovered a wide vein, in places fourteen feet, but including thin horses of rock. The dip is almost vertical and towards the southeast. The ore coming from the top of the vein was mixed with some earth. This character continues but a few feet, to the more solid bluish-black ore which contains some quartz, hornblende, and a very little pyrite. The present workings are southwest of the first explorations, and since 1871 E. Canfield has had the mine. The line of attraction is said to be traceable southwesterly across the road to the *David Horton Mine*, and northeastward across the Lawrence property to the *Carbon Mine*.

Carbon Mine:—About two miles south of Dover, it was formerly known as the *Dalrymple Mine*. In 1868 it was comparatively new in its workings. Since that time the Carbon Iron Company has mined a great deal of ore, opening the whole length of the vein on their property nearly half a mile, from

the Lawrence boundary line to the *Trowbridge Mine*. The main workings are at the northeast, near the latter mine lot, and have attained a depth of about two hundred feet, measured on the dip of the vein, which is very steep towards the southeast. Several small faults or offsets have been met with. This vein in its varying thickness is a good example of the lenticular or *bean-shaped* form so characteristic of our iron-ore beds. More extensive opening will probably show a succession of such irregular masses, or *shoots* of ore, so finely exhibited in the Mount Hope, Ringwood, Weldon, Hurd and other old and large mines. In the most northeasterly stipes the vein has measured eighteen feet in width, pinching up in a few yards to a single layer not over as many inches thick. Descending the *pinch* is sometimes due to the change in the dip of the hanging wall, *cutting out* the vein. Another observed feature is the continuation of the dip and of course the walls, while the ore is replaced by rock. This irregularity in the thickness renders it impossible to make an approximation as to the average width of the ore. Very much of the material from the vein is very lean, or more correctly stated is rock having magnetite, or ore as one of its constituents, so that there is a regular gradation from workable ore, lean ore, rock with fifty per centum of ore to that wherein it enters but sparingly. In many cases the magnetite is arranged in parallel laminae or thin layers with the other rock minerals, but more often it is disseminated uniformly throughout the whole mass. No pyrite was seen in any of the ore on the bank at the time of our visit, and it is said that there is no sulphur in it. The rock of the walls is a grey feldspathic gneiss, separated on the foot wall side from the ore by a thin layer or selvage of mica schist. The dip compass shows a positive attraction which is nowhere very strong. At one of the offsets this changes to negative, following the course of the vein. The mine is in low and swampy grounds, and in wet seasons much water has to be raised. The ore is carted to Dover whence it is sent to the company's furnaces at Parryville, Pennsylvania.

Lewis or Herrick Mine.—This opening is on the farm of Aaron Lewis, two miles southwest of Walnut Grove, and near the Mendham township line. There are three shafts east of Lewis' house and Indian brook. One of these was reported to be one hundred feet deep, and the vein in it from four to six feet in width. When visited it had been abandoned, and consequently very little could be learned about it. The ore left lying about the mouth of the deeper shaft was coarse crystalline and mixed with a greenish mineral very much decomposed. No work has been done here since 1870.

Combs Mine.—This is an old mine, reopened in 1864, and stopped again sometime since. The most reliable information was that the quantity of ore was large, but much of it was too lean to mine and cart several miles to the railroad.

Cooper Mine, two miles south of Dover. This locality was worked a little by the Boonton Iron Company. Since 1870 it has been idle.

Solomon Dalrymple Farm, south of Dover and adjoining on the northeast the Trowbridge Mine. A. Beemer, of Dover, has here met with some success in his searches for ore, but nothing further is at present known.

Canfield Mine, a new mine on the Dickerson estate, north of Dickerson Mine. Most of the work has been done during the past three years. At the engine shaft the vein was in places twenty feet wide, but of this from five to ten feet was rock. Southwest of this, and at the border of the meadow, there is an old incline ninety feet long. Here the vein measured seven feet. The ore from the shafts in the meadow has mixed with its magnetite a little quartz and feldspar, but no mica nor pyrite. An analysis reports only traces of phosphorus. The jointed, columnar structure seen in some of the Dickerson Mine ore, is quite a common character of this ore also, and as at other localities where observed, the planes of cleavage traverse the ore at right angles to the plane of the dip, *i. e.*, they run from wall to wall across the vein. In this they resemble the joints in our basaltic trap rocks. About two hundred feet west of this vein another has been opened by a shaft and consider-

able drifting. This vein dips more gently (about forty degrees) towards the southeast, and measures from four to six feet between its walls. A portion of this breadth is filled with rock, varying the thickness of the ore from one to five feet. The figures given here applied to the workings about a year ago. The mining since may have changed some of them. The Dickerson Mine railroad, passing near the workings, gives a ready means of transportation, and dispenses with the necessity of so frequent handling. This mine is worked for the Dickerson Mining Company by E. Canfield. Over six thousand tons were mined during the year.

Canfield Phosphatic Iron Mine.—This vein of mixed apatite and magnetite is near the road, a few rods northeast of the Ferrumonte store. No work has been done since the publication of the annual report for 1871, in which it was described at length.

J. D. King Mine, on the north end of King's hill, southwest of Port Oram. This is supposed to be a continuation of the Johnson hill vein. The ore was of very superior character, but on account of the small size of the vein, its extraction was too expensive for profit. In 1871 the same line was opened further towards the southwest and near the crest of the ridge. Here also the small amount of ore obtained stopped further work.

At the foot of the hill, bordering the Succasunna Plains, and near the Dover and McCainsville road, a vein fifteen feet wide is reported by A. Beemer, of Dover, under whose direction the searches at this point were conducted.

Of the older mines in Randolph township the *Henderson, Bryant, Connor Foulan, Charles King, King, McFarland, Evers, Brotherton, Erb and Scrub Oak* have not been worked to any extent for several years. The uninterrupted work at the *Dickerson, Byram, Baker, Millon, Randall Hill, Jackson Hill*, and the *Irondale Mines*, has added largely to the dimensions given for some of these mines in their descriptions published in 1868, and proved the continuity of workable veins to depths beyond which the expenses of hoisting and drainage will be too large for profitable mining. The deepest of these mines and the deepest in the State are the Byram, whose slope measures seven

hundred and thirty-five feet, and the Dickerson, which is six hundred feet. For the removal of the water from these depths very heavy machinery is indispensable.

The extension of the drifts and the new shafts with their stopes are slowly bringing the mines together, proving the great longitudinal extent of some of these lines. Some of the intervening gaps will, in this way, soon disappear, and we shall see a great vein or sheet of ore, or if not continuous, a belt of veins occurring in a sort of step-like or *en echelon* arrangement upon the upturned edges of which are the several excavations known as mines. So far as penetrated downwards the same general laws of structure and general characters of the ore are found as in the workings nearer the surface. The *pitch* of the *shoots* and the dip are found maintaining remarkably constant angles, and the deviations from the general direction or degree of inclination are short.

ROCKAWAY TOWNSHIP.

Nearly all of the old mines in this township are in operation and much deeper and longer in their workings than in 1868, as then described. Since that date the *Washington Forge Mine* has been deepened over one hundred and fifty feet, and opened over two hundred feet in length. In fact it has been almost entirely developed in this period. The Carbon Iron Company work it.

The *Mount Pleasant Mine* has been steadily worked and very much increased in the length and depth of its workings. The interesting series of *faults* or *offsets* by which the vein here has been broken across, includes several recently discovered and larger displacements, all of which will, by the aid of a mine map and sections, very fully exhibit this structural phenomenon of our iron ore veins.

Baker Mine.—Here, too, the amount of work done has been large, and the bottom in the southeast vein is three hundred and twenty-five feet down, and the extreme length of the stopes here, three hundred and thirty-five feet. The size of the vein, free of

rock, the regular dip of the footwall and the great thickness of the earth and rotten rock covering the strata on a part of this property, are very remarkable. This together with the extent of the several workings are to be seen in a mine map from a recent survey accompanying this report. For over two hundred feet down, there was no firm hanging wall and a portion of the ore was left supported at intervals by pillars in place of rock. The Allentown Iron Company, working this mine, are sinking a shaft southwest of this and near the Mount Pleasant turnpike, east of the *Mount Pleasant Mine*. This is on the strike of their southeast vein, and the expectation is to go through the rock on the hanging wall side, several hundred feet, to the vein worked in the Mount Pleasant Mine. A third vein has lately been opened on the Baker Mine property, twenty-five feet west of the main northwest vein. It is small in comparison with the two here worked.

The *Richards, Allen and Teabo Mines* are all yielding large amounts of ore annually, and are important links in this wonderful chain of mines stretching from the Dickerson to Mount Hope. At the *Allen Mine* a tunnel is being driven west from the *Teabo vein* or main vein here worked to strike the big or jugular, Mount Hope vein, which is supposed to cross the property about three hundred feet west of the present line of openings. When last heard from, this distance was almost reached without as yet crossing any workable veins.

Mount Hope Mines.—The very extensive mining operations here conducted and producing annually over one hundred thousand tons of ore, justify more than a passing notice in this description of new mines and workings. The changes since 1868 are so great that a supplementary account is almost an impossibility. The most of the ore mined here, comes from slopes on the jugular, or Taylor, the Teabo and the Brennan veins in Mount Hope, and the jugular vein in Hickory Hill. The big tunnel cutting the veins in Mount Hope about two hundred feet below the summit of this hill, serves for the removal of ore above its level, and also for very much that is mined in the stopes of the Sturgis Mine on the jugular vein, the

bottom of which is one hundred and seventy-five feet below the big tunnel level. This vein has been opened underground all the way to Hickory Hill, displaced, however, at the brook at southern base of this hill about one hundred feet towards the east. In Hickory Hill the vein has been worked from two hundred to two hundred and seventy feet in depth for several hundred feet on its course. Such extended openings have brought out, in a most striking manner, the *shoot* structure of magnetic iron ore veins showing the *pinches*, *swells*, *pitch* and *dip*, characterizing them to an extent seen nowhere else in the State. In a full report, these features of this large mine will be noticed at length after more careful examinations shall have furnished the facts for such a description.

East of the Mount Hope veins, two additional veins have been opened in Hickory Hill, but are not now worked.

Johnson Hill Mine.—The Crane Iron Company worked here for several years—up to 1869, since which nothing has been done beyond some surface explorations.

Huff Mine.—This old mine formerly worked at intervals by its owner, Mr. Huff, has during the past three years, been quite actively driven, the ore going to the Port Oram furnace.

Dolan Mine is a short distance north of the Mount Pleasant turnpike and west of the Baker and Richards mines. It was opened in 1869 and worked a short time by the Crane Iron Company. A shaft one hundred and twenty feet deep is said to have passed through three shoots of ore, but they were small and the ore was lean, excepting some got near the surface. On the foot wall the ore limit was clearly defined, but on the hanging wall side, the ore and rock were mixed.

Swedens Mine.—The Boonton Iron Company work this mine. The line so far opened is about thirteen hundred feet long and the bottom drifts two hundred and twenty feet (vertical) deep. The per centage of metallic iron in this ore is reduced considerably by the amount of hornblende quite uniformly distributed through it. But this is compensated by the facilities in mining afforded by the firm walls and the excellent arrangements for

removing the ore and water from the mine. The ore is shipped by the Morris canal to Boonton.

Sigler and White Meadow Mines have not been going for several years.

Hibernia Mines.—This long and rich line of ore is furnishing every year a very large aggregate product through the steady operations of the several companies here at work. A careful survey of the whole line has lately been made, and a tunnel is being driven in on the course of the vein from the Hibernia brook valley, at the southwest end of the ridge, which is intended to relieve the shafts on the hill by furnishing a more ready exit for the ore and the mine water. Eventually this tunnel will be continued throughout the several mines to the north end of the hill.

Beachglenn Mines are still worked by the Boonton Iron Company.

Tichenor's Diggings.—On the strike of the Beachglenn vein prolonged towards the northeast, David Tichenor, of Newark, has sunk three shafts and found small quantities of ore. The attraction is said to be continuous from the Beachglenn mines to these shafts, and the rock here resembles that at the mines. The financial crisis temporarily stopped the explorations, so that decisive results are not yet had.

Righter Mine:—West of Meriden and south of the road leading thence to Splitrock. Of the extent of work done here nothing certain is known. A chemical examination of the ore showed it to be of good quality, with a small per centage of titanitic acid.

The *Meriden* and the *Splitrock* or *Cobb Mines* are not working.

Splitrock Pond Veins.—On the east shore of this pond a vein has been quite recently opened by W. S. DeCamp, but beyond the removal of the earth and boulders scarcely anything has been done towards further testing its extent.

At the north end of the pond W. DeCamp has re-opened an old mine hole and found a rich coarse-granular ore, resembling some of the Dickerson shot ore. This is supposed to belong to

a line west of the main Hibernia Mines while that on the east of the pond is considered as the latter continued. A great deal of careful examination or extensive mining is needed to substantiate these opinions, but as they may be suggestive of fruitful searches they are here stated.

Greenville Mine.—Opened by Pollard & Welsh in 1872, on lands of Hudson Smith, south of the Splitrock and Green Pond road. The vein is said to be about four feet wide. Some ore has been sent away on the Hibernia Mine Railroad.

Southwest of the last mentioned mine the Bethlehem Iron Company did some work in searches for ore, the past season. A long line of attraction is reported.

In this township west of Greenville and near the foot of Copperas mountain, three new mines have been opened during the past three years. Beginning at the southwest the first is on a tract owned by the Chester Iron Company. Richard George, of Dover, has here discovered at several points a quite wide vein of good ore.

Pardee and Canfield's Mine.—Here there are several open cuts longitudinally on the vein, which runs close to the boundary line between the outcrops of gneiss and the conglomerate of the Copperas mountain. These excavations are about fifteen feet in width, but there are some layers of rock in this space. The dip is steep towards the southeast. About two thousand five hundred tons of ore have been mined and sent away. The bottom ore is hard, compact and fine-grained, and contains a notable per centage of pyrite. Near the surface this had been removed by *weathering*. No mining has been done here since it was visited in the fall of 1872. The quantity of ore here is large, and the only drawback is in the cost of transportation.

Green Pond Mine.—This is about a mile northeast of that of Messrs. Pardee & Canfield and near the old Copperas mines. It was opened about a year ago by W. S. DeCamp, since which it has been worked for the Green Pond Iron Mining Company. The principal working is at an open cut or *quarry* at the southern end of a low flat ridge of gneiss. In the heading the ore as exposed is between forty and fifty feet wide, dipping

about forty degrees towards the east-southeast. This breadth is measured across a thin horse of rock quite near the foot wall side. The rock on this side of the ore is a rusty-grey fine-grained gneiss containing here and there pyrite. The rock in the *horse* is a micaceous gneiss. In consequence of the thin covering of drift earth, the weathering of the ore has made the upper portion of the beds very friable and almost earthy. At the bottom it is unchanged and very hard. The percentage of sulphur is quite large, owing to the pyrite (or marcasite) occurring in all the layers of the vein. In some of the thinner beds it is much more abundant. A little green hornblende is seen in some specimens. Already three thousand tons of ore have been quarried out and the hanging wall side is not yet fairly uncovered. Fifty yards north of this the vein has been worked to a depth of fifteen feet, but without finding regular walls. The ore closely resembles that at the south opening. Going northward on the strike of the vein shallow test pits have been dug at frequent intervals and ore found in them.

A wagon road along the valley of Timber Brook is being constructed, over which the ore can be carted to the New Jersey Midland Railway, at Charlotteburgh. A branch railroad is in contemplation by the mine owners, and the large body of ore here and at the mines lying southwest of this, would justify its construction. Up to the present time only a few car loads of the ore have been shipped, and this had to be hauled over the steep Copperas mountain to Newfoundland. After roasting, this ought to be a valuable ore, as it contains little foreign matter, except the sulphide of iron.

Charlotteburgh Mines.—The old mines near Charlotteburgh have, since the opening of the New Jersey Midland Railway, been actively worked by the Bethlehem Iron Company. The average shipments for much of the season was one hundred tons a day.

PEQUANNOCK TOWNSHIP.

John Botts' Farm, about two miles north of Powerville and east of the Rockaway Valley. Some work in exploring was done

here in the winter of 1872-3, by Charles O. Ripley and William S. De Camp. A shaft was sunk twenty-three feet deep, and about seventy tons of ore taken from the vein, which was between three and four feet wide. The ore resembles that from Mine Ridge, and this is on a northeast and southwest line with the openings on that ridge.

De Camp Mine.—The openings known under this name are on the western slope of Mine Ridge, three miles north of Powerville and east of the Rockaway Valley. The line of attraction and the vein as discovered follow the trend of the ridge for three-quarters of a mile. Some ore was mined here more than fifty years ago for the Powerville forge. The present operations were begun about two years ago, when the whole length now occupied was tested by William S. De Camp. A portion of the property was then leased by the Musconetcong Iron Works. They have five openings in a length of twelve hundred feet, of which the deepest is down eighty-five feet. The dip is about sixty degrees towards the southeast. The rock of the walls is very uniform in character throughout, and is a hard, grey hornblende gneiss. The ore occurs in a succession of *shoots*, which pitch at about forty-five degrees towards the northeast, are about fifty feet on the outcrop, and average four feet thick. The ore is very hard, quite close-grained, and contains a small amount of pyrite, and in some places a little hornblende also. The hoisting and pumping in the several shafts is done by a single steam engine, from which the power is carried by a wire rope running over friction wheels, and arranged so as to be connected or detached, as needed. This mode of transmitting power is new in New Jersey iron mines. Where the work is at irregular intervals of space and not continuous, it is economical and efficient.

