failure; in fact, that the company possessed in this belt but a short extent of profitable ground. Near the Calumet and Hecla line the vein corresponded in texture and in richness to its known character in the lands of its celebrated neighbor, but further to south the vein becomes soft, friable and worthless. The productive ground must soon be exhausted, and then in the apparent condition of facts, the existence of the company must terminate. In this emergency a most fortunate discovery was made of an amygdaloid belt, 800 feet to the east, and it was determined to prove this bed and ascertain its value, so that, if favorable, mining operations could be transferred to it, prior to the failure of the mine already opened in the conglomerate. This work was begun in 1877, and now the company have sunk in this deposit four shafts down to the respective depths of 600 feet, 400 feet, 400 feet, and 100 feet. The second level is drifted 1,850 feet, the third 1,200 feet, the fourth 600 feet. The distance between the extreme points of openings is 4,000 feet; 3,000 feet of levels have been driven in this belt the present year, and the whole is developing with a degree of uniformity and richness that the success and prosperity of the mine seems entirely assured.

The vein bears north 39° E., and dips to the northwest 40°, and has a width of from 3 feet to 30 feet. In all there are six shafts started. The workings are on the west part of Sec. 26 and N. ½ Sec. 27, T. 55, R. 33, which was formerly the Sewabic mine. The combining of the two companies occurred at the time of the organization. In 1879 a further consolidation took place with the Opechee, which latter held the S. ½ of Sec. 27 and the west part of Sec. 26. The Opechee was originally a part of the company's property. The company also own Sec. 24 and the remainder of Sec. 26, which was organized as the Laurium Mining Company.

The known veins crossing the property are, the most westerly, Allouez conglomerate, next east the Calumet conglomerate, the Osceola amygdaloid, the Kearsage conglomerate, Kearsage amygdaloid. On the Laurium, are the two latter lodes, one the Isle Royal; but only a small amount of exploration had been done on them.

The company has only been at work in the amygdaloid for two years; the first year and a half were spent in finding out what they had. The shafts are sunk at an angle of 40° and are sometimes in the foot wall and sometimes in the hanging wall.

There are three large rock houses; one on the conglomerate and two on the amygdaloid. In the latter mine, a rock house is built on the east side of No. 1 shaft, so that the skip cars run up directly from the shaft into it, and the rock from No. 2 shaft is also run to it on an elevated railway. The building, as are the other rock houses, is entered by two tracks for filling the cars from two rows of shutes, one on each side of the building; these tracks connect with the main line of the Mineral Range railroad, over which the rock is taken to the stamp mill on Portage lake, near Hancock, 11 miles distant. The rock house at No. 4 shaft was built the past season, and is not yet entirely completed although in use. At present only the rock from No. 3 shaft is dumped into it. The cars from No. 3 run on a trestle 50 feet in height, and are drawn to and from the building by wire rope running over drums; 120 tons per day are run from No. 3 to this rock house, and are there handled by three men. The cars dump upon a large coarse bar screen, which carries the heavy pieces to the floor and allows all the smaller stuff to fall through upon a gabled shape screen slanting either way at right angles to the direction of the upper one. By this double screening arrangement the material is separated for economical handling. The large pieces are by themselves, to be thrown into the heavy Blake's crushers. The smaller portions carried to the floor down the under screens, are broken in the medium sized crushers, and all the fine particles pass through the screens directly into the rock bins below, as do also the broken materials from the crushers. The large breakers are 15x24 inches, and there are two smaller ones. When the other shaft is used there will be like arrangements on the same floor for that also. In all there are seven small or medium sized breakers in use in the several rock houses. The new building is 50x90 feet, and is entered by the elevated track at a height of 50 feet above the ground. The bins have a capacity of 2,500 tons of rock. The entire structure with its appurtenances, elevated track, engine and engine-house, etc., cost $70,000. The company own the cars in which the rock is conveyed to the stamp mill, and the railroad company charges 37½ cents per ton for hauling a distance of 11 miles. The Osceola also put in and cares for the side tracks, etc.

The rock house on the conglomerate belt is furnished with a hammer which will be soon transferred to No. 4 rock house.

There are two hoisting engines on the amygdaloid and one on the conglomerate; two pumping engines and two compressors. The company operate 15 Rand's drills; four men and two boys to each drill. In fact, the underground work is done as far as possible with machinery. Capt. Daniels, the efficient agent of the mine, states that he finds a saving of expense of 40 per cent in stoping by use of power drills and 20 per cent in drifting.

The stamp mill is one of the most complete on the lake, and is furnished with the latest and most approved mechanical appliances for separating the the copper from the rock. It is provided with three Ball's stamps, 15 inch cylinders, 54 Collum's washers and five Evans' slime tables, and they are now treating at the mill 450 tons per day. The cost of the mill was about $125,000. The heads of the stamp are covered by chilled iron shoes, weighing upwards of 600 pounds each, and in running on the conglomerate rock they wear down one-sided, so as to be useless in three or four days.

The original mine, as before stated, was opened on the conglomerate. Six shafts were sunk. No. 1, 600 feet south of Hecla line, is the only one that has proved of any value. This shaft dips with the lode at an angle of about 45°, and at a depth of 1,000 feet reaches the boundary of the company's property. To this limit the workings have already nearly attained. No. 2 shaft was sunk to a depth of 300 feet, and No. 3 to 900 feet. Both have been abandoned, as they yielded no copper; but on the product from No. 1 the company were able for a few years to make an excellent showing. Mining was begun in the fall of 1873, and in the following year the company shipped 629 tons of mineral= 468 tons of ingot copper. In 1875 the product was 665 tons 303 pounds; in 1876, 2,405,631 pounds, yielding 70 40-100 per cent=1,693,737 pounds of ingot copper, which sold at 20 56-100 cents per pound=$348,333.25; silver obtained, 8,475.80=$349,189.87. The expenses were $298,087.56; profit, $51,-093.27. An assessment of $2.00 per share was made. Up to this time the company had leased the Albany and Boston stamp-mill, at which mill its rock was treated, but in November of that year the Osceola mill was started. In 1877 the ingot product was 1,382 tons 777 pounds, and in 1878 the product was 3,316,725 pounds, yielding 79 178-1000 per cent=2,626,120 pounds of ingot. In addition was obtained a low grade of mineral, got by washing the sands—603,595 pounds, yielding 13 33-100 per cent=79,878 pounds of ingot, thus making a total production of 2,705,998 pounds of refined copper, which

sold for $420,340.14; silver sold for $5,525.61=$425,865.75 for the total year's earnings. Total expenses, $338,481.78, leaving a profit of $87,383.97. A dividend of $1.00 per share was paid. The company met with the loss of a rock house, destroyed by fire. The yield of ingot per fathom was 57.3 pounds; 341 fathoms were broken on the amygdaloid; 79,439 tons of rock were treated at the stamp mill at a cost of 62 46-100 cents per ton. In 1879 the product of the mine in mineral was 3,764,444 pounds, yielding 83 38-100 per cent= 3,138,828 pounds of refined copper. In addition the copper obtained from the sand washings amounted to 368,335 pounds, which smelted yielded 14 642-1000 per cent or 53,935 pounds of ingot. The tribute washings were 4,624 pounds, making in all 3,197,387 pounds of ingot, which sold for an average price of 17 786-1000 cents per pound, which sold for, including silver, $573,588.25. Total expenses were $375,834.54, leaving for profit $197,753.71. A dividend, payable February, 1880, was declared of $1.00 per share.

No. of tons of rock stamped, 95,055, which cost, including mining, hoisting, tramming, stamping, washing, and every other expense connected therewith, $3.20 82-100 per ton. The cost of treating at the mill was 51.02 cents per ton; cost of transporting rock from mine to mill, 37½ cents; breaking, etc., 17 cents; office and other surface expenses, 12.12 cents per ton.

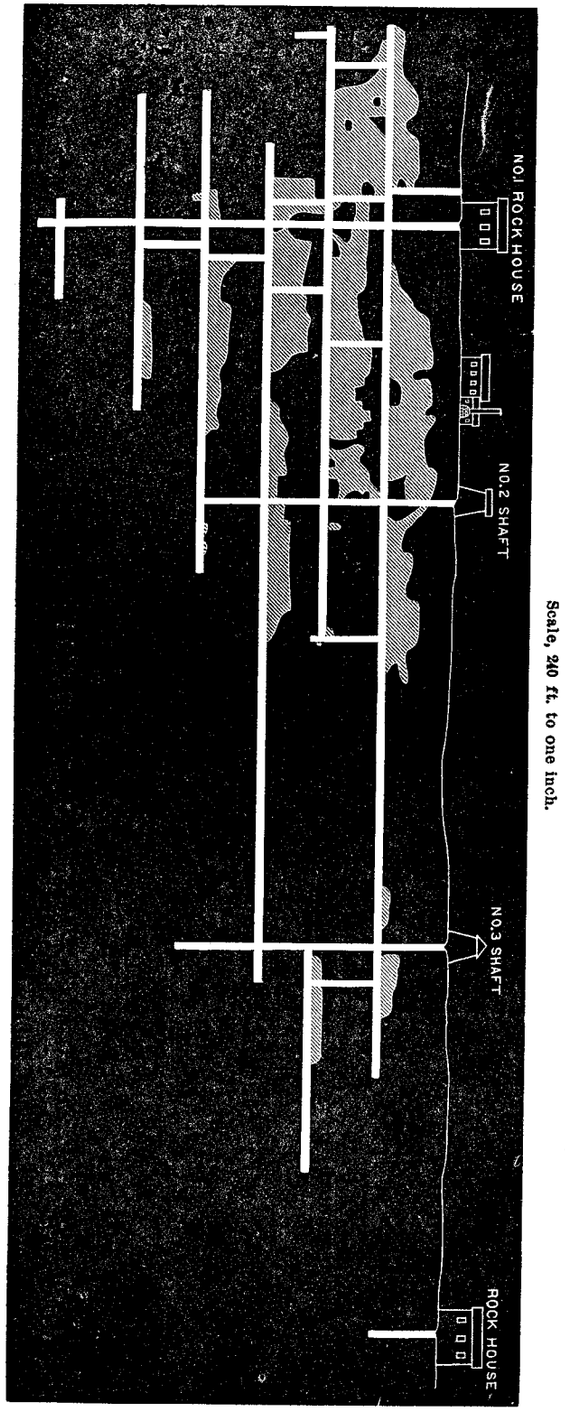
Number of tons of conglomerate rock hoisted, 64,052; discarded, 5,452 tons; sent to mill, 58,600 tons. Number of tons of amygdaloid, 44,506; number of tons sent to mill, 36,455; number of tons stamped and washed per cord of wood consumed, 15½.

The number of tons of rock treated in 1880 was 107,530, yielding 3,971,319 of 85 per cent of ingot—the highest per centage obtained by any company on the lake. Some months the product yields 87 per cent of ingot. The number of men employed during the year, 420, of whom 120 were miners. The tailings are worked on company account, and just about enough is obtained to pay the expense of working. The cost per fathom for stoping was $9.00; sinking per foot, $18; drifting, $10. The number of tons raised from the amygdaloid during the year 1880 is 75,000; number of tons rejected, 7,000. The timber work in the mine costs about 25 cents per ton. More labor and money have been expended in opening during the year than in stoping.

The cost of treating the rock is less than for any previous years, but the exact figures cannot be given, as the details are not all made up. The amygdaloid yields somewhat less than two per cent of ingot copper. In character the lode is similar to the Pewabic.

In February last the previously-mentioned consolidation was made with the Opechee, which joins the Osceola on the south. The Opechee estate comprised 400 acres, and carries across it several important lodes, including the Calumet and Hecla. The consolidation was made on the basis of an exchange of stock —two shares of the Opechee for one share of the Osceola. It is the aim of the company, if the developments shall warrant the outlay, to ultimately increase the output to 1,000 tons of rock per day.

The number of shares is now 50,000, and the latest quotations of the market value per share is $37, thus making the current value of the mine=$1,850,000; capital stock, $1,250,000, and the total amount of dividends paid to date is $460,000. The treasurer's office is No. 178 Devonshire street, Boston, Mass. Joseph D. Clark, President; A. S. Bigelow, Secretary and Treasurer; John Daniels, Agent, Osceola, Mich.



LONGITUDINAL SECTION OF THE OSCEOLA MINE (ON THE AMYGDALOID VEIN), 1881.

Scale, 240 ft. to one inch.

THE CALUMET AND HECLA CONSOLIDATED MINING COMPANY.

Among copper mining companies the Calumet and Hecla stands alone. In all the estimates and consolidations applicable to other mining companies, this company must be excepted. The mine so greatly exceeds all others in extent and richness that there is none to be compared with it in product or in profit. If any comparison is instituted it must be borne in mind that the Calumet and Hecla lode is probably by far the richest vein ever known in the annals of copper mining. Not only is this true, but it is the only mine ever extensively and successfully worked in a conglomerate vein. The Allouez is worked in a conglomerate, but bears no comparison in productive capacity to its neighbor. And so far as yet known this company possesses all of this remarkable deposit that is of any considerable value. On the Osceola, except adjacent to the Hecla boundary, the lode proved worthless, and to the north, on the Schoolcraft location, this company was ruined in its efforts to derive a support from this belt.

With a capital stock of $2,500,000, it is worth in the market upwards of $25,000,000; shares, which have a par value of $25 are worth upwards of $250 in the market, and with only an expenditure of the capital stock of $1,200,000 the mine has returned to the stockholders in dividends the sum of $18,850,000, besides supplying a mining plant and surface improvements superior, it is believed, to that possessed by any other mine in the world.

