IRON MINES.

THE JACKSON IRON COMPANY

Is the oldest iron mine, of this region. The opening of the mine with its attendant trials and temporary disappointments, but final success, are so intimately associated with the early history of the Iron District that whatsoever is of interest will be found embodied in that chapter. Capt. Henry Merry, its able and efficient agent, has had charge of the mine since 1858, and how well he has performed his duty not only the condition of the mine, but the high price at which the stock has ever been held, attest.

Few, if any, mistakes have been made, which is something remarkable, considering geologically the very irregular structure of the ore formation. It is ever the ambition of mining captains to win a maximum amount of ore with the least quantity of rock at a minimum cost, without compromising the safety of the miner; and it would seem as if this ideal had been as nearly realized in the Jackson mine as is possible under the circumstances. This object, when once attained, is apparently very simple; but to appreciate fully its accomplishment one should have a foretaste of the many difficulties that are strewn in the pathway to consummation. To day we have ore in abundance; but to-morrow, a barrier of rock may rise up before us, cutting off the deposit. The question now is, is its continuation ahead of us, below or above us? to the right or to the left of us?

This seeking after the ore may be likened to the surgeon probing for the bullet; only that the latter has a path to guide him, and a complete knowledge of the anatomy of the ground before him, though great skill and care are necessary in either case, since a mistake may prove as fatal to

the interests of the former as to the life of the patient. It will therefore be understood how essential it is for the mining captain to constantly observe and study the facts that are continually passing before him, and to correlate and systematize his results, so that he will eventually be enabled to decide with a considerable degree of certainty the position of the deposit when suddenly cut off by the very nature of the disturbing element, thereby lessening, in a remarkable degree, the chances of failure.

Just here allow me to advise all honest seekers after the geological history of our Iron or Copper districts, to go first of all to the mining captain, and obtain from him the very cream of years of experience. Let him tell it in his own way; and when furnished, should any ideas advanced not exactly coincide with preconceived ones of your own, do not discard them, but note them all the more carefully, and when "the round" is finished then endeavor, unbiased, to combine what you have.

To describe the Jackson mine intelligibly, without the aid of cross sections and plans, would be quite impossible, and it is therefore reserved for a future number of this report to do the mine justice.

If a stranger, unused to mines, but versed in mythology, were to stroll through the mine workings on some Sunday, climbing in and out of the open pits, or creeping along on the narrow pathways around some of those huge "horses" or masses of shining Jasper, peering into the long side drifts or tunnels, where the sunlight never penetrates, then too, seeing the iron smoke-stacks reaching down to something beneath, he might easily imagine himself in the abode of the ancient Titans; or, perchance, were a heavy blast to go off, making the ground tremble under his feet, he might suppose it was old Vulcan himself forging thunderbolts for Jupiter. The bottom of these open pits are certainly not the place for a timid person; for the high, narrow walls of Jasper, reaching far upwards, frowning down upon one in such a "lowly" position, are not pleasing subjects to contemplate, especially when a booming blast somewhere below you fairly makes everything shake.

The cause of all this "general crookedness" and a want of uniformity, which meets one at every step in going through the mine, is, as has been already intimated, chiefly due to the very irregular occurrence of the ore deposits. The original stratum, if I may be allowed to use the term, with the Jasper and other strata of the series, appears to have been sharply folded and faulted, the harder and tougher beds often buckling into the softer ones, thereby giving them frequently a lenticular shape.

In some instances the ore stratum has folded on itself, affording a bed of double thickness, and where the upper portion of the fold has been worn away, as is usually the case, it will lead the unwary miner to believe that it is a single stratum, continuing downward and up again somewhere in the direction of the dip; instances of this kind are surely vexing enough, but even more so are they when a fault comes in and slides the strata past each other, thus complicating the problem still more. The shipments from the mine are as follows:

YEAR.	GROSS TONS.
1856	447
1857	12,442
1858	10,309
1859	28,377
1860	41,295
1861	12,919
1862	46,096
1863	77,237
1864	83,905
1865	65,505
1866	92,287
1867	127,491
1868	130,524
1869	125,908
1870	127,642
1871	132,297
1872	119,910
1873	130,131
1874	94,708
1875	87,283
1876	98,480
1877	80,340
Total,	1,725,533

THE CLEVELAND IRON COMPANY,

Which shares with the Jackson the honor of being the first developed mine in the District, filed articles of association in March, 1853, with a capital stock of $500,000 in 20,000 shares. The corporators were John Outhwaite, Morgan L. Hewitt, S. Chamberlain, Samuel L. Mather, Isaac L. Hewitt and E. M. Clark. Previous to 1855 was mined and used at their forges 3,000 tons of ore, and during that year the first shipments were made. It will be noticed by reference to the accompanying map of this mine, that the company's workings are somewhat scattered; all of their openings, however, do not appear on the sketch.

No. 1 Pit is a small opening located in the northwest corner of Section 11. It is about 100 feet long by 50 feet wide, but at the bottom, some 60 feet down, it has narrowed to an average width of less than 10 feet. The deposit is probably a sharp contact fold, similar to that in an old pit just east of here which is now mined out.

Nos. 2 and 3 pits nearly adjoin No. 1 on the southwest; these two are now merged into one. Standing at the head of the main incline of this mine and facing west, we have before us an open pit, 300 feet long by 150 feet wide, which pitches at an angle of about 25 degrees to the southwesterly. On the north and east sides of this pit the foot wall comes to the surface, while the south and west sides are limited by nearly vertical headings or walls of massive quartzite. At the southwest corner of the pit it is over 100 feet deep. Under this immense body of rock they have mined out the ore, leaving huge supporting pillars of ore, to prevent the roof of quartzite from falling.

Passing down and into the under ground workings, (see map of mine,) we find that they extend at present (May, 1878,) about 400 feet westerly, and average 250 feet north and south. The vein of ore varies from ten to forty feet in thickness, averaging about 25 feet. The ore is a fine quality of specular and is very rich. An average sample, consisting of several hundred pieces, collected this season by myself from their stock pile of over 30,000 tons, afforded, on partial

analysis, 66.90 per cent. of metallic iron, and only 1.62 of silica.

The lowest point in the pit is 150 feet from the surface. The ore is now brought to the surface by one double incline and two single ones, all starting from one point above, and are operated by the same engine. These inclines, as well as the hoisting machinery, were constructed and put into operation in 1877, and altogether are as complete as anything of the kind in the iron district. The machinery was made at the Iron Bay Foundry, Marquette, which of itself is a sufficient guarantee for its efficiency.

Immediately south of No. 9, is the incline pit, which a few years ago had one of the largest "shows of ore" of any mine in the county.

The pit near the surface was 500 feet long and from 150 to 200 feet wide, with a "floor" of nearly all ore, and dipping apparently vertical; but now 150 feet down, it has proven to be a sharp contact fold, wherein the southerly portion of the fold came to the surface and originally lapped over the jasper mountain on its foot wall side, while the northerly portion of the same in the eastern half of the pit, after making the turn at the bottom comes within 70 feet of the surface, and then dips at an angle of 35 degrees to the northwest. The entire pit, however, has a lateral pitch to the southwesterly. In the westerly end, on the north side, the ore vein dips at a low angle to the northwest. The vein here varies from 10 to 30 feet thick, with a working face 130 feet long. In the eastern end of the pit they are now under and mining toward No. 5 pit (see map). The ore is of an excellent quality, and averages about the same as that from No. 3 pit already noted. The ore is brought to the surface over four inclines.

Passing over into the underground workings of No. 4 pit, which is really a northerly extension of the incline pit, we find the vein has very much narrowed, and owing to this fact, and the insecure character of the roof, mining operations were stopped and no work has been done there for some time save by "Scrammers," who, too frequently, care less for their heads than for their pockets.

Leaving No. 4 we pass south a few steps to No. 5 pit—at the bottom 140 feet long by 45 feet wide, at its west end, and not more than 10 feet at the east end. On the surface the vein was much larger, being about 80 feet wide and 150 feet long. This vein, no doubt, was originally continuous with the incline mine, and like that, is a sharp synclinal fold. The lowest point in the pit is 130 feet below datum.*

To the southeast of the No. 5, is a small opening, and around the jasper bluff is the Little Mountain mine. These are irregular deposits which require considerable experience to be worked profitably. Continuing around the jasper hill, in a westerly direction, we pass some small openings and finally come to the Saw Mill mine.

This is 350 feet southwest by south from the nearest point of the incline pit, and is probably on the same vein as that deposit. The deepest workings here are 72 feet deep. It is an irregular shaped deposit, and has an apparent dip to the southwest, which will probably change to a westerly one as the workings are extended. The ore is a very hard specular variety, fully equal to that of the Incline mine.

Seven hundred feet southwest of the saw mill mine is the school house mine. The workings in this mine are entirely underground, and have been so for a number of years. The dip of the vein is to the northwest, varying from 15 to 30 degrees, and the thickness is from 3 to 30 feet.

The hanging wall is quite regular, but not so with the foot wall; at some points the dip of it flattens, at others it is steeper, narrowing the vein in the former instance, and widening it in the latter. Near the bottom of the mine the vein widens out to 30 feet, but a little further down the foot wall flattened in its dip, narrowing the vein so much as to render the mining of it no longer profitable. My impression, however is, that this narrowing is only of a local character, similar in its nature to those above this point in this mine, and that the vein will again widen out below. On the northeast side of the mine the workings are limited by a "fault" or slip in the formation; that is, the strata on the

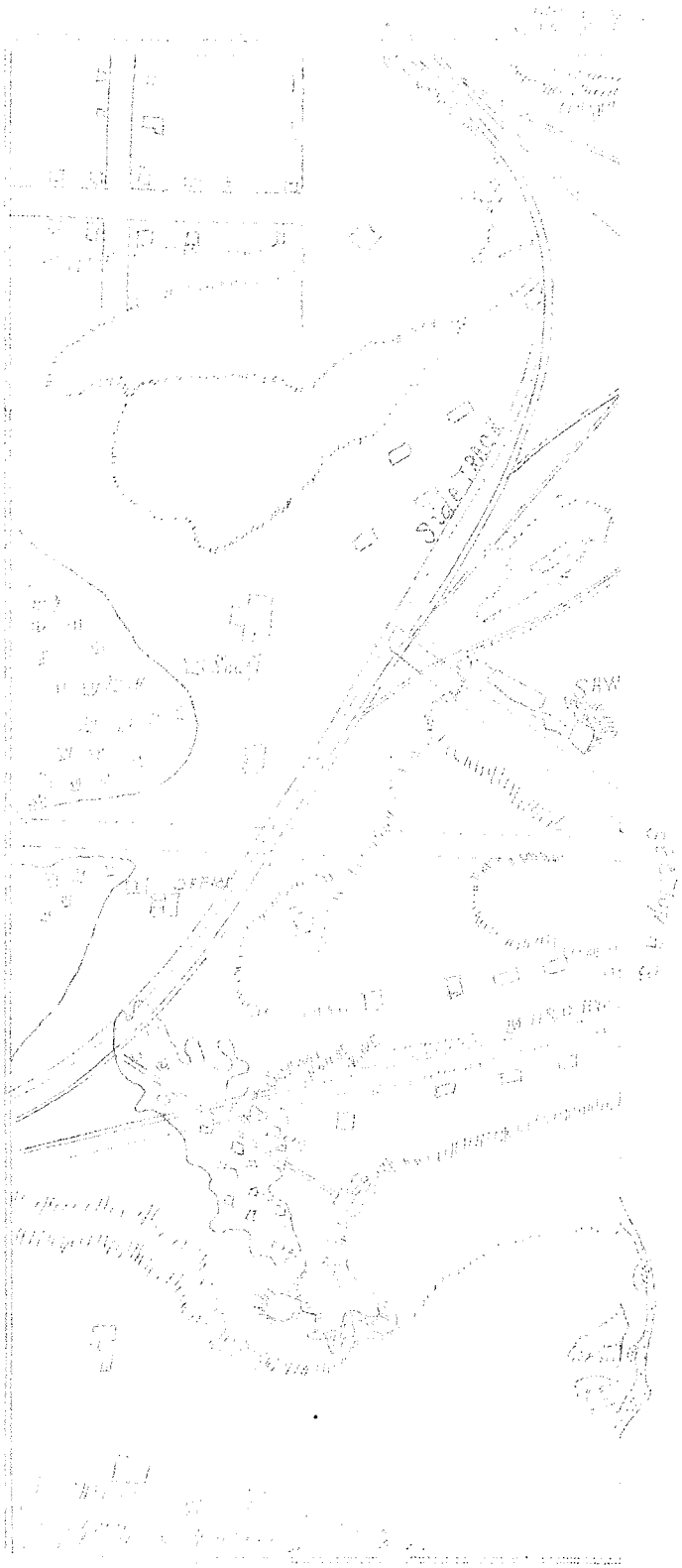
*Datum is on the same level as the top of sill of old engine house.

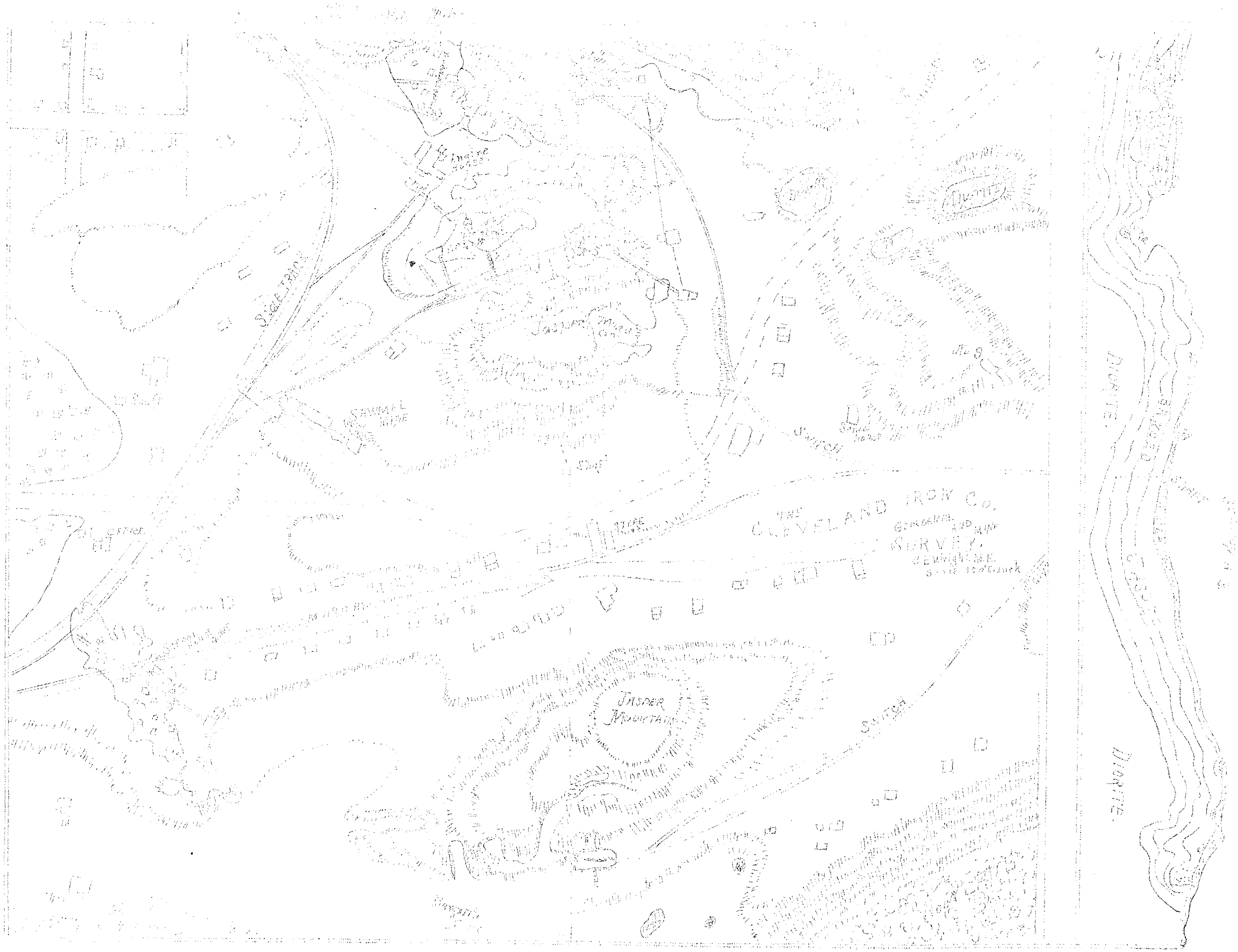
northeast side of the fault have been pushed upward, carrying with them the stratum of ore. The "slickenside" striæ are very plain, and from them can be easily made out the direction of the "throw." In addition to this, the heading of rock, limiting the working, is a banded jasper—the foot-wall of the ore. On the southwest side is a corresponding fault which limits the workings in that direction. The "heading" or "breast" here, is a gray quartzite and jasper conglomerate—the hanging wall of the ore.

Glancing at the ground plan of this mine it will be noticed how nearly parallel are the workings just considered; showing that the two faults have a common direction. The large fault in the Lake Superior mine, two-thirds of a mile east of here, has about the same course; whether we can locally make out any system to these troublesome freaks of nature, is a problem reserved for the future. Taking a hasty glance at the sketch of the mine with the folded and crooked cross section, the irregular shape of the ore beds, and not forgetting the faulting or slipping of the strata, to confuse matters still more we see that even iron mining, as simple as it may appear to some, is not a business suited to novices.

The fine condition of the mine, and the few accidents that have occurred, as well as the completeness of the mine appointments, and the perfect system in all the details of the management, coupled with the good will of the employes towards the employers, reflect much credit upon the agent and the superintendent of the mine. For the past season they have been using, quite extensively, the diamond drill in boring holes down at different points, to determine the position of the ore stratum. Some of the results have been very interesting, but we will wait for others and then, in our next annual report, will show by a geological cross-section their practical application. The annual shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1854	
1855	3,000
1856	1,449
1857	6,343
	13,204





SIDE TRACK
Engine House
Jasper Mine Co.
SAWMILL
No 3
SWITCH
THE CLEVELAND IRON Co.
GENERAL AND MINE SURVEY.
JASPER MOUNTAIN
SWITCH
DIORITE.
DIORITE.