The ore from this mine is sent by the Morris Canal to the Musconetcong Iron Works at Stanhope. The average monthly product during the year up to September was four hundred and fifty tons.

Southwest of the company's lease DeCamp has sunk two shafts on the same vein and mined about five hundred tons of very

fine ore. It is peculiarly laminated in its structure by alternations of coarse and fine granular material. At one of these shafts a *cap rock* was found over the ore descending steeply towards the northeast, indicating the same *shoot* structure here as in the company's mine. To the southwest of this lot this same line has been opened on property held by the Musconetcong Iron Works, but the ore found was lean. Several small veins, parallel to this which is worked, are known, but thus far their size and the sulphur in them has prevented their being worked.

Decker Farm.—On the same ridge with the last, just over its crest and east of the mines, a breadth of twelve feet of ore was lately uncovered in a shallow trench and smaller outcrops at other points near this on lands of Mr. Decker. The explorations cannot be regarded as at all conclusive in the results thus far obtained. And here it may be remarked that there is a tendency among those searching for ores to stop with the removal of the overlying earth and to consider the outcrop then visible as representing the size of the vein. In some cases this may be the truth, but more often the breadth at the surface in consequence of *overflows* exceeds that of the more regular and undisturbed vein below.

Gould's Farm, half a mile southwest of Stony Brook. A vein of good ore five feet thick was found on this farm, near the farm house, by Mr. Hussey, of Bloomingdale, using the diamond drill. Three holes were bored, each striking the vein, which dipped steep southeast. The attraction here is said to be very strong and decided on a line one thousand five hundred feet long.

Pike's Peak and Righter Lot, reported in 1868 under the name of *Stony Brook Mine*. This is about three miles southeast of Charlotteburgh and near Earle's Forge, on lands of M. J. Ryerson and Charles Righter. The ore from the openings on Ryerson is apparently of very superior quality. The size of the vein was not learned. On the Righter lot there was said to be thirteen feet of ore and rock between the walls.

PASSAIC COUNTY.

POMPTON TOWNSHIP.

Wynokie Mines.—No work has been done at these mines in several years.

Monks Mine.—This is a new opening on the north side of Wynokie creek, on the property of J. W. Schermerhorn, and about two miles above Boardville. The ore is hard and black, with a little pyrites in it, but almost entirely free from other foreign substance. It has been opened on a vein seven feet wide, but its extent is not tested, and mining has not begun on it.

Board Mine.—This mine was first opened in 1872. It is on the lands of J. W. Schermerhorn, about two miles from Boardville, and perhaps three hundred yards to the right of the road from the latter place to Greenwood Lake. It has been worked along on the vein for a hundred feet or more, and been sunk down perhaps seventy feet. The vein is nine feet thick, and dips southeast thirty degrees. The ore appears to be silicious, and is of a uniform and rather fine grain. A second opening has been made farther northeast on a vein parallel with the first and fifty feet east of it. About nine hundred tons of ore a month have been sent away from this mine during the past year, and it is not driven to its capacity by any means.

Ringwood Mines.—These mines are worked by Cooper and Hewitt for the supply of their furnaces at Ringwood and Durham, Pennsylvania. The amount of work done has, until within a year, been limited by the lack of transportation. This is now removed by the completion of the Midland Railway to Boardville and a branch from that point to the mines. Thus far, however, the product is in nowise proportioned to the capacity of the mines as now opened, much less to that of this property when all its rich veins shall be vigorously worked. The *Cannon, Hard, Keeler and Cooper Mines* have furnished the ore needed during the past few years. A new opening near the Hard Mine has been named the *Cook Mine*. The attraction is

strong and the quantity of ore appears to be large. Since 1868 the *Hard Mine* has been worked down from one hundred and fifty feet, as then reported, to four hundred feet, its present depth. The *Cannon Mine* is not much deeper than in 1868, but is opened so as to show the pitch of the *shoot* between the cap and bottom rocks very beautifully. The ore is remarkable for the smooth, striated plane surfaces which traverse it in all directions. The walls are also wonderfully grooved and polished in lines parallel to the direction of the pitch, which is forty-five degrees northeast. The *Saint George Mine* has been idle for ten years, although the heading of ore is thirty feet across. It is supposed to connect with the Cannon shoots or vein. The *Blue Mine* was worked to a depth of four hundred feet on the slope. It is not now working. The *Keeler, Miller and Peters Mines* have also been idle for some years, excepting some mining at the former by M. J. Ryerson for supplying the forge at Bloomingdale. The *Cooper Mine* has a vein twelve feet wide, of bluish ore resembling that of the *Hard, Blue and Bush* mines, fine-grained, rhomboidal fracture and free from pyrite. The Hewitt vein is opened, but not worked. It shows a width of twelve feet. The ore, like that of the *Snyder*, in the same range, contains some sulphur.

Annexed are tables of analyses of the ores of these mines. The specimens were selected by Philip George, Manager and Mine Superintendent at Ringwood :

ANALYSES.

	Cannon No. 1.	Cannon No. 2.	Cannon No. 3.	Cannon No. 4.	St. George.	Miller.
Sesqui oxide of iron..	65.95	76.08	96.16	90.47	94.66	84.56
Oxide of manganese.....	.....	.....	.....	.....	.20	.25
Phosphoric acid.....	5.56	6.59	trace.	trace.	2.50	4.74
Sulphur.....	.....	.....	.....	.....	.....	.....
Titanic acid.....	.80	.70	.70	2.72	.65	.50
Lime.....	6.83	7.77	.....	.....	2.58	5.04
Magnesia.....	.07	.14	.22	.72	.21	trace.
Alumina.....	5.09	1.94	1.74	1.91	.39	3.00
Insoluble.....	18 10	7.00	3.10	5.80	2.00	4.60
	102.40	100.22	101.92	101.62	103.19	102.69

The Cannon ores No. 1 and No. 2, are reddish in color, and contain very little magnetic ore, most of it being the red oxide.

	Old Blue.	Hard.	Keeler.	Cooper.	Peters.	Old Hope	N. Hope.
Sesqui oxide of iron..	95.98	90.14	78.30	85.08	91.11	94.06	97.29
Oxide of manganese. ....		.30	.25	.20	.20	.25	.35
Phosphoric acid.....	.06	1.86	3.39	5.12	.90	.45	.47
Sulphur.....		.01	.01	trace.			trace.
Titanic acid.....	1.95	.40	1.44	trace.	.30	.30	.52
Lime.....		2.18	4.08	6.62	1.23	1.57	.62
Magnesia.....	.43	.94	trace.	.28	trace.	.22	trace.
Alumina.....	.66	1.00	1.17	2.80	3.19	2.59	.52
Insoluble.....	4.10	5.60	12.60	3.10	5.40	3.00	2.60
	103.18	102.38	101.19	103.20	102.33	102.44	102.37
						Hewitt.	Snyder.
Sesqui oxide of iron,	-	-	-	-	-	69.64	70.68
Oxide of manganese,	-	-	-	-	-	.15	
Phosphoric acid,	-	-	-	-	-	.19	.13
Sulphur,	-	-	-	-	-	4.54	.20
Titanic acid,	-	-	-	-	-		
Lime,	-	-	-	-	-		trace.
Magnesia,	-	-	-	-	-	trace.	.47
Alumina,	-	-	-	-	-	9.17	.72
Insoluble,	-	-	-	-	-	17.30	28.90
						100.99	101.35

The excess above 100. in these analyses is due to the iron being weighed as sesqui oxide, while in the ore it is part protoxide. The phosphoric acid is combined with lime, and not with the oxide of iron.

WEST MILFORD.

Indications of iron ore are numerous in this township, and some ores containing pyrites have been found, but the remoteness from railroad or canal transportation has made iron ore of no value. Now that the Midland Railroad crosses the township and supplies the needed connection with a market, we may expect more activity in the search for ores, and the opening of new mines.

In New York this belt terminates near Monroe and Turner's, Orange county. In that State the numerous mines of the *Sterling Iron Company*, and the *Alice, Forshee, O'Neill, Mount Bashan* and *Clove Mines* are within its limits.

The number of the localities and the extent of the veins as already opened is so much in excess of that of the other belts that it might with justice be named the *iron ore belt*.

MUSCONETCONG BELT.

HUNTERDON COUNTY.

The mines in this belt within the limits of this county reported in the "Geology of New Jersey" were *Bethlehem*, *Van Syckle's*, *Asbury* and *Banghart's*, all on the Musconetcong mountain range. The *Bethlehem* and *Van Syckle's mines*, are the only ones of these which have been worked to any extent since 1868.

The *Bethlehem Mine* has been in operation most of the time. When visited two years ago, the old shafts had been abandoned and the openings then making were further to the east. There were two lines of attraction, and shafts were being sunk on both. The strike was east northeast by west southwest. The ore at that time mined was fine-grained, mixed with a little rock, and the wall rocks hornblendic gneiss with some syenite. The mine is reported as in operation and the ore is shipped from Valley station, on the Central Railroad of New Jersey.

About half a mile south of the *Bethlehem Mine*, some ore has been found on the farms of J. Van Syckle and George Hubs, on the former five hundred tons were taken out several years ago. The localities have not been visited.

Van Syckle's Mine.—This mine now belongs to Cooper and Hewitt, and the ore is carried to Durham and worked in mixture with silicious ores. This ore is remarkable for the large amount of titanitic acid in it.

ANALYSIS.

Magnetic iron ore,	.	.	.	.	.	69.34
Oxide of manganese,	.	.	.	.	.	0.00
Phosphoric acid,	.	.	.	.	.	trace
Sulphur,	.	.	.	.	.	1.21
Titanic acid,	.	.	.	.	.	11.60

Silicic acid,	5.40
Lime, - . . . . .	.39
Magnesia, -	3.35
Alumina, -	9.29
	<hr/>
	100.58

Miller Farm:—About a mile southwest of Glen Gardner. Here some mining has been done at intervals for several years past, but without finding much ore. The line of attraction is said to be traceable from this farm northeast to the Central Railroad, crossing the "stone cracker quarry" and thence across several farms in Lebanon township. There are supposed to be two veins, about one thousand feet apart. A thin vein of ore occurs at the railroad quarry.

Fritts' Farm, White Hall. A shaft was sunk the past season on George Fritts' farm, northwest of White Hall, and a wide vein of lean granular ore, largely mixed with white quartz, was uncovered.

East of White Hall, one mile, the Union Iron Company, of High Bridge, has a vein of ore opened on the farms of *J. S. Appgar*, *Morris Fritts* and — *Banghart*.

Banghart's Mine of the "Geology of New Jersey," is on this vein, but it has not been worked since described in that report. This vein is said to be lean wherever it has been opened.

Hunt or Pidcock's Mine:—Near the old Washington turnpike, about two miles east of Pennwell, on Schooley's Mountain. Ore was mined here seventy years ago and used in forges. In 1871 Pidcock and Rothe began work here, sinking a shaft about seventy feet southwest of the old mine hole. When visited about a year ago, they had uncovered a breadth of eight feet of ore. The strata dipped sixty degrees towards the southeast. A very little pyrite was observed in some specimens.

MORRIS COUNTY.

Schooley's Mountain, Pleasant Grove.—During the past three years there has been considerable work done in searching for

ore in the vicinity of Pleasant Grove and the Schooley's Mountain boarding houses. But none of these points, excepting the Stoutenburgh Mine, are yet developed into producing mines. West of the Pleasant Grove church a long line of attraction, which in places is very strong, has been tried by several parties who have successively held leases on the property, and some very rich and highly magnetic ore has been found. From information lately received in regard to the openings on the farm of J. P. Sharp, it would appear that the diggings went through the "overflow" and failed because of neglect to follow the ore.

A half mile northeast of Pleasant Grove and near the old Washington turnpike, the Lehigh Valley Iron Company sunk two shafts on lands of Wm. Hann. The attraction was positive and strong, and some lean ore was obtained with rock containing ore as one of its mineral constituents. The same line of attraction was tested about one thousand feet southwest of these shafts by Marsh and Trufant, of Hackettstown. Some ore mixed with rock was found, although the attraction stretches over a wide area about their openings. This may, however, be due to the ore occurring in thin strings and as a constituent mineral in the rocks underlying this area of attraction.

Stoutenburgh Mine.—This is located a half mile northeast of the Schooley's Mountain Seminary, on the farm of L. I. Stoutenburgh. It was opened in October, 1872, and has been worked without interruption to the present time. The mine is now about one hundred feet deep, and opened on the line of the vein about one hundred feet. The vein averages five feet in thickness, widening to nine feet near the main slope. The attraction was quite strong and generally positive for three hundred feet southwest of this slope. The ore was found within two feet of the surface, and for several feet down it was mixed with a little earth, and in loose, irregularly-shaped masses. The dip was from thirty-five degrees to forty degrees towards the south-southeast. Deeper and west of the main slope it is now reported as steep towards the northwest, whereas east of this the southeast dip is maintained.

The following analysis is of ore about twenty feet down on the slope. At the bottom as now opened it is said to be richer :

Silica,	6.70
Magnetic oxide of iron,	83.04
Alumina,	3.87
Lime,	3.25
Magnesia,	0.86
Titanic acid,	0.70
Sulphur,	0.10
Phosphoric acid,	1.92
	<hr/>
Total,	100.44
Iron,	60.180
Sulphur,	0.096
Phosphorus,	0.839

The mine has yielded monthly about four hundred tons of ore which has been used in the furnaces at Stanhope. On the same farm another vein of rich ore, but quite small, has been opened north-east of this mine.

Mr. Stoutenburgh has opened a small vein, north of this mine, on the farm of L. W. Hunt and mined about forty tons of ore free from sulphur.

Naughtright Mine:— A new mine on the eastern side of Schooley's Mountain, and a short distance west of Naughtrightville. It was opened in 1870 and worked about a year, two shafts being put down ; the deepest, one hundred and forty feet, measured on the dip of the foot wall. On the north of this slope, a huge trap dike runs obliquely across the line of the vein, entirely *cutting out* the ore in a northeast direction. The rock adjacent to the vein was very much disintegrated and crumbling for forty feet downwards. The ore measured between twenty inches and four feet in thickness, was coarsely crystalline and mixed with a little rock and pyrite.

About one hundred yards west-northwest of this, a shaft thirty feet deep struck a vein eight feet wide, and here, also, the ore

towards the north was abruptly replaced by rock. About two hundred tons had been mined when visited. This mine was not in operation the past year. The small size of the vein and the distance to canal or railroad transportation operate against it.

Sharp's Diggings.—On lands of Wm. Sharp, two hundred and fifty yards northwest of the Naughtright Mine, J. M. Sharp, of Budd's Lake, sunk a shaft twenty-five feet deep, in 1870, on a strong, positive attraction, and found some very rich ore with other that was mixed with rock, and quite lean. For two hundred feet southwest from this point, a strong, negative attraction was observed. The rock here is very friable and earthy in consequence of the decomposition of the feldspar, and the dip of the strata is steep towards the southeast. This locality has the same disadvantages as the Naughtright Mine, of distance from transportation.

Rarick Farm.—Adjoins the Sharp place on the north. The slight explorations here indicate a rock containing magnetite rather than a workable vein. It is unlike that at Sharp's in being darker colored and less disintegrated.

Hopler Farm or Bartleyville Mine.—One mile southwest of Bartleyville. From ten to fifty degrees positive attraction was observed over a large portion of the hillside north of the Hopler house. There are some old holes here but no work has been done recently.

Mount Olive.—The mines about Mount Olive have not been in operation for several years past. A. A. Drake has opened two parallel veins on Peter Solomon's farm, and mined ore for the Stanhope furnace, but to what extent has not been learned. At the northeast end of this range of mines several hundred tons of ore have been mined on the *Baptist Church Farm*. This locality is one mile west of Drakesville. From all that can be learned now of the old mines of this Mount Olive range the veins appear to have been continuous but quite small.

The Beattyestown or Fisher, Dickinson, Marsh and Smith Mines are all on the western side of this mountain range or table land. They have been worked to a considerable extent, but no important developments are reported.

WARREN COUNTY.

SCOTTS MOUNTAIN.

Lanning Farm:—On the summit of the ridge southeast of Oxford Furnace and south of the Washington road. Here are two lines of attraction which intersect going southward from the road. One of them has a course a few degrees east of south, while the other follows the more commonly observed northeast and southwest direction. The point of intersection is near an old mine hole in the field near the woods bounding it on the south. The dip-needle on the western line (north of this hole) varies from forty to ninety degrees, positive; that on the other line (running northeast) varies from twenty to forty-five degrees. The constancy and continuity of these lines is remarkable, and the development of the locality is desired as a test of the value of such magnetic indications. A small vein was uncovered in a shallow trial pit on the eastern line, and ore was found in the older opening near the intersection of these lines. Ore has also been discovered southwest of this in the woods—but the openings are so filled up that the extent of the ore could not be learned.