It is situated in T. 56, R. 33, Secs. 14, 15 and 23, a distance from Lake Superior of about five miles, and from Portage lake of 12 miles, with which it is connected by the Mineral Range Railroad.

At the close of 1865 the stock was held at $1 per share, but speedily thereafter it began to advance, the rise being due to the discovery of the vein, which is said to have been the result of mere accident. But whatever the origin of the discovery, or to whomsoever the credit may be due, it soon became noised abroad, and excitement was the order of the day. The stock by successive upward moves soon reached to $30 per share. An assessment of $5 per share was made to develop the lode, and as the developments made by working the lode bore out all that was anticipated, the value of the shares continued to rise, and in a few brief months reached $75. In the summer of 1866, having a large territory, the company determined to organize a new company, and thus created the Hecla, the stock of which was apportioned to the holders of the Calumet, share for share, at $5 per share, and the sum used for a working capital. But before winter, ere the new mine had been opened, the stock advanced to $75 per share; two additional assessments were made, amounting to $8 per share on the Hecla, and an additional one of $5 on the Calumet, which caused its stock to fall to $15. Other assessments were called in amounting, February, 1868, to $15 per share on the Calumet, and to $25 per share on the Hecla stock. The stock was then selling at $30 per share. The results of the mining operations continuing favorable, the stock of the companies gradually went up as public confidence became secured, so that in December, 1869, the Hecla had advanced to $85, and paid its first dividend of $5 per share, which it has since uniformly repeated at each succeeding quarter, with an occasional extra added.

The Calumet made its first dividend in August, 1870, which it repeated each quarter up to the period of the consolidation of the two companies, in May, 1871. At this date the Hecla had paid $32.50 per share in dividends, and the stock had been assessed $25 per share. The Calumet had paid $15 in divi-

dends and the stock had been assessed $15 per share. The union of the two companies made the capital stock $1,000,000, in 40,000 shares, and a stock dividend increased the number to 50,000, and in 1873 a further increase made the number 80,000. At that date the dividends amounted to $2,800,000. In 1874 there were 230,000 tons of rock treated, and the total cost of the rock per ton was $7.40. In 1875 239,000 tons were stamped, and the cost per ton of rock was $5.82. Only about two per cent of the rock is rejected; it goes directly from the hoist to the stamp mill. With other mines a careful selection is generally necessary, and sometimes 25 per cent and even upwards is rejected. The average of ingot per ton of rock in 1874, was 4.28 per cent; in 1875, 4.33. The product in 1873 in gross tons 10,152 tons, 942 pounds, 80 per cent ingot; 1874, 12,670 tons, 647 pounds mineral; 1875, 13,219 tons, 1,595 pounds.

YEARS.	Product—Gross.	Product—Ingot.	Per Cent.	Assets.	Liabilities.
1875	14,333 tons, 1395 lbs.	10,901 tons, 173 lbs.	77.46	$2,669,873.54	$150,235.31
1876	14,135 tons, 114 lbs.	10,802 tons, 1401 lbs.	76.43	2,763,691.67	133,444.11
1877	15,528 tons, 735 lbs.	11,823 tons, 555 lbs.	76.16	2,648,118.91	180,076.36
1878	16,463 tons, 911 lbs.	12,578 tons, 582 lbs.	76.22	3,877,353.59	462,681.87
1879	18,465 tons, 1616 lbs.	14,277 tons, 1425 lbs.	77.32	----------	----------

The mine is kept open five years ahead. In 1878 the rock in the south end the mine yielded 2½ per cent, against 4½ per cent in the old mine. In 1879 the capital stock was increased to $2,500,000, 100,000 shares, the limit allowed by the laws of this State.

The average bearing of the lode is N. 32° E., and the general dip with the horizon 38° northwesterly. The height above Lake Superior is 640 feet. The lode—conglomerate—is all stamp rock, and the extreme length to which it has been opened on the property is 5,700 feet, 4,200 feet of which is considered first-class ground. The levels are laid out with a base of 60 feet perpendicular, and the lowest is the 24th; distance down, on the lay of the rock, is 2,250 feet. In the Hecla mine are six working shafts, and in the Calumet five. In the south part of the Hecla, adjacent to the Osceola, are two shafts down to the fourth level. The underground work is performed with the aid of compressors, while on the Hecla side are Rand's double, 28x42 inches. Double compressors are being put in at the Calumet mine, 32x48 inch, Rand's. There are now in use in the mines 62 power drills, Rand's pattern, and four Bailey's engines are used for hoisting from the bottom of the shafts to the skip levels. The main air pipe extending down into the mine is from four to one and one-half inches diameter, and the extent of air pipe under ground is 5,400 feet in one continuous line. The number of tons hoisted per day is about 1,000. The main hoisting engine at the Hecla is Leavitt's compound style, having a working capacity of 1,000 horse power; in addition to the hoisting it drives also the double compressor. The power is applied by means of wire rope transmission attached to the winding drums, of which there are four, 25 feet diameter and seven feet face. The cylinders, high pressure, are 23¾ inches diameter, the low pressure 36 inches, with six-foot stroke. At the Calumet the present hoisting power is a 24-inch and 48-inch cylinder compound engine, four-foot stroke, with four drums, 10 feet diameter, 12 feet face. The foundations are laid and a compound Leavitt's engine is being erected at the present time of 4,700 horse power. This engine is designed to run the compressor, hoisting gear, pump and man engine by means of wire rope transmission. The pump and man engine are located near No. 1 shaft. To provide against accident to hoisting engine, the gearing house is provided with an Allen & Porter engine, ready for any emergency that may possibly occur. The machinery in this new engine is of very heavy pattern, and will probably last for many years to come.

To assist in ventilation in the mine, in summer season, there is a large exhaust fan, 30 feet in diameter, in brick casing of ample size, Guebel's pattern. It is found to answer the purpose admirably, and becomes a necessity in hot weather. It makes 50 revolutions per minute. The exhaust chambers are 8x10 feet.

The rock is transmitted from the shafts to the rock houses in cars running on elevated track, Frue's automatic elevated railroad. The longest run is 1,500 feet. The largest pieces of rock are broken with the steam hammer, having a weight of six tons. The smaller portions are broken in the Blake crushers, of which there are two sizes, 24x18 inch and 10x15 inch. To supply the necessary water for the engines at the mines, extensive water-works have been completed during the past season, located on Calumet creek, at a distance of 4,000 feet to the north from the Calumet hoisting-engine house. The water-works are supplied, at the present time, with a compound Worthington pumping engine, cylinders 12 inch and 24 inch, three and a half foot stroke. It is the intention to substitute for the one now in use, next season, one of Leavitt's compound style. The water is derived from the pond made by damming the creek. The pipe from the water-works to the mine is 16 inch diameter. The hoisting engines are furnished with Stur's friction gear.

The stamp mills are located at Torch lake, five miles distant, and are connected with the mine by a railroad, four-foot gauge, operated with locomotive engines, of which there are three single 30-ton Fairlie engines and one 30-ton common engine. The stamp mills are furnished with six Ball stamps, 15 inch cylinders, and one Ball-Leavitt head now in use, soon to be increased by a second Ball-Leavitt head. The stamp heads make 90 blows per minute, and the shoes last about seven days on an average. From the top of the bluff, at the terminus of the railroad, the cars run to the stamp mills on a gravity incline three-fourths of a mile in length.

The water for the use of the two mills is pumped from the lake by a compound Leavitt's pumping engine throwing 9,000,000 gallons each 24 hours, supplying the stamps, wash houses, etc. The stamp machinery, washers, etc., are driven by a compound Leavitt engine, and are supplied with very expensive wire rope transmission. The Calumet mill is lighted by the Brush electric light, and the Hecla mill with the Siemen's; 12 lamps in each mill. In each mine is a man engine, going down about 1,700 feet at the present time, but gradually being extended to greater depth. The high explosive used is No. 2 Hercules.

President, Alexander Agassiz; Secretary and Treasurer, Chas. W. Seabury; office, No. 67 Milk street, Boston, Mass. Agent, J. N. Wright, Calumet, Mich.

THE SCHOOLCRAFT MINING COMPANY.

The Schoolcraft Mining Company was organized in 1863. The property adjoins the Calumet and Hecla lands on the north, being the S. E. ¼ of Sec. 12, T. 56, R. 33, and work began and was prosecuted on the Calumet and Hecla conglomerate. The company expended its entire capital stock in unsuc-

cessful efforts to produce a paying mine, and in about 1873 was obliged to shut down for want of funds, or of any reasonable expectation of ultimate success. The mine was then leased to Capt. Wm. Harris, who expended considerable money in what he thought would be a profitable venture of working over the burrows, etc., but which proved otherwise. The company expended its resources and went into bankruptcy, and the property was bought at a bankrupt sale in 1876, and the organization of a new company decided upon by the purchasers to be called the Centennial, which project was consummated about two years later; capital stock, $1,000,000 in 40,000 shares.

Recently the new company have begun work on the Osceola amygdaloid, which crosses the property. Two shafts are started, 660 feet apart, and are now down nearly to the first level; judging from present appearances there is every indication of promise. The vein is, thus far, opening favorably.

There are some improvements on the property, in the way of agent's house, office, dwellings for miners, etc., and mining plant; two hoisting engines, and one pumping engine; a stamp mill with 32 heads of Gates' improved stamps, all intact. The water is supplied by a launder from a dam in Calumet creek. The property is but a short distance from the village of Red Jacket. The officers are S. L. Smith, president; Jesse Hoyt, secretary and treasurer; office, New York; William Harris, acting agent, Houghton, Michigan.

THE ALLOUEZ MINING COMPANY.

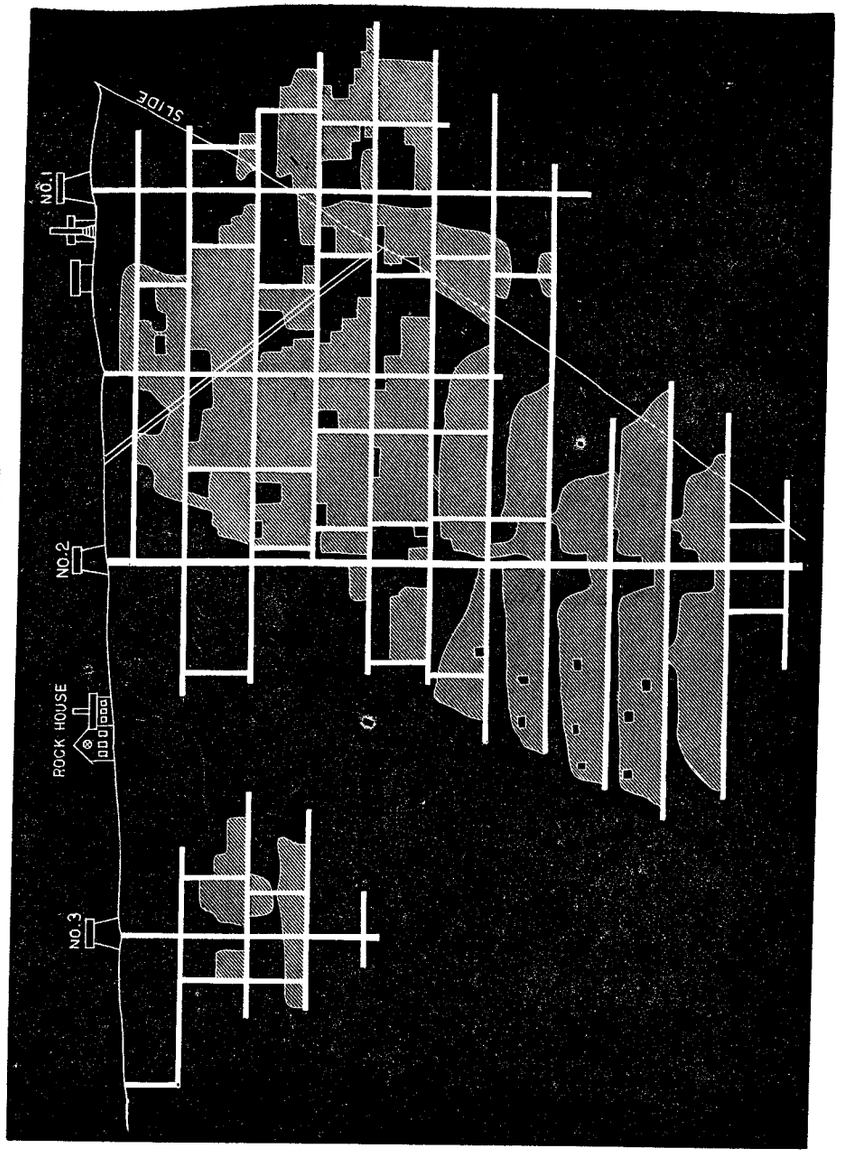
This company was originally organized in 1859, and held 2,800 acres of land in the southwest part of Keweenaw county, but the mine is situated in the S. ½ of Sec. 31, on the county line, T. 57, R. 32. Although the company is an old one, but little except exploring work was done during the first 10 years, and in 1869 it was decided to begin on the conglomerate belt, since known as the Allouez conglomerate. This belt is the same that immediately underlies the greenstone extending through the whole length of the trap range of Keweenaw county, and is now also being opened at the Delaware mine.

At the Allouez, the lode bears N. 39° E., and dips to the northwest 38°. It varies in width from 10 feet to 30 feet, and yields in mineral 1.30 per cent to 1.50 per cent, a fair percentage as compared with the majority of the mines. The work in 1869 consisted in sinking No. 1 shaft, commencing No. 2, extending a drift, and sinking a winze. A temporary suspension occurred, but work was resumed again in 1870, and in 1871 arrangements were made and work from that time was pushed forward on a large scale, and continued until September, 1877. During these years the mine was opened with three shafts sunk, the deepest 750 feet, and levels which extended in extreme length 1,600 feet. Houses sufficient for a working population of 400 men were built, together with agent's house, office, store, warehouse, shops, rock house, stamp mill, railroad, etc. The mine was under the charge of Captain A. P. Thomas, now agent of the Conglomerate Mining Company.