1858	7,909
1859	15,787
1860	40,091
1861	11,795
1862	40,364
1863	46,842
1864	44,959
1865	33,355
1866	42,680
1867	75,864
1868	102,112
1869	106,133
1870	132,884
1871	142,658
1872	151,724
1873	133,265
1874	105,858
1875	129,881
1876	145,661
1877	151,554
Total,	1,685,372

Adjoining the Cleveland workings on the north, and contiguous thereto, are those of the

NEW YORK IRON MINE.

This company was incorporated April 8th, 1865; capital stock $250,000 in 10,000 shares. The stock is now held by S. J. Tilden and W. L. Wetmore. The land was leased from A. R. Harlow, of Marquette, and comprises the S. E. $\frac{1}{4}$ of the S. E. $\frac{1}{4}$ of Sec. 2, T. 47, R. 27. Actual mining commenced in 1864, and during that year was shipped 8,000 tons of ore. The product gradually increased to 94,809 tons in 1870. For several years it appeared as if there were two independent veins of ore, each having on the surface nearly an east and west direction, and a dip of 33 degrees to the south, and separated by about 50 feet of rock—the northerly deposit apparently dipping under the southerly one; but after a depth of one hundred feet had been attained in the former bed, the foot and hanging walls rapidly approached each other, cutting out the ore altogether. The upper vein, the southerly one, has produced the most ore. The extent of the workings on this vein is about 850 feet east and west.

At the easterly end they have mined out down to the Cleveland line. At the westerly end the workings are 160 feet vertically beneath the surface, and the present breast of the ore there is forty feet from the south line of the property. The ore formation at this point makes a gradual turn to the north, and in a horizontal drift 117 feet below the surface it may be seen that the formation even swings around to a northwesterly direction and joins the northerly deposit.

During the past season I have made a careful mining and geological survey of this mine, which has developed some interesting and valuable facts. It has shown that the northerly deposits, above alluded to, is a sharp synclinal contact-fold, and that it and the southerly deposit are of the same stratum, and were originally joined by a sharp anticlinal or inverted trough-like fold. To satisfy the present conditions, we must assume the upper portion of the folds, above considered, to have been worn away, which would afford us, apparently, two parallel strata of ore, separated by a "bar" of rock. The entire formation "pitches" to the west.

North of these workings, before reaching the north line of the property, there occurs, in my opinion, two other complete synclinal and anticlinal folds. These seeming facts will probably be demonstrated during the coming season, and they, in connection with those expected from the Cleveland diamond drill holes, directly south of here, will furnish us with the data for one of the most complete and valuable geological cross-sections ever made of this distiict.

The ore is a very rich specular, and ranks high among furnacemen, as making a strong foundry iron. This mine, for its size, has probably proved more profitable than any other of the district ; and the management, which has resulted so favorably with the present excellent condition of the mine, reflects great credit on Capt. W. E. Dickinson, the superintendent, to whose skill these results are largely due. The mine shipments are as follows :

YEAR.	GROSS TONS.
1864	8,000
1865	12,214
1866	33,761

1867	43,302
1868	45,665
1869	71,456
1870	94,809
1871	76,381
1872	68,950
1873	70,882
1874	77,017
1875	70,103
1876	58,863
1877	55,581
Total,	786,984

In the southwest portion of the city of Ishpeming is the

LAKE SUPERIOR IRON COMPANY'S MINES.

This company was organized in March, 1873 ; Capital stock $300,000, in 12,000 shares ; after this the stock was increased to $500,000. The incorporators were Samuel P. Ely, Geo. H. Ely, and Alva Strong, of Rochester, N. Y., and Heman B. Ely, and Anson Gorton, of Marquette, Mich.

Operations were begun in the summer of 1857, on 120 acres of land, situated in sections 9 and 10, T. 47, R. 27. Subsequent purchases have increased the total number of acres to 6,551. The principal openings, however, are located within the original 120 acre tract though there are other important mines belonging to and operated by this company, known as the Section 19 ; the Section 16 ; the Lowthian, and the New England, which are described under the Saginaw Range. It would be quite impossible to convey an intelligible idea of the stratigraphical structure of this mine without the aid of geological plans and cross-sections. I have made of this mine a geological and mining survey during the past season, but wishing to embody the results of some explorations which the company are now making, I shall defer until the next season the presentation of some interesting cross-sections of this mine which the accumulated results will enable me to make. The structure is very complicated. The main deposit is, apparently, a synclinal trough having nearly an east and west trend, and pitching to the west. The trough is wide, with sharp minor waves or folds along its

bottom; while a fault, starting from the south east side and dipping at a high angle to the southwesterly, traverses diagonally, in a northwesterly direction, the trough and its minor waves above alluded to. To confuse the structure still more, a throw in the formation has taken place along the plane of the fault, whereby the southerly portion of the series is lower than that on the northerly side of the fault. The direction of the movement is not at right angles to the axis of the synclinal, but forms a very oblique angle thereto. It is very evident that to operate a mine, so irregular in its structure, to the best advantage requires much experience and constant care and study. Even then we cannot always anticipate what is before us; the only safe ground, therefore, is to keep the exploration sufficiently ahead of the mine working. At the beginning of 1877 the outlook of the mine was not bright; but subsequent discoveries have established it in its former position in the front rank among our most productive mines. The ore, a specular slate and granular specular, is, when properly selected, of the best quality, and a satisfactory guarantee to consumers of pig iron is, that it was manufactured from this ore.

About 200 feet southeast from the opening just considered, are extensive hematite workings. There are several small openings in the immediate vicinity, but to locate them intelligibly, a plan of the mine is required. Last season Mr. C. H. Hall, the agent of the mine, sunk a shaft at a short distance from the company's office, that has since developed the existence of a large deposit of rich specular ore, which bids fair to surpass any of the kind which the company now have. At the present writing they have mined out a chamber at the bottom of the shaft, one hundred feet long by forty feet wide, and twenty feet high, without finding any foot or hanging wall to the ore. An analysis of several small fragments, collected by myself as an average, from the bottom of the mine, afforded 65.30 per cent. of metallic iron, and 3.60 per cent. of silica. West of the main opening first considered, some 600 feet, is another promising opening, known as their No. 7. The vein is about 20 feet thick; it

has a good strong hanging wall of quartzite, and a foot wall of banded jasper. The quality of the ore and its adaptability to the manufacture of Bessemer steel is not equaled by any of the mines of the Ishpeming district. An average analysis of the ore afforded me:

Metallic Iron	65.50
Phosphorus	.03
Silica	3.87

Another analysis of the ore gave only .02 of phosphorus, which needs no comment of mine to be appreciated by Bessemer steel makers. The machinery and other appointments of the mine are very complete, and the excellent condition of everything about the location betokens good management and unremitting care by its local officers, seconded by those residing east. The present officers of the company are Joseph S. Fay, President; Richard S. Fay, Treasurer; A. C. Tenny, Secretary; C. H. Hall, Agent. and Capt. J. D. Day, Superintendent. The total number of gross tons of ore shipped by the Lake Superior Iron Company are given in the following table:

Year.	L. S. Mine.	Section 19.	Section 16.	Lowthian.	Total.
1858	.....	.....	.....	.....	4,658
1859	.....	.....	.....	.....	24,668
1860	.....	.....	.....	.....	33,015
1861	.....	.....	.....	.....	25,195
1862	.....	.....	.....	.....	37,709
1863	.....	.....	.....	.....	78,976
1864	.....	.....	.....	.....	86,773
1865	.....	.....	.....	.....	50,201
1866	.....	.....	.....	.....	68,002
1867	.....	.....	.....	.....	119 935
1868	.....	.....	.....	.....	105,745
1869	.....	.....	.....	.....	125,560
1870	.....	.....	.....	.....	166,582
1871	.....	.....	.....	.....	158,047
1872	.....	.....	.....	.....	185,070
1873	.....	.....	.....	.....	158,428
1874	97,271	7,040	.....	.....	104,311
1875	105,560	13,805	.....	.....	119,365
1876	97,474	12,861	235	.....	110,570
1877	98,670	15,992	3,666	9,021	127,349
Total....	.....	.....	.....	.....	1,890,159

Adjoining the Lake Superior Mine workings, on the west, are those of the

BARNUM MINE,

Which is owned and operated by the Iron Cliffs Company.

The first shipments were made in 1868, and have continued very regular ever since, averaging about forty thousand tons each year. The vein on which they are now working, dips about 55 degrees to the south, and the strike is a little north of west. The workings embrace about 700 feet of the vein, and the deepest point in the mine is about 293 feet, measured on the angle of dip. The average thickness of the ore deposit is about 13 feet, which is a fine quality of specular slate ore. The hanging wall is a chloritic schist and quartzite, and the foot wall a jasper. The mine begins to present some of the complicated features of the Lake Superior mine, already noted in the description of that mine. The mine is well equipped, and ably managed, as its condition attests. Captain Wm. Sedgwick, the superintendent, has held this position for several years. The shipments are as follows:

YEAR.	GROSS TONS.
1868	14,383
1869	37,503
1870	44,793
1871	45,939
1872	38,381
1873	44,388
1874	40,256
1875	40,914
1876	37,750
1877	38,341
Total,	382,648

THE LAKE ANGELINE MINE

Belongs to the Pittsburgh and Lake Angeline Company. The mine is one of the Ishpeming group, and is located on the south shore of Lake Angeline. The formation has here nearly an east and west trend, and the dip is to the north. The foot wall of the mine is a decomposed jaspery schist, which is underlaid by the diorite bluff that rises, on the south side, to 150 feet above the lake. The hanging wall of the present workings is a hematitic schist. The deepest part of the mine is near its eastern portion, and is 100 feet below the lake level. The lenses of ore pitch to the west.

The entire workings embrace about 1,000 feet of the vein,

which varies greatly in its width; the widest place in the bottom, at present, being about 50 feet. Formerly the lake shore was less than 100 feet from the mine pits, but now with a large accumulation of waste material used as filling, they have a splendid frontage of some 300 feet of dry land. This soft hematite schist, is almost impervious to water, and the result is that the lake water scarcely, if at all, finds any access to the pits.

The mine is well managed, and, in a quiet way, produces considerable ore. The ore, a hard and soft hematite, is of a good quality, and, when properly assorted, averages well in metallic iron; it is low in phosphorus, which property renders it desirable for the manufacture of Bessemer steel. The officers of the company are: John Outhwaite, President; L. E. Holden, Secretary and Treasurer; A. Kidder, General Agent, and Capt. Harvey Diamond, Superintendent. The mine shipments are as follows:

YEAR	GROSS TONS.
1864	19,500
1865	20,151
1866	24,073
1867	46,607
1868	26,651
1869	39,694
1870	53,467
1871	33,645
1872	35,221
1873	43,933
1874	30,499
1875	30,282
1876	22,539
1877	19,113
Total,	445,375

From Lake Angeline mine, going south and around the east end of the greenstone ridge, we reach, in less than a mile, the

SALISBURY MINE,

Which is one of the mines belonging to and worked by the Iron Cliffs Company. It is a large open pit, 350 feet long and about 80 feet deep. The lens, or body of ore, dips about

60 degrees to the south, and has an average width of 35 feet. The ore is a very superior quality of soft hematite. A partial analysis of this ore made for the company last June afforded as follows :

Metallic iron	68.20
Silica	.52

This hardly could be considered an average, still when we consider that it is quite impossible to select out the richer ore from that which is fairly good, it shows that the ore is of a very excellent quality. Other analyses of this ore which I have made go to verify this supposition.

The hanging wall is a greenstone and the foot wall a chloritic schist. The hoisting machinery consists of a steam cylinder 16-inch diameter by 30-inch stroke engine, and two friction drums, and is well provided with pumping machinery, &c. Everything about the mine speaks well for the local management, and the careful supervision of T. J. Houston, Esq., General Manager of the Iron Cliffs Company. The shipments have been as follows:

YEAR.	GROSS TONS.
1872	545
1873	11,023
1874	6,730
1875	4,571
1876	20,510
1877	37,868
Total,	81,247

SAGINAW RANGE.

SAGINAW MINING CO.

The mine is situated on the N. W. $\frac{1}{4}$ of the N. E. $\frac{1}{4}$ of Section 19, T. 47, R. 27; besides this forty is embraced four others, cornering around the center of this section. This property was first worked in October, 1871, by Messrs. Maas, Lonstorf & Mitchell, of Negaunee. In the fall of 1872 the lessees sold out to parties representing the Cleveland Rolling Mill company, for a consideration of $300,000, and very soon thereafter the Saginaw Mining company was organized, which company have continued active mining

ever since. The product of the mine is brought to the surface through four shafts sunk on the lay of the vein. No. 1 shaft, the most westerly one, is down 170 feet, and has an inclination of 45 degrees to the north. The average thickness of the vein is about six feet. No work has been done on the west side of this shaft, but on the east side a stope 20 feet high has been driven 20 feet east. In No. 2 shaft, 400 feet east of No. 1, a depth of 360 feet, on the lay of the vein, has been reached. To the west of the shaft they stoped out 150 feet, when a crossing of rock limited the working, and the same proved to be the case on the east side after they had stoped out 160 feet. These crossings have a lateral pitch to the west of 86 degrees. The bed of ore varies in thickness from 5 to 30 feet. No. 3 shaft is located 300 feet east from No. 2, and is down 325 feet. The dip of the vein is 45 degrees, and its thickness is from 6 to 20 feet. The vein was very irregular down to the first level. To this level they stoped out at either side one hundred feet, when they struck a crossing of rock. From this point the crossings rapidly approached each other, until at 325 feet they came together. No. 4 shaft, the most easterly one is 250 feet from No. 3. The thickness of the vein here varies from 15 to 25 feet. On the west side of the shaft, down to the first level—100 feet from the surface—has been stoped out 100 feet, while to the east the workings extend some 80 feet to the boundary line between this company and Section 19 mine. Twenty-five feet below this level a crossing of rock came in from the Section 19 side, while on the west side of the shaft the crossing pitched westward; this gradually carried the entire deposit of No. 4 in that direction. The inclination of the east and west side being nearly the same, the length of the bed—180 feet—was, therefore, very uniform for 255 feet down to the bottom of the present workings. The thickness of the vein in this shaft is from 15 to 25 feet. Taking a general view of the field just gone over, we find that the length of the mine is 1030 feet east and west, and that the deepest workings are 360 feet on the lay. In No. 1 shaft but little has been

done, partially owing to the character of the ore and to a large influx of water. In No. 2 mine shaft the workings are 310 feet in length. Between Nos. 1 and 2 is a block of unexplored ground 130 feet in length, while down to the first level, between Nos. 2 and 3, the crossing is only 40 feet long; but as either end of No. 3 working inclines towards the other, the crossing widens until, at the bottom of No. 3, it extends across and nearly joins the crossing between No. 3 and 4. It is a remarkable fact that the length of the deposits of Nos. 3 and 4 should be so nearly the same, the former 200 feet, and the latter 180 feet. This, however, continues down only to the first level, when No. 3 begins to narrow, as we have already seen. The lens structure of the ore bed is quite apparent in No. 3 shaft, and it will be interesting to know where the upper end of the next lens below is located, as its relative position will furnish, to a certain extent, a key to the location of the other unknown lenses beneath; for, I believe that all the present workings will, sooner or later, terminate as in No. 3; but, with the proper amount of prospective work, the annual product of the mine need not be materially lessened for want of ore—at least for many years to come. The hanging wall of the mine is a jaspery quartz conglomerate, and the foot wall proper is a banded jasper, with usually a thin layer of talcose rock between it and the ore. One trouble they have to contend with is the large amount of water to be raised, which constitutes in their case a very important item in the cost of mining. The ore drills hard, but, in blasting—owing to the jointed structure of the formation—very little block-holing is required, and were it not for the unusual amount of water, the cost of the ore would be nearly as low as at any other mine in the district. The ore is all specular, but varies greatly in texture and structure. Much of it is from a fine steely to coarsely granular, while some of it is slaty. No. 1 shaft is a mixed, slaty ore; in Nos. 2 and 4 the ore is a slate and granular; while No. 3 has furnished only granular ore. The granular variety has disseminated through it whitish spots of impure kaolinite,

a silicate of alumina. These spots are probably decomposed bunches of felsite. The alumina is a very necessary constituent of furnace cinder, and ores containing it are usually preferred by manufacturers of pig iron. The ore is well mined in every respect, and the condition of the mine reflects much credit on the able management of its superintendent, Capt. Samuel Mitchell. Considerable attention is given to handling of the ore, in order to reduce the cost to a minimum, and it would seem that this point has nearly been attained. During the shipping season the ore is handled only once, and in the winter is stocked, without the aid of horses or carts, near the side tracks, where it may be loaded directly into the cars in the spring. Branch tracks from the two competing railways of this district afford them excellent shipping facilities. The mine shipments have been as follows:

YEAR.	GROSS TONS.
1872	18,503
1873	37,138
1874	45,452
1875	52,006
1876	57,122
1877	44,006
Total,	254,227

The officers of the company are: A. B. Stone, President, Cleveland, Ohio; A. G. Stone, Secretary and Treasurer, Cleveland, Ohio; Capt. Samuel Mitchell, Agent and Superintendent.

THE ALBION MINE

Was opened by the Messrs. St. Clair Brothers in 1871. The property is contiguous to the Saginaw mine—adjoining it on the west. It was worked by the above parties under a lease from Messrs. E. Breitung and S. L. Smith, and considerable work was done; but the results were not altogether satisfactory, and after two years of unsuccessful operations the lessees abandoned the mine and gave up the lease. The total shipments of the mine were 1,168 tons of specular ore.