Chapin and Lommasson Diggings:—South of the Lanning place and in the hillside, west of the Oxford and Washington road. A great deal of tunneling has been done here, following a very small vein of ore into the hill, but without discovering any workable amount. The peculiar features of the place are east and west strike of the rock strata, so finely exposed in the extensive excavations and the very disintegrated, even earthy condition of the gneiss rock, so that nearly, if not all, the work was done without need of blasting. The dip is steep northward. Much of the rock is very brown on its fractured surfaces, and from this prevalent color was supposed to contain manganese to a considerable extent, but an analysis showed only a small fraction of one per cent. of that substance. Higher up the hill, towards the west, there is said to be a fair attraction and favorable indications. The Bethlehem Iron Company has lately leased the property.

Oxford Furnace.—These old and noted mines continue to supply the two furnaces here with rich and first-class ores. The yearly product amounts to about thirty thousand tons, but their capacity is much greater than this. It may not be out of place here to refer to the richness and purity of a sample sent to our laboratory from the *New Mine*.

ANALYSIS.

Sexquioxide of iron,	95.08
Oxide of manganese,	0.30
Phosphoric acid,	0.03
Sulphur,	0.10
Titanic acid,	0.00
Lime,	0.31
Insoluble matter,	7.32
	<hr/>
	103.14

Such ore is suitable for the manufacture of Bessemer steel. It is equal to the best of the celebrated Dannemora ore of Sweden.

NORTH OF THE WARREN RAILROAD.

Confucius or Creagor Mine.—This is on the farm of P. Creagor, one mile west of Port Murray. It was opened in 1871 and has been worked quite up to the present time by Charles B. Wight, of Hackettstown. The deepest shaft is down fifty feet, and in this the average width of ore is nine feet. Another shaft twenty-three feet deep, has at that depth struck the solid rock and the vein. A sample from near the surface in the main shaft was analyzed. It is rather lean.

Mitchell Mine.—One mile north of Port Murray. This was opened in 1870. The Musconetcong Iron Company has done a vast amount of work here in mining and searches for additional supplies. A very large open cut removed some hundreds of tons of good ore. A shaft was then put down one hundred feet without much success. Another is now sinking. A mass of

granite cut in the open workings and in the shaft appears to have disturbed the strata here so much that the geological relations are not understood. The rock is much disintegrated near the surface. The company is manifesting a great deal of energy in thoroughly testing the property, and their persistence is deserving of better results than so far attained.

Johnson's Explorations.—G. W. and W. H. Johnson, of Hackettstown, are exploring for ore, on a farm a half a mile or less west of the Mitchell Mine. When visited a few months ago, a very little ore had been found.

Egbert Mine:—Two miles from Port Murray, and a quarter of a mile north of the Mount Bethel M. E. Church. It has been worked since 1871 by the lessees, Smith, Gorkey & Sutton. The vein has been opened for considerable length from two slopes, which are one hundred and fifty feet apart, and in the bottom is said to be from six to eight feet in width. Above this there was a pinch and the vein for twenty-five feet down was but a few inches wide. The foot wall is *clean* and well defined, while on the hanging wall side the rock is mixed with ore as far as worked. All the ore contains pyrite, and the percentage of sulphur must be nearly two-hundredths of the whole.

Northeast from this mine the attraction is said to be traceable across three farms—and the line has been tried at several points but without finding ore.

Rockport.—On the same general mountain range near Rockport, a number of trial shafts have been sunk, but none of them have as yet found workable veins. Ore has in every case been seen in the rock strata penetrated, either in thin sheets, in irregular masses in coarsely crystallized granite, or as smaller granular components of gneissoid beds. The attraction leading to searches at these localities may be due to these occurrences of ore or magnetite and not to regular well defined veins. While these shafts are conclusive at certain points, more careful examinations with the needle may justify diggings at neighboring points.

Bald Pate and Searle Mines described in 1868, have been idle since that date.

Buck's Hill, Hackettstown.—During the past autumn the Hackettstown Iron Mining Company sunk a shaft on the Mitchell farm, about thirty feet deep, penetrating a coarse crystalline aggregate of greyish-white orthoclase feldspar, vitreous quartz and magnetite, probably a dike. This may lie between beds of gneiss, but it is more likely to traverse them irregularly and to vary exceedingly in its dimensions, following it downwards.

Frase's Farm:—West of the Hackettstown and Warrentown road, on John Frase's farm, two shafts have been sunk by Bulgin & Cummins, and a lean ore uncovered in one, and a narrow vein in the other.

Young Farm:—Within a few rods of the above mentioned road and on the farm of J. M. Young, a shaft sunk on a line of attraction, penetrated a dark colored gneiss containing in some layers a large percentage of magnetite. On the top of the ridge west of this an ore-bearing rock was again encountered, but this was a light colored feldspathic gneiss.

Pyle's Farm.—The surface explorations here exposed a gneiss dipping steeply towards the southeast, crossed at right angles to its line of strike by an ore-bearing syenite.

Axford Farm.—Here a short line of strong attraction was tested by Perry & Somerville, of Hackettstown. When visited, the ore was in a very narrow vein. The stoppage of the work soon after this was probably due to the limited amount of ore discovered. These ore localities are all west of the road to Warrentown, going from Hackettstown, and within two miles of the former place. East of Warrentown on the brow of a very rocky hill the Hackettstown Mining Company did some work searching for ore. The amount found was inconsiderable.

Bryant Mine:—On the farm of William Bryant one mile southeast of Warrentown and three-quarters of a mile from the Morris Canal. The first openings here were made about seven years ago. The property is now held by the Bethlehem Iron Company but is not worked. When visited, the ore seen on the bank at the easternmost shaft was a mixture of quartz, partially decomposed feldspar and magnetite. That at the western opening was still coarser, crystalline and really a granite with.

a very large percentage of iron. This is another locality of the so called *ore-bearing rock*. Here, however, there is enough iron in it to allow of its employment as an ore of that metal. As the openings were then full of water the extent of the ore was not seen. But it may be safely said that in such an outcrop there is no certainty beyond what is *in sight*.

Excelsior Mine, on the Stevens' farm near the canal, and three miles north of Hackettstown. This was opened in 1871, and the work of developing it has gone on, up to the present time. Here the ore at the surface is the coarse crystalline mixture of magnetite and the common gneiss and granitic rock minerals, the first so preponderating that it is properly termed an ore. The percentage of iron increases, following this dike downwards. An average sample forty feet from the mouth of the slope gave forty per cent. of iron. The gneiss cut in the excavation is greenish-gray and syenitic. Its dip is steep towards the southeast. When visited a few months since the appearances indicated a change in the course of this dike and a possibility of its assuming the form of a regular vein between regularly stratified rocks. Should this prove to be the case it would be a most interesting locality, proving the association or origin of the ore of these dikes in the stratified ore beds or *veins*. The mining operations have been conducted by Charles B. Wight, of Hackettstown, and his perseverance deserves the success now promised.

Eureka Mine.—This is half a mile north of the Excelsior Mine and in the side hill, not far from the canal. Between these openings there is a wide belt over which the dipping needle shows a very irregular attraction. And this may be explained by the presence almost everywhere of ore in the rock. The geological features and the ore here closely resemble those of the Excelsior Mine. The breadth of ore-bearing rock or lean ore uncovered appears greater than at the latter mine. But little has been done since it was first opened two years ago.

Brookfield or Waterloo Mine.—This mine is worked for the Musconetcong Iron Works at Stanhope. It has been in active operation since 1868, and yielded many thousand tons of very

superior ore. The main slope is down about three hundred feet, dipping with the vein thirty-three degrees towards the southeast. A peculiar feature is the north and south course or *strike* of the vein. At the extreme southwest stopes this changes a few degrees towards the west, thus approaching the general trend of our iron ore veins. The ore lies in two sheets or thin veins, separated by a very irregular horse of rock, making the extraction of the ore costly. This is offset by its nearness to the furnace, and also by the quality of the ore.

MORRIS COUNTY.

Jefferson Township.—No new mines have been reported in the portion of this township included in this belt.

The *Hurdton, Weldon, Dodge, Ford and Scofield Mines* have all been actively worked. During the year 1873, the aggregate carried from these mines over the Ogden Mine Railroad, amounted to thirty-eight thousand three hundred and thirty tons. The deepest of these is the Hurd Mine, whose main slope is about eight hundred feet in length—the longest in the State. In consequence of its rather gentle inclination—being that of the pitch of the shoot, twenty-two degrees; its vertical depth is not equal to that of the Dickerson or Byram Mine. This shoot maintains its size, and the cap and bottom rocks together with the side walls enclose it on all sides. The ore continues rich and free from pyrite. It is used by the Glendon Iron Company in their furnaces at Glendon, Pennsylvania.

The *Weldon Mine* is interesting on account of the two shoots of ore which pitch side by side towards the northeast at about thirty-five degrees, slightly approaching one another as they descend, so that at the bottom now reached they are only seven feet apart. A survey of this mine was made in the summer of 1872, and the sections then constructed show plainly this unusual structure.

Lower Weldon.—South of the Weldon and on the same vein is the *Lower Weldon Mine*, worked by the Weldon Iron Company. Beyond this towards the southwest there have been some

searches made on the Johnson property, but these were not very successful.

The *Ford Mine* is worked for the Musconetcong Iron Works and is opened three hundred feet in length, and yielded during the past year about twenty thousand tons of ore. It is remarkable for the width of the vein and its almost vertical walls; in this latter feature resembling the Hurd Mine.

The *Davenport, Boss, Fraser, Goble and Duffee* and *Shongum Mines* also in this township, are not in operation.

SUSSEX COUNTY.

BYRAM AND SPARTA TOWNSHIPS.

Smith or Cascade Mine.—This is an old mine worked fifty years ago for the Andover Forge, re-opened in 1869, since which date it has been quite steadily worked. It is about one hundred feet deep, and opened two hundred and thirty feet in length, having a breadth of ore varying from three to eleven feet. The foot wall is a hard hornblendic gneiss, while the hanging wall rock is more micaceous. An irregular horse of rock separates the two portions of ore which are worked. Pyrite is quite abundant in both the ore and rock, although it is said to decrease in amount going down. The dip is fifty degrees towards the southeast, while the strike is northeast by southwest. About sixty yards north of these openings is the outcropping "steel vein," a thin vein of very rich and highly magnetic ore; but this is so small and irregular, appearing more like a true vein, that it has not afforded any considerable amount of ore.

On an adjoining property belonging to Elisha Allis, north of the Smith Mine, ore has been discovered and some mining done.

French's Mines.—West and northwest of Waterloo, there has been considerable searching upon the lands of Jas. French, and some of the ore mined on his property was seen last summer on the canal bank near Byram. This was a very coarse crystallized mixture of magnetite and feldspar, similar to the ore from

some of the *dike* localities above mentioned. The mines were not visited. The amount mined was reported as less than a thousand tons.

Hude or Stanhope Mine.—This old mine was re-opened in April and worked until September last by E. Carfield. The veins appeared irregular and quite flat, and the ore was taken out from open workings. About three thousand tons were mined and sent to the furnaces at Stanhope and Port Oram.

The old *Silver* and *Haggerty Mines*, also near Stanhope, have not been in operation in several years.†

Sickles' Mine, on the farm of W. Sickles, two and a half miles south of Sparta. It was worked a short time in 1870 and 1871 by the Bethlehem Iron Company. A whim shaft thirty feet deep was sunk near the farm house, and from this short drifts were driven. These yielded about four hundred tons of ore. The rocks as seen on the dump were a light greyish gneiss traversed by seams of epidote. The ore was said to have been twelve feet wide at the top, but only five feet at the bottom. In a second shaft on the line of strike, and one hundred and fifty yards from the first, the vein was between two and three feet wide and the ore was very rich. The wall rock at this point contained some ore in layers or sheets, separated by thin partings of rock. A noticeable feature here is the change in the direction of the dip from east-northeast at the west side of the shaft to east on the south side. Northeast of this near the brow of the hill, the attraction, strong and positive, was observed over a quite long and broad belt. A shallow trench on it exposed a little good ore. On this line continued on McMickle's farm, a single trial pit showed some ore, but beyond the fact of its discovery, nothing further was learned. The magnetic indications are sufficient to stimulate to further trials.

Gafney Farm.—Three miles north of Roseville, Byram township, Sussex county, now belonging to the Rutherford estate. These are old openings on this property—they are now partially filled up, but ore of good quality is scattered about them. There is a strong attraction in a line through them which was followed for eight hundred feet, and was found to be continuous, though

there were several changes from positive to negative, indicating that the ore is in shoots or else is broken up by offsets. The range is a little east of north, and further on in that direction, in a wood lot, the attraction is so strong and decided that we have mapped the notes of its survey and present them with the map under the head of searching for ore.

Southwest of the Gafney farm, the range and attraction continue to the *Lawrence farm*, where there are also some old mining works. This long and well marked line of attraction is worthy of further examination.

East and southeast of Sparta, and south of Norman's Pond, indications of ore are found, and some pits are reported to have been dug and ore uncovered, but no mining has yet begun.

Ogden Mines.—These old, well known and productive mines are still vigorously worked. The Allentown Rolling Mill Company, the Lehigh Valley Iron Company, and the Musconetcong Iron Works occupy the mines. Twenty-seven thousand seven hundred and twenty tons of ore have been sent out on the Ogden Mine Railroad in 1873.

In Hardyston Township, southwest of Snufftown, there is a long line of attraction from the Midland Railway, on lands of George Greer and the Franklin Iron Company, southwestward almost to the Ogden mines. The attraction is variable in strength and changes many times from positive to negative, but is continuous. Pits have been sunk on the line in a number of places, and some lean ore has been found, not enough as yet to warrant mining. It would however, warrant a much more thorough exploration by digging.

The Hopewell Forge line of attraction has been worked upon in many places, but we have no information of its present condition and prospects.

WEST MILFORD TOWNSHIP, PASSAIC COUNTY.

Kimble Farm.—A mile northwest of Stockholm. Three shafts or trial pits have been sunk on the ridge northeast of the farm house. One of these was thirty-five feet deep—twenty feet

being in earth and boulders and ten feet in a lean ore. The work was discontinued.

The Budd and Hunt Tract, near the head of the Dunker Pond brook. Diggings for ore were made here many years ago. In 1872 the search was resumed and ore containing pyrites was found. There is a strong attraction to be observed there, but no mining has been done.

West of the tract just named, on lands belonging to S. T. Scranton and the Rutherford estate, there is a line of remarkably strong and constant attraction. Trial pits have been sunk in several places, and ore was found in all of them, quite near the surface. No mining has yet been begun.

On the hill northwest of the last named lot, two long lines of attraction have been tried at three points, and a pyritous ore uncovered. The openings were very shallow, and no further work has been done. A map of these lines of attraction is given to illustrate the article on searching for ore.

The Jennings and Rutherford Line is a line of attraction that runs on a northeast and southwest course obliquely across the county line, and is said to be traceable quite up to the Wawayanda Mine. The Carbon Iron Company own the mines on the Jennings property, and have tested by shallow pits, the condition of the vein at many places, the one three hundred yards north of the Jennings house, being the most southerly. The average thickness of the vein uncovered is eight feet, and it dips steeply to the east-southeast. The ore is rather lean and contains some pyrites. On the Rutherford property the same line was tested by E. H. Wright, in 1870. A vein twenty-four feet wide was uncovered in a trench dug across the line of attraction. The ore appeared to be of good quality. The needle was singularly affected in crossing it, being negative at the edges and strongly positive at two intermediate points. At one of these points the ore was changed from massive to a shot-like structure. Nothing was seen to explain this unusual action, and another cross trench gave negative attraction throughout. No further work has been done to prove the vein.

VERNON, SUSSEX COUNTY.

Canistear Mine.—On lands of the Franklin Iron Company. The magnetic surveys of this property indicate at least three veins. The attraction was strong and positive on the most westerly line. The explorations made at the time of our visit two years since, showed a wide vein of rather lean ore, dipping steeply to the southeast. Ore had been raised from each of the other veins, and large piles of rather lean and pyritous ore were seen. Considerable mining has been done at this place, as we are informed, since the time we examined it.

Tracey and Crane Farms, north of Stockholm, in Hardyston, have ore upon them. It is rich and contains very little sulphur. The mine is only a half mile from the railway station. Some ore has been sent away. It was mined by George Richards.

Henderson Farm joins the last mentioned property on the north. The line of attraction here is strong and continues for a long distance. Ore was uncovered in a single opening eighteen feet wide. The line is thought to be west of that on the Tracy property.

Williams' Mine.—This mine is on lands of J. I. Williams' heirs, a half mile east of the Vernon and Snufftown road, and in Vernon township. It is an old mine, and has been worked at times for the last sixty years. It has been actively worked during the past year by Potts & Linn, of Jersey City. Three shafts are down. The southwest shaft is the deepest, and shows a steep dip to the northwest. The next is one thousand feet farther northeast, and the ore in it dips steeply to the southeast. The third shaft is two hundred feet farther northeast, and has the same dip with the last. The vein is irregular in breadth—the ore is quite free from rock and from sulphur. The mining operations are quite extensive and a large amount of ore has been taken out. It formerly went to Wawayanda Furnace, but now it is carted to Stockholm.

Segur & Wright Lease.—On the Rutherford estate, adjoining the Williams Mine on the northeast, and probably in continu-

ance of that vein, ore has been found but no mining has yet been done.

Still further to the northeast ground has been opened on two different lines of attraction, on the farm of Jacob Hunt. Ore was found upon both lines, but it was not further proved by mining. The northwestern line may correspond with a line across the Williams property, about a thousand feet west of that on which the mine is worked.

East of Vernon, on the Wawayanda Mountain, searches for ore have been made on lands of Azariah Parker, but the results are not reported.