The company exhausted its capital stock, and contracted, in addition, a heavy indebtedness, and suspended work in September, 1877, or rather leased the mine to Messrs. Watson & Walls, who at that date began operating the mine on tribute, by which the company was to receive one-eighth of the product, clear of all expense. The lease expired in September last, and the company again resumed control of the property, and began to work the mine under a new organization which has been made, making the capital stock $2,000,000,

LONGITUDINAL SECTION OF THE ALLOUEZ MINE.

Scale, 300 ft. to one inch.



in 80,000 shares. An assessment of $1 per share ($80,000) was made to liquidate the indebtedness and furnish a working capital.

Under the lease were produced:

	Tons and Pounds Ingot.	Tons of Rock Hoisted.	Per cent of Copper in Rock.	Per cent of Ingot in Copper.
In 1877.....	2,026,729 lbs.	.....	....	....
" 1878.....	827 tons, 25 lbs.	81,000	1.37	76
" 1879.....	735 tons, 1,611 lbs.	67,000	1.45	75½
" 1880.....	685 tons, 1,088 lbs.	73,000	1.30	....

The cost of crushing the rock at the stamp mill during the past two years has been 52 cents per ton. About five per cent of the rock hoisted has been rejected. Mr. Fred Smith, the company's efficient and gentlemanly agent has resided on the location during the period of the lease, to look after the interests of the company, and is now conducting the operations. A longitudinal section of the mine accompanying this report shows the underground workings to the present time.

The mine is opened to a depth of 1,060 feet, and the three shafts are connected with the rock house, each with a separate track laid on trestle work, operated with wire ropes, automatically. At present the hoisting is all done in No. 3 shaft, which is fitted with a skip road, and the cars run from the shaft house to the rock house on the automatic elevated railway previously mentioned. The rock house is furnished with six Blake's crushers, one of which is 18x24 inches, and it is connected with the stamp mill by a railroad, 4-foot gauge, operated by locomotive engine. The road is two and one-fourth miles long.

The mine is situated on Hill's creek. This stream supplies a portion of the water necessary for the purposes of treating the rock, and is brought in from a pond made by a dam across the stream, in a launder; a part of the water is obtained from Gratiot creek, conducted to the mine in a launder. The mill is provided with two Ball's stamps, 12-inch cylinders, and with 28 Collum's washers.

Mr. Smith is endeavoring to open the mine ahead, and also to furnish the ground for present stoping; about 300 men are employed. Two Burleigh drills are in use and a Rand drill is on the ground for trial. After the expiration of a three years' lease a good deal needs naturally to be done on the location, especially to the machinery and in opening ahead in the mine. The contract has been let for the manufacture of new friction gears of more approved pattern than that now in use.

The conglomerate lode has an extent on the property of 3,000 feet, and lying north of it will doubtless be found the ash bed, but no effort has been made to determine the fact. The officers are Emmerson Coleman, President; William C. Stewart, Secretary and Treasurer; office No. 29 Drexel building, 25 Wall street, New York. Fred Smith, Agent, Allouez, Michigan.

ISLE ROYAL.

In the commencement of copper mining on Lake Superior, a great deal of attention was given to Isle Royal. Very uncertain, but extravagant notions prevailed regarding its mineral value; numerous cupriferous veins were observed along the shore, and formed the basis of much wild conjecturing. It

was even at first asserted that the copper masses found here and there on the mainland had been derived from Isle Royal, carried by the ice in some former geological epoch.

The island is situated about 50 miles from Keweenaw point, and is 75 miles in length, 8 miles in width in the widest portion,—the south end of the island, and about 2½ miles at the north end. The island is formed of thin beds of trap, running longitudinally; is indented with numerous bays and coves, some of which form excellent harbors; and is covered with a dense growth of dwarfish forest trees, largely of the evergreen species. The formation is crossed, as in Keweenaw county, by numerous copper-bearing veins, and veins also frequently occur conforming in direction with the trend of the rock, but dipping at angles independent of the dip of the formation. The frequent change in the formation, arising from the thin bedding or strata of the rocks, affects in a corresponding degree the character of the veins, making the work of mining in them exceedingly uncertain and causing all the mining ventures which have thus far been made on the island, to prove unprofitable undertakings.

All the mines which have been opened were situated near the shore, and mining work was prosecuted with considerable zeal prior to 1853, after which time the island was practically abandoned for a period of 20 years, after which time attention was directed to the extensive "Indian diggings," which are found to occur here in, perhaps, greater quantity than elsewhere in the copper district. In 1872 Mr. S. W. Hill did some exploring work on the island, and as a result the Island Copper Mining Company was formed, and a force of men put to work on the location, near the southern extremity of Siskiwit bay. Work was continued three years, when the company suspended operations. The mine was let on tribute. A small stamp mill was built in the fall of 1875 to work up the accumulated stamp rock, but was destroyed by fire very soon after. The total shipments of the mine were about 68½ tons of refined copper.

THE MINONG COPPER COMPANY

is located near McCargoe's cove, on the northwest side of the island. The company was organized in 1874, and commenced working a lateral vein which lies about a mile from the lake shore, and which was marked for a great distance with ancient pits. A stamp mill was built in 1876, and furnished with a Ball's stamp. The rock was found to yield about one per cent ingot copper; 1,579½ tons of rock treated in 1876 gave 20¼ tons of mineral. A diamond drill was employed in the exploring work. In 1877 the company produced 72,737 pounds of ingot copper, and employed 30 men. The expenditures were $126,943.34. At the present time there are a few men working on tribute, producing in 1880 about 13 tons of copper. The officers are Hiram Walker, President, E. W. Hudson, Secretary and Treasurer, Detroit, Mich.

In visiting the copper district, while collecting the data of the foregoing pages, the writer must acknowledge his obligation to the mining agents to whom he is indebted for many kindnesses, courtesies and favors voluntarily extended, which these gentlemen, with few exceptions, have uniformly given. They have combined hospitality with a readiness to accord any information in their power to convey. Obligation is also most cheerfully rendered to Messrs. J. R. Devereaux, editor of the Houghton Mining Gazette, E. P. Kibbee, editor of the Northwestern Mining Journal, Hancock, Mich., and Alfred Meads, editor of the Ontonagon Miner, for information obtained. These gentlemen very freely gave the writer access to their files, and the use of their mining reports and other sources of information collected in their offices.

NAM

1 Adve
2 Ætna
3 Alba
2 Allou
2 Amy;
3 Arca
3 Atlan
1 Azte
2 Bay S
1 Caled
3 Calu
1 Carp
2 Centr
2 Clark
2 Cliff
3 Conc
2 Copp
2 Dela
3 Doug
2 Eagl
1 Ever
1 Flint
3 Fran
2 Gard
3 Gran
3 Hanc
1 Hilto
3 Huro
1 Inter
3 Isle
4 Islan
1 Knov
1 Lake
2 Madi
1 Mass
3 Mesn
1 Mine
4 Mino
1 Natio
1 None
2 Nort
2 Nort
1 Norw
1 Ogim
1 Ohio
3 Osce
2 Penr
2 Peth
3 Pewa
2 Phœn
3 Quin
1 Ridg
1 Rock
3 Scho
2 Sene
3 Shelc
4 Sagin
5 Star
2 St. Cl
1 Supe
1 Tolte
1 Victo
1 Wind
Sundr

Total

Tota

High

1 Mine

MARQUETTE IRON DISTRICT.

JACKSON MINE.

In one particular this celebrated mine out-ranks all the others in the district: it was the first discovered iron ore deposit in the region, and the company is the oldest corporation, and the mine was the earliest worked, and from the ore of the Jackson the first iron was made ever obtained from the deposits of Lake Superior. In many other particulars is the Jackson mine entitled to eminent consideration. The excellent quality of its product early served to establish the reputation of the Lake Superior ores, and the magnitude of its shipments, and the great financial success of the company stimulated mining enterprise, practical exploration, investment of capital immigration, and the settlement and improvement of the country.

The company derives its name from the city, where, in 1845, the association was originally formed. The parties to this organization were Abram V. Berry, P. M. Everett, S. T., G. W. and F. W. Carr, E. M. Rockwell, F. W. Kirtland, W. H. Munroe, A. W. Ernst, and F. Farrand, of Jackson, Michigan.

In 1848 a reorganization of the company was effected under an act of incorporation passed by the legislature of Michigan, and the name assumed was the Jackson Mining Company of Michigan. The present title of the company is the Jackson Iron Company. A short time previously, however, a forge had been constructed on the Carp river, in which the first iron ore was made into blooms. The daily product of this forge, when in full blast, was about three tons of iron. The manufacture of blooms in this forge was abandoned in 1856.

In 1850 about five tons of the ore had been taken to Newcastle, Pa., and there worked up. This small shipment was followed two years later by one of 70 tons, taken to Sharon, Pa., which was smelted in a blast furnace. The first regular shipments from the mine began in 1856, the company shipping that year 5,000 tons. The aggregate shipments since that date amount to upwards of 2,000,000 tons of ore, being nearly the same as the Cleveland, which also began about the same time, and until 1864 the Jackson, Cleveland, and Lake Superior were the only companies which shipped ore from the region. Geologically the formation at the Jackson possesses great irregularity, and the occurrence of the ore deposits is largely a matter of conjecture, and their continuance, when formed, is only determined by the working. Extensive explorations are constantly made in the mine by means of trial shafts, cross-cuts, and drifts made here and there, seemingly, to the novice, at random, but really located with the greatest care by Captain Merry, whose 20 years' experience in charge of the mines and the company's interests have given him a degree of

familiarity with all the difficulties to be encountered, and a knowledge of the peculiarities of the formation.

The ore has always been in the greatest demand, bringing the highest prices, owing to its superior quality, and the care which has been observed in selecting it. In the east end mine, No. 7 and old No. 1 pits, the product is the best grade of hematite, possessing a percentage of manganese, and also of chromium. Even here occur veins or pockets of hard ore, alternating with the soft ore deposits. The formation is exceedingly contorted and broken up, the veins doubling and folding in a manner nearly defying definite determination.

The somewhat friable, disintegrated character of the rock has added an element of perplexity to the problem of how best to find and to win the ore. The success of the company, however, and the condition of the mine sufficiently indicate that the difficulties have been understood and economically overcome. The Jackson is the most easterly mine in the district, producing first-class specular ore.

The most easterly portion of the mine is No. 7 pit, a deep open excavation close to the railroad track, and main street in the west end of the city of Negaunee. From the bottom of this pit extend in nearly all directions short drifts and openings. At the extreme west end a tunnel starts; bending around to the north and assuming a northwest direction it extends a distance of 600 feet, passing beneath the railroad and Capt. Merry's house. This drift, as are most of the drifts that have been run, is mainly for the purpose of exploration, but some ore has been intercepted near the north end which it is hoped will be a lead to a larger deposit, and it is contemplated to sink at this point from the surface. A second tunnel runs west from the bottom of the open pit, 200 feet through rock but showing no ore. A little to the south of east a vein has been followed 250 feet, and a large amount of ore mined out, and they are still stoping in this direction. At 100 feet from the opening they are following a vein which narrows at the bottom and widens out upwards; to the west it dips down under a wall of rock that cuts the top of the vein. The product of this pit is estimated at 10,000 tons; the quality is very superior, mostly manganiferous hematite. There is also some hard ore obtained.

To the west we come to No. 1 pit, and from here the underground workings extend west a distance of 1,900 feet, and an extreme distance north and south of 600 feet. In the second level, a distance below datum of 150 to 170 feet, the workings are all connected, the pits to the east, Nos. 1, 2 and 3 being connected with those to the west by a drift 300 feet in length.

No. 1 pit is mined out on the second level over an area of 200 feet square, and is connected with No. 2 by an irregular drift 175 feet long; thence southwesterly 300x100 feet, the ground has been all stoped out, no sinking having been done in this part of the mine below the second level which has been worked out so that no mining is doing in these pits. To the west a tunnel 300 feet long, running N. 50° E. intersects another drift of equal length running at the same angle to the southwest, and both united, immediately open into No. 5. The open portion of this pit presents on the north a vertical wall 100 feet high which is separated by a rock partition penetrated with an arched opening from another similar roofless chamber to the east. In the south and east parts of this pit they are now mining, and have also extended drifts to the south and to the east which have intersected deposits of ore to facilitate the mining of which two shafts are lowering from the surface; one of these deposits is a vein of ore crossing the formation. In the west end of No. 5 an opening has just been made in the bottom by the miners below, working east from No. 6 in the fourth level, breaking through.

Passing down through this aperature, or which is perhaps the more preferable way, ascending to the surface and descending the shaft which starts near the engine house, and inclines at a steep angle to the south, we arrive into the main productive portion of the mine. In this pit the vein is worked in the fifth, sixth and seventh levels, the bottom being 350 feet below the datum level. The walls of the vein are nearly vertical, and in the fifth level it has been worked out to a distance east from the shaft of nearly 200 feet, and to a width of from 12 to 25 feet; at the end it presents a stope of nearly 40 feet in height, on which the miners are taking down the ore. Above the floors have been generally mined out, and in their place, when needed, timbers have been substituted. To the west, in this level, the vein has been mined out to a distance of 100 feet from the shaft, and presents at the end an equally favorable appearance. A drift reaching to the south 100 feet struck a pocket of ore, which is also taking out. At about half-way along this latter drift there starts to the southwesterly an irregular tunnel, which intersected some productive deposits of ore. This drift opens into the east end of the underground workings of the Pioneer mine, the most easterly pit on the location.