Immediately west of the Albion mine, and located on the N. W. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of Section 19, T. 47, R. 27, is the

GOODRICH MINE,

Which is owned by Capt. Goodrich, of Chicago. The formation is very irregular, and the results, thus far, have not been, financially, satisfactory. The shipments from the mine are as follows:

YEAR.	GROSS TONS.
1873	3,258
1874	3,048
1875	1,718
1877	503
Total,	8,527

THE SECTION 19 MINE

Adjoins the Saginaw mine on the east, and is situated in the N. E. $\frac{1}{4}$ of the N. E. $\frac{1}{4}$ of Sec. 19, T. 47, R. 27. It is owned and operated by the Lake Superior Iron Company. The first ore was mined in Nov., 1871. The formation, as in the Saginaw, has a strike of east and west, and a variable dip to the north. No. 1 shaft is located near their west boundary line. This shaft has an inclination of 45 degrees, and was sunk 100 feet on the lay, when the crossing of rock, already alluded to in the Saginaw mine, cut out the ore altogether. No. 2 shaft is 480 feet east from No. 1; the workings are down 200 feet, and they have stoped out 180 feet to the west and 250 feet to the east. The average dip of the vein is 49 degrees; its thickness on the west side is 10 feet, and on the east it averages about 16 feet thick. The hanging wall is a jaspery quartz conglomerate, and the foot wall proper is a banded jasper. Everything about the mine is in fine working order, and the mine itself is in good condition. Capt. P. T. Tracy, until lately superintendent, had just cause to feel proud of his mine. The ore is chiefly a granular variety. It is rich in iron and contains quite a percentage of alumina, as may be seen from the soft, whitish, greasy feeling mineral disseminated through it. They are now sinking to another level, and they expect soon to have some fine stopes on either side of No. 2 shaft. The mine is quite dry, and is, no doubt, partially drained by the Saginaw mine. The mine shipments, in part, will be found under the Lake Superior mine.

THE NEW ENGLAND.

Is the next mine to the east, and is situated in the E. $\frac{1}{2}$ of the N. W. $\frac{1}{4}$ of Sec. 20, T. 47, R. 27. This property was formerly mainly owned by Capt. E. B. Ward, of Detroit, and was opened in 1866. H. G. Williams operated the mine for a long time under a contract. The ore is chiefly a soft hematite, though a narrow bed of good specular ore was mined for several years; but it did not prove sufficiently remunerative, and was finally given up. The hematite ore deposit is considered to be in formation XII. The mine has now come into the possession of the Lake Superior Iron Company. The shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1866	3,150
1867	9,075
1868	8,257
1869	14,148
1870	24,871
1871	33,359
1872	17,465
1873	181
Total,	110,506

Adjoining the New England Mine, on the east, is the

LOWTHIAN MINE.

It is owned and operated by the Lake Superior Iron Company. The mine consists of a large open pit, about 250 feet long by 125 feet wide. The formation dips about 30 degrees to the north, The ore is a good quality of soft hematite. A single skip road brings up the product of the mine, and the ore, during the shipping season, is dumped into pockets and from thence passes into the cars. The appointments, for a small mine, are very complete, and conveniently arranged. The total shipments are 9,265 gross tons.

THE WINTHROP MINE

Is situated about one-half mile east of the Lowthian mine. The mining property embraces the southwest quarter of section 21. T. 47, R. 27. It was owned by Messrs. A. B.

Meeker, A. G. Clark, and H. J. Colwell. In 1870 it was opened by Messrs. Richardson and Wood. The property, last August, 1877 was leased by Messrs. H. J. Colwell and the St. Clair brothers, and is now known as the Winthrop Hematite Company.

The mine at present (January, 1878,) is a large open pit, about 300 feet long by 200 feet wide on the surface, and 150 feet deep. The bed of ore is, probably, in formation XII. and dips about 60 degrees to the north. The apparent thickness of the vein, at the bottom, is not far from 40 feet. The hoisting machinery answers very well the present requirements. A double skip road is so arranged that when the loaded car is drawn up the weight of the car itself is counter balanced by the empty one going down.

The ore, when well selected, is an excellent quality of soft hematite, and at one time was a favorite among furnacemen. The percentage of iron was above 60 per cent., and the phosphorus was very low, and it is hoped that its present lessees will, by careful selection, win back its old friends. It is highly probable that specular ore will be found to the north of this, in formation XIII., immediately overlying XII. Branch lines from the two competing railroads furnish them with good shipping facilities. The shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1870	3,469
1871	7,319
1872	14,239
1873	31,150
1874	8,248
1875	8,622
1876	27,236
1877	12,549
Total,	112,832

Adjoining the Winthrop, on the east, is the

SHENANGO MINE,

Which is really only a continuation of the former mine, and to a stranger the two would appear as one mine, as they both form a large open pit. The land on which the

mine is located is owned by the Pittsburgh & Lake Angeline Company. The Shenango Iron Company was organized in September, 1872, with a capital stock of $500,000. The officers are: C. Donkersley, President, Marquette; Geo. C. Reis, New Castle, Pa., Vice-President; H. D. Smith, Appleton, Wis., Secretary and Treasurer. The first ore was mined on a contract by Messrs. Orthey & Hurd. At present, 1877, it is worked by Messrs. Mitchell & Stone, and is known as the Mitchell Iron Co. The shipments are as follows:

YEAR.	GROSS TONS.
1872	197
1873	8,552
1874	7,699
1876	5,596
1877	3,897
Total,	25,941

THE HOWELL-HOPPOCK

Is located about one-half a mile south of the Shenango. But little work has been done here, and the ore is hardly up to the standard ; the shipments are:

YEAR.	GROSS TONS.
1873	1,240
1874	966
Total,	2,206

THE FOSTER MINE

Belongs to the Iron Cliffs company, and is one of the oldest soft hematite mines of the district. It is located about three miles south of Ishpeming on the southwest quarter of section 23, T. 47, R. 27. The mine was opened during the spring of 1865, and worked with considerable force until sometime in the season of 1873, when the production gradually decreased, as may be seen by reference to the annual shipments.

The ore occurs in lens-shaped masses or pockets, having for its hanging wall a greenstone, and for its foot wall a talcose schist. The workings, or open pits, aggregate about 500 feet in length, and the deepest of them are 70 feet. The average width of the vein is 15 feet.

The shipments from the mine are as follows:

YEAR.	GROSS TONS.
1868 and previous	6,000
1869	14,540
1870	23,458
1871	13,532
1872	18,684
1873	18,107
1874	4,719
1875	847
1876	125
Total,	100,012

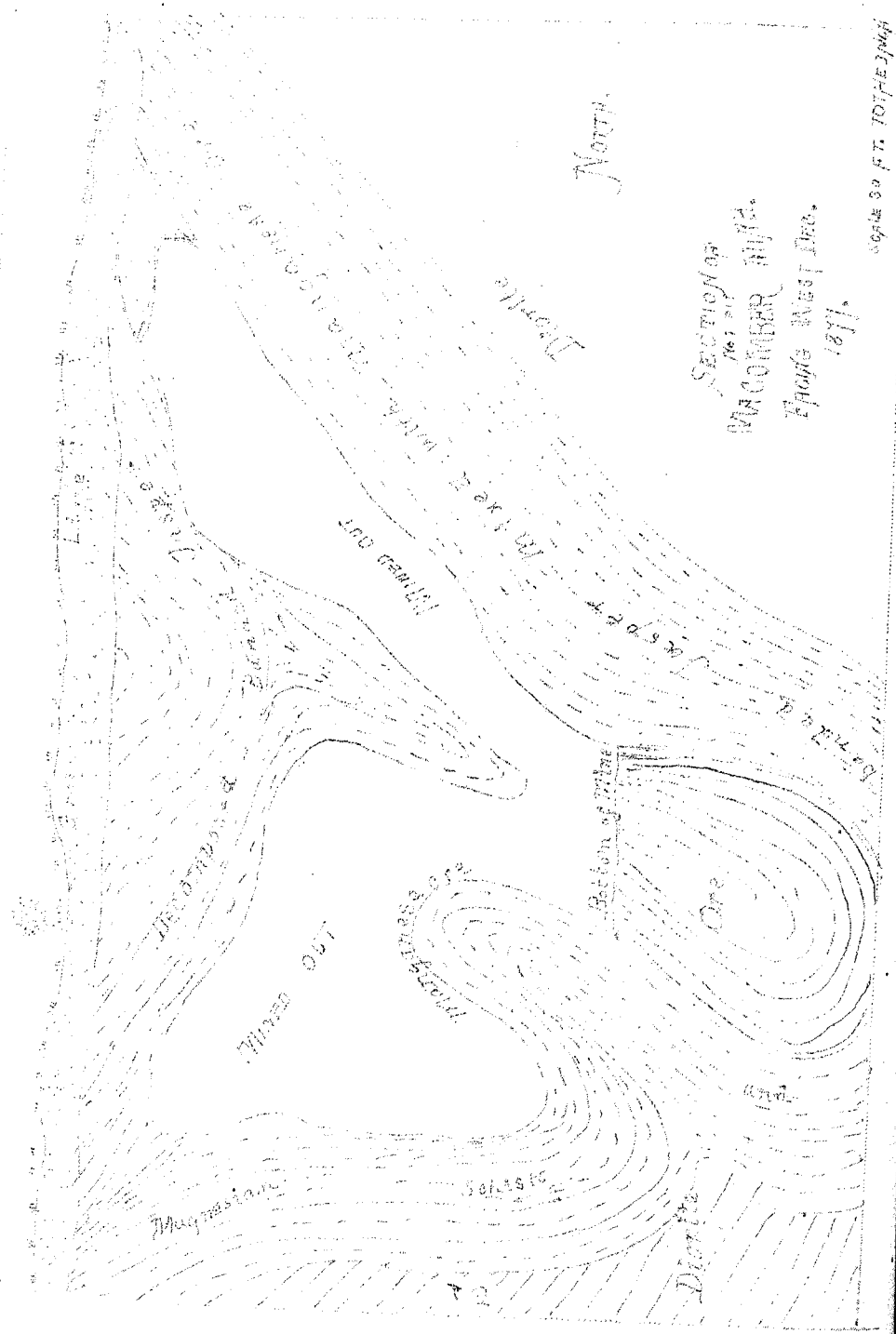
The other mines owned and operated by the Iron Cliffs company are the Excelsior, Miller, Rowland, Gilmore, and Section 18 mines. Their shipments in gross tons are:

YEAR.	EXCELRIOR.	ROWLAND.	MILLER.	GILMORE.	SECTION 18.
1872	755	.....	.....	.....	.....
1873	.....	2,003	3,612	162	1,405
1874	1,014	379	1,144	.....	.....
1875	3,029	368	.....	.....	.....
1876	2,688	52	.....	.....	.....
1877	.....	196	.....	.....	.....
Total....	7,486	2,998	4,756	162	1,405

The Pioneer opening, at the Jackson mine, is worked by the Iron Cliffs Company but as this ore is included in the Jackson mine shipments, we will not give it here.

NEGAUNEE HEMATITE MINES.

Just south of Negaunee, only a few minutes, walk, is a range of hills having nearly an east and west trend; on their north slope, facing the town, may be seen several small openings of the different mining Companies organized within the past ten years. Some of these openings are mere test pits—the mine existing only in name. The McComber, Rolling mill, and New York Hematite (formerly Grand Central) mines are among the largest of their class of any in the district. The ores are the soft hematite and limonites, and are, when properly selected, of a good quality, averaging well in metallic iron, and exceptionally low in phosphorus, a desideratum now sought for by the Bessemer Steel makers. Some of them are rich in manganese, sufficiently so for the



manufacture of Spiegel iron which, in quality, fully equals, if not excels, the foreign article, because of its low percentage in phosphorus; at least it surpasses anything yet produced in our own country. To describe all of these mines would only be a repetition; we will therefore select some one of them:

THE McCOMBER MINE

Was first opened by Wm. C. McComber, in 1870. In 1872, the leasehold from James P. Pendill, Esq., the owner of the land, was sold to the McComber Iron Company, which was organized August 14th, 1872; Capital stock 500,000, in 20,000 shares. The officers are S. L. Mather, Cleveland, Ohio, President and Treasurer; Fred A. Morse, of same city, Secretary; Jay C. Morse, Marquette, General Agent, and Capt. D. H. Bacon, Superintendent.

The mine workings are located on the N. W. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of Sec. 7, T. 47, R., 26, and at present are limited to five large open pits, though it is their intention to begin, as soon as practicable, regular under ground mining.

The formation is very irregular and the strata much folded, as may be seen from the sectional sketch of the west end of No. 1 pit. The ore "*in situ*" has the same banded structure as the jasper which it frequently resembles, and it sometimes passes very gradually into this rock. The stratum from which the ore is wrought is No. X. of the Huronian series; hence, the banded jaspery structure is not surprising. It is more than probable that the hematite deposits along this entire range were, originally, hard, highly silicious and more or less felsitic beds of jasper, that have been acted upon by thermal alkaline waters, which have dissolved out the silica and left the alkaline bases oxides of iron manganese, lime, magnesia and alumina, behind. By this operation the percentage of iron oxide would be increased. Some of the beds of jasper, no doubt, were largely feldspathic, as is evident from small bunches and specks of a soft, whitish, greasy feeling mineral kaolinite disseminated through the ore.*

*See sketch opposite of page, 24 which was made since the above was written.

The mine has produced many very interesting minerals, such as rhodochrosite, a carbonate of manganese; pyrolusite, a binoxide of manganese; baryta, and some pseudomorphs of hematite after pyrite. These latter possess more interest to the mineralogist than to the miner. These crystal cubes are very hard, and, outwardly, resemble a stained crystal of iron pyrites. The facets have often a bright metallic luster and are finely striated after the pentagonal form, so characteristic of the pyrite. The powder is of a deep red color, and in none of them have I been able to discover, on a fresh fracture, any of the unaltered pyrite. Though these pseudomorphs may have but little interest to the miner, still they add another fact to strengthen the theory of thermal alkaline water, as the agent which has transferred the worthless jasper into a merchantable iron ore. What is surprising is the low percentage of silica contained in these ores. An average sample collected by myself from No. 1 pit, in March, 1877, afforded, on careful analysis, the following result:

Oxide of Iron	71.430
Oxide of Manganese	17.250
Alumina	2.200
Phosphoric Acid	.073
Sulphuric Acid	.073
Silica	2.050
Water Combined	5 320
Undetermined	1.604
	100.000

Metallic Iron	49 80
Metallic Manganese	10.90
Phosphorus	.034
Sulphur	.021

An average of several analyses taken from the different pits, gave:

Metallic iron	60.33
Metallic Manganese	1.46

The greater portion of the manganese ore occurs in pockets, which in some instances are 25 feet across, and are very rich in this desirable ingredient. This, with the very small percentage of silica and phosphorous, and the appreciable amount of alumina, renders it one of the very best of ores for the manufacture of spiegel iron; in fact, as has been already noted, it is ahead of anything of the kind yet discovered in the United States, and fully equal to the best of foreign manganiferous ores. The other ores, less manganiferous, in this mine, are fairly low in phosphorous and silica, average well in metallic iron, and contain quite a percentage of alumina.

When we consider the wavy structure of this range, it seems highly probable that there must be other parallel belts of this ore to the north of the present workings of the McComber mine. Whether the silica has been sufficiently dissolved out to render them good merchantable ores, is a question that can only be determined by actual exploration.

During the past season 1877, the company have replaced the machinery that was damaged by fire with a very complete plant, from the Iron Bay Foundry of Marquette. The mine, though a small one, has all the conveniences of the larger ones.

Late in the season of, 1877, just at the close of navigation, Messrs. J. C. Morse and Col. Jas. Pickands, stockholders of the mine, determined to demonstrate the adaptability of the ores to the manufacture of spiegel iron. An excellent opportunity offered itself in the Munising Furnace, which was then being "blown out" for repairs, &c. Availing themselves of this they hastily sent, on a tug boat, some 50 tons of ore from the McComber mine. Only a part of this was of their best quality, as no time could now be lost in selecting. Fluxing the furnace properly for this process, the first run was a spotted, or a partially spiegelized iron; but the next cast gave a beautiful spiegel pig iron. The crystal facets of the spiegel were an inch ore more across; in fact the result was even more flattering than we had hoped for, considering the quality of the ore treated. A

partial analysis made by myself of the pig iron afforded the following:

Iron	85.490
Manganese	10.600
Sulphur	.028
Phosphorus	.120
Silicon	.681
Carbon &c	3.081
	100.000

The annual shipments from this mine have been as follows:

YEAR.	GROSS TONS.
1870	4,866
1871	15,942
1872	25,030
1873	37,332
1874	2,642
1875	10,357
1876	17,282
1877	19,691
Total,	134,142

Adjoining the McComber on the east is the

NEGAUNEE MINE.

It was worked in 1871 and 1872 and then laid idle until the present year. The ore is a maganiferous soft hematite, and very similar to that of the McComber mine. The shipments have been as follows:

YEAR.	GROSS TONS.
1871	4,787
1872	9,154
Total,	13,941

Immediately north of the Negaunee mine is the

GRAND CENTRAL IRON COMPANY'S MINE.

It was first worked in 1870 under a sub-lease from Hon. Ed. Breitung, by S. S. Burt and J. S. Waterman. In 1874, owing to the stress of hard times, following the panic of '73, they forfeited their lease, and in 1875 it was again subleased to M. T. Gaffney, Esq., Negaunee. The ore, when properly selected, is a fine quality of "soft hematite" and brown iron ore. The following are the shipments:

YEAR.	GROSS TONS.
1870	1,809

1871	2,921
1872	9,925
1873	6,629
1875	750
1876	456
1877	3,307
Total,	25,797

THE ROLLING MILL MINE

Adjoins the Negaunee property on the south. Work was first begun at the Rolling Mill mine late in the season of 1871. The mine is very conveniently located, both for mining and for the transportation of the ore. The deposit has the form of an immense horse shoe, the walls on either side inclining towards the other at a high angle. A fault and throw diagonally across the two arms of the horse shoe appears to have slightly complicated the structure. The ore is of an excellent quality of soft hematite and brown iron ore, and when carefully assorted is as good as any ore of this class which is mined in the district, but unlike the McComber or the Negaunee mine ores, it contains but very little manganese. W. W. Wheaton, Esq., is the General Manager, and Captain James Bale is the superintendent. The shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1871	236
1872	6,772
1873	13,112
1874	14,796
1875	33,638
1876	50,997
1877	38,901
Total,	158,452

Only a few steps to the south are the workings of the

HIMROD HEMATITE COMPANY.