Wawayanda and Green Mines, have not been worked since 1868.

Ten Eyck's Diggings, near Greenwood, West Milford township, Passaic county. Here there is a long line of strong attraction, opened at five points and a lean ore uncovered, beyond which no further work attesting the extent of the ore has been done. The strata are nearly vertical, dipping southeast. Nearer the Warwick road and east of these openings the dip is toward the northwest.

This belt extends into Pennsylvania, and all the mines of the South Mountain range, between the Delaware and the Schuylkill are in it. It also extends into New York, and the Warwick and Bull Mines are in it.

In the Musconetcong Belt, at several of the localities described, reference has been made to *ore-bearing rocks* and dikes containing magnetite, either in addition to the ordinarily occurring minerals of granites and syenites, or as replacing one of these. Such rock affects the dipping needle as strongly as a regular vein, but careful magnetic surveys show generally a distinction, as the deflection over such rock outcrops is more unsteady and varying from negative to positive in character, or vice versa. And also such outcrops show broader and more irregular areas of attraction and not *lines* or belts corresponding with the strike of the rocks, as is indicated by viens. From the indications given by the needle over these rocks many persons have worked in them hoping to find regular veins. More

than a dozen such localities have been visited during the past season, and others in previous years. They have been studied closely, and with two exceptions they have all failed to repay the explorer for his time and the money spent in testing their value. Adverse opinions have always been given to prospectors working in such rocks, based on the nature of dikes in general, and upon the numerous failures in the range of our observations. In the pursuit of field examination of rocks a number of additional outcrops of such ore-bearing rocks have been seen, some of them occupying extensive areas. In the two exceptions alluded to the percentage of iron was sufficient to make the whole workable as an ore. Sometimes there is a marked increase in the percentage of iron in descending, as at the Excelsior Mine near Hackettstown. And it is possible that these dikes may sometimes be followed to regular veins, showing them to have in some way derived their magnetic iron ore from the regular ore-beds or veins. But in general it may be safely asserted that from the known irregular and uncertain extent and direction of dikes, a fact well established in geology and from the experience of miners who have worked in such outcrops, that the explorations in them should be conducted with the utmost prudence and always considered as extremely hazardous.

PEQUEST BELT.

WARREN COUNTY.

Marble Mountain Mine.—This is properly in this belt although the ore is a red oxide. Considerable interest attaches to this locality, as the ore lies in a talcoid rock formation occurring in the gneiss, or resting upon it, unconformably. Practically, the mine has little value, as the amount of ore appears very limited. It is included under this general head, exceptionally, since it is not magnetic, but because this variety of ore and its accompanying slaty rocks are found in this belt only, and it may therefore be considered as one of its characters. It has not been worked for more than a dozen years past.

Schuler Openings.—These are on the farm of William Schuler

half a mile north of Roxburg, Oxford township, Warren county. There are two shafts here, one of which is merely an old mine hole deepened. This was dug about one hundred years ago. As re-opened it is twenty-seven feet deep. The other, fifty feet west of this, is fifteen feet deep. Both are in a greyish white crystalline limestone, dipping steep towards the southeast. The vein as worked in the westernmost shaft was two feet wide and much broken up, so that it was got out with pick and shovel. In the old shaft the stratification and the size of the vein were not made out with certainty. The ore is brownish-black, fine-grained and highly magnetic, and contains considerable manganese. At the time it was visited only a few tons of ore had been mined and this was then on the bank. Samuel Vannatta and Alexander Sherrerd are the lessees. It was re-opened the past season.

Roseberry Mine.—This mine is on the farm of Depuy Roseberry one mile southeast of Belvidere. Three shafts have been put down. The work began in 1872, and mining was discontinued after about a year's operation, owing to the vein pinching to a thickness of six inches and failure to find another shoot. About one thousand tons of ore were shipped to the furnaces of Messrs. Cooper & Hewitt, at Durham, Pennsylvania. The ore is mixed with considerable mica and a bluish shaly rock and consequently is lean. It was liked at the furnaces to flux with other ores.

Barton Mine.—This is on lands of Mrs. Barton, half a mile south of Oxford. The principal shaft is on the eastern slope of the ridge and about five hundred yards east of the Oxford and Montana road. About two hundred feet west-southwest of this and on the summit of the ridge there is a trial pit on the same vein as indicated by a continuous line of attraction (of ten to twenty degrees positive) connecting these two openings. The ore seen at the mine was reddish-black granular mass, with a little hornblende in it. A dark colored micaceous gneiss abounded in the ore dump. At the trial pit or trench the stratification is very distinct, standing on edge, with a strike north eighty degrees east. The mine was not working when visited.

Shoemaker's Diggings.—Northeast of Oxford three-quarters of a mile, on top of the ridge east of George Shoemaker's residence a shaft was sunk in the past autumn in search of ore, which resulted in discovering a wide belt or vein of rock containing magnetic ore arranged in parallel lines with the usual gneissic minerals. The hope was entertained that the magnetite would gradually increase until the beds should be rich enough to work as ore. At the time of our visit this locality was not promising, and the experiment appeared likely to be costly and fruitless.

Redell Mine.—At the foot of the hill about three hundred yards east of the Shoemaker locality, the North Penn Iron Company worked here in 1872, and mined an ore which was considered of very superior quality. It is brownish black, mangiferous, free from sulphur and contains traces only of phosphorus. There were two shafts from which there was some drifting. At the lower one, at the border of the meadow, report says the rock next the ore was a greyish crystalline limestone. As this rock is seen but a few rods southeast of this point, it is highly probable that the report was correct. The reason for the stoppage of work was not learned.

Little Mine.—This also is a new mine and is on the farm of Jephtha Little, one mile west of Oxford Furnace. The outlay here in mining, is said to have been very considerable, and the amount of ore raised not at all commensurate with this large expenditure. Much of this was required by the large body of water to be raised. As no opportunity was had of going through the mine, it being stopped before it could be examined thoroughly, the extent of the vein is not known. The lines of attraction indicate two parallel veins, about one hundred and sixty feet apart. The main shaft on the westernmost was said to be seventy feet deep, connected by a drift with a second towards the northeast. The ore near the surface was black, granular and mixed with a brownish-black earth. This was washed. Below this, it was very compact, hard and almost entirely free from all foreign matters. The purity and quality are best shown by the following analysis, of the best ore of the mine:

Insoluble matter, - - - - -	1.60
Magnetic oxide of iron, - - - - -	94.76
Phosphoric acid, - - - - -	0.10
Magnesia, - - - - -	0.29
Oxide of manganese, - - - - -	1.00
Sulphur, - - - - -	0.10

The soft surface ore contained more manganese than the above sample afforded. The purity of this ore and the favor it received from Oxford Furnace, should prompt to a thorough but judicious search to test the extent of the workable vein. It was worked by a Belvidere company.

Raub Farm.—On the farm of Philip Raub, about one mile northwest of Oxford Furnace, several test pits in examination of this property, have been dug under the direction of the lessees, the Bethlehem Iron Company. One of these, about two hundred yards north-northeast of the farm house, was sunk sixty-eight feet before reaching any very solid rock. It passed through several feet of brown-black earthy, manganiferous iron ore which, as cut in this pit, seems to dip gently towards the northwest. It appears likely that further digging, by following this earthy bed, will find below a regular vein of which this is the *overflow*—*i. e.*, the vein spread out or fallen over from its original highly-inclined or vertical position. It now lies as opened, between earthy beds mainly made up of disintegrated gneissic rock. This soft earthy ore was found to contain of

Iron, - - - - -	49.34 per cent.
Oxide of manganese, - - - - -	7.50 "
Phosphoric acid, - - - - -	0.25 "
Water and organic matter, - - - - -	13.55 "

Southwest of Raub's house and across the Oxford road, a shallow pit uncovered a bed of earthy ore very similar to that described above, and in the bottom exposed a magnetic ore associated with an impure limestone. This opening appears to be on a line connecting the deeper shaft and the Little Mine

shafts. The ores are alike at the three points. The attraction at these openings is very slight and irregular. The discoveries already made should lead to further exploration in order to thoroughly learn the value of these deposits. From their proximity to the crystalline limestone outcrops, it is very probable that this vein is in that rock. And, if so, the character of the ore is almost assured in advance.

Titman Shaft.—This is in the road near Titman's house, southeast of Bridgeville, and on the southside of the creek. The rock in which it was sunk is a greyish to red slate, bordered on the south by micaceous and hornblendic gneiss, and on the north by the ordinary blue magnesian limestone, and probably unconformable to both of them. The ore found here so far has been very little. It resembles the red hematite of Marble Mountain and this is another of such localities, characterizing this belt. It is intended to resume work early in the spring.

Pequest Mine.—Oxford township, Warren county, two miles northeast of Oxford Furnace. This name is properly limited to the large open working or *quarry*, at the side of the Pequest creek, although it sometimes includes the tunnels in the side hill north of this on the same property. Ore was discovered here about four years ago, and from that time onward, it was worked almost uninterruptedly for three years. A large amount of material was taken out including several thousand tons of lean ore, making a very large excavation in the hill-side. The geological features were for a long time not understood and even the stratification was uncertain, and it was regarded as a huge *pocket* of ore, and not a vein having walls and a dip and strike. The removal of so large a mass shows the foot wall dipping about seventy degrees towards the east and southeast. On the hanging wall side, the rock is more mixed with ore, although here also the dip of the strata is now plain. Towards the southwest the mining appears to have removed all the ore, leaving micaceous and hornblendic gneiss as a sort of bottom rock, underlying this great swollen shoot of ore. A shaft sunk thirty feet beneath the floor of the open cut penetrated rock

containing some ore, but not rich enough to work. On the north, the ore was bounded by a wall of grey syenitic rock which ran east and west and dipped steep towards the north. In the language of the miners it was "cut out" by this "cross-course," or dike of geologists. Beyond this the vein has not been discovered, and it has probably been displaced towards the west, or up the hill, judging from the direction of this dike. A tunnel was driven into the hill some rods southwest of this to intercept the vein continued in that direction but no ore was found. Very recently another was started near the store, running in from near the creek level to cut any vein below the quarry or mine level. But this was stopped by the water coming into it from the mine. So large a body of ore so near the surface was easily taken out, after the overlying earth and boulders had been removed. A short tunnel for a track crossed the interval of rock between the ore and the road, below which level but little was found. Another advantage in *mining* here, if such it could be called, was the soft and disintegrated nature of both ore and accompanying rock so that very little blasting was necessary. Hence a very large amount of comparatively lean ore was taken out, and sold at a profit at *low* prices. A large percentage of it consisted of greenish hornblende, partially decomposed. The locality is characterized by the abundance of this mineral, as can be seen in the dark-colored hornblende gneiss forming the foot wall of the mine. Some of this rotten greenish mineral was analyzed and its composition is here given.

Silica,	49.050
Protoxide of iron, -	14.952
Alumina,	4.987
Lime,	17.584
Magnesia, -	9.648
Phosphoric acid, -	trace.
Water,	3.300
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	99.521

The magnetic portion of the ore consisted of

Insoluble matter, - - - - -	18.300
Magnetic oxide of iron, - - - - -	67.471
Alumina, - - - - -	3.226
Lime, - - - - -	5.936
Magnesia, - - - - -	3.276
Oxide of manganese, - - - - -	0.250
Water, - - - - -	1.950
Phosphoric acid, - - - - -	trace.
	100.409
Iron, - - - - -	48.84

Some of this ore was tried in one of the furnaces of the Crane Iron Company, at Catasauqua, Pennsylvania, making an open grey pig iron, which went to the National Iron Company's works, at Danville, Pennsylvania, and was worked into steel, which was said to be of superior quality. About three and a half tons of ore were needed for a ton of iron, showing it to be quite lean. In consequence of the ore *running out*, or, in other words, the gradual replacement of the magnetite of the strata by the more common rock minerals, the mine has been abandoned.

Henry Tunnel.—About three hundred yards north-northeast of the Pequest Mine, and on the same property, but one hundred and fifty feet above the creek, an old tunnel has recently been re-opened and extended into the hill until it has attained a length of six hundred and fifty feet on a nearly north course, and following most of this distance, the foot wall of a vein which is, on an average, fifteen feet wide, and dips steep towards the east. Lower down the hill, a second tunnel strikes the same vein about fifty feet below the Henry tunnel. This is now connected, by a shaft at its farther end, with the upper tunnel. A third drift, starting near the foot of the hill, runs across the strata and strikes the vein about one hundred feet below the upper one, thereby affording easy and ready means of working and draining this new mine. The strike and dip of the vein at

the several points, in addition to the uniform character of the ore, prove these different levels to be in the same continuous vein, and show its great extent and remarkable uniformity of character. The walls everywhere are unusually regular and well defined. The ore from near the surface of the hill, has a very striking banded or laminated structure from the alternations of magnetite and rock (mostly a micaceous gneiss). This ore is quite lean. An analysis shows its composition to be as follows :

Insoluble matter, - - - - -	54.400
Magnetic oxide of iron, - - - - -	37.265
Alumina - - - - -	4.764
Lime, - - - - -	trace.
Magnesia, - - - - -	1.611
Oxide of manganese, - - - - -	0.400
Phosphoric acid, - - - - -	0.096
Water, - - - - -	1.200
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	99.736
Quartz or silica, - - - - -	49.400
Iron, - - - - -	26.984

Deeper in the hill these partings of rock grow thinner or disappear in part, and the ore is richer and does not exhibit the banded appearance of the upper portions. It should be stated that this parallelism of mineral arrangement conforms to the stratification.

This gradual increase in the richness of the ore going down in the vein is interesting, and in this case of vital importance, as the top ore is hardly workable. The regularity and size of the vein, and the ease of approach to it, may enable this company to use all the ore mined.

North of the upper tunnel this same lean ore has been uncovered in a succession of trenches dug across the line of the vein, extending quite to what is known as the *Hoit Farm Mine*. The attraction is noticeable as covering a great portion of the hill near its summit, and connecting the Henry tunnel with the Hoit farm mine, one thousand five hundred feet apart. This connection is not, however, yet demonstrated by openings.

Hoit Farm Mine.—This is also a new mine, and with the Pequest Mine, belongs to the Pequest Mining Company. It is about half a mile northeast of the company's new furnace and on the western slope of the ridge, but a few rods from its crest. The slope is now one hundred feet long, measured on the dip of the vein which is about thirty degrees towards the southeast, growing steeper going down. From this a drift has been cut about seventy feet into the vein going southwest. As now opened this drift presents the curious phenomenon of an arched roof with sides of ore, the vein dipping from it towards the southeast at the angle of the slope, and in the opposite direction more gently. There may be an anticlinal axis here, or an overthrow of the vein westward or down the hill. The slope has proved its course towards the southeast. Of the probable extent of the western dip nothing additional can be said. The walls of the mine are regular and the ore comes off *clean* from them. Stratification is shown finely in the vein itself. The ore is not so fine grained as that of the tunnels above mentioned, nor does it have the same parallelism in its structure. It is very hard and contains much brown garnet in irregular masses, also considerable augite and less quartz, and other more common minerals of the gneiss. The composition of an average of the mine is as follows :

Silica,	18.90
Protoxide of iron,	27.23
Peroxide of iron,	38.29
Alumina,	12.48
Lime,	4.45
Magnesia,	0.86
Phosphoric acid,	0.06
Oxide of manganese,	0.55
Titanic acid,	1.30
Sulphur,	1.23
Total,	100.25
Iron,	61.69

It has not yet been tried to any great extent, most of the ore mined being on the dump. From its composition there appears to be no considerable percentage of constituents which might work injuriously.

About a quarter of a mile north of the Hoit farm house, a shaft sunk on a strong attraction struck a fine-grained aggregate of magnetite and hornblende crystals, too lean, however, to be called an ore. It has been said that this was the Pequest Mine line, *thrown* one thousand feet towards the west, but a difference in the structure and character of the *ores* is against the hypothesis.

Northeast of the Hoit Farm mine there is a strong attraction traceable for a long distance, and there are some old mine holes at which a striped, or banded ore, like that at the Henry tunnel, was found.

Smith's Mine.—A new opening made during the past summer and autumn on the farm of Philip Smith, a few rods south-east of his residence, and not quite a mile northeast from Green's Pond. When visited, a few weeks ago, two trial shafts not over twenty feet in depth had been started, and a long ditch was then being dug to drain these of the large amount of water flowing into them. The covering of drift earth was about six feet thick. Under this the shafts went through several feet of brownish-black earthy ore, which contained forty-five per cent. of iron and 6.5 per cent. of oxide of manganese. This resembles in appearance and composition the soft ore, at Raub's place and at the Little Mine, also in this belt. Some calcite and some very fine white mica was noticed, also asbestos among the rock constituents of the strata cut in the shafts and ditch. The hard black ore resembles that of the Deats Farm, a mile northeast of this point. No ore had been taken out excepting that coming from the shafts. Edward Turner and Geo. E. Swayze, of Hope, are working the locality.

Deats Farm.—This also is a newly opened ore-locality, and is scant a mile from Smith's Mine. It is about one thousand feet south thirty degrees east from Deat's house, and on the Bartow Hill range. It was opened the past summer and the

explorations were continued quite to the beginning of the winter. A Belvidere company did the work. The vein found in the deepest shaft (which, when visited was twenty-two feet deep,) consists of an irregular mixture of hornblende and magnetite, very compact and hard. A little calcite was noticed in the syenitic gneiss of the hanging wall. Also, a few small crystalline nodules of pyrite. The attraction here was light, nowhere more than ten degrees positive, and quite irregular. Two hundred feet west of this a trench opened a coarse-grey syenite in which there was some magnetite. The locality cannot as yet be considered as a mine.