Starting near the shaft in the fifth level is a tunnel which has been driven through the rock 450 feet. This work has been in progress for three years and is mainly exploratory; some ore has been found in a small vein, which Capt. Merry thinks is only a leader. He feels certain that the ore is there, and that the drift will find it. In a recess opening into this drift is set the pump which hoists the water collected in this level, and pumped up from the lower levels to the surface. The ore from the several stopes is trammed to the shute, from which it is drawn out into the hoisting skip. Descending to the sixth level, 301½ feet below datum, we find the vein to be considerably widened and more uniform in its width. It has been mined to the east and to the west about 60 feet each way, and at either end of the drift thus made are stopes 40 feet in height and 20 to 25 feet in width. In the bottom the men are sinking in the ore to another level, and the depth now reached is the lowest attained in the mine.

The product from all that portion of the mine between No. 7 pit and the Pioneer is hoisted to the first level and thence trammed to the ore pockets, of which there are four. The cars are drawn into and out of the mine by a small locomotive engine, and are filled from the shutes. The track is laid into the mine from the north, connecting with the Northwestern road, and passing through a tunnel, which, with its branch to the last, is 500 feet in length.

The Pioneer mine is the most westerly pit on the location. It is worked by the Iron Cliff Company, and the ore is used in the Pioneer furnaces at Negaunee. The pit is opened in the fifth level a distance of 300 feet east and west and 10 to 60 feet north and south, and with a long drift extending southeasterly. In the sixth level the vein has been mined a distance of 225 feet and to a width of about 10 feet, with a wider head or pocket towards the east end; extending southeasterly in this branch the vein has a width of 15 feet. To the west it widens out into an irregular deposit that has been worked out. In the seventh level, 321½ feet below datum, the workings to the north and to the east extend 75 feet each way, and at the south and west a much shorter distance. These openings are 10 feet in width, occasionally branching out to 15 feet, but the pit appears to be nearly exhausted. The miners are working here and there, wherever a little ore can be obtained.

The most favorable stoping ground at present in this pit is in the vein which is proving so productive in No. 6. The Pioneer is working easterly in this deposit, and is also sinking from the surface, the better to work this ground to the east.

Recently the Iron Cliff have begun working the North Jackson, as it is called, which is situated 200 to 300 feet north of the main workings, and between the lines of the C. & N. W. Ry., and the M. H. & O. R. R. The vein here dips to the west at a sharp angle, and its course is nearly north and south; it has been worked in an open pit down to a depth of 50 feet, and for a distance of about 200 feet. They are now taking out ore at several points in the pit, and are also sinking to intersect the north drift from No. 6. The product from the Pioneer workings, the past year, was about 27,000 tons.

The South Jackson is the most westerly pit of the Negaunee hematite openings, and is in the southeast part of the company's property; the section corner-post stands upon the edge of the south pit, and the line west from it crosses the opening, cutting off the north part of the Iron Cliff, and the line from the stake, south, cuts off a portion of the pit to the east, belonging to McComber Company.

The pit is now idle, but during the past winter—1880–81—it was actively worked, the Jackson Company having taken out several thousand tons of ore, which are now in the stock pile. In the winter there was no water, but when spring opened the water came in, and as the mine was unprovided with a pump, work here was suspended. The workings extend down about 70 feet deep in the west end, and the ore in the bottom still continues good, though the vein is not wide. To the northwest a short distance is the main pit, and is now vigorously working. This pit is about 350 feet in length, and the depth to the first bottom is about 30 feet. Near the center and at the west end they are sinking another level, and are down below the first a distance of 40 feet. Below the first floor a tunnel comes in from the north, laid with a railroad track, and is entered by the cars, which are filled from the dock laid on a level with the first floor. This tunnel has been extended a distance of 500 feet further to the south, to the diorite bluff, without finding ore, except in one pocket, which proved to be of limited extent east and west from the line of the drift.

In the west end of this pit the diorite comes in from the south, and partially cuts off the vein or pushes it to the north, and the company have opened again to the west of this diorite spur. A diminutive engine and drum does the hoisting. The product of the South Jackson is about 25,000 tons of an excellent quality of soft hematite, corresponding with the McComber, Grand Central, etc. The ore is carefully picked, and although somewhat mixed as it comes from the mine, the rock is all sorted out.

The drilling is all done by hand; the company has no compressor, and uses no power drills. Captain Merry does not regard their use as likely to prove economical or advantageous in this mine; neither is the diamond drill used to any great extent, at least to a degree at all comparable to the extent in which it is used in some of the great mines in the district. The difficulties attending its use arise mainly from the peculiar nature of the rock; the small, loose pieces of hard jasper wear out the diamond so rapidly that it is almost impossible to proceed.

Capt. Henry Merry has been in charge of the mine since nearly the commencement of operations, and while, as this long continued service shows he has maintained the confidence of his employers, he has ever possessed in an equal degree the good will of the employés of the company, and enjoys the

reputation throughout the region of being not only a skillful miner, but an upright, faithful citizen.

CLEVELAND MINE.

The estate of this important company comprises 2,200 acres, situated mainly in sections 2, 3, 10, 11, T. 47, R. 27, but the principal workings are in the north part of the east half of Sec. 10 and west half of Sec. 11, adjoining the Lake Superior and the New York mines.

These lands were first taken by a "permit" from the war department, by Dr. Cassels, of Cleveland, in 1846. This gentleman visited Lake Superior in the interest of the Dead River Silver and Copper Mining Company, of Cleveland. Dr. Cassels was directed to the locality by Mr. Everett and party, who had previously secured the Jackson Company's lands, lying adjacent to the east. Other parties subsequently entered upon the lands and instituted a preemption or mining right claim, but the title was finally accorded to the Cleveland Company.

Although the association was previously formed, the company did not do any business on Lake Superior until 1853, at which date the present Cleveland Iron Company was organized, and in following year the company mined 4,000 tons of ore, which was made into blooms at the several forges in the country; and in 1855 the company shipped 1,449 tons of ore down the lakes to the furnaces to be made into pig iron, anticipating the shipments of the Jackson Company one year, and thus becoming the first company to ship from the region any considerable amount of iron ore. This small beginning grew from year to year till the annual product exceeded 150,000 tons, affording at the present time an aggregate of shipments of over 2,000,000 tons of ore of a quality which has been ranked with the best in the market; and perhaps no mine in the district affords a better assurance of continuing to yield in the future as in the past than does the Cleveland.

Commencing with No. 1, in the northwest corner of section 11, the east part has been worked out and the mine is working to the west; at this end of the pit, at 43 feet below the datum, about 100 feet down from the immediate surface, the vein is about 20 feet high and 12 feet wide. From here has been taken during the past year about 1,200 tons of ore.

No. 2 is considered as being worked out, although there is some ore in the west end, but the pit has not been mined for the past year.

No. 3, the largest mine on the location, adjoining the New York mine on the south, is also being pushed to the west. The roof of the entire eastern portion of this pit—the extent of the underground workings of the pit up to that date—fell in two years ago, causing a good deal of delay in the mining and an expenditure of $40,000 in clearing and constructing, ready to resume work. This seeming misfortune was, however, no disadvantage, as the portion of the mine which fell in was mainly worked out, and the mine is now much safer. The principal workings in the western end of the mine are close to the hanging wall; the length of the stopes is about 160 feet, and in height from 15 feet to 45 feet. On the north they are cutting through the ore to the New York line, leaving large pillars upon either side. Some work is being done in the south part of this pit on a stope 100 feet long. The total product of the pit is about 300 tons of ore per day, which is run up to the surface on two single and one double skips. The skip roads are furnished with switches, which facilitate the hoisting of a greatly increased amount. Six or seven Rand drills are in use in

this pit. On the south the quartzite seems to be working in, creating an apprehension that the vein may be cut off, but a drill hole sunk 240 feet to the southwest passed through 60 feet of ore at 240 feet from the surface. The quality of the ore struck in this drill hole is first-class.

Nos. 4 and 5 lie southeast from No. 3; the former is mined out. The men are "scramming" the pillars to get out what ore can be saved intending to let the roof fall in. But No. 5 is working in the west end down about 100 feet; the east part is mined out, and the outlook is not favorable for a long continuance of working in any portion of it. There is a stope of perhaps 20 feet of first-class ore, and the rest is second-class. Connected with the west part of this pit and lying northwest of it, is the No. 6. Operations in the west part of this pit were a short time ago partially interrupted by the fact that the mining had approached as near as safety would admit, to the tunnel which conducts the water to the pumping shaft. They went 200 feet east and sunk below the water tunnel, intending to drift under it. Some jasper is coming in, and on the whole the pit is not regarded as looking very promising; but eight men are at work in it, and they have mined from it only about 2,000 tons of ore the past year, much of the time having been taken up in sinking. An increased product will be obtained the ensuing year.

Lying west of No. 6, and opening into it is the incline pit, the most important of the company's present workings. The southerly portion of this mine consists of an open pit upwards of 300 feet in length, and from 120 to 140 feet in breadth at the surface, which has been mined out; thence following the dip of the vein the mine extends underground to the northwesterly, a horizontal distance of from 150 feet to 200 feet, attaining a depth of from 112 feet to 190 feet below the datum level. At the westerly end of this pit there are at the present time an aggregate length of stopes of 280 feet, and fully 60 feet in height, and there are still 20 feet of ore between the bottom of the workings and the foot wall, thus giving a width of vein of 80 feet of first-class ore. At the present writing the men are mainly engaged in breaking up and hoisting the ore, of which there are about 15,000 tons that has previously been thrown down from the stopes. Heavy pillars of ore are being left to support the roof, and near the open portion of the pit some large crib pillars made up of timber and filled in with stone have been added as an additional security. Considerable difficulty is naturally experienced in mining a vein of such enormous thickness. The method pursued is to drift through the ore to the hanging wall of the vein and stope down to the level of the drift, and then to sink again in the ore and proceed in like manner until the foot wall is reached.

In addition to the lamps carried by the miners, the electric light is used. From five to seven power drills (Rand's) are used in this pit. The pit is entered by three skip roads carrying five switch tracks which are operated by a new hoisting engine made at the Marquette foundry and machine works—cylinder 20 inch diameter, 30 inch stroke, variable cut-off. The hoisting drums are 6 inch diameter. In the same building is also placed the duplex Rand's compressor—cylinder 16x30 inches.

Situated 500 feet to the south of the west end of the last described openings is the saw mill pit. This opening presents many peculiarities. Not long ago it was thought that the deposit would soon be exhausted, owing to the jasper coming in at the top, but subsequent work developed the fact that the ore pitches under the jasper and comes out on the other side; as now looking the thickness of the vein in this direction will be 30 feet. In the previous workings in this pit the ore has been taken out to a height of 50 feet. Only

hand drills are used and about 100 tons of ore per day are mined, which are hoisted up by a single skip. This product is estimated as good as it is possible for ore to be; analysis shows it to be exceedingly pure, and this result is verified in the furnace. Two diamond drill holes have been sunk from this pit during the past year in one of them at a distance of 37 feet; 12 feet of ore was passed through. In the other hole only jasper was found.

Nos. 7 and 8 pits are worked out and in No. 9, the most easterly with the exception of the hematite pit, work was stopped in April last (1881).

No. 10, the hematite pit, is nearly a mile to the east, being but a few hundred feet from the east line of the Jackson property. This pit also seems to be nearly exhausted. Work here has never proved profitable, but has been continued, hoping for better results. Two drifts have lately been started, one of which is in ore, but has not yet been pushed sufficiently far to determine anything. Work has been temporarily suspended, but the pump is kept at work to prevent the mine filling with water. No work has lately been done at the old school-house pit which once produced 30,000 tons of ore annually.

On the location is a machine shop, carpenter shop, etc. The company also operate two locomotive engines and possess an ore dock at Marquette which is furnished with 114 ore pockets and six steamboat pockets. The officers of the company are J. C. Morse, Agent, Marquette, Michigan; D. H. Bacon, Superintendent, Ishpeming, Michigan.

NEW YORK IRON MINE.

This mining property comprises the S. E. ¼ of the S. E. of Sec. 3, T. 47, R. 27, the fee simple of which is held by Mr. A. R. Harlow, of Marquette, Mich. The land is hemmed in on the north and south by the Cleveland estate, and in an early day when the Cleveland Company commenced its mining operations, its officers were desirous of purchasing this property, lying in such close proximity to their workings, but Mr. Harlow, fortunately for himself, declined to sell, and subsequently, upon the discovery that it held a large deposit of ore adjoining the Cleveland mine, a lease of the land was secured of Mr. Harlow for a term of years, including a mining right, at 25 cents per ton royalty. A company was organized in 1865, the greater portion of the stock being held by Mr. Samuel J. Tilden, of New York, who afterwards became the sole owner of the lease.

The estate comprises but 40 acres of land, and the mine workings are comparatively limited in extent, yet from this small area has been taken upwards of 900,000 tons of rich specular ore, and while the mine fails to afford its former magnificent product, still an annual yield of perhaps 60,000 tons is no insignificant output for so small a mine.

The bottom of the mine in the several shafts, and the backs of the different levels, the breasts and stopes which are seen, yet reveal, in the aggregate, an abundance of ore for present mining, and the promise afforded by the outlook in some portions of the mine that its existence as a large producing mine is likely to be prolonged for many years to come.

The company is shipping none but first-class ore, but in order to accomplish this a good deal of assorting is rendered necessary, occasioning also the necessity of washing much of the ore. This labor increases materially the cost of production. The second-class ore, which is less than 10 per cent of the product, is stocked and held.