This company was organized Nov. 27, 1872. Capital stock $500,000, in 20,000 shares. After shipping 5,065 tons of ore in 1873, the company ceased mining operations, and have not resumed. The ore is similar to that of the adjacent Rolling Mill mine, but does not average as well in quality. Adjoining the Rolling Mill mine on the east are the mine

workings of the Green Bay Iron Company. The following comprise their total shipments:

YEAR.	GROSS TONS.
1872	7,633
1873	1,949
Total	9,582

Contiguous to the Green Bay Iron Company on the east, is the

ALLEN MINE,

Which has made the following shipments:

YEAR.	GROSS TONS.
1872	8,707
1868	510
1869	130
Total	9,347

This embraces, I believe, all the iron mines of the Negaunee range—excepting the South Jackson—which have made any shipments of ore.

About one mile north and west of Negaunee is the Teal Lake range. The Bessemer, Cambria and Cleveland Hematite mines belong to this range.

THE BESSEMER IRON COMPANY.

This company was organized in February, 1876. The mine property comprises 70 acres of land located in the S. E. $\frac{1}{4}$ of section 35, town 48, range twenty seven, and is worked under a lease from the Teal Lake Iron Company. It is a little more than a mile from Negaunee, and is situated on the south shore of Teal Lake. A branch from the C. & N. W. R'y. to the mine affords them excellent shipping facility. The first ore was mined in July, 1876, and shipped to Cleveland. In the present workings (Dec. 1877) they have attained a depth of 54 feet below the surface. The mine is very much like many of our other soft hematite ones, consisting of a large open pit, the steepness of whose sides depends on the stability of the wall rock. The vein is some 60 feet thick, with an occasional horse of rock interstratified with the ore. The formation has a strike of nearly east and west, and dips about 45 degrees to the south. This belt probably belongs to No. X. of the iron series. The ore is a very good quality of soft hematite, and some portions of it contain quite a percentage of kaolinite—a silicate of alumina. An average sample collected from different portions of the pit, in July, 1876, afforded on partial analysis:

Oxide of Iron	87.54
Phosphoric Acid	.19
Sulphur	.92
Silica	3.20
Metallic Iron	61.28
Phosphorus	.082

The officers of the company are Charles M. Wheeler, Marquette, President; Jas. H. King, Painesville, O., Treasurer; G. Jones, Negaunee, Secretary; C. M. Wheeler, Agent.

The shipments are as follows:

YEAR.	GROSS TONS.
1875	144
1876	6,801
1877	10,127
Total	17,072

CAMBRIA IRON COMPANY.

This property lies immediately east of the Bessemer, and was leased from the Teal Lake Iron Company early in 1876. The mine is on the same belt as the Bessemer, and the bed has about the same strike, but the dip of the formation is a few degrees less. Just at present—Dec., 1877,—they are contending with some large horses or lenses of rock, but this is a phase of all our soft hematite iron mines, though in some more common than in others. They are now sinking on the dip of the vein and intend to go through a heading of rock, expecting to meet another lens of ore further down which, from the past experience in other mines of the district, is quite reasonable. The hard and soft hematite ores occur in this mine and, when well selected, are of an excellent quality. The shipments are as follows:

YEAR.	GROSS TONS.
1876	6,329
1877	10,082
Total,	16,411

CASCADE RANGE.

In this district—some four miles south of Negaunee—great activity prevailed during the years of 1870 to 1873. Preparations were begun on an extensive scale to meet the requirements of an expectant large business. Commodious frame buildings were built and a branch railway constructed to connect with the Chicago & Northwestern Railway; and, in fact, everything was done that seemed to be necessary to carry on such business.

The deposit of iron ore appeared to be, practically, inexhaustible, and the quality was unquestioned: the locations of the mines were exceedingly favorable, and nothing seemed wanting to the fulfillment of their brightest anticipations.

The panic of 1873 came, and with it a lack of demand for the ores which the majority of the mines on this range furnished.

The Palmer mine, or "west end Cascade" and, possibly, the Pittsburgh and Lake Superior mine of this range, are the only mines which are enabled to furnish the quality of iron ore demanded by furnacemen. The showing of ore, at the former of these two locations, is certainly very good, both as to quality and quantity. The bed of ore in the larger pit of the workings, dips about 55 degrees to the northwest, and the strike is southwesterly. This pit is about 230 feet long and 115 feet down, on the lay of the vein; near the center of the working, the vein branches—one portion to the northwesterly and the other one to the northerly. Turning southeast and passing over a few steps to another pit, we find the strike of the vein to be nearly north and south and the dip about 60 degrees to easterly; this pit is about 150 feet long, and is deeper than the first one we examined. The ore bed varies from 6 to 30 feet in thickness, and in the first pit, just described, are some very fine stopes of ore, which is a specular slate and granular specular, and is of a good quality. The capacity of the mine itself is somewhat greater than that of its present equipment; put in

proper shape, the mine could produce,as it now appears, at least 40,000 tons annually. The other mines, leased and opened by the Cascade Company on this range, are the Emma and the Bagaley; but these latter have not been worked since 1874. The mine is at present under the able management of Joseph Kirkpatrick, Esq., who gives it his personal attention.

The total shipments of the Palmer, Bagaley and Emma mines are as follows:

YEAR.	GROSS TONS.
1871	4,171
1872	39,495
1873	41,204
1874	16,106
1875	4,070
1876	15,324
1877	20,211
Total,	140,581

THE PITTSBURGH AND LAKE SUPERIOR,

Already mentioned in connection with the Palmer, adjoins that mine; the ore, a specular slate variety, is of a good quality, but requires unremitting care to separate it from the specular schists occurring with it. Operations were suspended there until the fall of 1877, when mining was again resumed by Messrs. Bacon and Morse, of Negaunee. The shipments are as follows:

YEAR.	GROSS TONS.
1872	1,160
1873	21,498
1874	1,362
Total,	24,020

The other mines on the Cascade range, that have been opened but are now lying idle—owing chiefly to the quality of their ores—are the Carr, Gribben and Home. They will probably remain in their present condition so long as the high standard of Lake Superior iron ore is held where it now is. The respective shipments of these mines, are as follows:

CARR

YEAR.	GROSS TONS.
1873	1,432

1874..... 948

Total,..... 2,380

GRIBBEN MINE,

1873.....3,599

HOME MINE,

1873.....1,091
1874.....2,139

Total,.....3,230

WASHINGTON IRON COMPANY.

This company was organized in July, 1864, with a capital stock of $500,000, in 20,000 shares. The corporators were Hon. Edward Breitung, I. B. B .Case, Esq., Samuel P. Ely Esq., Joseph S. Fay and Edwin Parsons. The company own 1,000 acres of land, located in the northeast part of T. 47, R. 29, and the mine is just south of the M. H. & O. R. R. The improvements made by the company are quite extensive, but changes met in the formation of the ore beds, not always possible to anticipate, rendered some of these expenses of little value; hence the lack of dividends, the financial embarrassment and the temporary suspension of of mining. The different openings and their respective positions, are faithfully represented on a map of this mine, published with the geological report of Michigan, for 1872-3. The first ore was shipped in 1865, and in 1876 the mine was leased by Messrs. Maas, Lonstorf and Mitchell, of Negaunee, who, for certain reasons, have taken the name of,

THE HUMBOLDT IRON Co.

The present parties have done and are doing considerable work in the way of explorations which have amply repaid them. West of the main engine house, about 25 feet, they have sunk what is called the No. 2 shaft. The first hundred feet of the shaft is vertical, then it makes an angle of 43 degrees to the north, and continues on this pitch for 100 feet farther. A drift was then driven 20 feet to the north, where they "struck" a fine bed of ore some 25 feet thick. This bed has nearly an east and west trend, and its dip, on the lower level

is very high to the north. On the east side of the shaft the ore is a rich magnetic variety, fine to coarse grained in texture, and quite free from rock; a fine stope has been driven to the eastward on this ore, for nearly 100 feet; and it is proposed to continue in this direction, under the old workings of the former company, leaving a good roof so as to be entirely independent of any possible insecurity of the old mine. At the eastern end, however, will be built a skip road to do away with the otherwise too long tramming. On the west side of No. 2 shaft comes in a fine deposit of specular slate ore, resembling very much, that of the Republic mine; it is quite friable, and has a dull, leaden sound when struck. It will be seen that the shaft happened to come very near what appears to be the junction of two lenses of ore, the one specular, and the other magnetic This is a common phenomenon in some of our magnetic mines. The prospect for ore, from present indications, (Dec. 1877) is certainly very flattering. An average sample of these ores, consisting of a large number of small pieces, taken by myself, from different parts of the stopes at the bottom of the shaft and from the stock piles, for partial analysis, afforded respectively as follows:

Magnetic ore all kinds, metallic iron.....68.30
Silica..... 3.02

Specular slate ore, metallic iron.....65.14
Silica..... 3.33

The ore is well adapted to foundry purposes, but contains rather too much phosphorus to be smelted by itself, for the manufacture of Bessemer pig. The company are now constructing a railroad switch to connect with the branch of the M. H. & O. R. R. to the Edwards mine. At the upper end of the switch they are building ore pockets and docks, which, when completed, will be very convenient, and will materially lessen the cost of handling the ore,—a consideration too frequently overlooked in mining districts. The old Washington or Franklin mine, now known as the west Humboldt mine, is included in the same lease and forms

a part of the Humboldt mine. It is located just west and south of the Edwards mine, and at present promises very fairly. The vein or bed of ore has a dip of 65 degrees to the northward, and a strike of nearly east and west, and averages from 10 to 12 feet in thickness. The mine is now down about 100 feet, on the dip of the vein, and at the bottom they have developed about 200 feet on the strike. The ore occurs in lenses, and is interstratified with lens shaped horses of rock; an average sample from the mine and stock piles, afforded,

Metallic iron	67.51
Silica	3.94

This mine, under the present management, cannot fail to resume its former position among the first class mines of the district. The shipments from this mine have been as follows:

YEAR.	GROSS TONS.
1865	4,782
1866	15,150
1867	25,440
1868	35,757
1869	58,462
1870	79,762
1871	48,725
1872	38,841
1873	38,014
1874	27,890
1875	9,642
1876	3,333
1877	16,545
Total	402,343

EDWARDS MINE.

This property, lying contiguous to that of the Humboldt, was first operated under lease from J. W. Edwards, by the Pittsburgh & Lake Angeline company. Work was begun in 1865, and the first ore was shipped during the following season. This company operated the mine successfully, under the able management of A. Kidder, Esq., until 1873, when, owing to the stress of hard times, they surrendered their lease—Mr. Edwards purchasing of them the mine machinery.

The quality of the ore up to this date gave entire satisfaction. The mine, from its very beginning, was worked as an underground one, the only instance of the kind in our iron district. Judge Edwards immediately made arrangements to continue mining, but before he had fairly commenced the engine house was unfortunately consumed by fire—ruining the machinery. He then purchased the Kloman mine machinery, and within less than two months had it in operation at his mine. Soon after this Mr. Edwards sold the mine to W. W. Wheaton Esq., who then took possession and assumed the general management. Mr. Wheaton, with his indomitable energy, desiring to realize early from the mine, and wishing also to use a portion of the product as a mixture in the Rolling Mill furnace at Marquette, of which he had charge, began mining on the stopes of ore left by his predecessors, and thereby failed to do sufficient prospective work. The result is that the mine to day, to one not acquainted with our iron ore deposits, appears nearly worked out, which may, in a measure, be true of the lenses of ore in sight. At the west end of the mine is a narrow bed of very fine specular ore which is, possibly, the point of a lens, and may widen out into a large deposit or lens of good ore. In the east end of the mine the present outlook is no better; still, I cannot attribute this unpleasant aspect to the mine itself, for there is no question, in my own mind, but what good magnetic ore is near at hand and only needs the requisite amount of labor and time to develop it. The beds of ore in this mine, since the very commencement, have been found to occur in lenticular shaped masses, or, as Mr. C. H. Hall so aptly expresses it, "it has a pumpkin seed structure, the one overlapping the other;" and the longer axis of the seed, instead of being horizontal, is nearly always inclined, and usually at a high angle, so that in considering the position of these lenses we should mention the dip of the formation, its strike and the pitch of the lens for this latter is an important fact to the miner. The deepest part of the mine is nearly 400 feet down, measured on the dip of the formation, which is 50 degrees to the north.

The extreme limits of the workings, on the east and west ends, are 560 feet apart. All the ore in the mine is brought to the surface over two skip roads, and is chiefly magnetic, with some fine quality of specular slate. The mine shipments are as follows:

YEAR.	GROSS TONS.
1866	
1867	2,843
1868	4,928
1869	17,360
1870	21,450
1871	24,232
1872	26,437
1873	26,026
1874	39,281
1875	2,849
1876	12,804
1877	19,420
	10,591
Total	208,221

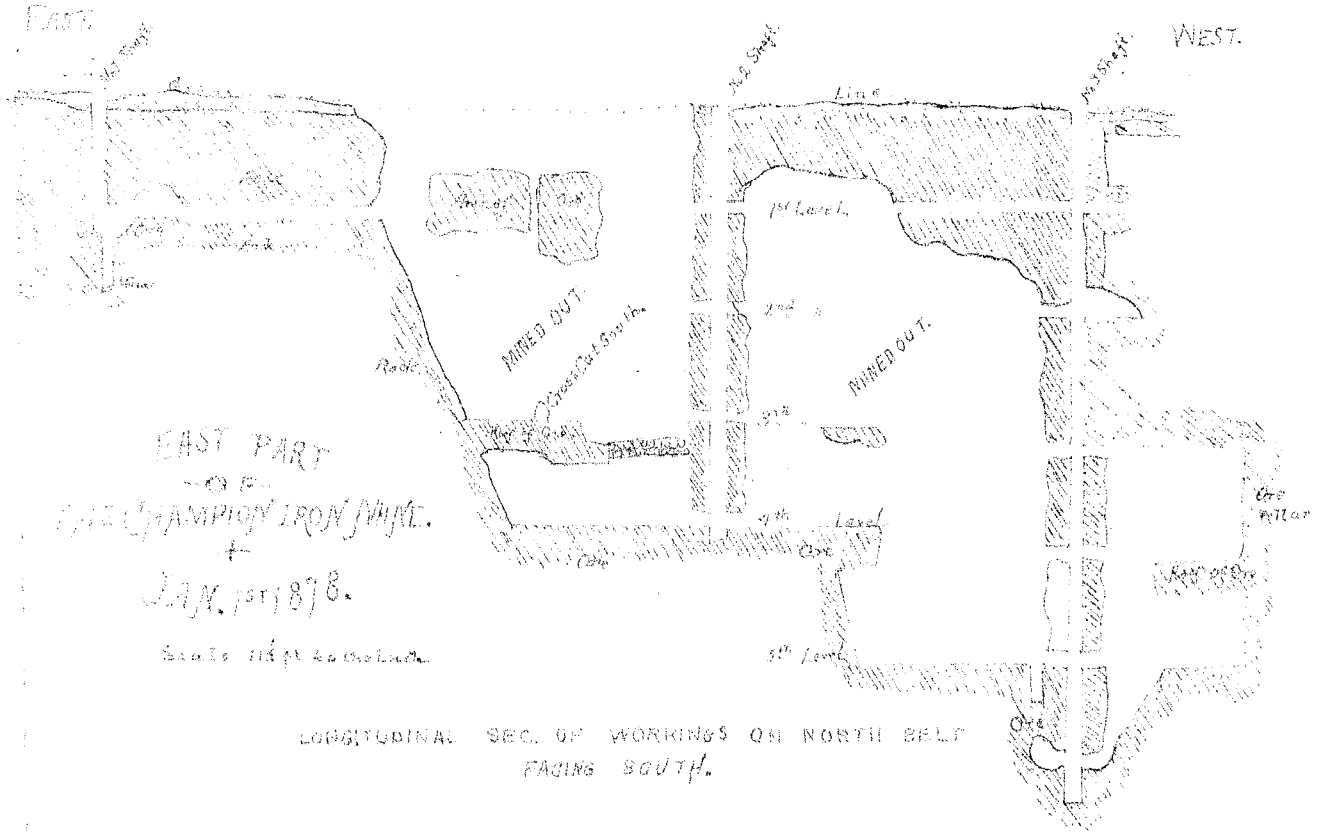
THE CHAMPION IRON COMPANY

Was organized August 26th, 1869, with a capital stock of $500,000 in 20,000 shares. The corporators were J. S. Fay, of Boston, Edwin Parsons, of New York, T. C. Foster, of Cambridge Mass., and S. P. Ely and Peter White, of Marquette. The company own some 1,600 acres of land, embracing that on which the mine is located, being the S. ½ of Sec. 31, T. 48, N., R. 29 W.; the workings are about one-third of a mile from the main line of the M. H. & O. R. R., with which it is connected by a branch. The mine is 1,117 feet above Lake Superior, and its product is a granular magnetic and a specular slate ore; the former of these varieties, however, predominates.