Kishpaugh Mine.—This large and noted mine is two and a half miles west of Danville, and about a quarter of a mile south of the Hope and Danville road. It was opened in the summer of 1871 by Edward Bulgin, and has been vigorously worked by the Crane Iron Company, proprietors of the Kishpaugh Farm. The main slope is two hundred and thirty-five feet long, descending at thirty-eight degrees at the start, and more steeply near the bottom. The main heading on the bottom drift, southwest, is about one hundred feet from this slope. Here the vein, as worked, is twelve feet wide, but some ore is left on the hanging wall side, as the ground above is not very safe. In places it has been twenty feet wide. The foot wall consists of a rotten feldspathic gneiss, mostly made up of feldspar and quartz. Northeast of the slope now worked the *overflow* was fifty feet wide, and the surface diggings removed almost an acre of ground. A few rods beyond the open workings there is another slope in which very little ore was obtained. A sloping drift towards the southwest struck the vein where it was quite as wide as in the extreme southwest stopes. These two slopes are thus connected. On the strike northeast of this last slope a small trial pit showed only a foot of ore beyond which point the vein has not been tested. Southwest of the hoisting slope now working there are several pits, and in all, the ore was uncovered, although in consequence of the very great overflow and the disturbed state of the vein and rocks everywhere near the surface, the size of the vein is not certainly settled. As

thus tested the vein is about seven hundred feet long. But the attraction shows that it is continued southwest beyond the property line on to the Cook Farm. The amount of attraction is small, generally under ten degrees, positive. At a few points, where first opened it is strong, and both positive and negative are observed within short distances. A remarkable feature is the extent to which the rock has disintegrated, becoming a loose mass of stone and earth, so that for seventy-five feet down the main slope was in what might be termed an overflow. And at the bottom, at least one hundred feet, vertically, from the surface, the rock is very fragile and the ore is removed with the aid of only an occasional blast. This rottenness of ore and rock makes timbering expensive and the mine to some degree insecure. The ore contains considerable rock, mostly mica and a green hornblende, in thin layers and irregular sheets in the vein stratification. Some of the richer portions are entirely free of rock and show very often a jointed or prismatic structure, the divisional planes of which run at right angles to the plane of the dip. On the foot wall side a thin layer of the vein holds some pyrite. A carefully selected sample, considered to be an average of the mine, was obtained from the dump at the Crane Iron Company's furnaces, Catasauqua, Pennsylvania, and analyzed. The analysis is here given, viz.:

Silica,	21.80
Protoxide of iron,	17.97
Peroxide of iron,	40.32
Alumina,	9.00
Lime,	4.37
Magnesia,	4.03
Oxide of manganese,	0.50
Phosphoric acid,	0.32
Sulphur, °	0.05
Water,	1.64
Total,	100.00
Metallic iron,	54.25
Phosphorus,	0.128

The ore is smelted without admixture of other ores, and requires only about half the amount of limestone that is used in their blast-furnaces working other ores. The ore is almost earthy in consequence of its extreme disintegration, so that the blast penetrates the compact mass with difficulty. Also takes more coal per same burden as their other ores. The pig from it is sold to the Pennsylvania Steel Company at Harrisburgh, for manufacture into Bessemer steel, of which it is said to make an excellent quality. The ore is carted to a switch on the Delaware Lackawanna and Western Railroad, near the new Pequest furnace and is thence shipped to Catasauqua. The annual product is approximately estimated at eighteen thousand tons.

MINES ALONG THE EAST SIDE OF JENNY JUMP MOUNTAINS.

Welch and Inschow lots.—These occupy a low limestone and gneiss ridge west of the Great Meadows, about a mile north of the Hope and Danville road. Two trial pits were dug here by Chas. Scranton a little more than a year ago, and in these a lean ore was found imbedded in a greyish-white crystalline limestone, whose dip was steep towards the northwest. The rock is quite impure, containing hornblende, a little mica and considerable graphite. The attraction from the main pit southward to the house of Inschow is from five degrees to twenty degrees, positive. The ore appeared to be of good quality, and contains some manganese, but it is lean, and the extent is apparently quite limited. In a hole on Welch's lot the rock was also calcareous, and the ore similar to that on Inschow, but only thin strings of it were found. Some of the limestone ledges near this point contain brown-garnet and serpentine. Franklinite has been reported from this locality, but these reports are not authenticated by the specimens.

Stiff Farm.—This lies west of the road and west of the last mentioned locality, at the foot of the main mountain range. There are several openings, all of them in the coarse crystalline *dike* ore, consisting of feldspar (orthoclase), brownish quartz and magnetite. In one of the openings, the latter mineral very largely preponderates, occurring in irregular strings and sheets

in the granitic matrix. The explorations were made about two years ago by Chas. Scranton, since which no further work has been done.

Potter Farm.—This property is owned by the Crane Iron Company. The mining here consists of a single pit in the valley between the mountain and a ridge bordering the great meadows. It is about a half mile northwest of the farm house. This shaft was put down fifty feet, and in it ore four feet in width was struck, said to resemble that of the Kishpaugh Mine. The attraction here is very light.

Garrison Farm.—North of the Potter Farm and east of the main mountain. Ore was mined here fifteen years ago, but since that, no further mining has been done. The opening was about half a mile northwest of the house, and near a small brook.

Davis' Mine, on top of the mountain west of A. Davis' house. When visited in November last, the shaft was twenty-five feet deep, and at the bottom there was a layer of ore a foot in width. The dip of the rocks was steep towards the southeast. Some calcite and a little pyrite in both the ore and the enclosing rock strata. Some chalcopyrite and azurite noticed. The latter in thin coatings in seams of the rock. On the hanging wall side, the amount of calcite is so large as to be called an impure limestone. These beds are interstratified with the gneiss.

Albertson Mine, on the mountain west of and about four hundred yards from Davis' shaft. These openings were made by Edward Bulgin, of Danville, within a year. The rock is a micaceous gneiss, dipping steep towards the southeast. Several narrow layers or sheets of ore are stratified with the rock. The locality has not been fully developed. According to an analysis of specimens sent to our laboratory by Mr. Bulgin, there are but traces of sulphur and phosphorus in this ore, and a little manganese.

Shaw Mine.—This mine is still idle.

Howell Farm Mine.—Under this head are included several openings, near the Howell farm house, on the north slope of the ridge and east of the main road, and several others in the hemlock woods, near the road. Some of these were made years

ago, by Nathan Hopkins. The explorations were resumed in 1872, after the purchase of the property by S. T. Scranton & Company. The farm was visited in 1871, and carefully explored with the dipping needle. The observations then made were, that in the fields, near the old copper mine shaft, the line of attraction ran nearly north and south, and was most of the length which it was followed positive, but negative at the north end of the line. This line was, in places, seventy feet wide. The new shaft near the northern end of this line of attraction, found the vein ten feet wide. This width includes some calcareous rock—an impure limestone. The dip is about seventy degrees towards the southeast. An adit tunnel is now being driven in from the west to strike the vein below the bottom of this shaft, and so drain off the large amount of water which now impedes work. This will be about one hundred and fifty feet long. The rock is a hard, greyish, close-grained gneiss. A narrow trap dike was observed in this cutting. This tunnel is expected to strike two or more veins within fifty feet of the shaft, two of which are opened above on the surface. In the hemlocks, three hundred yards south-southwest of these openings, considerable sinking has been done, and a vein eight feet wide worked. Here the dip is about sixty degrees towards the southeast. A large amount of calcite and graphite accompany the ore. An analysis of the average ore of this mine gave the following percentages, viz :

Sesqui oxide of iron,	83.63
Oxide of manganese, . . . . .	.65
Carbon, . . . . .	.70
Phosphoric acid, . . . . .	.10
Sulphuric "	1.09
Carbonic "	4.63
Titanic "	0.00
Silicic "60
Lime,	4.82
Magnesia,	1.22
Alumina,	2.67
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	100.11

Metallic iron, - - - - -	58.50
Phosphorus, - - - - -	0.05

This mine is yet so far from railroad lines, that no ore has been sent away, and the explorations are going on slowly, waiting for the construction of the contemplated Pequest and Wallkill Valley Railroad.

WARREN COUNTY--EAST AND NORTHEAST OF THE GREAT MEADOWS.

Scranton's Lease, north of Danville, about a mile from Danville, and on the east side of the Great Meadows. A single trial pit found a good vein of ore. Nothing further is known of the locality.

Schaeffer Farm, two miles southwest of Warrentown. A little work done here in 1872 uncovered a small vein of rich ore. Latest reports say that it has pinched out.

Livsey's Mine, on the farm of Andrew Hibler, in Warrentown. About a dozen shafts have been sunk on this farm within a short distance (north) of Hibler's house. There appears to be a wide vein of ore-bearing gneiss—consisting of alternate layers of magnetite and rock, resembling the Henry tunnel ore and that on Shoemaker's, near Oxford. The strata dip steep towards the southeast. When visited the shaft then sinking was intended to go down through the hanging wall rocks to a richer ore.

This lean, banded ore and rock, (of which average samples were obtained on the ground) contains:

Magnetite, - - - - -	26.95
Phosphoric acid, - - - - -	1.02

or over seventy per cent. of foreign minerals.

Maring Farm, half a mile southwest of Warrentown. The explorations here were made by Richard Stephens, of Mount Hope, and resulted in opening some good ore. The line of attraction is long and constant. Southeast of this the Hibler line crosses this farm also, being traced by the outcrop for nearly a mile.

Haggerty's Diggings, north of Warrentown and west of the Alamuchy road—made by T. Haggerty, of Alamuchy. The work

of breaking this ground consisted in digging narrow trench across the strike of the strata, down to the solid rock or ore. In this way the hill was pretty thoroughly tested at comparatively small expense. No large veins were found, but several small ones and strings of ore.

SUSSEX COUNTY.

Glendon Mine.—This old mine has not been worked for several years. With the ore there is a large amount of calcite, and it contains some oxide of manganese. Of the extent of the ore nothing was learned.

Andover Mine.—The old mine remains as it was left years ago. Towards the northeast, what is known as the *Sulphur Hill Mine*, was worked two years ago for a Harrisburg furnace. The ore was very full of sulphur. The place was abandoned over a year ago.

Roseville Mine.—This mine was visited last summer, but no mining was in progress, and the works appeared to be abandoned.

Tar Hill Mine.—Not working.

Franklin.—The vein of ore in the white limestone has been worked largely, near the Walkill, and to some extent on the high part of Mine Hill. The mines in gneiss are not worked at present.

Green's Mine, on Pockhuck mountain, near McAfee valley. Nothing has been done here in many years.

Bird Mine, on Pockhuck mountain. This too is idle.

HEMATITE IRON ORES.

The mines of this ore of iron now worked in the State are comparatively few and at widely separated points.

Pockhuck Mine.—This old and well known mine belonging to the Franklin Iron Company is being put in working order by the completion of a new slope, heavy pumping and hoisting machinery, and by the construction of a gravity railroad over

the ridge eastward, down to the railroad at McAfee Valley. These changes will afford easy and extensive facilities for mining on a large scale. The blowing in of the furnace at Franklin will set the work going.

Cedar Hill or Ten Eyck Mine.—This is a new opening on the brow of the steep limestone ridge west of McAfee Valley. It was opened about three years ago by Mr. Ten Eyck, of Warwick. The Franklin Iron Company has quarried out several thousand tons of lean ore, which is still at the mine. Its geological relations are strange, and not well understood. The ore appears to have all been worked out.

Beattiestown Mine.—Here the Musconetcong Iron Works Company is working for the Stanhope furnaces. The prospects are very fine, and the ore of excellent quality.

German Valley.—The explorations here have not been continued this year. Upon the completion of the High Bridge and Chester Railroad, they will be further continued and probably worked.

Carpentersville.—This mine is reported steadily working.

New Village.—A mine of hematite is reported as recently opened near this village. It has not been visited.

Shiloh, near Hope, Warren county. A little hematite was found the past summer in some test pits dug on the farm of a Mr. Burdge at this place, but no workable amount. The locality is at the western foot of the Jenny Jump Mountain and near the boundary line between the gneiss and the blue limestone.

Bird Mine.—This deposit of hematite is on the farm of B. Bird, about a quarter of a mile west of Clinton, Hunterdon county. It was opened the past year, and worked by G. M. Conover and J. K. Large until stopped by the panic in September. It lies in the blue limestone near its junction with the red shale. The covering of earth at the north end of the pit was slight. Southward it increases, the ore appearing to dip in that direction. About two thousand tons of wash and lump ore have been taken out of this main excavation, which does not yet exceed twenty feet in depth. From test pits sunk near this, the quantity of ore is considered large, belonging to a single body or

pocket rather than detached masses. So far, only about one-fourth of the ore raised needed washing. The short time which this mine has been worked explains the lack of deeper and more extended excavations.

SEARCHING FOR NEW BEDS OF IRON ORE.

With the rapid increase in our yearly production of iron, and the prosperity of the mining interest, there has been a very general inquiry for new locations for mines, and an active search for new beds of ore. The owners of old and established mines pursue their inquiries and searches with prudence and intelligence; but a great deal of money is wasted in useless or injudicious explorations, by inexperienced and sanguine persons, who know the value of mines, but have not learned the difficulties of finding them. The following directions to those who are looking for iron-ore deposits may be useful.

1. *The workable beds of magnetic iron ore are all in the Azoic rocks.*—Strong local attraction is not uncommonly found in the trap rocks of our state, and some attempts have been made to work them, but as yet without success. The ore in the trap is disseminated everywhere through it, but has not yet been profitably separated from the rock.

2. *The magnetic iron ore is all found in beds which are interposed between the layers of the gneiss and are conformable to them.* It is never in veins which cut across the layers of the rock; it has no gangue rock of calc spar, fluor spar, quartz or any other mineral different from the common minerals of the adjacent rock layers; it has no rock walls by which the ore is separated from the adjacent rock, which at all differ from any other two adjoining beds of rock which are separated by a seam of softer or otherwise different mineral, and in many cases there is no seam at all, but the ore adheres firmly to the rock; and there are many instances in which it passes into rock by a gradual diminution of magnetite in the mass. These beds of magnetite, like the rocks among which they occur, are highly inclined or almost vertical. In this respect they have an acci-

because another form can be used which gives indications more rapidly.

The Miner's Compass, which is the one now most generally used, has a magnetic needle balanced on a *horizontal axis* so that the needle itself may turn up and down instead of sidewise as in the other form of compass. Such a mode of suspension constitutes it a *dipping* needle. The needles used are from two to four inches long and are hung in circular boxes having brass edges and glass sides. The needle is suspended in the middle of the box, and the box itself is held by a ring attached to its edge. The circular edge is graduated inside to degrees, and these are numbered so that when the needle is level it points to 0°, and when it dips down vertically it points to ninety degrees. The box must be held so that its faces are towards the east and west, the needle is balanced so as to be horizontal when in this position, if there is no local attraction. If the box does not face east and west the needle will not be horizontal even if there is no local attraction, so that caution must always be exercised when making observations with it. There is a Swedish compass for miners which has both horizontal and vertical motions, and is most approved there. It has not the steadiness of our instruments, however, and cannot be used with so much confidence in its indications. Messrs. W. & L. E. Gurley, of Troy, have made for me a miner's compass which has the two motions, dipping perfectly and having sufficient horizontal motion to prevent making mistakes in holding the compass. It is mounted in a box like the common miner's compass, and I have no doubt is the best that has yet been invented.

All the compasses need handling with care, they are very delicately suspended, and can easily be broken, worn or displaced. The magnetism of the needle may also be diminished or weakened. If the compass is out of order, the only safe way is to send it to an instrument maker for repairs.

Indications.—It is well known that if a bar of iron is held perpendicularly, it acts like a magnet; its upper end attracting the north end or pole of the compass needle, and its lower end the south pole. If the upper end of the bar is leaned over

dental resemblance to true veins, and this has led to their being commonly called *veins*. And, understanding that the word vein, simply means a flattened mass of ore standing on edge, the name may be accepted without conveying a wrong impression.

3. *Since the layers of ore and rock stand on edge, it necessarily follows that the ore must come to the surface of the rock.*—The rock surface is usually covered with loose earth and boulders, and of course this outcrop of ore is hidden from sight. But it is only necessary to remove the loose earth, in order to determine whether the ore is there. Blasting out or sinking expensive shafts in rock is not necessary, and such expense should not be incurred in ordinary explorations.

4. The direction in which the beds of ore *range* is the same with the strike of the rock, and the extension of worked beds of ore is frequently proved by ranging, and many successful searches for new openings upon ore have been made in this way.

5. *In ordinary cases where the surface is covered with loose earth it is common to search for ore with a magnetic needle or a miner's compass, and for preliminary examinations it is now the chief reliance.* In using this instrument much practice is required; but this joined to good judgment gives indications of the presence of ore which are almost infallible. The importance of this mode of search is so great that we may describe the instruments, their indications, and the mode of using them, at some length.