There are four shafts, or skip roads, operated in the mine. Nos. 2 and 3

descending into the east mine start from the same shaft house, but rapidly diverge as they go down, since owing to the sharp bend in the formation the one, No. 3, descends to the south, and the other, No. 2, to the west. These shafts are down about 300 feet on the incline. From the bottom of No. 3 they have worked to the Cleveland line, and can go no further in the direction of the hanging wall side, but are stoping on the foot wall, having here breasts of ore to the easterly and westerly 20 or 30 feet in height and of equal breadth. From this pit the captain estimates a product of 20,000 tons the present year, and the bottom is favorable for obtaining, by sinking, an equally productive lift the following year. But while a continuance of the ore will give workable ground ground in this part of the mine for a few years to come, they must within a lime time work out the whole of this deposit to the south line of the property. No. 2 shaft does not furnish a large amount of first-class ore; the estimate is between 6,000 and 8,000 tons.

From No. 2 the vein makes another twist, so that No. 4, which is about 200 feet distant to the northwest, measured on the surface, but which rapidly converges towards the former as it goes down, has an inclination to the south, and No. 5 again more to the west. At the bottom of No. 4 are to be seen some fine stopes of ore, but the deposit at intervals is interrupted by horses of jasper. A stope at the east is 16 feet in width and has been formed to 80 feet in length, and directly above on the next level is a body of ore equally as good.

While there are many difficulties to contend with in working the mine, yet, as before stated, there is an abundant assurance of a large yield of ore for many years to come.

No. 6 is a small opening some distance to the northwest which has been worked for several years, and a limited quantity of ore obtained; scarcely enough, however, to repay the cost of working. Operations are continued in the hope that something better may result. The pit is down about 100 feet, and a small engine does the pumping and hoisting.

The mine is supplied with a compressor, and there are six power drills being used. The force employed is about 250 men.

The water is pumped from the mine through No. 1 shaft, which is used only for this purpose. The shaft was originally sunk with the expectation of reaching a large body of ore, but none of any considerable value was found.

Capt. W. E. Dickinson, the former efficient superintendent of the mine, resigned in March last, and has been succeeded by Mr. J. H. McCloskey.

LAKE SUPERIOR MINE.

With the exception, perhaps, of the Jackson, none of the great mines of Marquette county have experienced more fully the difficulty incident to the mines of this district, arising from the nature of the deposits of ore. The foldings, the contorted character of the formation, the sudden appearance or disappearance, the widening out or narrowing up of veins or horses of ore, seem, in this mine to have attained a climax, affording many knotty problems both to the geologist and to the miner.

The results of the earlier mining in old No. 1 pit, owing to the remarkable folding of the vein, as still observable in the westerly wall of the pit, led to the expressed opinion, by a prominent scientific authority, that the ore deposits were probably shallow. A similar occurrence at the same time at the Jackson mine, where the bottom of the deposit seemed to have been found, seemed to strengthen the opinion that the ore deposits might be wanting in depth. So

little was known at that time regarding the geology of the country and the nature of the rock formations, and of the character of the iron ore deposits, that it is not surprising that so intelligent and courageous a gentleman as Mr. C. H. Hall, agent of the company, should have been troubled with apprehensions regarding the persistence of the ore.

But notwithstanding the discouragements, the obstacles which have been met with have been surmounted, so that the mine has ever maintained a position in the front rank of the mines of the iron district, both as regards the quantity and the quality of the product; and to-day, as one examines the underground workings, and observes the important and substantial improvements that have been recently made, and are at present being carried forward on the surface, and acquaints himself with the persistent and successful efforts constantly in progress in the direction of further exploration, he cannot fail of the conclusion that in the future, as in the past, the mine is sure to sustain its well earned reputation.

The company is one of the oldest in the district, having been formed in 1853, with a capital stock of $300,000, which was subsequently increased to $500,000. Operations were begun in 1857 on Secs. 9 and 10, T. 47, R. 27—the seat of the present workings. The first shipments of ore—4,658 tons—were made in 1858, since which time the annual product has regularly increased until it has attained to upwards of 200,000 tons. Until about ten years ago the mining was all done in pits, open to the surface, some of which became of great size, and were carried down to depths of 100 feet to 210 feet.

At present the mining, with the partial exception of at A shaft, is all underground, and as regular a system of shafts and levels as a knowledge of the position and nature of the ore deposits will admit, is carried on.

The first level is 180 feet below the surface (datum); above that the workings were irregular. At 60 feet below the 180-foot level the second level is extended, but this distance proving too great, owing to the insecurity of the walls, the subsequent lower levels are driven at a vertical distance apart of 40 feet.

The A shaft, the most easterly one, inclines to the north at an angle of 67°, and is down 100 feet to the level of the bottom of the pit, from which the ore is being taken, and drawn up the shaft on the skip, worked by an engine, the water being abstracted by the pumping engine at the hematite mine, situated some distance to the southwest. The ore from the pit is trammed through a short drift to the shaft. The deposit here is the lower portion of a sharp minor fold, which extends upward to the surface of the rock formation, thence being covered with 30 feet of earth. The mining here will be extended westerly, the earth being stripped in advance, as the mining proceeds, rendering necessary the removal of buildings erected upon the surface.

Two diamond drill holes have been bored from A shaft to the north, the line of the lower one of which is to be followed by a shaft to reach below a deposit, showing 40 feet of ore that was found by a vertical boring 500 feet to the north.

Besides the A shaft there are five shafts fitted with skips and used for hoisting, designated as Nos. 1, 2, 3, 7, and hematite shafts. Nos. 1, 2, and 3 are connected underground, and the hoists in each are worked by the same engine by wire rope transmission. The water is drawn from this mine through an old shaft that is abandoned for any other purpose than as a pumping shaft. The old engine and hoisting apparatus proving inadequate, two new engines have

recently been set up, —— 22x48 inches each, and a new building for the hoisting apparatus is now being built, to be supplied with 4 drums of 12 feet diameter and 4-foot face, one drum each for Nos. 1 and 3 shafts, and two for No. 2 shaft, which is fitted with a double skip.

Descending No. 2 shaft and passing the 180 foot level, we arrive at the bottom of the 240 foot level; passing around a short distance to the west in an irregular opening, we go south through a cross-cut which extends through the minor folds of the ore deposit. The first fold of the vein which is reached by the cross-cut has a width of 25 feet with walls of chloritic schist. The vein continues westerly from this point a distance of 225 feet, and then turns to the northwest, extending into the Barnum property. Eighteen feet more of cross-cut to the south brings us to the second minor fold of the vein, of an equal width with the former but shorter extension west, opening into a large chamber from which the ore has been taken. In both of these tunnels the pitch is to the south about 75°. The product is a first-class slate ore.

Again passing through 12 feet more of cross-cut we come into the opening made in the third fold of the vein. Here the walls stand nearly vertical, and the vein is worked out to a width of 18 feet, and to the west a distance of 180 feet, but at 100 feet west it is united with the second fold making an enlargement of the vein to 60 feet in width. From this point the vein diverges to the northwest. These two portions of the vein come together in the 280-foot level at a distance of 100 feet east of the cross-cut.

Thirty feet further south through the cross-cut to the fourth or north fold of the vein, which is the main foot wall vein. To the east it unites with No. 3 vein at about 350 feet distant, and it is opened up in this level also to the west, a distance of 275 feet. This is the finest part of the mine so far as regularity is concerned. The walls are regular and have a parallel inclination of 82° and are about 20 feet apart. The stopes at the extremities of each of these veins are showing equally promising for a yield of ore as are the floors of the level. At the west end of what is termed the long drift in this level, that is 40 feet north and 250 feet west from the No. 3 shaft, a diamond drill hole was bored in a southwest direction, inclining 2° with the horizon, which at 74 feet passed through 21 feet of first-class ore, and at 274 feet came to 28 feet of slightly mixed ore. A drift was extended on the line of this hole which resulted in showing that the first body of ore corresponded with the first fold to the north. A hole was also driven in the opposite direction 420 feet, but found nothing but rock.

No. 3 shaft starts from the surface but a few feet from the Barnum line, and in the 240th level we soon reach the Barnum openings as we go northwesterly from this shaft. In the 280-foot level, down to which the shafts extend, the north vein has been struck at 50 feet distant, and opened 40 feet in one direction and 30 feet in the other. In this part of the mine are stopes of extraordinary magnitude.

Going back to No. 3 shaft and descending to the 280-foot level, and proceeding south through a cross-cut 50 feet, we again come into No. 1 fold of vein which is opened to the west 200 feet, appearing about as in the level above. Twelve feet more of cross-cut strikes No. 2 which is opened to the west 250 feet, and to the east 300 feet. The vein shortens and narrows to the east more and more in each successive level and in a corresponding degree; marks in magnitude in the opposite direction.

The points of union of the folds are found to be further to the west as we go deeper. The main southerly fold preserves the regularity which characterizes it in the 240-foot level, though the vein has not yet been worked as far west into 250 feet as it has in the level above.

Descending to the 320-foot, the lowest level, we reach, through 40 feet of cross-cut, the No. 1 fold of vein, which has almost disappeared, and at a short distance further in the cut we find No. 2 and 3 folds united in ore which they have just commenced to work. No. 4 foot wall vein has been worked a distance of about 100 feet in this level, the floors and stopes remaining equally good as in the levels above.

No. 6 shaft, several hundred feet southwesterly from No. 3, is sunk to the 180-foot level, and is being lined up and made ready for a skip. The frame of a shaft house has been erected. The water is raised by the pump at No. 7, and the hoisting will be done from No. 7 by wire rope transmission. No ore has been raised from the shaft. Between Nos. 3 and 6 and between shafts 6 and 7 a number of diamond drill holes have been sunk, none of which struck first-class ore.

At No. 7, the most westerly of the company's mines, there are two shafts, the oldest of which will be abandoned as soon as the later one is carried down to the lowest level in the mine. Descending the most easterly of the two shafts to the 1st level, 60 feet below the surface, we find a well defined vein of ore that has been worked out to the west a distance of 75 feet and to the east 100 feet. The hanging wall is chloritic schist and the foot wall a quartzite. The ore is good second-class. Descending to the second level, we find it opened to the west 125 feet to the old No. 7 shaft, and to the east 300 feet. In this direction the vein is seven or eight feet wide; to the west the width is 12 feet, the foot and hanging walls remaining as above, and the product a hard steel ore rather second-class. Descending 40 feet, we reach the third level, and going east we find the vein to have been worked out a width of 30 to 40 feet for a distance of 140 feet. The vein dips to the north at an angle of 50°; further to the east the vein narrows. At 250 feet east from the shaft a cross-cut was driven to the north 60 feet without developing ore. The quartzite hanging wall passes into a schistose rock in this level. Descending from the foot of the shaft down a breast of ore 40 feet high that is being stoped easterly, we reach the fourth level. Here we find the deposit of great width and of the best quality. Going west to old No. 7 and beyond we find a floor of over 300 feet wide, with walls diverging downwards and contracting upwards and further to the west, until the vein seems to terminate.

The whole length of this mine underground is 560 feet, and the average width of vein about 20 feet.

A new stone engine house has been built the past year, and new hoisting apparatus put in which includes two Lane's drums, 6-foot diameter and 4-foot face.

THE HEMATITE MINE.

The remaining mine is the Hematite, which lies to the south of the main mine. Here is a double skip shaft, down 200 feet below the surface. The opening underground is 450 feet in length and 50 feet wide. About 40,000 tons of ore are raised annually from this mine. A lower level will be started this summer. The pumping engine here pumps also from "A" shaft and the water for the city of Ishpeming, the water for the latter purpose being drawn from Lake Angeline. The steam for the pumping engine is brought from the boilers at No. 2 shaft.

Seven diamond drill holes have been sunk during the past year, the deepest being the one on the base-ball ground, north of "A" shaft, down 960 feet. Two other holes struck good deposits of ore.

The electric Bell telephone is used in the mines, and it is the intention to use the electric light also. Among the other important improvements made during the past year, not previously mentioned, is a commodious stone machine shop, supplied with lathes, etc., and run with an engine; also a new Rand's double compressor, which drives the drills in all the mines; 16 power drills are used. Side-tracks connect both with the C. & N. W. R. and with the M., H. & O. R. R. The mine employs about 500 men. The officers of the company are Joseph S. Fay, President; Richard S. Fay, Treasurer; A. C. Towns, Secretary; C. H. Hall, Agent.

BARNUM MINE.

This mine, the most important one owned by the Iron Cliffs Company, adjoins the Lake Superior, the line between the two properties extending east and west through a portion of workings of the two companies, the quarter post, the southeast corner of the Barnum mine, being near the edge of old No. 1 pit. The old mine is situated on the S. E. part of the N. ½ of Sec. 9, T. 47, R. 27. The new mine, which is being opened, is on the N. ½ of the N. W. ¼, Sec. 10. The first shipments of ore were made from the mine in 1868, consisting of 14,380 tons, which amount was more than doubled the succeeding year, and in 1870 the shipments were 44,793 tons, increased to 48,076 tons in 1873. In 1878 the product fell off 10,000 tons from that of the preceding year, and a still greater diminution made it only 24,015 in 1879, and 24,522 tons in 1880.