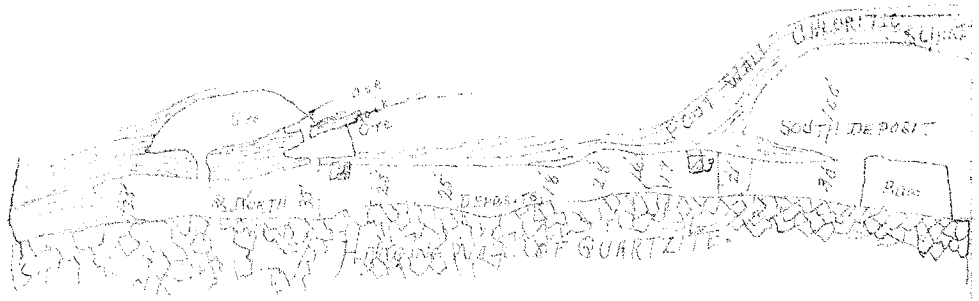
A few years ago, owing to want of care in selecting the ore, considerable fault was found with its quality; but for the past three years, under the direction and watchful care of its agent and superintendent, it has again come to the front rank of our first-class mines, and is now, as it justly deserves to be, a favorite among furnacemen. This, however, is readily accounted for, since its first-class ore averages in metallic iron, above the present high standard, and the

No 1

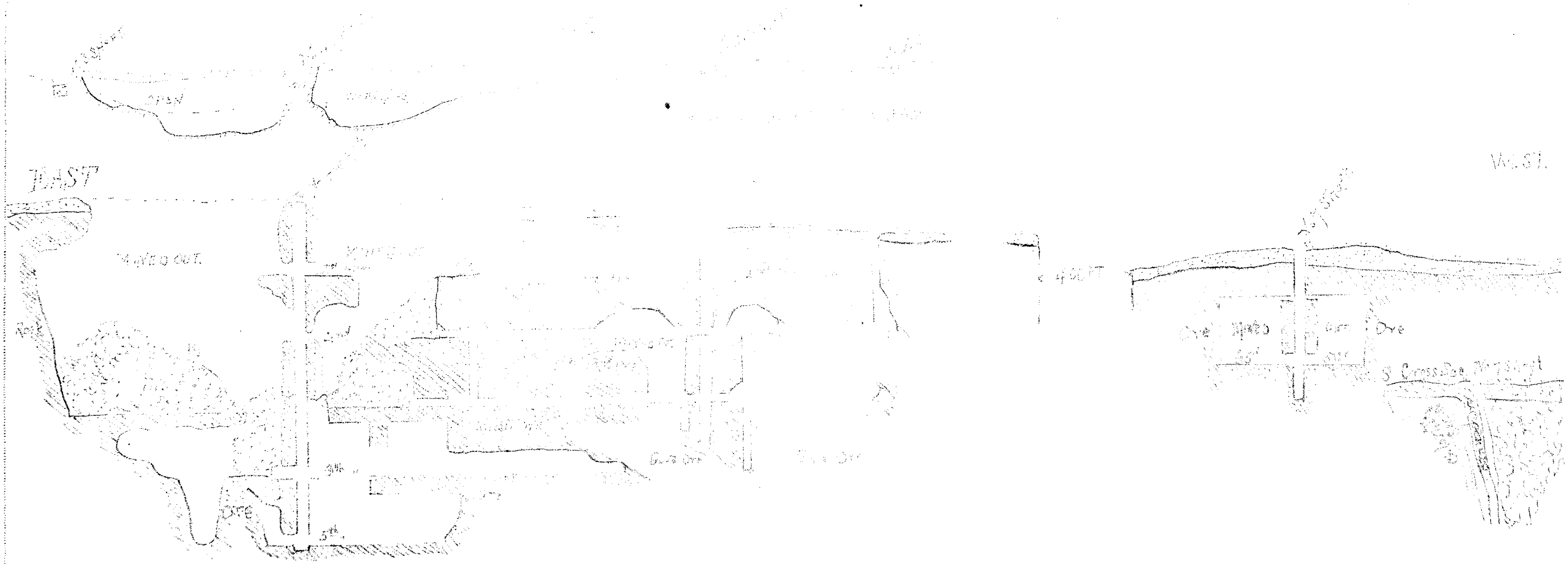
GROUND PLAN AT SURFACE.



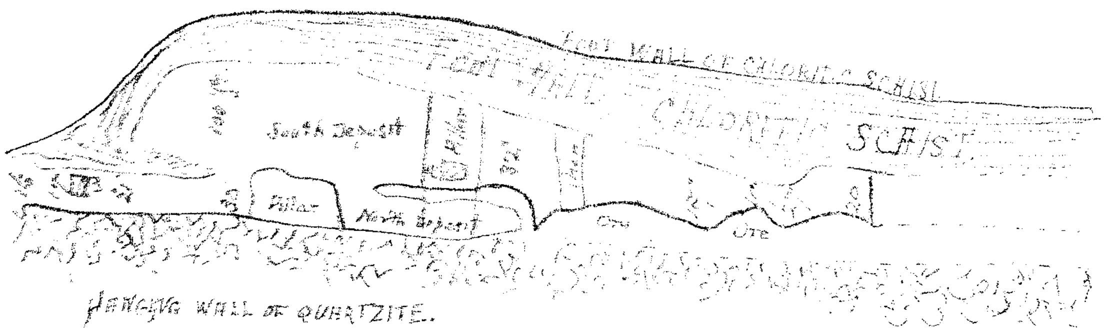
LONGITUDINAL SEC. OF WORKINGS ON NORTH BELT
FACING SOUTH.



GROUND PLAN TO WORKINGS ON NORTH & SOUTH DEPOSITS AT 4th LEVEL.



LONGITUDINAL SEC. OF WORKINGS OF SOUTH BELT.



GROUND PLAN OF WORKINGS AT 4th LEVEL.

WEST PART
OF
THE CHAMPION MINE

JULY 1st 1878

Scale 115 ft to the inch.

percentage of phosphorus contained is less than five hundredths of one percentum.

The workings are underground; but before going below the surface, let us tarry a moment above. The hoisting machinery, one of the attractions, was made at the Delamater Iron works after plans furnished by Geo. H. Reynolds, modified and improved, in many important particulars, by Messrs A. Kidder and D. H. Merritt. There are six large drums, arranged three on each side of the driving shaft, which latter is kept constantly revolving by two powerful engines, placed one at each end of it. For compactness and facility with which it can be operated, it is difficult to conceive of anything more complete, though there are some minor points that require service to prove their practicability; still, these are details that can be remedied without affecting the principle or arrangement of the plant. To each engine is attached an air compressing cylinder. The company have a small machine shop where their ordinary repairing is done.

The formation in the mine has an east and west trend, and dips about 80 degrees to the north, though in some places, especially at the widest part of the lenses of ore, it even dips to the south. The hanging wall is a massive gray quartzite while under the ore lies a thin bed of magnesian schist. The true foot wall, however, is a jaspery or magnetic schist. The workings embrace about 1,900 feet of the vein, and the ore is brought to the surface through six shafts, located at convenient distances apart. Between No. 5 and No. 7 is a blank, left for No. 6 shaft. Beginning with No. 1 shaft, (Feb., 1878,) the most easterly—see diagram of mine—we find the shaft down to the first level, sixty feet below the surface, and a winze has been sunk 14 feet deep in the west side of this shaft, sufficient to develop a 12 foot vein of ore, which can be mined out at any time, should the production in the western pits fall short for a season. In No. 2 shaft, which is down to the fourth level, or 240 feet from the surface, all the available ore in the north deposit to this level has been taken out, as appears on the diagram; but from the

nature of the foot wall they were induced to drive a drift to the south on the third level—110 feet east from the shaft—which, within a short distance, resulted in finding a fine lens of magnetic ore, 100 feet long by 30 feet wide at the centre, and which extended above the third and below the fourth levels. At the easterly point of this lens is, apparently, the beginning of another lens of specular slate ore. On the fourth level, just east of the shaft, a drift was driven south, passing through the point of another lens of fine magnetic ore which widens out to nearly thirty feet in stoping west. They have "raised" on this lens some 35 feet, and at this height it holds its thickness; but a drift driven directly over it, on the level above—only 25 feet higher up—failed to intersect it. Since our diagram was made the lens has suddenly terminated to the west, on the fourth level, in two abrupt forks. These lenses are very deceptive, at one moment raising our expectations to the utmost, leading us to believe that we have a veritable bonanza, to be as quickly dispelled by a provoking "heading" or "horse" of rock intruding itself without any warning ; and as we have not the magic wand of the conjurer, and can lay no claims to the art of divination, we needs must submit as graciously as possible to these strange freaks of nature, resolving next time to be more conservative. But, perhaps, at some future day, when this lens structure is more thoroughly understood, we may be enabled to deduce a system by which their hidden position and their unknown magnitude may be determined; but until then we must continue as at present, and trust chiefly to "luck" and vague "indications." Glancing a moment at the diagram, it will be noticed that the heading of rock, limiting the workings to the east of No. 2 shaft, pitches about 70 degrees to the westerly. On the bottom of the fourth level we have a floor of ore averaging about 20 feet wide. In No. 3 shaft they are mining on the east side, between the fourth and fifth levels, a sixty foot stope of splendid magnetic ore, averaging 25 feet thick, and to the west of the shaft there is a similar stope of ore—this shaft has now been sunk to the sixth level with winzes at either side.

The company have adopted a system of mining wherein, for the future, No. 3 shaft will be the only one in which any sinking is required. The stopes from this shaft will be carried each way to No. 1 and 2 on the east and Nos. 4 and 5 on the west, leaving pillars on one side to protect these shafts; other intermediate pillars will be left, which will be arranged so as to break joints as much as possible, thereby preventing the occurrence of long cracks or open joints in the hanging wall. This method, though not new, still, where it can be applied, as in the present case, is very economical, since it reduces the sinking and drifting account to a minimum. Proceeding westward on the fourth level, we pass through a small drift and enter what is called the south deposit, another large lens of ore, and just beyond this place, or where the point of rock terminates—as is shown on the ground plan of the diagram—we have an aggregate thickness of over 100 feet, measured across the formation. Standing on the edge of a stope and facing west, we look downward and see here and there in the apparent far distance, the moving to and fro of the small lamps of the busy miners, whose forms are only dimly outlined by the feeble rays, making them appear more like evil spirits; an impression which is enhanced by the clanging of the drills and hammers, the heavy reports of the blasts, the rumbling of the skips moving up and down the shafts, and all these sounds echoed and re-echoed from invisible walls, pillars and roof, create in the mind an impression akin to awe and fear. It must be a strange feeling to one not accustomed to mines to creep around in such gloomy places, realizing that if their light should become extinguished by a sudden draught of air or from some unlucky drop of water, they dare not move a single step, since a false one might send them headlong upon the jagged blocks of ore below. With this great width of vein it requires the very best judgment and skill to win the maximum amount of ore and still leave the roofs and sides perfectly secure; to understand how well these conditions have been fulfilled needs something more than a written description. Center pillars have been left,

which are connected by strong arches sprung to buttresses left on the sides opposite these pillars, and the pillars themselves are also connected by arches. This is a general outline, still the details are even more interesting. The south portion of the south deposit is a fine specular ore; the mining in No. 4 pit is chiefly done between the fourth and fifth levels. A sharp bend to the south in the quartzite, between No. 4 and 5 shafts, narrows the ore vein to only a few feet. No. 5 shaft is down to the fourth level, and between this and third level there promises from present indications to be considerable slate ore. We now have left only No. 7 shaft, which is down 100 feet to the first level, and is stoped out 65 feet on the east side and fifty feet on the west side of the shaft. The ore is a superior quality of specular slate, and resembles very much the Republic slate ore. The vein averages about 16 feet on the west side, and from 3 to 7 seven feet on the east side of the shaft; they have sunk about thirty feet below this level with encouraging results. Returning now to the surface, we find the product of the mine is divided into three classes. The first-class ore is that in which no rock or iron pyrites can be seen, and it will average 67 per centum of metallic iron; the second-class will average about 65 percentum of metallic iron—it is really a first-class ore, and in ordinary times would be accepted as such; the third-class is about a second-class, and even the lean ore that goes to the rock dump will average above 50 per centum of metallic iron, causing one to think that they are too radical on the grading of ores; still, it is, perhaps, the surest way to avoid trouble with consumers, who are now only too ready to avail themselves of the slightest pretext to depreciate the price of ore. The officers of the company are Joseph S. Fay, of Boston, president; W. P. Fay, treasurer; A. Kidder, general agent, and Capt. Jas. Pascoe, superintendent. The shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1868	6,255
1869	21,535
1870	73,161
1871	67,588
1872	68,404
1873	72,782
1874	47,097
1875	56,877
1876	66,002
1877	70,883
Total	550,584

REPUBLIC IRON COMPANY

Was organized Oct. 20th, 1870, with a capital stock of $500,000 in 20,000 shares. The corporators were Hon. Ed. Breitung, S. P. Ely, and E. D. Parsons. The company own 1,953 acres of land. The property, originally explored by S. C. Smith, Esq., was entered by James St. Clair in Dec., 1854. The mine is located in section 7, town 46, range 29, and is 37 miles west from Marquette, on a branch line which connects with the M., H. & O. R. R., at Humboldt. This branch, which is nine miles in length, was completed in Oct., 1872, and after this date, before navigation closed, the mining company shipped 11,025 tons of ore.

The ore stratum, as well as the associated overlying quartzite and underlying ferruginous schists and massive greenstone strata, originally horizontally bedded, have, by lateral pressure from the northeast and southwest, been sharply folded, while subsequent glacial action and other agencies have worn away, above a certain horizon, the entire iron bearing series, leaving us the remaining strata, with their upturned edges, apparently bent in the form of a large oxbow, the arms of which have a northwesterly trend—the bend or bow being at the southeast side.

Possibly we can more clearly understand how this present structure was brought about if we will suppose the Huronian strata we are now considering, and the underlying granite to have been bent upwards by lateral pressure. It is plainly evident if a weak line existed in the granite stratum, for any distance, that our arch would naturally bend sharply downward along this line, and should this line of least resistance suddenly terminate there would occur a trough like depression, which would become more apparent if the over-

lying strata were worn away down to the granite. This condition we have already assumed in the first example.

Returning to our oxbow, we find its sides or upturned edges dipping nearly vertical, except at the southeast end, where it dips about 60 degrees to the northwest; the prevailing dip or inclination of the strata is towards the center of the trough. The trough extends northwesterly about eight miles, where its sides rapidly diverge from each other; its average width for this distance is less than a mile from outside to outside. The Michigamme river follows along the basin of this trough, and at the Republic mine widens out into a beautiful bay. The arms of the bow at this point are about one-half mile apart. The mine workings are located on the north arm and at the lower end of the oxbow, and extend altogether, on the course of the vein, about three-fourths of a mile.

The ore stratum has for its hanging wall proper a massive gray quartzite, similar to that of nearly all our hard ore mines, while the foot wall is banded jasper. The mine is divided into fourteen pits—numbered from one to ten; the remaining four are known as the Gibson, Ely, Morgan and Perkins.

The first pit we meet, as we approach the mine, (March, 1878,) along the ore belt, is No. 10; then, some 350 feet farther along, we reach No. 9 pit, which is entered by a tunnel 200 feet long, driven in from the south side of the hill and intersecting the vein about 80 feet below the surface; the vein, at this point, is about ten feet thick. The pit is open all the way up to the surface, and has been worked 50 feet to the northwest of the tunnel and 100 feet to the southeast, but the vein narrowing at either end, they concluded to abandon the pit for the present; possibly, when the main workings are continued in this direction, at a lower level, it may be found that the vein has widened out sufficiently to pay for mining.

Continuing our course, we come to No. 8 pit, 250 feet from No.9; it is, however, only a small opening, and is not now worked. The company propose to drive a tunnel,

somewhere between here and No. 7 tunnel, from the south slope of the hill to intersect the vein.

About 550 feet southeasterly from No. 8, is the mouth of a tunnel leading into No.7 pit. The tunnel level is 80 feet above the lake or bay.* Passing through the tunnel we enter No. 7 pit, nearly opposite No. 7 shaft, and descending on the elevator or cage, working in the shaft, we come upon the 3d level—27 feet below the lake. The first thing that attracts attention is a huge "horse" of jasper one hundred feet long, with an average thickness of fifteen feet, on either side of which is about ten feet of pure specular slate ore. The "horse" pitches or inclines at a high angle to the northwest; turning ourselves in that direction, we soon reach the end of the jasper horse—the shaft being near its center and on its foot wall side. Leaving the horse we have a vein of splendid specular slate ore some 30 feet thick, which a little more than holds its own in thickness for 75 feet. Within this area they are working a stope of ore 45 feet high; climbing up this stope, which is 18 feet above the lake level, we continue and, at the end of our 75 feet, find the beginning of another jasper horse which again divides the vein. The ore vein on the southwest side of the horse being quite narrow, apparently about five feet on an average, they left it for the present and mined out on the northeast side, where the vein averages about ten feet. This horse is about 100 feet long, and as soon as we pass it we have another run of first-class specular slate ore for 90 feet more, averaging 25 feet thick. From this point we climb up another stope, about 40 feet high, where the vein gradually narrows, and for the next 40 feet it averages only ten feet thick.

Returning now to No. 7 shaft, we find a tunnel driven into the foot wall, for the purpose of cutting a narrow lens of ore; on the level above a winze has been sunk in this lens down to this level, and the tunnel is expected to meet it. Going southeasterly from the shaft, we pass the end of the jasper horse already noticed, and have before us a

*The bay or lake is 914 feet above Lake Superior.

fine stope of ore fifty feet high; climbing to the top of this, we proceed only a few steps before we come to the point of another jasper horse, somewhat larger then the others, and the ore vein is again divided, leaving about ten feet on each side of the jasper horse. Passing around on the south side of the horse, and when about one-third the way along, we descend some 15 feet. This point terminates No.7 pit, and is 160 feet from No.7 shaft.

Continuing, we enter No. 6 pit, and at the southeast end of the jasper horse we have a vein of nearly pure specular slate ore, over 50 feet thick; about 40 feet from the end of the horse we descend to the 3d level, which is 41 feet lower than the lake. Turning around, we have before us a stope fifty feet high by forty feet wide, of solid slate ore, save a narrow seam of chloritic schist (soapstone) near the hanging wall side. The vein here, as in No. 7 pit, dips about 80 degrees to the southwest. Looking upward we can see a narrow ribbon of day-light over 200 feet above us, broken here and there by pillars of ore left to prevent the walls from closing in. When we are told of the many tens of thousands of tons of ore which have been mined out of this deep opening, and begin to realize the enormous weight of these huge supporting pillars, sprung from wall to wall, it seems that they must surely fall and crush everything beneath. Resuming again our way, the vein gradually narrows, and at 250 feet from where we entered No. 6 pit, we come to a double cage shaft, the southeasterly limit of No. 6 pit. On the northwest side of the shaft has been left twenty-five feet of ore, and on the opposite side thirty feet of ore, to protect the shaft.