Instruments.—The surveyor's compass with a horizontal needle was the instrument first used for detecting and locating beds of magnetic ore, and it may still be used for that purpose, but it is unnecessarily large and heavy, and searches with it go on slowly. Pocket compasses, or those having needles only two or three inches long, which are without sights and so light as to be held steady in the hand, were used very generally till within the last five or six years. As indications of less than two or three degrees were not noted, these instruments were sufficiently large, and much good work was done with them. They may still be used to advantage, but have gone into disuse mainly

towards the south about twenty-five degrees in this latitude, its magnetic properties are developed most powerfully, and on the contrary if the bar slants away from this position it shows its magnetism less strongly, and when it lies horizontal in an east and west direction it shows no magnetism at all. This magnetism in the iron bar which is developed simply by its position, is considered to be due to the influence of the earth. Magnetic iron ore is susceptible of being made into magnets by the influence of the earth, the same as the iron bar. The beds of ore are like great flattened bars of iron which stand on end with their upper extremities slanting towards the southwest, and their lower ends extending down into the earth towards the northeast. Their upper ends which, of course, are those under the soil but nearest the surface, should attract the north end of the needle, and this they always do. If the bed of ore is broken across by an offset, or its continuity destroyed in any other way, the lower end next this break or offset should attract the south end of the needle, and this it always does if the break or offset is near enough to the surface to move the needle in any way.

Again, if a bar of iron is laid down with its ends pointing north and south, the north end will attract the south pole of the compass needle, and the south end of the bar will attract the north pole. In crossing a vein of magnetic ore from the south towards the north, the north pole of the needle is attracted during all the first part of the passage, but just at the place of passing off the vein the south pole of the needle is attracted; a short distance further all attraction ends, all of which is quite in accordance with the experiment with the bar of iron. The attraction which draws the north pole is often spoken of as *positive*; and that which draws the south pole as *negative*; and in writing, these attractions are expressed by the algebraic signs, plus and minus.

The indications from the magnetic needle, in searching for ore as it usually occurs in our State may be stated as follows:

An attraction which is confined to a very small spot and is

lost in passing a few feet from it, is most likely to be caused by a boulder of ore, or particles of magnetite in the rock.

An attraction which continues on steadily in the direction of the strike of the rock for a distance of many feet or rods, indicates a vein of ore; and if it is positive and strongest towards the southwest, it is reasonable to conclude that the vein begins with the attraction there; if the attraction diminishes in going northeast, and finally dies out without becoming negative, it indicates that the vein has continued on without break or ending until too far off to move the compass needle. If, on passing towards the northeast along the line of attraction, the south pole is drawn down, it indicates the end of the vein or an offset. If, on continuing farther still in the same direction, positive attraction is found, it shows that the vein is not ended; but if no attraction is shown, there is no indication as to the further continuance of the ore.

In crossing veins of ore from southeast to northwest, when the dip of the rock and ore is as usual to the southeast, positive attraction is first observed to come on gradually, as the ore is nearer and nearer to the surface, and the northwest edge of the vein is indicated by the needle suddenly showing negative attraction just at the point of passing off it. This change of attraction will be less marked, as the depth of the vein is greater, or as the strike is nearer north and south. The steadiness and continuance of the attraction is a much better indication of ore, than the strength or amount of attraction is. The ore may vary in its susceptibility to the magnetic influence from impurities in its substance; it does vary, according to the position in which it lies—that is, according to its dip and strike; and it also varies very much according to its distance beneath the surface.

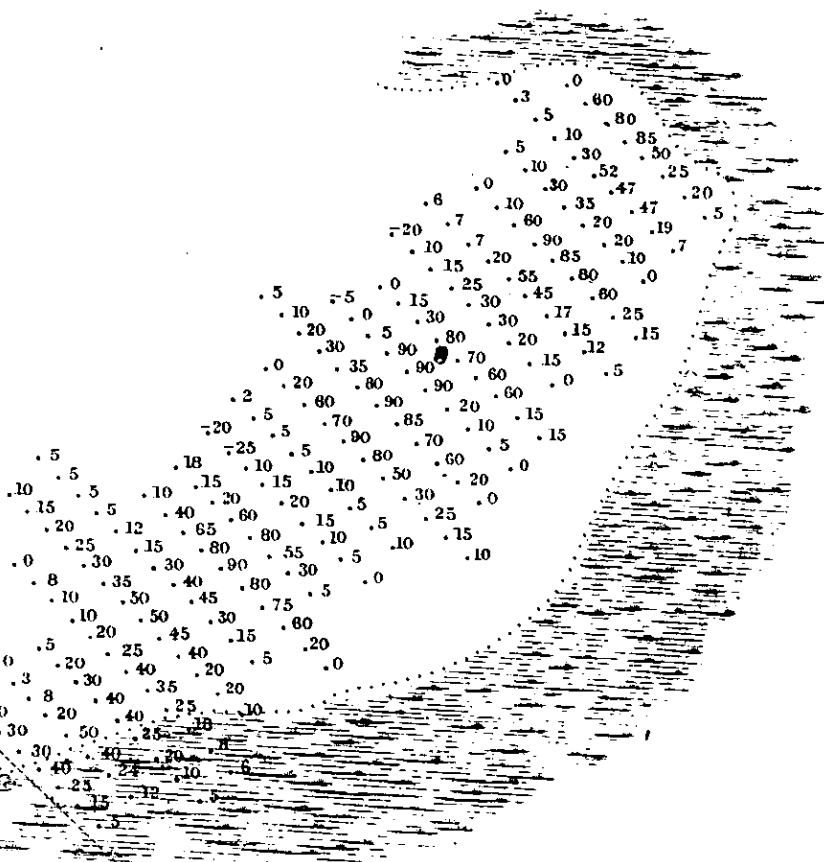
Method of Using the Compass in Searching for Ore.—The following maps of surveys for ore, illustrate the methods pursued, and do away with the necessity for much explanation. It is sufficient to say that the first examinations are made by passing over the ground with the compass, in a northwest and southeast direction, at intervals of a few rods, until indications

MAGNETIC SURVEY,
LANDS OF SCRANTON & RUTHERFORD,
WEST MILFORD TOWNSHIP, PASSAIC COUNTY.

Scale 80 feet to one inch.

— indicates negative attraction

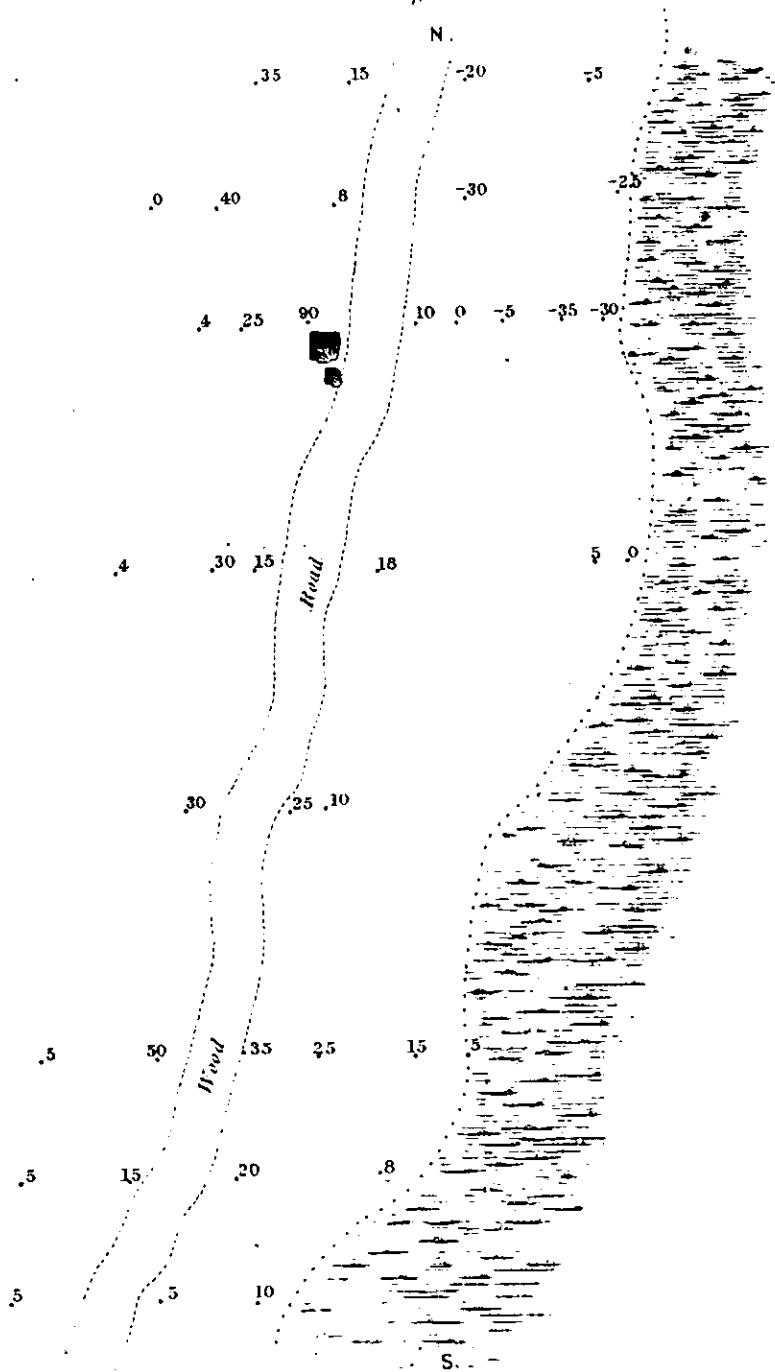
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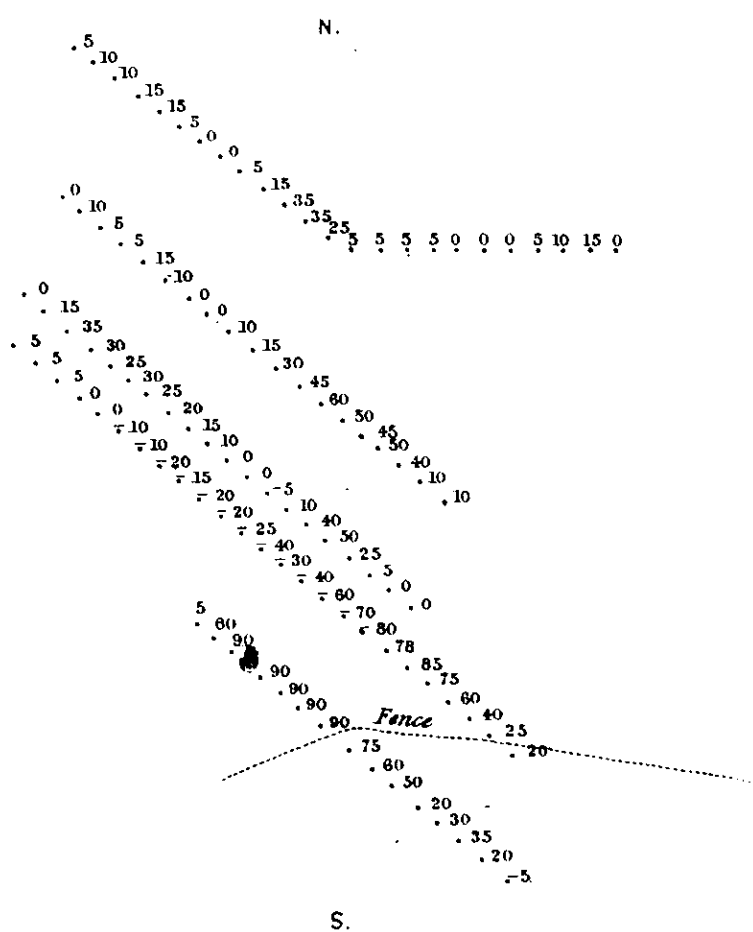
MAGNETIC SURVEY,
GAFNEY FARM, BYRAM TOWNSHIP,
SUSSEX COUNTY.

Scale 80 feet to one inch.
...indicates negative attraction.



MAGNETIC SURVEY,
 LANDS OF SCRANTON & RUTHERFORD,
 WEST MILFORD TOWNSHIP, PASSAIC COUNTY.

Scale 80 feet to one inch.
 - indicates negative attraction



of ore are found. Then the ground should be examined more carefully by crossing the line of attraction at intervals of a few feet, and marking the points upon which observations have been made, and recording the observations. In this way, materials may soon be accumulated for staking out the line of attraction, or for constructing a map for study and reference.

After sufficient exploration with the magnetic needle, it still remains to prove the value of the vein by uncovering the ore, examining its quality, measuring the size of the vein, and estimating the cost of mining and marketing it. Uncovering should first be done in trenches dug across the line of attraction, and carried quite down to the rock. When the ore is in this way proved to be of value, regular mining operations may begin.

In places where there are offsets in the ore, or where it has been subject to bends, folds or other irregularities, so that the miner is at fault in what direction to proceed, explorations may be made with the diamond drill.

In the report for last year, this was urged upon the attention of capitalists and mining engineers interested either in working the large mines or in the examination of unexplored territory. During the year past, the diamond drill has been employed at two points in Pequannock township, Morris county, in searching for ore. The work was under the direction of J. W. Hussey, of Bloomingdale, who has kindly furnished the following results: On the Kabart farm, about three miles southwest of Bloomingdale, five holes were bored on the line of the supposed vein, and at distances thirty feet apart. The holes were vertical. In each of these the vein was found and from the core its thickness and degree of dip were ascertained. The depths at which the ore was struck, ranged from fifteen to ninety feet beneath the surface. The dip was reported as fifty degrees towards the north. This unusual direction or inclination of the ore is also seen in the old mine holes on the same line on this farm.

The other line tested was two miles northwest of the Kabart farm, and near Stony Brook, on lands of Abraham Gould. Here three vertical holes were bored, and ore found in each of them.

The rock was a very hard gneiss. From the experience gained here, Mr. Hussey says that in ordinary gneiss rock holes can be put down eighty feet deep at a cost of \$3.00 per foot, and fifty feet at \$2.00 per foot, provided there is an adequate supply of water near, for running the drill. From these results and from the successful employment of the drill, in testing the extent of iron ore beds on Lake Champlain, New York, and Cornwall, Pa. and in boring for coal in the latter state, it can be safely recommend, as not only cheaper, but also much quicker, especially when the examinations are to be at all deep. And "time is money." The American Diamond Drill Co., of New York, agree to put down holes not exceeding three hundred feet for \$6.00 per foot. Under favorable circumstances this drill will bore thirty feet in a day. As the boring deepens this rate is much less. Near Pottsville, Pa., the drill has been employed to bore several holes preparatory to sinking shafts. Several contiguous holes were bored and then filled with sand, quite to the top. This was removed in lengths for a cartridge of nitroglycerine, which exploding, tore up the rock about the size of the shaft. The core brought up by the drill shows the character and thickness of the successive beds pierced as also the amount of the dip, but not the direction. Wherever a great thickness of rock lying over a supposed vein is to be penetrated this is the cheapest and quickest mode of determining the extent and character of the ore. And in case of some of our larger mining companies, such an examination of property might develop large extent of ore, justifying machinery and modes of working commensurate with the amount of work before them. In some instances this would be more economical than the falsely conservative plans now followed.

At two other points, the use of this drill had been decided upon, but the financial difficulties so severely felt by iron mining companies prevented the trial.

The subject is earnestly and urgently commended to all our iron-mine superintendents, and to capitalists or others connected with mining or prospecting for ore.

Searching for Hematite ores cannot be done with the miners compass. The ore does not affect the magnetic needle. All the deposits of this ore yet known in New Jersey have been found in or near the magnesian limestones. Nearly all have been found at the meeting of the limestone and the gneiss rock, though a little has been seen near the meeting of the limestone and the slate. To search for this ore, the first requisite is to be familiar with its appearance, so as to recognize it even in very small fragments. The next point to be attended to is the geographical position of the magnesian limestone. This is accurately laid down upon the map accompanying the present report. A careful examination of the surface of the ground where hematite exists, will detect fragments of the ore among the little stones and gravel that may be exposed; and in some cases pieces of the ore weighing many pounds are found loose upon the surface. Very full directions for sinking trial pits in the search for hematite, were given in the Geological report for 1872, and the reader is referred to that for particulars.

ZINC ORES.

The mines of zinc ore at Franklin and at Stirling Hill continue to be worked. The Lehigh Valley Railroad Company, the lessees of the Morris Canal, report that they have transported on the canal the past season seventeen thousand five hundred tons of zinc ore. This has been carried to the New Jersey Zinc works in Newark, and the Passaic Zinc Works in Jersey City, where the ores are reduced.

The extraordinary richness and value of these mines has stimulated the search for other deposits to a remarkable degree. We are continually receiving specimens to test, which have been taken from new localities, with the hope that they might prove to be valuable zinc ores, but so far, we have not found any new ones of value. Boulders of ore from Franklin or Stirling zinc veins are found scattered among the gravel and loose earth for several miles south and southwest of these veins. One near Sparta weighs as much as a hundred tons. Fragments of

this easily recognized ore have been sent to the office of the Survey from places twenty or even thirty miles from the mines, but it is suspected that they have got there by accident or by fraud, as no considerable quantity could be shown.

The hydrous silicate of zinc or calamine has a close resemblance to gray limestone, and many samples have been sent here to be tested. None of this ore, however, has been found in the State except at Sterling Hill, where it is mined by the Passaic Zinc Company.