The falling off in the product, and the limited extent of ground in the old mine, rendered it evident that a change of base must be made; accordingly Superintendent Sedgwick, with the consent of the directors, commenced boring with the diamond drill. A number of holes were sunk, sufficient to develop the existence of a body of ore reaching to 50 feet in thickness, covered by from 350 to 585 feet of drift and rock. The company's borings have tested the deposit a distance of about 3,000 feet by four drill holes on a line east and west on the south side of the swamp, and latterly 800 feet by other drill holes to the north and south of the former. These investigations show the deposit to be a synclinal trough, having an inclination to the east of about 1 to 8. Upon the rise of ground north of the swamp, which intervenes between the seat of these new operations and the old workings, two shafts are sinking, 750 feet apart east and west, following the two most central drill holes. These shafts are descending vertically; the easterly one, "A" shaft, is 10x14 feet inside the timbers, and is being divided into two departments, is lined up with pine timbers, sawed, 12 inches square. The shaft is now down 375 feet, and has but 82 feet more to descend to strike the ore. No important difficulties are met with here; the water is raised by a succession of Knowles' pumps to within 35 feet of the surface, and thence flows through an adit to the south and empties into the swamp. The amount raised is about 320 gallons per minute. A shaft house has been completed over the shaft. The cost of the shaft has been thus far $100 per foot. In sinking "B" shaft much difficulty is experienced; in fact, the work is suspended from inability to proceed. The shaft, 12 feet square, was carried down 41 feet, when the quick sand coming in so rapidly from below as to preclude further progress, an iron caisson, 10 feet in diameter, was sunk inside the shaft, which was got down 72 feet; but the workmen have not been able to get within 10 feet of the bottom, as the sand comes in as

fast as it can be removed. A pump capable of removing 1,500 gallons per minute has been ordered, and when got to work it is hoped they will be enabled to proceed. These shafts will intercept the ore in the lower axis of the fold, and will be connected by a drift from which the vein may be stoped indefinitely either way, affording, probably, a far greater quantity of ore than the mine has ever yet produced. A large stone building is erecting, and is nearly enclosed, for the reception of the machinery. It is located at the lowest point of land between the two shafts, but a short distance from a small lake that lies to the north and only 12 feet above it, giving easy accessibility to water for the low pressure engines which are to be put in.

The engine room is 54x96 feet inside, and in it will be erected two engines (Hodge's), 28-inch cylinders, 36-inch stroke, one for hoisting and one for pumping; two drums, each 8-foot diameter and 7½-foot face, capable of holding 2,000 feet of 1½-inch rope. The water will be pumped up both the shafts from the sumps at the foot.

The compressor room is 36x45 feet, to be occupied by the Rand duplex 16x36 inch compressor. The boiler room is 36x55 feet.

The ground from the shafts slopes to the south to the level land below, where the railroad track will be built, affording excellent advantages for stock piles, ore pockets, etc.

In and about the old mine 90 men are employed, and there are two working shafts. No. 3, the most westerly one, is down to the eighth level, 400 feet below the surface on the line of the shaft, which inclines to the south at an angle of 60°. Descending to the bottom, we find at the end of the drift, 40 feet west of the shaft, what is stated by Capt. Sedgwick, the best stope ever afforded in the mine; it is of good width, entirely unmixed and is gaining as it descends. One thousand tons per month were being removed here until the work was somewhat interrupted by the necessity of having a pillar, which they are now working around. They are also sinking in the ore for another level below and are assured of at least 100 feet of extent of ore to the west. To the east of the shaft in this level the lense of ore soon become too narrow to pay for working. Above this level but little ore that can be profitably worked yet remains in the mine. Ore is being taken from several points, chiefly in the fourth level, but at small profit and soon to be exhausted.

No. 2 shaft, sunk in the jasper north of the ore, leads down into an immense chamber, said to be the largest on the lake—made by extracting the ore and rock. It has a vertical height of 120 feet, and a length and breadth of 100x40 feet. It is really divided in two chambers which are connected by an immense arched opening. In the western end of this level the company are mining, following the hanging wall, which is but a short distance from the Lake Superior Company's line. This line crosses the east end of the chamber and has been overstepped by the Barnum Company in its previous workings. Another level is also sinking in the bottom of the chamber; hand drills only are used. To the east we can pass directly into the Lake Superior mine where we find an immense stope of ore to which the Barnum has been obliged to bid adieu.

Capt. Wm. Sedgwick, the gentlemanly and efficient superintendent, estimates the product for the ensuing year at 20,000 tons.

The ore is selected with great care and is all first-class. It requires the closest scrutiny in examining the stock pile to find a specimen mixed with rock.

PITTSBURGH AND LAKE ANGELINE.

This mine is pleasantly situated on the south shore of Lake Angeline at the foot of the high greenstone ridge, which rises to the south. The mine openings extend east and west along the foot of this ridge a distance of about 900 feet, and but for the bars of ground which divide the opening into three compartments, would constitute a single pit.

There are no underground workings. The hoisting is done by three derricks worked by steam power and winding drums, and on an open skip worked from the main pumping and hoisting engine. A vertical shaft is sunk in one of the bars of ground that divide the pits, but is used only for the water pipes—all the water from the mine being raised through this shaft.

The mine has been regularly worked since 1863, and has shipped, in the aggregate, upwards of half a million tons of hard and soft hematite ore of medium quality. The product of 1880, however, was 5,000 tons less than that for 1864, and for the ensuing year the product will scarcely be increased. An exploring shaft was sunk in the meadow 200 feet east of the present workings, to a depth of 111 feet, and from the bottom drifts were run to the north 40 feet and to the south 30 feet. This work developed the existence of a good deposit of hard, blue colored hematite ore, apparently of an excellent quality; but the depth being so great it became a question whether it will pay to mine it.

The company employ at the present time 50 men.

The machinery comprises one main hoisting engine, 14 inch cylinder, 28 inch stroke, working two 4-foot drums; a pumping engine, 10 inch cylinder, 20 inch stroke, working a Cornish pump, 10 inch plunger; also two small engines for working the derricks.

There are about 30 dwellings and other buildings on the location. The description of the property is the N. ½ Sec. 15, T. 47, R. 27, and is located about half a mile from Ishpeming. The officers are Joseph H. Outhwaite, Secretary and Treasurer, Cleveland, Ohio; A. Kidder, General Agent, Marquette, Michigan; Capt. Harvey Diamond, Superintendent of the mine, Ishpeming, Michigan.

THE SALISBURY MINE

is owned and worked by the Iron Cliff Company, and is situated in the north half of Sec. 15, T. 47, R. 27. The location lies directly south from the Pittsburgh and Lake Angeline, from which it is separated by a high greenstone ridge that intervenes. The mine workings comprise two open pits, and a few underground drifts. The east pit is 140 feet in depth in the deepest part, and below this bottom a distance of 70 feet, is a tunnel 207 feet long, connecting with the shaft south of the east end of the pit. The shaft is sunk vertically in the hanging wall, and extends below the mine workings so as to collect the water of the mine, which is pumped up through this shaft. The shaft is also fitted with a skip and used for hoisting. At the west end of the main pit an open skip road comes up to the south side, and No. 2 pit to the west, which is much shallower, is provided with a derrick for hoisting in buckets, worked with wire rope and winding drum. On a level with the bottom of No. 1 pit, a tunnel in the vein extends west beneath No. 2 pit, and the ore which is mined at this point is trammed through the tunnel to the open skip. From the tops of the two skip roads the ore dumps into deep pockets beneath which is the railroad track; they are also connected by an elevated track which extends east, with

two branches that run, the one to the rock dump, and the other to the winter stock pile. In the process of mining an immense amount of waste rock has been removed. Captain Bartle's plan for the future is to leave this waste rock in the mine to fill up the places where the ore has been removed; that is, to sink a 100 foot, and then by over-hand stoping remove the ore, and drop the rock, proceeding until the stope is exhausted, then sink again and proceed in like manner. The walls are poor, and the ore is a soft hematite, shoveling like dirt, so that the process of underground mining is not an easy one.

The vein dips to the south at an angle of about 60°, and is apparently from 30 to 50 feet wide. It narrows to the east, but widens out to the west, and runs to land somewhat to the south, and perhaps takes a more southerly direction after leaving No. 2 pit, but beyond that point it has not been much explored.

The pumping engine is a 16 inch cylinder, 2-foot stroke, working a Cornish pump, 12 inch plunger, and 12 inch drawing lift. The hoisting engine is a 16-inch cylinder, 30 inch stroke, and the winding gear comprises two 5-foot drums, and two 4-foot interior gear drums. Two 14-foot boilers, 72 inches diameter, supply the steam.

The mine was opened in 1872, and the maximum product, thus far, was shipped in 1878, consisting that year of 52,155 tons, two and a half times greater than the output of the mine in 1880.

NATIONAL MINE.

The National Mining Company have two openings which they are now working, distant from each other, east and west, about 1,200 feet. No. 5, the northerly pit, is looking exceedingly well; the bottom, which is 100 feet below the surface, is widening out to the east, so that a drift 18 feet long in the ore extending to the south, has not yet reached the hanging wall. The deposit is, apparently, 50 feet in thickness, very pure, hard granular ore. The vein dips to the south at an angle of about 70°, and following the foot wall down to the bottom of the pit is the skip road on which the ore is hoisted to the surface and thence trammed to the shute at the edge of the hill, beneath which is the railroad track, the conformation of the ground being very convenient for disposing of the ore and the rock. A new engine, 16 inch cylinder, 30 inch stroke, operates the two five-foot drums (only one is used), and does the pumping. Sixteen miners are employed in this pit, and there are at this end of the location 20 good dwellings. The course of the vein at No. 5 is east and west, but a little to the west the formation bends around and assumes at the south a direction north and south, the vein dipping to the west at an angle which gradually flattens until it becomes only 15 degrees.

In the open pit here the vein has been all worked out and the mining is now being prosecuted underground, having reached a distance of 400 feet, measured on the incline. The length of the stope is about 100 feet, and the height, being the width of the vein, is 12 to 14 feet. The product is a hard steel ore. Twenty miners are employed in this pit, and they are hoisting 50 skips per 24 hours.

Just west of this pit is another one, which has been nearly worked out; but three men are scramming about five tons per day in it. The mine is worked under a lease from the Lake Superior Iron Company, to whom the land belongs. It is embraced in section 16, T. 47, R. 27, and the lease covers 240 acres, being one and a half miles south from Ishpeming. Work was begun in

1878, and the aggregate product, as shown in the table of shipments, is nearly 67,000 tons.

The mine is under the general supervision of Captain Samuel Mitchell, of the Saginaw mine, who is also one of the lessees of the estate. The local superintendency is in charge of Capt. Williams, an experienced miner.

THE MITCHELL MINING COMPANY

is an organization which was formed and began work in 1877. The estate adjoins the National on the southwest, and comprises 200 acres in Secs. 21 and 28, T. 47, R. 27. A mine had been previously opened on the same location, under the name of the Shenango, in 1872, and operated until the organization of the new company. The former workings, however, have been entirely abandoned, and the pit which had been formed has been filled up by the debris removed from the new opening further to the east.

The present mine workings comprise a large open pit, 100 feet in depth, running east and west with the direction of the vein, which dips to the north at an angle of about 45°. Near the middle of the south side of the pit a skip road ascends to the ore pocket above the surface, and at the east end is a shaft which descends to a depth of 40 feet below the bottom of the pit. At the foot of this shaft is collected all the water which makes in the mine and through it the water is pumped to the surface. It is also fitted with a skip road and used for hoisting the ore taken from the level below the bottom of the pit. In this lower level a drift extending to the west will be used to take out this bottom.

Drifts have also been run from the shaft to the north 100 feet through soapstone where a vein of good ore was intersected, but it was not penetrated far enough to determine its width. A similar drift to the south at a distance of 93 feet from the shaft also intersected a fine vein of ore, and along the foot wall of this vein a tunnel 14 feet in width has been opened to the east a distance of 350 feet from the point of intersection.

A shaft has been started from the surface to meet this tunnel, and in sinking passed through 70 feet of dirt and then in the ore which it has now penetrated 30 feet. This ore is remarkably clean, a very fine quality of soft blue hematite, an analysis showing it to be very high in metallic iron and low in phosphorus and in silica. The extent of this rare deposit, however, is undetermined.

In this mine there is no rock capping the ore, the veins being directly in contact with the drift which overlies to a depth of 70 to 80 feet. The ore itself has very little more sustaining force than good dirt, so that in the process of underground mining unusual care will have to be taken to hold up the ground. Capt. James Walter, the local superintendent's plan, is to run a tunnel along the hanging wall corresponding with one along the foot wall, and to cross-cut between them at sufficient intervals to form supporting pillars which he proposes to stay with stulls thickly set about each of them and banded, or with timbers laid horizontally and locked at the corners forming a crib, having also a thick back to the level.

The company is now employing 65 men in and about the mine, and has about 20 houses on the location. The machinery embraces a new engine, three 4-foot drums, Lane's pattern. This engine does the hoisting and the pumping. The officers of the company are Samuel Mitchell, President; Chas. Merryweather, Secretary and Treasurer.

THE WINTHROP HEMATITE COMPANY.

The Winthrop mine lies in close proximity to the Mitchell, joining the latter on the west. The property embraces the S. W. ¼ of Sec. 21, T. 47, R. 27, and the mine was originally opened in 1870 and worked until 1877 by the Winthrop Iron Company, under a lease by Messrs. A. B. Meeker and H. J. Colwell. In the latter year the lease was transferred to the St. Clairs, who organized the Winthrop Hematite Company, and have since operated the mine under that name.

The mine, as will be seen from the tables, has yielded an aggregate product of nearly 213,000 tons of ore, which, like that of the Mitchell, is a very soft hematite.