The shaft is now being sunk 50 feet to what will be the 4th level; this is accomplished without interfering, in the least, with the working of the mine. It is done by sinking the shaft ten feet lower than the level, then timbering across; this constitutes the bottom of the working shaft. A winze is now sunk on the hanging wall side of the shaft, and when down far enough the shaft is sunk under the false bottom along with the winze to the next level, and everything

made ready to begin stoping on either side of the shaft, so that all that remains to be done is to clear away the false bottom, make the connections, and within five hours time the cage is gliding up and down the new shaft. Leaving the shaft we enter No. 5 pit, and are confronted with a stope of ore 50 feet high and 45 feet wide, which extends back from its upper edge to over 100 feet, widening out at the far side—230 feet from the shaft—to 70 feet thick, making, certainly, one of the finest stopes of ore in our iron district. Along the hanging wall side is a vein of chloritic schist some six feet thick, and between this schist and the hanging wall quartzite, comes in the thin point of a lens of granular magnetic ore.

Passing from No. 5 pit through a drift driven in the chloritic schist, we enter No. 4 pit. Here the magnetic ore has widened to 40 feet. To the northeast of the magnetic lens, and separated by the narrow seam of chloritic schist noted in No. 5 pit, is a fine body of specular slate ore, presenting a face 50 feet high; mounting to the top of this stope, we find it averages about 80 feet northeast and southwest, and 75 feet at right angles to this line; between this pit and No. 5 has been left an immense pillar of ore, 35 feet thick and over 100 feet long, measured horizontally, or say 500 tons of ore for every foot measured vertically. The foot wall of jasper in No. 4, after a couple of sharp folds to the southeast on this east side of the deposit, makes a bend to the southwest, and when within say, 10 feet of the magnetic ore lens, turns abruptly to the southeasterly. The stratum of specular ore conforms to the bendings of the foot wall, and forms two spurs of ore in the above folds of the jasper, about 50 feet long and ten feet wide at the center. Returning to the magnetic ore, we find at the boundary line of this pit and No. 3 pit—which is about 150 feet southeasterly from the division of Nos. 4 and 5 pits—that the vein of magnetic ore is about 35 feet thick. The ore is of an excellent quality, very free from any impurities; some of it is coarse grained and quite friable, while other varieties are even steely in texture.

As we enter No. 3 pit, which is opposite to the abrupt turn of the foot wall to the southeast, we find the entire formation gradually swinging around to the south. Underlying the magnetic ore is the thin bed of chloritic schist, and under this again, is our vein of specular slate ore, now narrowed down to three feet. Continuing southeasterly in No. 3 pit, for 80 feet, we come to a skip road where the magnetic ore is about 20 feet thick; but it gradually lessens in width for the next 100 feet beyond the skip road, when it is suddenly terminated by a heading of jasper cutting obliquely across the vein. The formation dips about 60 degrees to the southwest in this pit. When we examine this heading on the surface, and trace it through No. 2 pit, it appears to be a fault wherein the formation in No. 2 pit has dropped backward or has been thrown forward in No. 3 pit—in other words, we have a left hand throw. Leaving No. 3 pit, the level of which is 9 feet above the lake, we pass over into No. 2 pit, and begin again at the fault. The formation here has a southwesterly trend, and the ore is very unlike anything we have thus far examined. It is course to medium grained, slightly magnetic, and gives a brownish-red powder; much of it is true martite, that is, specular ore crystallized after magnetite. It would be quite impossible to distinguish it from the magnetic ore by its texture, but a stroke of the hammer upon it, affording the above reddish powder, detects it at once. What is interesting, practically as well as scientifically, is that it occupies the same position and bears the same relation to the underlying chloritic schist and narrow vein of slate ore as did the magnetic ore on the other side of the fault in No. 3 pit. Following it south for 120 feet to No. 2 skip road, it averages about 15 feet thick; but just beyond this point the underlying chloritic schist cuts across, in an easy curve, to the hanging wall side, and the specular slate ore, which has occupied thus far such a subordinate position in Nos. 3 and 2 pits, again widens out to about 15 feet in thickness. Below the level where we now are—which is 40 feet above the lake—they have sunk to another level, and are stoping on either side from the skip road. To

the southwest of the skip road, for 120 feet, the vein averages about 15 feet in thickness, when it then narrows down to two or three feet, and so continues for thirty feet, when we come to No. 1 pit, which is very irregular. The ore makes a sharp spur-fold to the southeast into the jasper for about 45 feet, then in a southwesterly direction continues for 100 feet, and folds sharply around a jasper point. This pit will average, altogether, about 100 feet long by 15 feet wide. The ore is a good quality of specular slate. They are now mining on the first level below the adit level. Passing around the jasper point we come to the Gibson pit, which is formed by the ore stratum making another sharp spur fold into the foot wall. The axis of this fold pitches about 60 degrees to the northwest. The ore is a superior quality of specular slate; but at present the pit is idle, and the ore at the bottom will, probably, be mined from No. 1 pit at a lower level.

Following around to the southwest for 400 feet we come to the Ely pit; which was first opened in 1872. The workings are about 200 feet long, with a skip road at the center; the vein dips about 60 degrees to the west, and has an average thickness of 15 feet. They are now down on the lay about 90 feet with a skip shaft, and have on this level, at either side, a 30 foot stope of ore, which is a first class specular slate. Leaving this pit, we go about 300 feet west to the Morgan pit, which was opened in January, 1877. The workings are now about 150 feet long, and the vein averages, say, 18 feet in thickness, and they are now down 50 feet below the surface, and have a working stope of 30 feet. The ore is an excellent quality of specular slate. The Perkins pit, about 300 feet further along from the Morgan pit, consists of what now appears to be two irregular deposits of specular ore, about 15 feet by 30, with a bar of rock between them. These include all the workings of the Republic mine.

Turning our attention now to the huge stock piles of ore, which, as they appear glistening in the sun, look more like heaps of polished steel, and clambering over them,

seeking sharply for rock or other matter on which to base an adverse criticism, we are, in the end, however careful our inspection, obliged to acknowledge ourselves discomfited, for they are stock piles of ore in every sense of the word; but when we reflect for a moment, it is not surprising that they are so free from rock, since there is no dirt to discolor it, or disguise the bright lustre of the specular ore which is so strongly in contrast to the dull hued rock, thus rendering it an easy matter to distinguish and to separate them; though still, some of the slate ore is laminated with seams of jasper, which then renders it more difficult to detect, but a glance at an end fracture usually reveals its presence. Satisfying ourselves as to the purity of the first-class stock piles, we turn to examine the machinery.

Inside the engine house we hear the rumbling of the engines and hoisting drums, but see no signs of exhaust steam. Entering the building we find everything appears to work nicely; but in the place of steam the engines are operated with compressed air, furnished by compressors located at a fall in the Michigamme river, just below the bay or lake, some 5,000 feet distant from the engine house. The compressing cylinders—four in number—are two feet in diameter by five feet stroke, and are driven by two of Swain's sixty-six inch turbines, under a sixteen feet head of water, which afford seven hundred horse power. The wrought iron pipe conducting the air to the mine is 15 inches in diameter, and the air, as it leaves the compressors, is pretty warm, but soon cools. Exactly how much power is lost by this cooling, and the friction, I never have as yet determined. The first item of loss could be very readily ascertained by multiplying the number of pounds of air by the difference of the temperature of the air as it leaves the compressor and as it enters the engine at the mine, and this product again by the specific heat of air; then dividing this last product by 8,000, the quotient would be equal to the number of pounds of pure carbon representing the above loss. The loss from friction, however, could not be so nearly estimated; another variable element to consider is the condensation of the

moisture in the atmosphere; still, the loss of heat as given above, I think, would exceed all other losses from whatever sources.

The advantages of compressed air as a motor, when obtained at so little cost, as in the present instance, are hardly apparent to the casual observer. There is but little danger, when the pipes are properly arranged, from freezing in winter, and but little oil is required in the engine cylinders; the drilling machines can be handled with greater ease; and ventilation is much improved.

The success of this compressed air plant, costing nearly one hundred thousand dollars, is chiefly due to the skill and untiring energy of Mr. David Morgan, the president of the company, who personally supervised the construction of this important undertaking. The result of Mr. Morgan's long experience is everywhere visible about the location—in the mine, as well as on the surface—aided I should add, by Capt. Peter Pascoe, who has been the superintendent ever since the mine was first opened; and to all who are interested in mining I can safely reccommend them to Capt. Pascoe as one ever willing to show them the mine, omitting none of its best points.

The present officers of the company are David Morgan, president; W. D. Rees, agent; Capt. Peter Pascoe, superintendent. The shipments from this mine are as follows:

YEAR.	GROSS TONS.
1872	11,025
1873	105,453
1874	122,639
1875	119,726
1876	120,095
1877	165,836
Total	644,774

At a distance of about one-mile northwest of the Republic, and on the same vein is the

KLOMAN MINE.

The ore is similar to that of the Republic, and in 1873 and, 74, the mine was worked with considerable vigor. The vein is nearly vertical in its dip, and much narrower than

at the Republic. In 1875, for some cause not generally known, operations here were brought to a close, and the machinery was sold and taken away. I find no reason for assuming, however, that this sudden and unexpected move on the part of the management was due to any apparent or real change in the mine, either as to the quality or the quantity of the ore. The mine shipments are as follows:

YEAR.	GROSS TONS.
1873	21,271
1874	34,348
1875	8,059
Total	63,678

The other mines northwest of the Kloman, located on or near the Michigamme river, are, as we meet them in their order, the Metropolis, Windsor, Erie, Cannon, Chippewa, Magnetic, Section 19 and the Berea; but only two of them, the Erie and the Magnetic have made any shipments of ore, the former having shipped 1,058 tons, and the latter 50. These two, together with Section 19, give indications that promise future results of some value—the latter belongs to the M., H. & O. R. R. Co. Considerable exploring has been done all along this range, especially on the southwest side of the river; more has been done by the Magnetic Iron Company in this direction than by any of the others, and it is to be hoped they may, at no distant period, determine results that shall reward them for their perseverance and expenditure.

MICHIGAMME RANGE.

THE MICHIGAMME COMPANY,

Was organized in Nov., 1870, with W. H. Barnum, Pres't; James Rood, Sec'y and Treas.; Jacob Houghton, Sup't. The company own 1,400 acres of land situated on the north side of Lake Michigamme.

Mining operations were begun here in 1872, in the south half of sections 19 and 20, T. 48, R. 30, though mainly in section 19. The M., H. & O. R. R. extension to L'Anse passing close by the mine, was completed in the winter of

1872. The general trend of the formation at the mine is nearly east and west, and the dip, though slightly variable, averages about 50 degrees to the south. The hanging wall is a massive gray quartzite, and the foot wall a ferruginous or magnetic schist. Immediately to the north is a high range of greenstone, while to the south the ground is low, probably underlaid by black slate and actinolite schist. The engine and hoisting machinery, made by S. F. Hodge of Detroit, are among the largest to be found in the district, and the engine house, a large stone building, rests upon a solid rock foundation on the foot wall side of the vein. The shaft house, as well as the skip road, is constructed with a view to permanency not commonly found in the beginning of the operations of our iron companies. In fact, the appointments of the mining plant are very complete and well calculated to meet all possible requirements of a large business, and show the work of a thorough understanding of the future necessities of such an enterprise. We will now examine the mine as it appears at this time—the spring of 1878—and begin with No. 1, the most easterly pit or shaft. The ore is a medium grained magnetic, of a very superior quality, averaging high in metallic iron and low in phosphorus. It is very free from actinolite—or white hornblende as the miners term it—which occurs in some of the westerly openings. The pit is an open one and is, probably, about 70 feet deep, and say 35 feet long by 20 feet wide, at the bottom. On the west side they have started a drift 40 feet above the lower level, and have driven it 75 feet to the west on the hanging wall side. At the mouth of the drift the vein of ore was 20 feet wide; but as the foot wall was not seen, only clean magnetic ore on that side, it is impossible to say how thick the vein may average; possibly, it may widen, or on the other hand it may be less than twenty feet; at any rate, one thing is certain—we have to begin with, a stope 40 feet high by 20 feet wide, and have very good reasons for supposing it to continue for 75 feet more. At present the ore is hoisted by a derrick operated by a small friction engine. Turning westward we

meet some open pits not worked at present, and come to No. 4 shaft. By means of ladders we go down to the adit level, along which a railroad track is laid, and which extends to a short distance beyond No. 7 shaft. It is a gradual down grade from this latter point all through the mine as we go eastward, and connects finally with the main line of the M., H. & O. R. R. From this level we continue down No. 4 shaft, two levels more, and reach No. 2 level. Turning eastward and proceeding 190 feet, we reach the eastern limit of this pit; at this point is a winze shaft connecting with the end above, affording on the west side of it a trapezoid shaped block of ore, which is 45 feet on the top and about 20 feet on the bottom by, say, 15 feet thick. This shape is owing to a crossing of mixed ore, some 30 feet wide, pitching to the east and south at an angle of about 45 degrees. To the west side of the shaft, 120 feet on the second level, we find a crossing of chloritic rock and mixed ore which limits the working in this direction. This crossing, so far as developed, appears to pitch about 50 degrees to the southeasterly.

Continuing now 60 feet down to the 3d level, we have on the east side a 27 foot stope of strictly first-class magnetic ore, 70 feet long by 18 feet thick; above this has been left a pillar 25 feet thick, but it is the intention of the company to take away 15 feet on its upper side by an underhand stope. On the west side of the shaft is a stope of ore 60 feet high averaging about 20 feet thick, which will, probably, be cut off by the above crossing, leaving some 20 feet on the top and say 40 feet on the bottom of the stope yet to be mined. From the 3d level the shaft has been sunk 46 feet, and on either side are winzes connected at the bottom by a short drift. It is expected that this will give them to the east a 46 foot stope of ore 160 feet long by 18 feet thick; on the west side the stope will, probably, be about 50 feet long.

Passing out of No. 4 shaft we proceed along the adit level to No. 5 shaft, 440 feet west of No. 4. This shaft is sunk 160 feet below the adit level, or down to the third level.

To the east, on the second level, they have stoped to about 140 feet from the shaft, but between the second and third levels, a distance of 65 feet, is unbroken ground for 300 feet to the east. To the west of the shaft nothing remains above the second level, between this shaft and No. 6 shaft, except the supporting pillars and a pyramid of mixed ore situated midway between the shafts. About 40 feet down from the second level, and 75 feet west from No. 5 shaft, we have the face of a stope 75 feet long, 40 feet high and about 9 feet thick. The thickness of the vein, on the third level, has not been determined as yet.

Out of No. 5 shaft, we pass the engine house in going to No. 6 shaft; down this we go some 70 feet, to the adit level, and are now nearly 400 feet west from No. 5 shaft. No. 6 is 165 feet down from the adit level, or down 235 feet all told. For 90 feet below the adit the ore has been mined out to No. 5 shaft, and 175 feet to the west. At this westerly point we have a 65 foot stope of ore, averaging about 12 feet wide; climbing to the top of its steep face, we find a crossing of jasper-conglomerate cutting off the ore, which on the adit level is 30 feet wide, and pitches to the southwest about 60 degrees. If it continues in this same course we will have a pyramid of ore about 60 feet on the base. Below the second level the shaft, as already observed, has been sunk 75 feet, also the winze at either side, and we have, therefore, a stope of unknown ground over 200 feet long by 75 feet high. At No. 7 shaft they are carrying a sixty-five foot stope to the west on the adit level, which level is 105 feet from the surface. The vein here is about 10 feet thick.

No. 7 is sunk 75 feet below the adit, and the winzes on either side are just begun. Standing at the top of No. 7 shaft and looking east may be seen two or three right hand throws along the ore belt. The juncture or faulting line of these is much broken, and the material lying in the crevices or breaks, is highly stained with iron oxide, and in some instances we have a soft hematite ore. It has been reported that complaints were made against this ore because of

the occurrence of fibrous hornblende (actinolite) disseminated in the ore which, on exposure to the sun, appears to bleach out, when it contrasts very strongly with the dark back ground of magnetic ore. The ore from Nos. 1 and 4 pits, which will constitute the bulk of this year's product, is of a first class quality, and there is no reason why the highest grade of strictly first-class ore cannot be produced from these openings; and furthermore, the ore from these openings is very low in phosphorus. and is therefore well adapted to the manufacture of Bessemer pig iron. Altogether, viewing the mine from an impartial standpoint, its prospects for first class ore appear much brighter then they were one year ago. The shipments from the mine are as follows:

YEAR.	GROSS TONS.
1872	141
1873	28,966
1874	45,218
1875	44,756
1876	70,074
1877	28,238
Total	217,393

THE SPURR MINE

Is about one mile west from the Michigamme mine, on the M., H. & O. R. R., and is 39 miles from Marquette and 24 miles from L'Anse, and is on the same range as the Michigamme. The Spurr Mountain Mining company was organized Aug. 16th, 1872, with a capital stock of $500,000, in 20,000 shares. The property embraces the north half of the S. W. $\frac{1}{4}$ and the south half of the N. W. $\frac{1}{4}$ of section 24, town 48, range 30.

Work was commenced in 1872. It was then an unbroken wilderness and the first thing to do, after exploring the deposit, was to make a clearing, erect dwelling houses, offices, barns, &c.

The vein or stratum of ore has nearly an east and west trend, and dips about 45 degrees to the south.

The workings occupy about 900 feet of the vein; the principal mining has been done on the western half of this

stretch. The ore is magnetic, averaging very fair in metallic iron, and is well adapted for foundry or mill iron purposes. To the back of the vein is a bluff some forty feet high, composed of jasper and banded ferruginous schist. Overlying the ore is usually a thin layer of chloritic schist which, in some places, is thickly impregnated with garnet crystals more or less completely changed into chlorite. These crystals vary in size from a small pea to an inch or more in diameter. The hanging wall proper is a massive gray quartzite.

The mine is divided into four shafts, No. 1 being the most westerly. This shaft is down 170 feet on the dip of the vein from the surface. The vein has been worked to one hundred feet to the west of the shaft, and within this area was a large body of ore, measuring at its widest part some 50 feet thick. It is really a chimney or lens of ore, with its axis pitching about 45 degrees to the southeasterly, but which narrows to 20 feet at about half way down, and then continues of nearly the same thickness for the remainder of the distance, as far as developed. The vein, on the west side or end of this opening, appears to be cut off by an irregular or zig-zag like heading of rock which, apparently, in its general course conforms to the pitch of the lens of ore.