Zinc blende has been sent to the office for examination. It was taken from some place on the Blue mountain in Warren county. From the specimens seen, there is nothing to encourage the search for more at that locality. The mineral in small quantities is not uncommon, but it is uncommon to find it in sufficient quantity to work. Searches will undoubtedly be continued at other places along the Pequest Belt, in the range of the zinc mines now opened—and as the oxides of iron and manganese which accompany the zinc at those mines, are found throughout the whole length of the belt in New Jersey, it is possible the zinc may be found also. It may facilitate the work of those who wish to make such searches to know that the veins both at Stirling and at Franklin, affect the compass needle, and though the attraction is not very strong, it is just as decided as it is over iron ore veins. Ore supposed to contain zinc is easily tested at a blacksmith's fire. The ore should be crushed fine, then if thrown upon the clear-burning red-hot coals, and the bellows blown, there will be an abundant white smoke, which is oxide of zinc.

COPPER ORES.

Ores of copper are very common in the red sandstone or triassic rocks of Central New Jersey, especially near the meeting of the sandstone and trap. They are very lean and irregularly distributed through the rocks, and no regular veins or beds have yet been found in the state. Failures in the attempt to work them profitably, have been very numerous, though some persons

still make the attempt. But the work is not promising, and we discourage any investment of money in our copper mines in the present condition of the metallurgy of copper. It is reasonable to hope that the art will yet so improve that our ores will be valuable.

GOLD AND SILVER ORES.

Many specimens of ore said to contain silver, have been brought to the office, but in none of them has any silver been found. Some came from the copper ores, some from the gneiss rocks of Schooley's Mountain, and a number from Jenny Jump. The reports of silver being found in the localities which these specimens represent are either intended for practical jokes or else they are frauds.

Gold in very small quantity has been found in some of the iron pyrites of the Blue Mountain in Sussex and Warren counties; but only just enough to prove it was there, and as specimens were tested from different places, it is considered very unlikely that gold in paying quantities will ever be found in those rocks.

BUILDING STONES.

Few new localities for quarrying stone for building purposes have been opened during the year. One of these visited was on the farm of M. J. Ryerson, near Bloomingdale. It is on the southern end of a rocky ridge about one-quarter of a mile east of the village and on the north side of the Pequannock River. The rock is grey gneiss, consisting of flesh colored feldspar, vitreous quartz and brown-black mica. The proportion of the mica varies considerably, being quite abundant in some of the beds, while in others only occasional plates are seen. The dip of the strata is very constant, from fifty to sixty degrees towards the southeast. Two systems of joints traversing it at right angles to the plane of the dip split it into very large rectangular blocks, which are easily divided into smaller and more convenient

sizes on lines parallel to these natural planes of division. The beds which crop out on the summit of this ridge are but slightly rounded on their edges and have retained their original fresh shades of color on the outside, showing no tendency to weather readily or to suffer from oxides or sulphides of iron so generally present in our gneissic and granitic rocks. Large sizes for foundations, sewer covers, &c., are easily got out. The smaller stones are used for paving blocks. They are split into oblong masses and are used for the so called granite block pavement. A few car loads have been sent to Paterson for trial. They can be delivered at the railroad station, Bloomingdale, at \$70 per thousand. By transfer to canal at Mead's Basin the transportation to Newark and Jersey City need not be very costly. Northeast of the quarry the stone is for a long distance remarkably even-bedded and appears equally well adapted for building as that at the south end of the ridge.

Ryerson's Granite.—This is on the north side of the Pequannock river, about three-eighths of a mile east of Charlotteburgh, and forms huge ledges in the steep hill above the road. This rock is a mixture of flesh-colored and white feldspar, quartz, quite clear, and black amphibole—more properly a syenite than a granite. The mass has a greyish color and resembles the Scotch granite. The stone split easily on long straight lines and are susceptible of a high polish. The supply of such stone is practically inexhaustible.

South of the river, opposite the granite, above the railroad, there is an old quarry worked by the railroad company for heavy stone for bridge abutments. The rock here is a grey gneiss, with a dip very distinctly seen towards the southeast. The railroad being below and near it, and abundant water-power at the river for sawing, dressing and polishing, this locality offers rare advantages for supplying heavy stones.

Bennett's Quarry, Deckertown.—About one mile southeast of Deckertown, and at the side of the Midland Railway track, a new quarry has been opened during the year and worked to some extent by E. P. Bennett. The stone is the ordinary blue, magnesian limestone, but quite remarkable for its regular bed-

ding and for the ease with which it can be dressed. The strata dip twenty-five degrees north fifty degrees east, and range between five and thirty inches in thickness. Stone from three to five feet wide are readily got out. The *spalls* go to a kiln to be made into lime. A few stone have been sent away, but the business is hardly yet started. When visited in December there were about fifty car loads on the bank. A switch from the main track running into the quarry affords ready means of shipment.

The quarry in the gneiss near Dover continues to be worked and a large amount of stone is taken from it every year for heavy work, for which it is admirably adapted.

There are many other points along our railroad and canal lines where gneiss suitable for building stone can be quarried, and its strength, durability and beauty commend it to the attention of builders. In selecting sites for quarrying careful examination should be made so as to avoid stone liable to disintegrate readily. Stone containing iron ore, iron pyrites or any sulphides of the metals is also to be carefully avoided, as such are quickly stained by weathering or even liable to partial disintegration. A little attention to the character of outcrops will determine in many cases the probable value of the stone at any given point. Where the stone has been covered by earth and boulders and so protected from atmospheric agencies a chemical examination will very quickly settle the question.

The employment of stone from iron mines, which under certain circumstances economical, is not however, to be recommended, from the extremely probable occurrence of ore or pyrite in it, which on long exposure would weather to a rusty-brown oxide, spoiling the appearance of the stone.

The brown stone so well known for its adaptation to the purposes of the architect and the engineer, continues to be quarried in large and increasing quantities. The most of the quarries which are largely worked, are on the Delaware or along the Passaic, where, by canal or river, the advantages of cheap transportation can be secured. From our location, in regard to the great cities of the country, we have peculiar facilities for sup-

plying this excellent building material, and the localities from which it can be obtained may be greatly increased by a careful examination of the red sandstone country that is traversed by our numerous railroads; and the variety of shades of color which it presents may be much increased.

An attempt was made to collect the statistics of the amount quarried at different points, but for want of time it has not been completed. Through the favor of Ashbel Welch, Esq., Engineer of Construction for the Pennsylvania Central Railroad in New Jersey, we have estimates of the amount quarried at Prallsville, on the Delaware, as follows:

The R. R. Co.'s quarries yielded	8,700	perches	of	25	cubic	feet,
Kessler's (Hoppock property),	18,300	"	"	"	"	"
Five other quarries, aggregate	8,600	"	"	"	"	"
Total,	35,606	"	"	"	"	"

Of these, about half went to Philadelphia for bridges, &c.; nearly a quarter was used by the Pennsylvania Railroad Company, as much by the Easton and Amboy Railroad, and a small quantity elsewhere. The value of these stones at the quarry before being dressed, was not far from \$30,000.

From Messrs. Prior & Son, of Trenton, we learn that the quarries about Greensburg yield sixty thousand tons annually, estimated to be worth \$90,000.

The quarries of free stone, at Newark, Belleville and Paterson, are steadily worked, the average sales per year for the past six years having been as follows:

Newark,	\$100,000
Belleville,	100,000
Paterson and Oldham,	40,000

At Little Falls there is not so great activity in quarrying, and the annual sales average about \$10,000.

These items were furnished by Robert Matches, Esq., of Newark, who is interested in the Newark quarries.

Clays.—The plastic clays, including the varieties known as fire clay, porcelain or china clay, paper clay and alum clay, extend entirely across the state from Raritan Bay and Staten Island Sound on the east, to the Delaware river on the west. The northern limit is marked by the outcropping red shale and sandstone of the triassic formation, following an almost straight line from Woodbridge, southwest by Bonhamtown, to the mouth of Lawrence's brook on the Raritan river; along this stream nearly to Monmouth Junction; and thence north of the railroad, near Penn's Neck and Baker's Basin, to the Delaware river at Trenton. The southern boundary of this sub-division of the cretaceous formation is not so well defined in consequence of the superficial beds of drift which cover it. Near Raritan Bay these are not so thick, and the division line between the plastic clays and the clay marls, is accurately located near the mouth of Cheesquake creek. But towards the southwest, the overlying drift is so deep that it is impossible to draw the southern boundary with much certainty. The pits where these clays are dug are confined to limited areas near Woodbridge, Amboy, Bonhamtown, Washington and Trenton. During the past few years the increasing demand for these valuable clays has stimulated searches beyond the old clay districts, and resulted in the discovery of additional localities where they can be profitably dug. The several pits between Staten Island Sound and the Raritan river, indicate a continuous and quite regular bed of clay under the surface beds of soil, red shale drift, sand and gravels. There may be points in which this continuity is broken, in consequence of the removal of the bed previous to the deposition of the newer and overlying drift materials. This is evident to all who are engaged in clay digging, to whom the very uneven upper surface of the clay is a striking and well-known feature. Such points of interruption in the bed are exceptional, and the probability of their occurrence not strong enough to deter explorations anywhere within the limit of this geological belt; and the thorough examination of this whole territory is here urgently recommended to land-owners and others interested in the clay business. In this

examination, regard should always be had to the probable thickness of the overlying deposits and the searches should be made in the lower grounds along the streams or near the red shale border where the bed crops out nearer the surface. Boring is the quickest and most economical mode of searching. Where there is no danger of quicksand, test pits or wells are almost as cheap and more thorough and satisfactory than borings. These should go down at least forty feet where new territory is being examined. Near old pits, less depths may be equally conclusive. In some cases this depth may be exceeded; as for example, near Woodbridge where the bed worked is so valuable as to make the removal of a greater thickness of top earth possible with profit.

Associated with these clays, *fire sand*, *moulding sand*, *kaolin* and *feldspar* often occur, and in quite thick beds. All of these are employed with the clays in various manufactures, and in such connection their extraction is profitable. Improvements in the modes of manufacturing refractory materials will undoubtedly increase their uses and make them everywhere worth digging.

Between the Raritan river and Trenton, there is a wide gap in which no valuable clay has been dug. Borings along the streams or in the depressions in this district may yet discover workable beds. The wells cannot be regarded as test pits, as they rarely go through the drift. The examination by boring of some of the more favorable localities would be interesting and probably find clay of value. The old and well-known clay pits continue to be worked with great activity. During the most of the year, the great demand for fire brick made the clay trade very brisk, and the amount of clay dug was large. The financial crisis affecting the metallurgical industries of the country, is equally depressing upon the clay business; but this will probably be temporary, and the re-establishment of business may accrue to the advantage of this interest by making the superior character of our clays more widely known and more generally appreciated.

For the details of localities the reader is referred to the Geology of New Jersey, and for modes of searching for clays, to the Annual Report for 1872, pages 24-26.

Glass Sand.—The manufacture of glass in the southern portion of the state, continues to be thriving, and the supply of sand suitable for it appears to be ample for all prospective demands. During the past year some boring was done near Winslow, on lands of Hon. A. K. Hay, to determine the area of surface from which sand could be profitably obtained. The results were highly satisfactory and showed the value of this mode of exploration. Its employment would doubtless increase the number of localities which could be profitably worked for this valuable material.

In the northern portion of the state sand for glass making has been obtained in quantity at one point only, viz: near Flanders, Morris county. It was worked fifty years ago for a glass house, at Columbia, Warren county, on the Delaware river. The sand was hauled this long distance by teams, crossing Schooley's mountain, through Hackettstown, Vienna and over the Jenny Jump mountain to the Delaware, and a good quality of glass was made from it. The pit is now owned and worked by the Boonton Iron Company. If valuable for glass the supply would be large, as the whole ridge in which the pit is located consists of this friable *sand rock*. For full description, see Geology of New Jersey, pages 93, 693 and 694.

Another glass sand locality is near Sand pond, on the Blue mountain, Hardwick township, Warren county. It was worked for the Columbia glass house, but only to a limited extent.

LIMESTONES.

Lime was the first of the fertilizers brought in to supplement the farmers' home supply of manure, and it still holds a very important place in the list of commercial manures. In those parts of our state where agriculture is the most improved, lime is still considered a necessary adjunct to the other supplies of

manure, and it is regularly and largely used. Our best farmers know that they get better crops where lime is judiciously applied than where it is not used at all; that weeds are less abundant and troublesome; that pastures are thicker, richer and more luxuriant; and that clover grows best on such lands. It is greatly to be desired, that an abundant supply of pure and cheap lime should be easily obtained in all parts of the State, and we look with much interest on the large addition made to our sources of supply by the opening of the Midland Railroad across the county of Sussex. From Ogdensburg to Franklin much of the road bed is on crystalline limestone, and it runs near many other fine exposures of the same between the last named place and Deckertown. Near McAfee Valley the White Rock Lime and Cement Company have started a kiln and are burning about thirty barrels of first quality lime daily, and about one-fourth as much of lime for farmers' use. This lime is pronounced by those competent to judge as quite equal, if not superior, to the best lime found in New York market, and its nearness to that great centre gives it an advantage in price over any of the others. There is an unlimited supply of white or crystalline limestone in this part of Sussex county, as indeed there is along the whole length of the Franklin belt from the New York boundary to the Delaware, and it must soon attract the notice of manufacturers and consumers of lime.

The farmers of Sussex have made less use of lime than most others. The production of an abundant supply of the best quality of this fertilizer should stimulate them to its more common use. It should be tried on pastures, spreading from fifty to one hundred bushels of the fine slacked lime on an acre, in the fall or winter; on sod to be turned over for corn planting, the lime may be used in the same way, or it may be spread on the plowed ground and worked in by harrowing. It can be used on plowed ground for wheat or rye with advantage.

The white limestone is in considerable part, though not all, pure limestone; the blue limestones east of the Blue mountain, are nearly all magnesian limestones. There has been much question among farmers as to which is the best. In places where

lime has been most used, it is conceded that pure lime is quickest in its action, but that the magnesian lime lasts the longest. In buying unslacked lime there is no question but what a bushel of pure lime is worth more by at least one third than the magnesian lime; but after they are slaked the pure lime swells so much more than the other that there is very little difference in their value, by the bushel.

Walkill Cement and Lime Company.—This is an association started by John H. Brown, at Hamburg, Sussex county, for the manufacture of hydraulic and other limes. Their quarry is on the side of the New Jersey Midland Railway, about a quarter of a mile northwest of the Hamburg Railroad station, and on the southwest point of the Pochuck mountain range. The railroad cut, crossing the ridge near its terminus at the Walkill, shows on the southeast a grey feldspathic gneiss a few feet in breadth whose dip is towards the southeast at a high angle. Going northerly this rock is followed by a few feet where no rock appears. This is succeeded by ledges of highly siliceous and conglomerate rock interstratified with more calcareous beds, followed by blue limestone, and the strata which are known as cement rock. Two principal varieties of stone are recognized as suitable for cement, a dark colored containing thin seams and nodular masses of calcite traversing the black or greyish black mass. These strata vary from fifteen to eighteen inches in thickness, and dip forty degrees west. On a line measured across the strata horizontally, these cement layers are not over thirty feet from the gneiss, so that geologically these lie closely and conformably upon the siliceous beds which probably belong to the Potsdam epoch. This dark colored rock is very hard, brittle, and breaks with a subconchoidal fracture. About one hundred feet from the gneiss at the west end of the cut, the light colored stone crops out. The same variety is seen in the newly-opened quarry on the north side of the railroad track. As here exposed, the strata of this variety occupy a breadth of ten feet between beds of quartzose black slaty rock, with thin sheets and layers of the same slaty rock at irregular intervals, interstratified with it. This light colored cement

stone has a finely laminated structure due to alternations of darker and lighter shades of material. In this it resembles closely some of the so-called ribbon limestone of the hills west of the Blue mountain. Some pyrite was observed in the more slaty beds as well as in the dark colored cement rock. For grinding and burning, the material is taken to "the Stone, mill" south of Hamburgh, where a small kiln has been erected and two run of stone put in the mill for grinding the burned cement. Coal dust and screenings are used to burn it. The grinding capacity of the cement mill is said to be two hundred and fifty barrels, each per ten hours' run. Thus far the manufacture has been of an experimental character, and very little of the cement has been put in the market. From the very limited trials given it, there are favorable reports as to its ease in working and durability. Robert H. Howell, of Hamburgh, is president and manager at the works.

Samples representing the two varieties of cement stone, were obtained at the quarry, which have been examined, with the following results :

ANALYSIS :

	(1)	(2)
Carbonate of lime, - - -	42.28	47.40
Carbonate of magnesia, - - -	33.26	37.19
Silicic acid, - - -	15.70	7.02
Oxide of iron and alumina, - - -	6.00	5.43
Potash, - - -	1.34	1.04
Magnesia, - - -	0.36	0.68
Carbon, - - -	1.35	1.17
	<hr/> 100.09	<hr/> 99.93

The analysis of these stones shows them to be impure magnesian limestones. They contain more magnesia than most of the cements which are in common use. Experience proves that they do not slake when burned, and that when ground and made into mortar, they quickly set and become hard, as cements

should. Their peculiar properties will become better understood by a longer trial. Every effort to make good and cheap cement should be encouraged. The uses for it are increasing every day. For ordinary masons' work, it is rapidly taking the place of quick-lime. It sets quicker, so that work can be safely put up faster; it is much stronger, so that thinner walls can be used in many cases, and a great saving of labor and material effected; and water does not hinder its setting, nor weaken or in any way damage the mortar made with it. South of the mill the Sussex Extension and the Midland Railroads both cut a magnesian limestone, dipping forty degrees to fifty degrees towards the northwest. Some of the strata here are light-colored and resemble that at the cement quarry; but a short distance south and east of this, the white crystalline limestone outcrops, showing that the blue limestone of these cuts is nearly of the same geological horizon, and, therefore, similar in character to the cement quarry beds.