The mine consists of a very large open pit, the bottom of which is 180 feet below the surface, and somewhat extensive underground workings beneath and to the north and west. The lowest level is 220 feet down. From the open pit at the height of the third level, two drifts have been extended to the north a distance of 80 feet, and connected by a cross drift 90 feet long, all in the ore. There seems to be several veins or lenses lapping each other or only slightly separated by the intervening rock which occupy the ground from the foot wall to the north for a considerable distance. These veins or lenses dip to the north at an angle of about 60° and their continuity in depth together with their great lateral extent affords a large amount of stoping ground. Two open skip roads on the east side of the pit, and a double skip vertical shaft a short distance from the west end, afford the channels for hoisting.

A large quantity of timber is used for supports in the mine. The ore being so soft it is deemed to be of but little use to leave it for pillars. These timber supports are made up into 12-foot cubical sections, and are so numerous as to furnish, it is thought, the requisite degree of safety.

There are two engines at the mine—one upright and one horizontal, supplied with steam from three boilers. There are three 4-foot winding drums and two 3-foot. Railroad connection is afforded here and at the adjoining locations with the M., H. & O. and with the C. & N. W. main lines. The employés number 130 men and the location contains 35 houses for the occupation of themselves and their families. The officers are J. O. St. Clair, President; E. G. St. Clair, Secretary and Treasurer; G. A. St. Clair, Superintendent.

THE LOWTHIAN AND NEW ENGLAND MINES

are owned by the Lake Superior Iron Company. The latter comprises the E. ½ of the N. W. ¼ of Sec. 20, T. 47, R. 27, and was worked from 1866 to 1873, producing an aggregate product of 110,506 tons of ore. Since the latter period it has remained idle. Adjoining it on the east is the Lowthian, which is now working. The mine consists of a large open pit 250 long and 100 feet wide on the surface, and 80 feet deep; below this bottom extend two underground levels of 40 feet and 80 feet respectively, and the shaft which is sunk from the lower level of the skip road is down 120 feet below the bottom of the pit. The ore in the 40-foot level, below the bottom, is worked out, and the mining is now carried on in the 80-foot level, and in a few days will also be inaugurated in the 120-foot. The vein dips to the north about 40°, and has a width of about 50 feet in the 80-foot level, where it has been opened a distance of 150 feet. About one-half of the width of the vein is good hematite ore; the north half, against the hanging wall, is a mixed hard ore and is not mined.

The machinery consists of a hoisting engine 18 inch cylinder, 32 inch stroke, two five-foot winding drums, Lane's pattern, and an inadequate pumping engine 12x18 inches, which is soon to give place to one of larger calibre. The mine furnishes employment to 80 men. The location is but a short distance west from the Winthrop.

SAGINAW MINING COMPANY.

This mine is situated on the N. W. ¼ of the N. E. ¼ of Sec. 19, T. 47, R. 27. Other contiguous lands are also embraced in the company's estate. The mine was opened by Messrs. Maas, Lonstorf and Mitchell in 1871, who in the following year sold out their lease for $300,000 to parties who organized the Saginaw Mining Company, since which time the product has been in the aggregate 389,981 tons of ore.

The mine was thoroughly examined by the commissioner in 1878 and described in considerable detail, in his report of that year, and there is little to add to the facts therein recorded. The mine, that originally extended 1,000 feet, with four working shafts, has gradually become circumscribed to a single available pit at No. 2 shaft, which is down 500 feet from the surface on the lay of the vein. The vein is here about 12 feet wide, and is opened so as to afford some good stopes for mining the ore. The great difficulty which has always been met with in this mine, regarding the water, is now somewhat intensified from the fact that the whole mine has to be kept free from water in order that the one pit may be worked. The mining plant, which was ample when all four of the shafts were working, is naturally in excess of present requirements.

The vein has a variable dip of from 40° to 50° to the north. The ore is an excellent quality of specular, containing some magnesia. Upon the location are 110 dwellings, several stores, a saw-mill, etc. The officers are Henry Chisholm, President; S. H. Chisholm, Secretary and Treasurer; Samuel Mitchell, Superintendent.

Adjoining the Saginaw on the east is the Lake Superior Iron Company's

SECTION 19 MINE,

which is now worked under a lease by the Saginaw Company. The description of the land which this mine embraces is the N. E. ¼ of the N. E. ¼ of Sec. 19, T. 47, R. 27. It was opened in 1871 by the Lake Superior Company, and continuously worked by that company until leased to the Saginaw in 1879. There are two working shafts, No. 1 near the Saginaw line, and No. 2, 480 feet to the east. The workings are now down about 300 feet on the lay of the vein, which dips to the north at an angle of about 50°, and has an average thickness of about 14 feet. The mine has all the appointments for successful working, and yields a rich, granular ore, containing a percentage of alumina, as can be readily seen with the unaided eye.

In the two mines the company employ about 170 men. The location is three and a half miles south of Ishpeming, and one and a half miles from the main line of the M., H. & O. R. R. It is also connected with the C. & N. W. R. R.

GOODRICH MINE.

The most westerly mine in the Saginaw range is the Goodrich, which joins the Saginaw on the west, the description being the W. ½ of the N. W. ¼ of Sec. 19, T. 47, R. 27. The mine was opened in 1873 by the St. Clair brothers,

but who soon after abandoned it, when the property was purchased by its present owner, Captain Goodrich, of Chicago, who has since continued to work it with indifferent financial success. The total shipments to the close of 1880 aggregate 31,361 tons, the product of the latter year being more than one-third of the total amount. Capt. Henry Davis, the present superintendent, is determined to make a reputation for the mine, and apparently he has the ability to do it if there is in the mine the material to respond to his efforts. The workings comprise three open pits running northeast and southwest, and a tunnel through the hill from the east enables the ore cars to run directly into the mine; the winter product, however, is run up the skips to the stock pile above. The formation is very irregular and the ore is peculiar. A greater development will be necessary to enable one to form an opinion of the value of the mine.

NEGAUNEE RANGE.

THE MILWAUKEE MINE.

The mine attracting the most attention at present is the Milwaukee, located on the southeast quarter of the southwest quarter of section seven. The lease-hold was owned by Messrs. J. Q. Adams and James F. Foley, who recently sold their interest to the company now operating the mine. The officers of the Milwaukee Iron Company are: President and Treasurer, R. S. Fay, Esq.; A. Kidder, Agent; Jas. F. Foley, Esq., Superintendent.

This mine, though less than two years has transpired since ore was first discovered on the property, bids fair to take the lead of the soft hematite mines of the Marquette iron district. A great change has been wrought within the past year. Then there was only one small building, the engine house, on the location, and mine proper consisted of two shafts. No. 1 shaft, the westerly one, was 95 feet deep with drifts driven to the east and west from the bottom respectively 65 and 50 feet in length. No. 2 shaft was 35 feet deep with a short cross-cut to the south. The ore in No. 1 shaft at present (March 28) appears to be the bottom portion of a lens. It is 110 feet long and 95 feet deep, and nearly pinches out at the ends and in the bottom. Captain Foley describes it as resembling a birch-bark canoe with the sides almost squeezed together. It was 23 feet wide at its strongest point. At No. 2 shaft we have an open pit 80 feet long east and west and 70 feet wide, by 80 feet deep. On the west of the pit is a stope of soft blue and gray ore 40 feet wide and 60 feet high. To the east side the ore is 30 feet wide and 30 feet high from the bottom of the pit. Near the center of the east half of the pit a winze has been sunk 29 feet deep, but within a very short distance the winze came upon chloritic schist which continued all the way down. From the bottom of the winze a drift is driven 45 feet to the north in chloritic schist; another to south 35 feet; the first eight feet was in chloritic schist but the remainder of the distance was in mixed ore and jasper. The east half of the bottom of the pit is ore. From the bottom of the pit a drift has been driven 115 feet to the west, which was all in ore except one short run of chloritic schist. Thirty feet above this point another drift was driven 65 feet to west, which was also in ore. From this it appears probable that the lens of ore in No. 2 laps on to the south side of No. 1 deposit. A branch from the M., H. & O. R. R. extends past Nos. 1 and 2 ore pockets. The skips at these shafts are at present operated by two of Merritt's internal gear 30-inch drums, though I understand it is the intention to put in two four-foot drums and use the smaller ones for the north side workings.

Six hundred feet to the north and 100 feet to the east of No. 2 shaft is the

No. 3 or Ryan's pit. Ore was discovered here last summer by some children digging into the side of the hill in imitation of the miners. The result was not only a large find of ore, but a new suit of clothes for each of the juvenile company, presented by Messrs. Adams & Foley. The Ryan pit is located on the south slope of a side hill, while Nos. 1 and 2 shafts are near the base of the north slope of that side of the valley. The bottom of the Ryan pit is 25 feet above the M., H. & O. R. R. track. A tram road now connects the pit with the ore docks and pockets alongside of railroad track.

Passing now along the tram road we enter the Ryan pit through an open cut. The first that attracts attention to either side of the cut is a ledge of massive diorite, and then comes on the north side of the diorite a soft blue ore resembling the Vulcan of the Menominee range. An analysis of several samples of this ore, collected by Mr. A. Kidder, as an average, afforded as follows:

Metallic iron	61.090
Phosphorus	.098
Silica	5.200

To the west of the entrance is a shaft 30 feet deep. The first 25 feet of the shaft was in ore, but the remaining five feet was in rock. A portion of this ore was a hard velvety-textured specular, or hard hematite. This ore is very rich, as may be seen by the following analyses made by myself:

Metallic iron	68.14	68.90
Phosphorus	.07	.05
Silica	1.10	.67

From this point to the north side of the pit is over 100 feet. The strike of the formation is S. 80° W., and the dip is 45° to the south. On the south side of the open pit the gradual rise of the hill gives a stope of ore at the northwest corner of over 25 feet high. The breast of ore at this part of pit is about 30 feet wide; south of this point for some distance the west side presents a face of lean ore and decomposed chloritic schist. But only 12 feet west of the upper edge of the pit and inside of its rocky face, ore appears on the surface of the ledge, and a drill hole at this point 14 feet deep is all in ore. The face of the east side of the pit contains more rock and lean ore than the west side. The earth is stripped from the ledge for 25 feet south of the upper edge of the pit, and shows a large percentage of ore all the way across.

Two hundred and fifty feet northwesterly from the Ryan is No. 4 pit or cut. The present level of this cut is 30 feet above the main railroad track, or 15 feet above the bottom of the Ryan pit. The present work in this cut is chiefly confined to removing the earth from the ledge. Tram cars are used to transport the dirt to the dump. It occurs to me in glancing over a sketch of the location that it would have been better to have started the No. 4 cut on the same level as the Ryan pit. This would have given a higher stope of ore to the north and uncovered the ledge lower down the side hill. It would also have avoided the possibility, in part at least, of dumping the stripping on what might be a ledge of ore, which I apprehend will be found to be the case. No. 5 cut is 230 feet southwest of No. 4. It is 20 to 25 feet above the main track. The cut has just struck the south edge of the ore. About 50 feet southeasterly from where ore was found in No. 5 a test pit was sunk and bottomed on diorite. This diorite is the same as that already noted at the entrance of the Ryan pit. The diorite has also been found in another test pit midway between these points. It is interesting, as it appears to form the hanging wall of this ore. The trend of the diorite is about the same as that of the plainly bedded ore. To the west

of No. 5, but on a higher level, and to the east between No. 5 and No. 4 cut, and between No. 4 and the Ryan pit, are three other cuts used for stripping the earth from the ledge. Tram cars are also employed in these to move the dirt to the dump on the south slope of the hill. One evil feature, as before remarked, is the possibility of having to remove these dump piles. Besides these pits and side hill cuts, numerous test pits have been sunk which partly proves the ore bearing belt to be from 150 to 200 feet in width and more than 500 feet in length. In this belt, however, are horses of rock, but what proportion they bear in the aggregate to the ore is impossible to say.

The present outlook of the new find is certainly good, and the ore after the earth is removed can be mined very cheaply.

East of the Milwaukee mine on the adjoining forty is the main opening of the

ROLLING MILL MINE, (APRIL 10th, 1881).

The main workings of this mine consist of a large open pit shaped in the form of a horse shoe. It is about 100 feet wide and probably 400 feet around the bend. The convex side of the bend lies to the south, and the end of the arms therefore are to the north, which gives an east and west trend to the pit. From the west arm, in going around to the east, the bottom of the pit descends so that the north half of east arm is 200 feet below the original surface. The bottom of the pit is looking very well at present. The vein of soft hematite appears to be narrowing and ore at certain points is becoming somewhat mixed. In the east side face, at the bottom, they have driven a drift in that direction for 150 feet, and have stoped out the vein which varies from six to eight feet wide for 30 feet above the drift. To the southeast is another small opening, but the ore from it is more or less mixed. On the whole the present outlook of the mine is not very good, still I cannot believe that the first-class ore has all been mined out in this mine. A few diamond drill holes would be of great value to this mine. Capt. George Berringer, an old and experienced miner, has been working the mine for the past two years under a lease, and was he fully assured of a long, undisputed lease of the mine I have no doubt but that he could very soon greatly improve the prospects of the mine. The mine has a good plant of machinery consisting of boiler, a large engine and three 4-foot drums, one of them being Lane's patent external friction.

THE CHICAGO MINE,

so called, is situated in the southeast corner of Sec. 7. The lease held by Mr. J. F. Stevens and W. C. Calhoun, the proprietors of the mine, covers the S. $\frac{1}{2}$ of the S. E. $\frac{1}{4}$ of that section. The work now in progress is being prosecuted in the bottom of an open cut at a depth below the surface of about 80 feet. This pit has a vein of soft brown ore of the color and apparent texture of rotten stone, greatly mixed with jasper so that the ore has to be picked out piece by piece. In this manner several thousand tons have been selected, of ore of a medium quality.

In the bottom of the pit at the southeast corner has appeared a vein of a much softer ore and of better quality. The owners are naturally anxious that this small beginning shall develop into a deposit of magnitude.