No. 2 shaft, 140 feet east of No. 1, is down 220 feet from the surface. About half way down the foot wall gradually approaches the hanging wall, narrowing the vein from 3 to 7 feet, but when within 80 feet of the bottom it again widens out from 6 to 15 feet. On the lower level it is stoped out for 100 feet east of the shaft, and at this point there is a stope of good magnetic ore 40 feet high by 6 feet thick. To the west, on this same level, it has been stoped away for some 90 feet, and considerable ore still remains between this point and No. 1 shaft. About 20 feet to the east of No. 2, on this level, has been sunk a winze 20 feet deep, then a short drift driven west to the main shaft, where they sunk 22 feet further. Another winze has been started about 40 feet to the west of the shaft. It was purposed to sink altogether 70 feet, and then begin stoping to either side of

the shaft. The ore from No. 1 and 2 shafts is brought up in skip cars over an incline, and dumped automatically into pockets. Nos. 3 and 4 pits are operated by derricks.

No. 3 shaft, 140 feet from No. 2 shaft, is down 100 feet, and the ore vein averaged for this distance about ten feet thick; but at the bottom the foot wall approaching the hanging, narrowed the vein to 6 feet thick. This pit has been stoped away entirely, to either side down to this level. At the bottom a sump or extension of the shaft, some 25 feet wide by 20 feet deep, has been made.

No. 4 pit is 200 feet east from No. 3, and is only down 75 feet. The vein averaged from 5 to 6 feet. From this point for 320 feet east we have an open pit from 30 to 60 feet deep, and a variable thickness of the ore vein from 2 to 7 feet.

The mining machinery, made at the Iron Bay Foundry, Marquette, is very complete, and for the requirements of the mine cannot be surpassed. It has four drums and a Cornish pump attachment, with ample steam and engine power to drive them. The mine switches and railroad sidings are very conveniently located.

The mine has been laboring under one very serious embarrassment, and that is a lack of ready capital. The first result of this is in not having sufficient new ground opened ahead to mine advantageously. Secondly, a higher price must be paid for labor, and thirdly, labor in reality "running the mine," and accomplishing less for a day's work, thereby lessening the capacity of the mine. It is only too plainly evident that when such conditions exist, under the present depressed state of the iron business, the question of failure is only a matter of time. The officers of the company are H. N. Walker, Esq., of Detroit, president; Col. Freeman Norvell, general manager; Capt. William Morrison, superintendent. The shipments of the mine have been as follows:

YEAR.	GROSS TONS.
1873	31,933
1874	41,765
1875	23,095
1876	20,276
1877	22,801
Total,	139,870

THE STEWARD MINE

Is located on the M., H. & O. R. R., and adjoins the Spurr, being about one-fourth of a mile west from that mine. It is on the same vein as the Spurr, and the ore is very similar. The formation dips about 60 degrees to the south, and the general trend is about east and west. The principal work that has been done is confined to two shafts, which are about 100 feet apart and sunk fifty feet on the lay. In the east shaft they have stoped away at the top, under the roof, about 80 feet to the eastward, and say 50 feet to the westward; while at the bottom the foot of the stopes are only 20 feet to either side of the shaft. The vein averages about 5½ feet thick, but is somewhat mixed with lean ore and fibrous hornblende, requiring considerable care in selecting. In the west shaft no work is being done at present. They have stoped out about 25 feet on the east side of the shaft and averages 15 feet to the west for half way down the shaft. At the bottom has been driven a drift some twenty feet to the west; this vein averages about 6 feet thick, but is even more mixed than in the east shaft. The mine, in 1877, was operated by Messrs. Curley & Gleason, but at present—1878—it is worked by Mr. M. Gleason. The shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1874	305
1877	992
Total,	1,297

Returning now to Negaunee we go south 18 miles along the line of the C. & N. W. R. R. to the Smith Mine Junction and thence, following the Smith mine branch, to

THE SILAS C. SMITH IRON COMPANY'S MINE,

Which is somewhat isolated and but little known to outsiders. The prevalent opinion among those not interested or familiar with this mine is that the ore is rather lean and not first-class. This summer (1877) I examined this mine and was most agreeably surprised. The mine is located on the S. E. ¼ of section 18, town 45, range 25. The branch

from the Chicago & Northwestern railway gives them excellent shipping facilities. At the mine the railroad track, coming from the east and southeast, follows around on the northerly side of a hill, and at the mine intersects the northern bounds of the present workings. From this point as we go southward, the hill, for some 900 feet, gradually ascends, when we come upon the table lands, which have an elevation of 80 feet above the railroad track at the mine.

Entering the mine through the railroad tunnel, we pass in on the "adit level" and find ourselves in an open pit about 150 feet long by 50 feet wide at the south end, and 70 feet wide at the north end. Near the mouth of the tunnel is an open pit about 30 feet across and say 20 feet deep; in the northeast corner of this pit is a shallow shaft with "blue, soft specular ore in the bottom, and on the south side of the pit is the same kind of ore, which continues from the bottom of the pit on this side to near the upper edge of the pit. An average sample of this ore, consisting of some twenty pieces, collected by myself, afforded me, on careful analysis, the following result:

Peroxide of Iron	86.730
Alumina	1.840
Oxide of Lime	4.820
Oxide of Magnesia	2.500
Phosphoric Acid	.087
Sulphur	.041
Silica	.320
Water	3.500
Metallic Iron	60.71
Phosphorus	.033

This ore resembles very much the soft specular of the Menominee range, not only in its physical or outward appearance, but also in its chemical composition, and it is very probable that these two ranges belong to the same geological horizon.

Proceeding now with our examination of the mine, we continue southward along the adit level or present bottom of the main open pit and pass over a narrow crossing of rock and mixed ore, which disappears, in a few steps, to the foot

wall side and leaves us a vein of soft hematite ore twenty-five feet thick. This vein continues to the south end of the adit level—a distance of over 100 feet. Just before reaching this we notice a drift driven easterly into the hanging wall side. The drift passed through about four feet of silicious schist and then intersected another vein of soft hematite ore. It, however, may be the same vein with a narrow horse of rock, which apparently divides the deposit at this point. At the south east corner of this level a small drift has been driven southward to give drainage to the ore above. Facing now south, we have before us a fine twenty foot stope of "putty hematite," as Capt. Wood aptly terms it," while above and beyond this is another stope of the same ore, eight feet high. At first it was attempted to carry forward the two stopes as one, but the peculiar nature of the ore deposit rendered it unsafe to continue this plan, and they were obliged to terrace or divide the stope as above described. An average sample taken by myself of this ore for analysis afforded the following:

Oxide of Iron	85 86
Oxide of Alumina	1 44
Oxide of Lime	1.19
Oxide of Magnesia	.25
Phosphoric Acid	.09
Silica	1.92
Water	8.20
Metallic Iron	60.10
Phosphorus	.04

This ore is a singular variety of hematite, and resembles a bronze colored putty. It is very free from grit and, no doubt, would make a very durable mineral paint. The above average analysis is not surpassed by any of the soft hematites of the Marquette iron district. Since my visit to the mine, Mr. J. J. Pierce, the President of the company, informs me that subsequent mining and explorations have shown that the ore vein continues, with the exception of a crossway of rock or so, for two or three hundred feet further south, with strong indications of a much greater extension in that direction. The workings, passing as they do

into the side of the hill, will have to the south a good drainage for some time to come. The location of the mine is very favorable, and the hardwood lands surrounding the mine will supply it with cheap fuel for many years; the land when cleared is well adapted to agriculture, which will eventually lessen very materially the cost of living; in fact, the more enterprising of the miners will, by improving their spare time during the summer season, be enabled to raise their own vegetables and garden fruits. The officers of the company are J. J. Pierce, President, Sharpsville, Pa.; J. F. Stevens, Agent, Negaunee, Mich.; Capt. A. Wood, Superintendent, Smith Mine. The mine shipments are:

YEAR.	GROSS TONS.
1872	
1873	13,445
1875	9,329
1876	188
1877	225
	8,433
Total,	31,620

MENOMINEE RANGE.

The product of the mines of this range find now an outlet over a branch railway, built in 1877, by the Chicago & Northwestern Co., which connects with their main line at a point twenty-five miles below Escanaba. The principal stations on this Menominee River Railway, as the branch is named, are, as we meet them in going westward from the above point, Waucedah, twelve miles, Vulcan, eighteen miles, and Quinnesec, twenty-four miles, respectively, from the junction. At all of these stations substantial depots and warehouses have been erected, which would do credit to many of our older and larger towns; in fact, the stranger on alighting from the train is at once favorably impressed with these well built and cleanly kept station houses. The road bed, for a new road, is in excellent condition; the gradients are not heavy and the curves are easy; a train of forty car loads of ore, averaging from six to seven tons of ore to the car, is easily drawn by the light twenty-five ton locomotives used on this branch. During the construction

of this road it was an open question as to whether it would pay; but even now the brighter expectations of the more sanguine have been more than realized, and it is to be hoped that the encouragement received from this fact will induce the C. & N.-W. Co., to extend the branch further west, that the Commonwealth and other promising ore deposits, may also have an outlet. The first mines we come to in our journey westward from the Junction, are the Emmett and Breen, at Waucedah. They are conveniently located to the north of the main R. R. track on a short Y switch branch.

THE EMMETT MINE,

The most easterly one, is on the edge of an open swamp or "meadow." The formation dips to the south at an angle of 60 degrees, and has nearly an east and west trend. The mine workings embrace about five hundred feet of the vein, though explorations have shown that this is not the extent of the vein. The ore belt consists of two distinct varieties of ore; a bluish colored "soft specular ore*" lies on the hanging wall side, and a soft brown ore on the foot wall side of the vein. In some places the beds are contiguous; in others they are separated by a narrow belt of lean ore, or rock. As yet it is impossible to give any definite data respecting the thickness of the ore beds, as neither the foot wall of the brown ore, nor the hanging wall of the blue ore, has been found. The main open pit, located in the west end of the main workings, is about 200 feet long and 70 feet wide by 35 feet deep. The brown ore, near the center of this pit, as far as developed, has a thickness, at right angle to the bedding, of 50 feet, and the soft specular ore, immediately overlying it, is, at present, 25 feet thick, with fair prospects of extending much farther south.

A person familiar with mining would naturally wonder why the company did not ascertain the extent and position of their ore belt so that everything pertaining to mining

*This ore is really a soft specular variety, as it consists of an aggregation of minute crystal particles of specular ore, and in this respect differs from our so-called soft hematites, which are chiefly an amorphous mass of the red and yellow oxides of iron.

could be, at the commencement, most advantageously located; such as buildings, railroad tracks, ore docks, waste rock piles, etc. The reason why this was not done is that the company have been so pressed with orders for their ore that their entire energies have been given, as far as possible, to the filling of these orders—certainly a very happy state of affairs in the present depressed condition of the iron ore market.

The workings east of the main pit, are not as extensive, and the ore appears to be more mixed. In the extreme east end, in the blue ore, there occurs a pocket of this ore mixed with iron pyrites. They were experimenting on this, endeavoring to eliminate the sulphur by calcination—they had piled a lot of the ore on logs. It was very evident that this was a new business to them, from the large amount of fuel they used, which would partially fuse some of the ore and pyrites, thereby making the matter worse. The soft specular ore is of an excellent quality and well adapted to the requirements of steel makers, as the following analysis will show:

Oxide of Iron	93.85
Alumina	.72
Lime	.87
Manganese	.60
Sulphur	.09
Phosphoric Acid	.11
Silica	1.40
Carbonic Acid, &c	2.36
	100.00
Metallic Iron	65.70
Phosphorus	0.47

The brown iron ore will make a good foundry iron, or would answer well as a mixture for other purposes; an average analysis of a large number of samples sent me by the company, afforded the following results:

Oxide of Iron	81.570
Oxide of Lime	3.150
Oxide of Magnesia	1.800
Sulphur	.056
Phosphoric Acid	.295
Silica	5.550
Water, Carbonic Acid, &c	7.579
	100.000
Metallic iron	60.33
Metallic Phosphorus	.129

The phosphorus in this is rather high, which may, in a measure, be accounted for by the fact that the samples were taken near the surface, where the swamp water had free access to the ore, and the probabilities are that the phosphorus will decrease as they go deeper.

South of the workings, they have sunk several test pits, which, in some instances, have shown good ore, and in others fair indications of ore. The ore at present is brought to the surface by means of two derricks, one operated by an attachment to the steam pumping engine, and the other by a horse-whim. At the time of my visit, (Oct. 1878), the miners of the Breen mine had been transferred to the Emmett, and the combined force of some fifty men made the iron buckets "spin up and down" at a lively rate.

The mine, in some respects, might be considered a wet one, owing largely, no doubt, to the seeping in of the water from the swamp. To obviate this latter cause, several plans are suggested; one is to carry the waters of the Hamilton creek, which flow through the swamp, in a wooden laundry across the swamp, and then to pump the mine water directly into this aqueduct. This project, from present appearances, seems very feasible; another plan, if the hanging wall should prove sufficiently firm, is to build a coffer dam along it, in front of the mine workings. This latter plan, if the above conditions should permit, would not be very expensive as the material could be obtained from the waste rock and dirt without any extra cost.

Altogether the ore, at present, is mined very cheaply.

The officers of the company are Hon. E. S. Ingalls, chairman; Bartley Breen, sec'y; Thomas Breen, treas. and sup't.

The mine shipments for this season will be given in the tables for 1878 at the end of this report.

Adjoining the Emmett mine are the older workings of the

BREEN MINE,

Which is located on the N. W. ¼ of the N. E. ¼ of Section 22, T. 39, R. 28. The company also own the north half of the N. W. ¼ of this section. The first exploring on this property was done in 1870, by S. P. Saxton, the present secretary and treasurer of the company. These explorations consisted of several test pits sunk at different points on and near the present site of the mine workings, also of two long trenches dug across the formation, which demonstrates the probable existence of soft specular ore in paying quantities. In 1873 the Milwaukee Iron Co. drove a drift, 26 feet long, northward from the south side of the hill, just above the level of the swamp, which developed a 16 foot vein of soft specular ore; later, the Menominee Mining Company was organized, and in the spring of 1877 began mining operations and shipped, during that year, 5,812 gross tons of ore, but in May, 1878, the company abandoned their lease, when the owners of the property continued the work of mining.

The ore in this mine, thus far, is nearly all of the soft specular blue variety, and is of a good quality, as may be seen by the following analysis made from an average of a large box of pieces of the ore sent me by Mr. Saxton:

Oxide of iron	83.86
Oxide of lime	2.70
Oxide of magnesia	1.60
Sulphur	.02
Phosphoric acid	.10
Silica	6.76
Carb. acid &c	4.96
	100.00
Metallic iron	58.70
Metallic phosphorus	0.44

The noticable percentage of lime and magnesia will be quickly seen and appreciated by furnace men. The ore deposit, so far as developed, is not very regular, which causes much annoyance, but on the other hand, the formation has some features that are interesting to the geologist. The eastern opening of this mine, which is west and north of the Emmett workings, is geologically the most complicated; they stripped the earth from what at first appeared to be a large deposit of blue ore, which has a very uniform dip of 60 degrees to the south, and a strike of nearly east and west, conforming therein to the prevailing lay of the formation of this locality. The deposit, on the north side of the opening, is covered with sandstone. After mining down from one to six feet, however, they came unexpectedly upon sandstone—certainly a new phase in this range; on the east end of the pit there is but little to denote any disturbance. Traversing the center line of the opening, in an east and west direction, is a vein of very good ore dipping under the sandstone. On the south side is a large boulder, some four feet across, composed of lean hematite schist, identical with those forming the leaner portions of the ore belt, which is embedded in the sandstone, and which has a dip to the north. The sandstone conforms to all the irregularities of the boulder, as it does also to the abruptly terminating ends of the layers or laminæ of the overlying slaty blue ore and schist, already noted. The hypothesis that these overlying tilted ferruginous schists are more recent than the undelying sandstone, is not to be entertained for a moment; and the only theory which explains most clearly to my mind the facts observed, is that these schists, during the silurian period, formed a bold cliff, which during the deposition of the sandstone at its base, was undermined by the waves of the silurian sea beating against it, and that a slip or slide occurred whereby the stratigraphical position of a portion of the mass was not changed, but that the loose fragments were tumbled down burying themselves in the sandy beach below. Near the center of the opening they sank a small shaft, which, within a few feet, passed through the sandstone and into very good ore again.

Only a short distance west from the opening just considered, is a much larger one—the main opening of the mine. From this has been taken the greater part of the ore shipped from the mine. At first it promised much, but the good ore, in the course of mining, too soon gave place to worthless ferruginous slaty schists. My opinion is that the soft specular ore deposits of this mine were originally lean specular schists out of which has been dissolved the silica, after the same manner, no doubt, as were the jasper beds of the Marquette soft hematite mines (see description of the McComber mine); to support this hypothesis, we have in this same opening, near the centre of a wide northerly branch of the same, a mass of horizontally bedded sandstone from 30 to 50 feet across in different directions, and, say, 25 feet thick. It is, apparently, a large pot hole worn out of the ferruginous schists which has been filled with sand and finally altered into sandstone. This boulder was, therefore, completely surrounded by these lean schists. Immediately around the boulder was a fine quality of blue ore, which varied in thickness from ten to thirty feet. If the "dissolving out" theory be correct, the above facts are precisely what we should expect to find. Dr. N. P. Hulst, agent of the Menominee Mining Company, a careful scientific observer, as well as a thorough chemist, told me that he had often found pieces of blue ore that were very open in texture, and presented every appearance as if something had been dissolved out of them, which had lead him to the conclusion that the dissolving out theory, in some instances combined with replacement theory, would largely account for these "unusual" deposits of ore. The bulk of the ore of this opening was found along the south base of the hill. West of this opening, and on higher ground, is another irregular shaped pit. The ore deposit appears to dip down nearly vertical; beginning at the east end of the pit the deposit extends westward for about seventy feet, when it turns abruptly to the south, cutting across the plainly stratified jaspery schists; the width varies from 6 to 20 feet, and on this southerly arm they have stoped out some seventy

feet in length by twenty-five feet deep. The impression now is that a considerable deposit of ore lies at the base of the side hill and in front of the openings already considered. The officers of this company are Hon. E. S. Ingalls, president; Bartley Breen, vice-president; S. P. Saxton, secretary and superintendent; Thomas Breen, treasurer.