GREEN SAND MARL.

This fertilizer, which has been of such great value to the agriculture of our State, continues to be dug in large quantities.

The Squankum Marl Company, W. E. Barrett, Superintendent, report their sales for the year at three hundred and fifty thousand bushels, which is seventeen thousand five hundred tons. It is largely used on the line of the New Jersey Southern Railroad and its branches, and is applied with beneficial effects on crops of all kinds, especially on wheat, buckwheat, potatoes and grass. A luxuriant growth of white clover follows it wherever applied; fruit trees and vines make a remarkable growth, and produce fruit of high flavor when liberally dressed with this marl.

The Squankum and Freehold Marl Company, A. A. Yard, Superintendent, report their sales for a little over nine months of the year at twenty-two thousand tons. In addition to their sales in New Jersey they have shipped to Massachusetts, Connecticut, New York and Pennsylvania. The good effects of the marl are well known and highly appreciated.

The Cream Ridge Marl and Transportation Company, N. S. Rue, President, report their sales for the year at fourteen thousand eight hundred and forty-six tons, which has been mostly delivered on the line of the United Railroads of New Jersey and their branches. The largest part of it is spread upon grass land, though it is also used upon corn, wheat and potatoes with flattering reports of its results.

The Pemberton Marl Company, J. C. Gaskill, Superintendent, report their sales for the past year at twenty thousand tons. Their marl is delivered along all the railways which cross western Burlington. It is sold at prices ranging from eighty cents a ton upwards, according to the distance from the pits at Birmingham. Large quantities of it are used in compost with barnyard manure, by those who raise truck. It is used in the hill on potatoes, without compost, and it is spread clear upon grass, wheat, oats and buckwheat.

The Vincentown Marl Company, H. J. Irick, Treasurer, report that their sales this year are nine thousand four hundred and twenty-six tons. In addition to the sales in Burlington county this marl has been used about Hightstown, Windsor, Yardville, Princeton, Trenton, Lawrence and Sharon. The company has positive reports that their marl has more than doubled the crops of grain, potatoes and grass in those neighborhoods. About Vincentown they can see the good effects of marl for many years after its application.

From the General Freight Agent of the Camden and Atlantic Railroad we learn that seven thousand five hundred tons of White Horse marl have been carried on that road the past season, which has been used by farmers along its line.

The West Jersey Marl and Transportation Company, I. C. Voorhees, Superintendent, report their sales for the past year at thirty thousand four hundred and sixty-eight tons. It has been sent from the pits at Barnsboro, along the lines of the West Jersey Railroad, and sold in Gloucester, Salem, Cumberland and Cape May counties. Smaller quantities have been sold in Camden, Burlington and Mercer counties, and some has been sent by boat to Delaware. It is mostly used upon grass,

potatoes and buckwheat, though a very large quantity has been used on fruit trees. This company sells large quantities of stone lime, which is thought to act well in mixture with marl.

Messrs. Dickinson Brothers, of Woodstown, report their sales for the year at thirteen thousand tons. This marl is all hauled away by teams and is used in Salem and the adjacent parts of Cumberland county. It is put on grass, potatoes, buckwheat, and a little on other crops. No better evidence of its value to the farmer could be given than this, that they draw it away in wagons and to distances where they can only get one load a day.

These in the aggregate amount to one hundred and thirty-four thousand seven hundred and thirty-four tons. No report has been received from the many localities in all parts of the marl region, where farmers dig it for their own use, and from farmers of the country around who draw their own supplies; but it altogether amounts to much more than the quantity given above.

In the country about the marl beds many farmers think they cannot farm without marl, and they use it most liberally. At greater distances off, and where the cost of transportation necessarily enhances its price, it is used much more sparingly. In such cases its effects are not so evident, and some persons consider it of but little if any value. Frequently its effects are not perceived at all the first year. Some four or five years ago a well-known citizen of Morris county was induced to try marl on his grass. The first year after he laughed at me for recommending marl, as it did not do his crops a particle of good. This fall he incidentally mentioned to me that his grass crop, where the marl was put, had been double what it was where barnyard manure was used, ever since the first year.

Those who are most successful in its use are very careful to have it dry and fine, so that it will spread evenly and uniformly over the whole surface of the ground. Much better effects are produced under this management than when the marl is spread while wet and lumpy. The addition of stone lime to the pile of wet marl must be of advantage by its slaking, and so heat-

ing and drying the marl, even if it has no chemical effect upon it; though the latter is claimed by its advocates. There would be a decided benefit in grinding the marl in a mill and making it as fine as possible. Common leached ashes, which have only about one and a half per cent. of phosphoric acid, and an equal quantity of potash, and a considerable quantity of carbonate of lime sell readily along all our navigable waters for about twenty cents a bushel, and never fail to satisfy those who buy them. The average price of marl is not more than ten cents a bushel, and in many places it sells for much less, it contains nearly ten times as much potash, and from three to eight times as much phosphoric acid; it does not contain as much carbonate of lime, but that is the cheapest constituent. The ashes are in very fine particles, and so in the best condition to dissolve, while the marl is in small grains, and at the best can dissolve but slowly. If the marl were equally fine with the ashes it ought to be worth at least four times as much. If it could be dried cheaply in the sun, or else by the use of unslaked lime, and then ground in a mill, it would pay to carry it much farther than it can be sent now, or it could be used in smaller quantities. There would be difficulty in grinding it between millstones on account of scattering grains of sand in it; but I have seen an English mill, made for grinding ore, coal, and even grain, in which the grinding is effected by the rapid whirl of a hollow iron cylinder with many cross rods in it. It was called Carr's Disintegrator; and a mill on somewhat the same principle is used in this country for comminuting glue. The subject of making the marl into fine dust or powder is well worthy the attention of our marl companies, as well as of the farmers, and I hope some mechanic will be found with the needed skill to provide for doing the work profitably.

Plumbago, Graphite or Black Lead.—This well-known and useful substance is found in small quantity in many places in northern New Jersey. There have been many specimens sent to the office of the survey, at different times, with a request for information as to their value. The answer has been in all cases, that as yet no specimens found in the State are sufficiently pure

to work without first separating the earthy and rocky substance that is mixed with it; and that this, though attempted, has not been profitably done in our State. There is a long vein of this mineral which is four or five feet thick on land of Mr. Englemann, one and a half miles northeast of Peapack; it is also found in several places near Mendham, and there is also a very thick bed or vein of it near Bloomingdale. All these localities are in the Pompton Belt of our crystalline rocks, and very near its northwestern border. On the farm of Chas. Conover, near the road to Clinton and three quarters of a mile from High Bridge, a vein of quite pure plumbago has lately been opened in a shaft about twenty feet deep. Samples of it were sent to the office by Mr. Conover.

Works were erected at Bloomingdale to purify black lead. It was separated from the rock mixed with it by grinding and sorting in water. Good black lead was prepared in this way. The works were stopped from some financial difficulty. At Ticonderoga, in the State of New York, black lead is successfully separated from the stony substance in it, by grinding and sorting in the dry way, in a blast of air. The mineral there is richer than ours, but it is in much smaller veins. Black lead has also been purified by chemical processes, and for some purposes this is said to be available. Brodie's process requires the use of sulphuric acid, chlorate of potash and some other chemical substances to dissolve out the impurities of the native mineral.

Materials for Road Making.—The development of our resources is to a large extent dependent on the construction and maintenance of good roads. The first centres of that growth of our State, which has been so rapid for the last few years, were places where there were good roads, and since then the progress of improvements has been inaugurated by the making of dry and solid highways. Any place with bad roads, or those which are unfit for rapid driving or for heavy traffic any part of the year, cannot thrive. No man or no business can or ought to be supported where from one to four months of the year are

lost for want of solid roads, if another place can be found where there is no loss of time from this cause.

Good gravel is found in all the middle and southern parts of the State, and excellent roads are being made of it. Turnpikes, county and township roads and even district roads are now graveled and made of the very best quality. The only requisites are to keep the road-bed dry, and its surface well covered with gravel, it is then always fit for travel.

In the central and northern parts of the State, gravel is not so universally distributed as in the southern counties. Gravel should be used wherever it is available, and where only earth or clay is to be found, the dependence must be in keeping the subsoil of the road-bed completely dry by means of tile or stone drains. If a ditch is dug in the middle of a road, and running lengthwise of it, and in this is put a draining tile or a stone drain, and then if the ditch is filled with the coarsest materials that can be got, and the upper surface shaped so as to not let the water stand on it, even the worst of materials will make a passable road. The benefits of thorough draining in a road, are beyond the expectations of even the most hopeful.

Stone roads are meeting very general approval in all places where there is travel enough to pay the interest on their cost. The first of these roads were built in Orange, where the trap rock of the mountain could be got in quantity and at little expense. The people there have gone on building these roads more and more every year, as they have proved their excellence, and at this time they have the best roads in the United States. The Essex County Road Board has wisely used its powers in covering all the main avenues which lead out from the city of Newark into the different parts of the county, with this material. The way in which the foundation is laid, was originated by Telford, and it is known by his name. The Road Board of Essex, occupying the most thickly settled part of the State, have been best able to begin this work, and they have set an example which sooner or later must be followed wherever there are roads on which there is much travel. Specifications and details of construction were given in the Geological Report of 1871.

Soils.—In almost all of Northern and middle New Jersey the soil is derived from the rock which underlies it. There are of course some exceptions to this, where deposits of sand and gravel appear to cover the surface; but even in these cases a close inspection will show that much of the material is like the rock underneath. The same principle holds also in the marl district and in the drift. The sand, the clay, and the loam which are found on the limestones of the north, are very different from those on the gneiss rocks, and these again are unlike those on the red sandstone. The marl region has its peculiar sands, clays and loams, and all these are different from those in the southern and southeastern parts of the State. Any classification of the soils under these common and well understood names is of very little use for comparison between soils from different geological formations. The chemical composition of the soils on these different geological formations is very different; while on the contrary the sand, clay and loam on the same formation resemble each other in composition, and these terms then express the mechanical condition of the soil and its relation to moisture, much more than its other qualities. On this account, we shall arrange the soils of the State for examination and study according to the rocks upon which they are found; and while the subject is only fairly begun, and we cannot give analyses of soils from all the different formations, still it is thought best to present representatives of our most marked varieties for present study and as a basis upon which to enlarge in future selections.

	Gneiss.	Limestone.	Slate.	Red Shale.	Marl.	Drift.	Drift (barren).	Miocene.	Alluvial.
Silica.....	31.40	70.30	62.90	71.07	87.80	12.42	14.08	78.85	90.95
Alumina.....	6.91	10.73	16.18	9.27	3.88	2.46	1.47	9.38	2.49
Oxide of iron....	3.06	3.52	5.63	6.56	5.17	.77	0.68	3.68	.82
Lime.....	.64	.84	.48	.22	.20	trace	0.02	.23	.53
Magnesia.....	.65	.97	2.10	2.02	.....	.06	0.09	.72	.29
Potash.....	1.07	4.34	4.06	.81	.44	.14	0.02	1.26	.18
Soda.....	.50	.37	.....	.20	trace	.04	0.15	.42	.....
Sulphuric acid..	.03	.02	.07	.03	.24	.08	0.05	.05	.08
Chlorine.....	.03	trace	trace	.01	.....	trace	trace	.02	trace
Phosphoric acid'	.13	.26	.32	.14	.19	.02	0.11	.07	.06
Organic matter.	8.55	6.26	6.55	5.00	.....	1.74	2.29	3.00	3.40
Water.....	1.55	1.54	1.55	3.80	2.56	.70	.35	1.10	.80
Oxide of manganese....	.45	.50	.....	.....	.....	.....	.....	.....	.....
Sand and gravel	45.10	.....	.....	.....	.....	81.50	80.83	.....	.....
	99.62	99.60	100.34	99.13	100.48	99.93	100.04	98.78	99.60

The gneiss soil is fertile and not easily exhausted. It is mostly on hilly or mountainous land, and is so encumbered with loose rocks and stones that more than sixty per cent. of it is unimproved. The growth of wood upon it is valuable, and wherever it has been found sufficiently dry and free from stones to admit of cultivation, it has proved itself to be well adapted to general farming, and it can be kept in good condition with only moderate manuring.

The limestone soils have been cultivated with better success than any others in the State, and so well is their fertility known that they are all in use now. They produce large crops of our staple products, corn, wheat, and grass, without any manure except lime, and some of them are known to have done so for seventy years past.

The slate soils are well known for their rich and abundant yield of pasture and hay. They are all in profitable occupation, and like the limestone soils, they are not easily exhausted. The analysis shows them to be as rich in potash and phosphoric acid as the soils referred to; it also shows that they have much more alumina and of course more clay, and they have less lime.

The Red Shale and Sandstone Soils.—These soils have all been cleared and cultivated, and for years after the first settlement of the country they yielded paying crops. They became exhausted, however, and large tracts were left in common. Quick lime alone, with good tillage, has been found sufficient for their renovation. Very little of this soil is now unoccupied, and with a judicious use of commercial fertilizers much of it is yielding very large crops.

The Marl Soils.—These soils are really very valuable. Those directly over the beds of greensand marl are practically inexhaustible, and have been cultivated from the first opening of the country. In the intervals below and between the beds of greensand, the soil is not naturally as rich, and much of it has been worn out or never cleared. The analysis is that of an average soil, somewhat sandy, and rather deficient in lime. The application of lime to it is highly beneficial, and that, with the addition of greensand marl, brings it to a high degree of fertility. It costs a little more for fertilizers to bring this soil to a proper condition for yielding crops that return a profit; but it is light, easily tilled, and sure in its returns when well managed. There is some of this soil still unimproved, but it is fast coming under cultivation.

Drift Soils.—These soils cover a large part of southern and southeastern New Jersey. They have heretofore been held in large tracts, and except where iron furnaces or glass works were located they were uncleared till within a few years. There are at least a million acres of these soils adapted to the best farm purposes that are still in forest. The analysis shows them to be deficient in lime and low in potash and phosphoric acid, and experience has proved that with the slovenly and exhaustive farming of the first settlers, these soils were not profitable to work; but under a better system of farming, they pay well. Enriched with light dressings of lime, peat, marl and commercial fertilizers, they yield abundant and remunerating crops. Wheat, rye, oats, corn, potatoes, sweet potatoes and hay are raised in large crops, and fruits of all kinds do well. The cost of land and fertilizers is less than that of the land alone in

the older parts of the State, the cost of tillage is very much less, and now that railroads and good wagon roads are extending through all parts of it, and that examples of its capabilities for improvements are to be seen at Winslow, Hammonton, Egg Harbor City, Vineland, Bricksburg, Glassboro, Clayton and many other places, the value of these lands for cultivation is demonstrated.

The Miocene Soils.—These soils are the high and retentive soils of Cumberland and Salem. They have been cleared early and have yielded well for a time, but under the old system of exhaustion they gradually wore out. The use of lime has done much to renovate them, and with that and calcareous and green-sand marls, they are easily and at moderate cost brought up to more than their original fertility. The analysis shows them to be low in lime, but rich in potash.

Alluvial Soils.—This class of soils includes all those along the ocean and other tide-waters, which are not more than ten or fifteen feet above that level. They are very productive and easily tilled, and have been in cultivation from the earliest settlement of the country. The soil analyzed as above has been cropped for fifty years without any manure whatever, and does not yet show any signs of exhaustion. It is a sandy soil, and the only element in which it abounds, is lime.

APPENDIX.

[HEMATITES.]

BIRD MINE NEAR CLINTON.

The following analysis shows the composition of the average ore as mined. The sample was selected by Mr. Conover, and sent to the State Laboratory :

Insoluble in acid, - - - - -	21.40
Sesquioxide of iron, - - - - -	57.88
Alumina, - - - - -	4.05
Lime, - - - - -	.16
Magnesia, - - - - -	1.08
Oxide of manganesc, - - - - -	.60
Sulphur, - - - - -	.00
Phosphoric acid, - - - - -	3.46
Water, . - - - -	11.05
	<hr/>
	99.69
Metallic iron, - - - - -	40.50
Phosphorus, - - - - -	1.51

The large percentage of insoluble matters is owing to the rock and earth, which washed samples would not show. The very large amount of phosphoric acid is also remarkable.

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The prices are fixed to merely cover the cost of paper, printing and binding; the expenses of the Survey and preparing book and engravings being paid by the State.

These publications can be had from Prof. Geo. H. Cook, State Geologist, New Brunswick, on remitting the price, or through the booksellers. They are also kept for sale at these prices by M. R. Dennis & Co., of Newark, and D. Van Nostrand, of New York city.

Annual reports for the years 1869, 1870, 1871 and 1872 have also been printed. These can be had by application to the State Geologist.

The publications are in the followin public libraries, where they can be consulted :

In all the State Libraries ; in some other of the large public libraries in different parts of the United States, and in all the public libraries in New Jersey and the cities of New York and Philadelphia. It is also in the offices of most of the County Clerks of New Jersey.

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