THE VULCAN MINE.

A little more than six miles from Waucedah, is worked by the Menominee Mining company. It was opened by this company in March, 1877, and during that year, after August, about the time when the railroad was completed to this point, they shipped 4,593 tons of ore.

The mine is favorably located near the summit of a hill, and enjoys every advantage for good drainage. The workings consist of a large open pit 280 feet long by, say, 75 feet across at its widest part. The mine is now entered on the adit level through a tunnel sixty feet long, and all the ore from the mine passes out on this level over a narrow guage tramway, and is dumped directly into pockets and from thence the ore is loaded, by means of "shutes," into the railway cars below. The adit level is 30 feet above the railway track, abreast of the ore pockets, and about 550 feet above Lake Michigan. It also intersects the vein of ore 40 feet below the original surface, though at present but little ore remains in the main pit above this level.

Glancing at a ground plan sketch of the mine the workings or open pit presents a lenticular shape, thinning out at either end. The formation dips about 60 degrees to the south, and has a strike of N. 75 W. Entering now the mine we find ourselves near the center of the workings at the widest place of the deposit; on the east side of the center they have mined the ore down twenty feet below this level for, say fifty feet to the west; on this lower level the ore is stoped away, on the north side, for some 60 feet from the center in that direction, and for, say 25 feet wide. Along on the top of the south half of this stope is the tramway which brings the ore from the west end workings. As already noted, the vein narrows to either side

of the center; whether it widens again or pinches out entirely, or the possibility of another lens of ore being in the foot or hanging wall sides, immediately to east or west, future operations can only decide, and the same may be said of the continuation of the ore as we go downward. At present there is a large amount of ore in sight, which can be cheaply mined, and the near approach of the close of the shipping season will enable them to do some necessary dead work, such as removing a portion of the hanging wall, and preparing for underground mining. It is an open question with me as to how they will support the roof of the underground workings; for I doubt very much if the soft specular blue ore, composing the vein, will stand as pillars or supports; since it is quickly affected by the weather—slaking and crumbling into fragments within a short time. Fortunately, however, if timbering is resorted to, they have an abundance of heavy pine that will answer well for "stulls" or similar purposes. The trouble with timbering will be in the wider places of the deposit, and will depend much upon the character of the hanging wall or roof. The ore thus far, in the Vulcan mine, has been well and cheaply mined, and it is fair to assume that the good judgment and careful management which will be necessary to duplicate the record of this year will not be found wanting for the coming season. The ore of this mine is of a good quality and well adapted to steel purposes; will work by itself, or will make an excellent mixture for other ores; it reduces easily in the furnace, as its porus nature affords the reducing gases of the furnace an easy access to the iron oxide. Two analyses of the ore are as follows:

	No. 1.	No. 2.
Metallic iron	60.13	62.29
Insoluble silica	12.63	5.84
Soluble silica	.28	
Alumina	.31	
Lime	.09	1.31
Magnesia	.03	
Phosphorus	0.27	0.22
Water	6.45	

No. 1 is a complete analysis made by J. B. Britton, and No. 2 is a partial analysis made by myself, Oct. 1878. The mine is connected with the main track by a Y switch, which leaves the main line about one mile west of Vulcan station. About the mine are several substantial buildings, and at Vulcan station a small village has already sprung up. On the west side of the village Dr. N. P. Hulst, the agent of the Menominee Mining Co., has a beautiful residence, which commands a fine view of a small lake a short distance to the west.

From the Vulcan mine we go northwesterly about two miles to the

NORWAY MINE,

Located on the N. E. $\frac{1}{4}$ of the S. E. $\frac{1}{4}$ of section 5, T. 39, R. 29. This is a new opening worked by the Menominee Mining Company, under a lease from the Portage Lake Canal Company. The first work was done here in August, 1878, and since that date has been built to the mine, a switch one mile in length, ore pockets constructed along the side of the track, several buildings erected, and now, (Oct. 24th,) they can ship easily 300 to 400 tons daily. The ore formation here is somewhat irregular; it has an east and west trend, and in the present workings there appears to be a narrow synclinal trough which pitches at a low angle to the west—though hardly enough work has been done to form a very clear idea of the structure. The ore is of two kinds—one a soft specular, and the other a hard, steely, specular variety, very much like the Cleveland mine ore. The former variety composes about 85 per cent. of all the ore. An average analysis of the soft specular ore sent me by Dr. N. P. Hulst, the agent of the company, afforded as follows:

Oxide of iron	85.200
Alumina	2.300
Lime	4.100
Magnesia	.620
Sulphur	.022
Phosphoric acid	.040
Silica	7.500

Metallic iron	59.64
Metallic phosphorus	.018

Another analysis made by myself gave:

Metallic iron	63.50
Metallic phosphorus	.017
Silica	7.420

From the Norway we go west along the switch about one thousand feet when we come to another newly fledged mine known as

THE CYCLOPS,

Which is worked under a lease by the Menominee Mining Co. This opening has certainly an extraordinary record. Oct. 1st, of this year, work was first done here and now, Oct. 24th, it is shipping, daily, 150 tons of good ore, at a cost not to exceed 20 cents per ton. The stripping of earth is light, probably, not averaging more than two feet. The vein has a strike of nearly east and west, and dips 45 degrees to the north. The opening is on the south slope of a hill, and will therefore have good drainage; as neither the foot nor hanging walls have been seen, it is impossible to give the thickness of the vein; but at present they have opened out across the vein sufficient to develop 30 feet of the thickness. The ore is similar to the Norway; an average analysis sent me in Nov. 1878, by J. J. Hagerman president of the Menominee Mining Co. afforded:

Oxide of iron	95.90
Oxide of manganese	Trace
Oxide of lime	.36
Oxide of magnesia	.30
Alumina	.62
Sulphur	.01
Phosphoric acid	.04
Silica	1.30
Undetermined	1.47
	100 000
Metallic iron	67.13
Metallic phosphorus	.018

Altogether the prospects of the Cyclops are very bright, as much so as any of the mines on the Menominee range.

The shipments of this mine for the season will be found in the tables for 1878 at the end of this report.

There now remains of the shipping mines only one to describe—the Quinnesec. The Quinnesec mine is located on the S. E. $\frac{1}{4}$ of Sec. 34, T. 40, R. 30. Explorations were made here early in 1873 by the Hon. J. L. Buell, of Menominee, Mich. Mr. Buell sunk several test pits across the vein, and then connected them by drifts; he also sunk a shaft some 70 feet deep, demonstrating the existence of soft specular blue ore in paying quantities. During the following winter he shipped, by means of sleighs, some fifty tons of the ore to the Menominee furnace, where it was smelted with very satisfactory results.

In Sept., 1877, the Menominee Mining Co., who now have a lease of the mine, after some more exploring, began the stripping of the vein and other preparatory work for the opening of the mine. The first ore they shipped from the mine was in March, 1878.

Visiting the mine to day, Oct. 23d, we find the very pleasant village of Quinnesec, which has a large, commodious hotel; dry goods and grocery stores; a drug store; a school house; several pleasant residences—among the latter is particularly noticeable a fine residence belonging to Mr. Buell. The Chicago and Northwestern Railway Co., with their usual foresight, have built an attractive depot and freight house. Turning now our attention to the mine, we find a branch track 2,300 feet long connecting with the main track on the east side of Quinnesec village. At the mine end of the branch, on the north side of the town, are constructed substantial ore pockets with a capacity of 200 tons each. The pockets are 32 feet high, and on the top of them is laid a double tram-road. Going westward and up the east end slope of the ridge—that rises to over 200 feet farther west—we reach the adit level of the mine, 20 feet above the level of the pockets. The adit tunnel is driven due west from its mouth; it is in now 250 feet; the first one hundred feet was through earth, and the remaining distance in ore. The tunnel has been rather a wet one,

owing to the thinness of its roof. Continuing up the slope we pass along the double gravity tram-road which transsports the ore down to the pockets from the level 50 feet above the adit.

On this upper level the first workings we meet is an open pit 90 feet long by 35 feet wide and 30 feet deep. In the east end of the pit is a shaft 20 feet deep, or sunk to the adit level, and it is purposed to "hole" the adit tunnel into the bottom of this shaft, which point is 350 feet from the mouth of the tunnel. The formation dips about 70 degrees to the north, and the strike is about east and west. The bottom of the open pit is all good ore, but at its east end a crossing of lean ore fifty feet wide cuts off the good ore. To the west, of this crossing the ore comes in again and continues for 200 feet west, when the ore on the foot wall gradually passes into lean ore again, very soon making the de posit too narrow to work profitably.

On the west side of the first crossing of rock a winze has been sunk near the hanging, on the dip of the formation, down to the adit level, and from the bottom of the winze a drift has been driven west. The first 20 feet of the drift was rock; then they struck a fine deposit of soft specular blue ore. A few steps further along in this drift we enter a large chamber twenty-five to thirty feet wide, and some twenty feet high, with no rock or lean ore on either side. Eighty feet west from No. 1 winze is No. 2 winze, which is also sunk to the adit level (50 feet deep.) The above chamber extends some forty feet beyond the bottom of No. 2 winze.

Returning to the surface, or to the 50 foot level, and continuing westward again, we soon reach the point already alluded to, where the deposit narrows, and find on the hanging wall side a large drift driven westward for 50 feet, which was partially in ore for the first half of the distance, but near the end the rock extended way across. Returning to the mouth of the drift, and then proceeding westward once more, we clamber up and over two benches, and at 130 feet we find a large shaft on the foot wall side sunk 40 feet on the dip of

the vein. The formation here is not very regular, the ore appearing first on one side and then on the other. The collar of the shaft is about 130 feet vertically above the adit level. Between the shaft and the lower workings, just considered, is a narrow vein of ore varying from two to six feet in width. The Quinnesec ore is nearly all of the soft specular blue colored variety, somewhat similar to the Vulcan. It is of a superior quality, as the following analyses attest:

	No. 1.	No 2
Metallic iron	65.70	65.30
Alumina	.83	1.29
Lime	.60	.48
Manganese	.15	.03
Phosphorus	.03	.034
Sulphur	02	.039
Silica	2.10	Insol.Res. 4.360

No. 1 is an average analysis which I made of ore collected by myself from the mine in 1873. No. 2 analysis was made by J. B. Britton in 1877. The excellent qualities of this ore and its adaptability to the manufacture of Bessemer pig iron, are too plainly apparent from the above analyses to require any comments to make them understood by the consumers. The mine has many natural advantages; its elevation will afford it good drainage for years to come, and in all probability will furnish a large amount of iron ore before the level of railroad track is attained. To a stranger the condition of the mine is not of the best, owing, in part, to a heavy overhanging capping of sandstone. It is, however, fairly braced up with stulls. Dr. N. P. Hulst, the agent of the mine, told me this was only temporary, owing to the fact that, at present, they are greatly pressed to fill the orders for their ore before the close of navigation, and as soon this was over they were going to blast away this overhanging cap rock, and open out some new stopes for next season's work. The company have a large store where dry goods and groceries are sold at reasonable rates, so that the miners can obtain good board and lodging for $3.50 per week. The officers of the Menominee Min

ing Company are, president, J. J. Hagerman, Esq., Milwaukee, Wis.; secretary and treasurer, Geo. D. Van Dyke, Esq., Milwaukee, Wis.; agent, Dr. N. P. Hulst, Vulcan, Mich. The present cost of mining ore is less on the Menominee range than in the Marquette district; the ore is easy to drill and to mine, requiring scarcely any block-holing and but little sledging to reduce it to the proper size for shipping; but as soon as depth is attained, so that the side walls will need trimming back, or that underground mining is resorted to, then will the cost of mining—considering the disintegrating nature of the ore, when exposed to the action of the atmosphere—be fully equal to the Marquette ores. The very small amount of phosphorus, and the noticeable percentage of lime and magnesia, will render them desirable mixtures for some of the Marquette ores containing too much phosphorus to make Bessemer steel pig iron, and for this reason the two ores could, in some instances, be handled to a good advantage by the same commission agent.

There are several promising iron properties on the Menominee range; some of them are conveniently located near the line of railroad, others, less fortunate, are ready to ship ore but cannot for want of transportation. The most prominent of the latter is the Commonwealth mine, located about 2½ miles south of the Menominee river on Sec. 34, T. 40, R. 18, Wis. The mine, probably, has more ore in sight with a fair prospect of its continuance, than any of the other mines of this district. The formation dips about 65 degrees to the south, and the strike is nearly east and west. At right angles to the strike they have uncovered an aggregate thickness of over 100 feet of soft specular red ore, which averages well in metallic iron, and which will answer well for foundry or mill iron purposes.

STATISTICS OF MICHIGAN COMPILED BY
CHAS. E. WRIGHT, M. E., COMMISSIONER OF MINERAL STATISTICS.

	NAMES OF FURNACE CO'S.	Previous to 1872.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	TOTALS.
1	Pioneer Furnaces	57,577	7,020	7,388	10,708	15,202	11,205	2,801	9,700	121,601
1	Iron Cliffs Furnace	.....	.....	.....	4,784	358	.....	.....	.....	5,142
1	Collins Iron Company‡	36,566	3,431	2,000	.....	.....	.....	.....	.....	41,997
1	Northern Iron Company‡	15,659	.....	.....	.....	.....	.....	.....	.....	15,659
1	Bameroft Iron Company‡	35,021	4,250	4,100	3,688	5,277	3,282	.....	.....	55,618
1	Morgan Iron Company‡	31,602	4,456	6,824	5,973	5,377	3,278	663	.....	57,573
1	Champion Iron Company*‡	20,512	5,006	3,949	1,581	.....	.....	.....	.....	31,048
1	Michigan Iron Company‡	23,344	4,001	4,467	6,621	3,098	.....	.....	.....	41,531
1	Greenwood Iron Company*‡	25,140	4,212	4,416	4,839	1,595	.....	.....	.....	40,202
2	Fayette Furnace	24,626	9,962	11,966	11,079	10,647	10,015	3,969	9,686	91,950
3	Munising Iron Company‡	7,557	2,500	2,237	6,092	4,230	2,407	3,280	.....	28,312
3	Bay Furnace‡	7,095	4,900	5,760	8,539	9,223	8,119	4,250	.....	50,706
1	Deer Lake Iron Company‡	7,833	2,720	3,447	6,524	4,615	.....	.....	.....	25,139
1	*Marquette & Pacific R. M. Co‡	1,610	4,854	1,138	3,238	10,940	10,514	6,856	.....	39,250
1	*Grace Furnace‡	.....	.....	1,800	3,546	.....	.....	.....	.....	11,346
1	Carp River Iron Company	.....	.....	.....	1,431	.....	1,272	3,176	4,464	10,343
1	Peat Furnace	.....	115	509	.....	.....	.....	.....	.....	624
4	Menominee Iron Company	.....	.....	2,299	1,702	5,780	4,829	5,647	2,339	25,596
2	Escanaba Furnace Company	.....	.....	2,175	5,803	70	.....	.....	.....	8,048
5	Michigan Central Iron Co	19,518	3,551	4,848	3,451	1,230	.....	.....	.....	32,598
5	Bangor Furnace Company	.....	689	3,606	6,219	8,359	10,280	10,457	10,531	50,041
6	Peninsular Iron Company	35,752	4,834	4,533	2,049	2,466	2,472	5,310	4,383	59,993
6	Eureka Furnace	60,000	2,078	3,572	549	2,255	3,421	4,458	.....	76,333
7–8	Leland Furnace	.....	.....	.....	.....	.....	3,000	2,000	.....	5,000
9	Frankfort Furnace	.....	.....	46,200	3,636	4,061	.....	.....	.....	13,917
9	Elk Rapids Furnace	.....	.....	.....	5,863	8,033	7,100	11,925	11,310	44,231
6	Detroit & L. S. Iron M'f'g Co	36,494	4,731	4,061	3,808	4,831	1,580	4,805	1,040	61,350
	Totals	443,066	73,310	99,795	114,563	107,650	82,774	70,097	53,653	1,045,148

1 Furnaces in Marquette County.
2 Furnaces in Delta County.
3 Furnaces in Schoolcraft County.
4 Furnace in Menominee County.
5 Furnaces in Van Buren County.
6 Furnaces in Wayne County.
7 Furnace in Leelenaw County.
8 Furnace in Benzie County.
9 Furnace in Antrim County.
‡ Swineford's History.
† Previous to 1874.
* Coal or Coke.
Caseville Furnace—no returns.
Union Furnace—no returns.
Ward Furnace—no returns.
* Huntramack Furnace—not in blast since 1873.

TABLE SHOWING AMOUNT OF COAL PRODUCED FOR 1877-8, AND TOTAL FOR PREVIOUS YEARS, PARTLY ESTIMATED.

	Previous to 1877.	1877.	1878.
Jackson mines	350,000	67,697	*55,715
Corunna mines			21,000
Other mines		1,500	1,000
Total net tons	350,000	69,197	77,715

*Dec. 1st.

BLE

from

—AS. E.

	1868	
Clev		
Jacl	102,112	1(
Lak	130,524	1:
Hun	105,745	1:
New	35,757	2
Lak	45,665	2
Iron	26,651	2
Edw	3,836	.
New	17,360	2
Chai	8,257	.
Barn	6,255	.
Fost	14,383	2
McC	6,000	1
Rolli	.....	..
New	.....	..
Marc	.....	..
Wint	7,977	
Palm	.....	..
Salisl	.....	..
Excel	.....	..
Smitl	.....	.
Howe	.....	..
Repul	.....	..
Mitch	.....	..
Michi	.....	..
Rowla	.....	..
Miller	.....	..
Howel	.....	..
Teal I	.....	..
Carr,	.....	..
Albion	.....	..
Goodr	.....	..
Himro	.....	..
Keysto	.....	..
Spurr	.....	..
Allen	.....	..
Sagina	.....	..
Green	.....	..
Kloma		