A small engine does the work of hoisting and pumping. Thirty men are employed.

McCOMBER MINE

was opened in 1870 by W. C. McComber, Esq., who obtained a lease of the property from J. P. Pendill, Esq., the owner of the land. In 1872 Mr. McComber disposed of his lease to the McComber Iron Company, which was organized August 14, 1872, capital stock $500,000 in 20,000 shares. The officers of the company are S. L. Mather, Esq., Cleveland, Ohio, President and Treasurer; Fred A. Morse, of same city, Secretary; and J. C. Morse, Marquette, General Agent. The mine workings are located in the N. W. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of Sec. 7, and the S. W. $\frac{1}{4}$ of the S. W. $\frac{1}{4}$ of Sec. 6, T. 47, and R. 26. Two years ago Nos. 1 to 5 pits were all being worked, but to-day all but No. 5 are idle, a depth in the first four having been reached where open mining is no longer profitable and underground work will have to be adopted. There seems to be a strong aversion in the most of our soft hematite to change from open to underground mining. To do this is much more expensive than in a hard ore mine. Shafts and winzes must be sunk, levels driven, and roofs must be left the same as in hard ore, and in addition they are obliged to support the roof and overhanging ground by heavy timbers. But while the ore now raised at the McComber is taken from open pits, work is being carried forward with a view to underground mining in the near future.

Near the west line of the property a shaft has been sunk to a depth of 40 feet, which is now in the ore, and from the bottom a drift is being extended horizontally for the purpose of determining the value and nature of the deposit. Also 100 feet to the north of the engine house a shaft is now being sunk, having already reached to a depth of 140 feet from the surface. The sinking is now in the ore, the product being raised and conveyed to the stock pile.

When a sufficient depth is reached, levels will be driven and a system of underground stoping inaugurated.

While there exists more uncertainty as to the permanency of soft hematite ore deposits than with the hard ore veins, there is yet very far from being any signs for apprehension to be observed at the McComber.

Since scarcely at any period in its history has the mine appeared more favorable than at present, both as to quantity and quality of the ore and the cheapness at which it can be apparently mined. In No. 5 pit, in the west end, the vein is fully 25 feet in width and is almost entirely free from mixture of rock. In the bottom and ends of this pit the ore is very easily and safely mined and hoisted to the surface in iron buckets worked with wire ropes from the engine house. This pit is about 100 feet in depth.

Near the engine house, on the south side, a surface drift has opened an extensive deposit of soft hematite ore. This deposit is being mined as readily as from a clay bank, and shoveled into the carts that convey it over a short haul to the car shute.

At various points in the mine are revealed promising deposits of ore, sufficient to enable the McComber to continue to hold its place as one of the leading hematite mines of the Marquette district.

The mine is now producing a weekly product of about 900 tons; 50 men are employed. The plant is simple and inexpensive, but sufficient for the purposes required. Mr. W. G. Pollock, formerly of Cleveland, Ohio, has been appointed agent, and has recently assumed the charge of affairs.

TEAL LAKE RANGE (APRIL 1, 1881.)

From Negaunee we travel along the railroad track, leaving the main track about half a mile west of the railroad depot, on a branch track to the northwest, which leads to the Cambria, Bessemer, Forest City and Cleveland hematite mines. About one and a half miles from the depot we arrive at the

CAMBRIA MINE,

the property of the Cambria Iron Company. This property embraces the S. E. ¼ of the S. E. ¼ of Sec. 35, and W. fractional ½ of Sec. 36, T. 48, R. 27. Ore was first discovered here in 1874 by R. P. Harriman, Esq., who leased the property from the Teal Lake Iron Company. In 1875 Mr. Harriman, associating himself with J. H. McDonald, John Q. Adams and Lewis Corbett, organized the Cambria Iron Company. The present officers of the company are W. H. Barnum, President; James Rood, Jr., Treasurer; John Q. Adams, Secretary; A. W. Maitland, General Manager. The past two years have wrought a few changes in the general appearance of the mine. The first working that we see as we approach the mine from the east is a long open cut, 350 feet east and west by 50 feet wide, and varying in depth from 75 to 20 feet. The formation here has an east and west trend and dips to the south at an angle of 45°. At the extreme east end of this opening the incline shaft, which the old company was sinking two years ago, was only carried down about 10 feet further where the vein nearly pinched out. Since that date, or within the past year, the new organization has driven down to the east of this shaft, under the east face of the cut for some 75 feet, and opened out a chamber in a lens of a fine quality of soft hematite ore. The chamber varies in height from 25 to 30 feet. To the east of this chamber is a drift near the roof driven some 20 feet still farther to the east. It looks now as if the ore was going to "make" in the bottom around to the west in front of the shaft. The ore to the west in the bottom of the long, open cut is more or less mixed with narrow runs of jasper and chloritic schist. It is the intention now to sink a shaft this season at the west end of the long, open cut, and to thoroughly explore this part of the mine.

About 300 feet westerly from the long, open cut, is another opening which was made in 1879. The opening is 90 feet long by, say, 40 feet wide and 40 feet deep. The ore of it is a soft hematite, but is hardly first-class. Still farther west, 100 feet, is a shaft which was sunk the first winter 26 feet deep. The first seven feet was through earth and remaining 19 feet is in a soft, shaly, bluish-colored ore, resembling very much the Vulcan ore of the Menominee range. An average of the ore from the shaft afforded:

Metallic iron	66.400
Phosphorus	.045
Silica	2.200

From the bottom of the shaft they have cross-cutted on ore, showing a total width of ore at this point of 39 feet. The vein widens to the west, but it is only 75 feet from the shaft to the west line of this property, or the division between it and the Bessemer mine.

The Cambria has now a new engine house, with an engine, boiler, and two three-foot V friction drums.

Adjoining the Cambria on the west is the mining property of the

BESSEMER MINE,

which comprises the W. ½ of the S. E. ¼ of Sec 35. Just at present the new find of the Cambria, above alluded to, which crosses the line into the Bessemer, is receiving considerable attention. Several test pits have been sunk to the ledge, which prove the ore thus far to have a length of not less than 116 feet west from the east line of the Bessemer, and a maximum width of 80 feet across the deposit. Preparations are being made to strip the earth from the ledge, so as to have a working stope by the opening of navigation. The ore is similar to that found on the Cambria, it being one and the same deposit. Seven hundred and twenty-five feet west of the new find, is the same open pit we examined and described two years ago, only that it is now down 145 feet below the surface. The pit is 120 feet long by 90 feet wide at the surface. In the east half, at about 90 feet below the surface, has been left a bench of ground and in the centre of it a well-timbered shaft is sunk to the bottom level. From the bottom of the shaft a drift connects with the open portion of the pit to the west. The drift is of good size and serves as a pump house, also as a safe outlet for the miners. The shaft no doubt will be eventually used for the purpose of changing from open to underground mining, which period, in the writer's opinion, has fully arrived. The soft hematite ore deposit is about 50 feet wide. The strike of the formation is about east and west, and the dip 50° to the south.

About 60 feet west of this open pit is another large open pit. This latter pit is 100 feet long by 80 feet wide and 120 feet deep in the west half and 80 feet deep in the east half of the pit. The ore in this pit is, at present, 30 feet wide at the bottom, but the hanging wall has not been reached. The west end of the pit is about 200 feet from the west line of the property. Both pits are worked by large derricks which are swung around to the dumping place by the engines. The present owners and operators of the mine are C. M. Wheeler, Esq., of Marquette, Mich., and J. H. King, Esq., of Painesville, O.

FOREST CITY IRON MINING COMPANY.

The location of this mine comprises 60 acres in the southwest corner of Sec. 35, T. 48, R. 27, lying between the Bessemer mine on the east and the Cleveland Hematite on the west, the mine openings being closer to those of the latter. Work was begun here in 1880, and about 500 tons of ore gotten out that year, when the lease was sold to Cleveland parties and the Forest City Iron Company organized in February last, with C. A. Otis, President; T. H. Brooks, Treas; F. A. Bates, Secretary, all of Cleveland, O., and Geo. R. Tuttle, General Agent, Ishpeming, Mich.

Mr. Tuttle began work soon after the organization of the company by sinking a line of test pits ten feet apart, from the south line of the property to the greenstone on the north. This work resulted in finding a deposit of ore a short distance south of the pit already opened, between it and the section line. The vein was uncovered, and early in May the work of mining the ore began with so favorable a result that before the end of the month 1,000 tons had been mined and shipped. The vein has been mined to a length of about 50 feet and to a depth of about 15 feet. It has hardly been sufficiently exposed to determine its extent, but the width at which it is worked is about 10 feet, with indications that what has been regarded as a foot wall is simply a thin covering of jasper, rock, beyond and under which the ore continues to the

north. The west end of the opening looks much the most favorable, and to the south the work is limited by the boundary line, in contact with which is the south side of the pit. The dip is to the south at an angle of perhaps 50°, there being, apparently, little regularity in this respect. No. 1 pit, a little to the north, is not worked out, there being a fair showing of ore in the west and south sides, but the water has come in freely, and there being no pumping machinery at work, it became necessary to await the erection of an engine and pump. From the bottom of this pit a tunnel 30 feet long running westerly intersected a pocket of ore which was mined out and hoisted to the surface through a winze. This work was done before the spring break-up, after which the water made too freely. If the ore in No. 2 pit shall appear to underlie to the north it is the intention to strip the ground between the pits and expose it to surface mining.

Where so little is known it is scarcely safe to conjecture, but is undoubtedly better to proceed cautiously, as Mr. Tuttle seems to be doing, until he becomes more sure of his ground, when he can go forward and perhaps avoid useless expenditure.

The company has, as yet, very little surface plant; a small engine to hoist the buckets to the surface and a larger engine not yet erected constitute the machinery. Mr. Tuttle hopes to get out 20,000 tons the present season, and if the mine maintains its present favorable outlook he will doubtless succeed in fulfilling his expectations. The ore is a fair quality of hard and soft hematite, yielding, if carefully graded, 60 per cent in metallic iron, and being low in phosphorus, finds a ready sale.

CLEVELAND HEMATITE,

located on Sec. 2 is the most westerly of the Teal Lake range of hematite mines, the Bessemer, the Cambria, etc. It has heretofore been worked on a lease by Mr. R. Nelson, of Ishpeming, but since May, 1, 1881, has been worked by the Cleveland Company, to whom the mine belonged, and who have purchased of Mr. Nelson the mining plant, etc. The mine yielded about 18,000 tons of ore the past year. The company is now engaged in sinking diamond drill holes south of the M., H. & O. R. R. track, near the superintendent's house. Six holes have been bored and they are now engaged on the seventh, in which latter they have just struck ore at a distance down of 300 feet. The holes have all been bored since January last, and are from 400 feet to 450 feet in depth. In two of these holes, 105 feet apart, ore has been found, at distance down of 308 feet and 215 feet, respectively, of a thickness of 56 feet and of 60 feet; of this 37 feet is first-class ore in the one hole and 52 feet is first-class in the other. In one of the other holes 15 feet of ore was found. It is the intention to commence sinking a shaft here as soon as a point can be fixed upon which the ore comes nearest to the surface. Further exploration with the diamond drill will be made to the west and south of No. 3 pit during the coming summer. This work is done on company account. A new pumping engine house will be erected also this coming season, furnished with new machinery, which will run one pump in the incline pit and one in No. 3, and one set of wire rope pumps in No. 6.

REPUBLIC IRON COMPANY.

This company enters this season upon its tenth year of shipments. It was organized October 20, 1870, capital stock $500,000 in 20,000 shares, by S. P. Ely, Hon. Ed. Breitung and E. D. Parsons.

The mine is located in Sec. 7, T. 46, R. 29, and is nine miles southwesterly from Humboldt, on what is known as the Republic branch.

In our report of two years ago, of this mine, we described its geological and topographical features, as follows:

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 overlying 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 northeast side or upturned edge 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.

We will now proceed under the careful guidance of Captain Pascoe, and make the "grand rounds" of the Republic mine, which, to-day, is second to none of the larger iron mines of the world.

We will begin with No. 10 pit, not because it is the most important opening, but that it happens to be the first one in our way as we approach the mine. Before entering the adit leading into No. 10 pit, which is 67 feet above the water in the bay,* we will tarry a moment to take a general view of the "location." To the northeast the ground rises rapidly, and within 200 feet is the bold face of the Jasper bluff, which, in the sunlight, sparkles with countless scales of specular ore. The range terminates abruptly to the northwest in a

* Water level in bay is 914 feet above Lake Superior.

few hundred feet, but to the southeast it continues for more than 1,000 feet in a fairly straight line, embracing in its course Nos. 10 to 4 pits inclusive. The formation within these limits has a strike of N. 50° W., and dips to the southwest or towards the bay at a high angle, which is only slightly inclined from vertical. From No. 4 pit the formation curves rapidly to the southwest, west, and even to the northwest, but the ore stratum, as well as the underlaying rocks, seem to have resisted the force that turned them from their course, and in several instances we notice sharp, contact folds of the ore vein into the foot wall, the banded jasper conforming to these spurry folds. The line, therefore, of our ox bow, as already noticed, is not regular, but is very crooked at its southeast end.

About 100 feet southwest of No. 5 shaft is the main engine house; from it are operated a skip in No. 7 shaft, a double cage lift in No. 5 shaft, and No. 3 skip road. In the engine house building is the machine shop, where all necessary repairs of the power drills and other machinery are made.

To the west, say 100 feet, is the engine house for the pumping engine, which raises the water from the fourth level to the surface of Nos. 7 to 3 pits, inclusive. To the southwest about 1,000 feet more may be seen the several masts and guy ropes of the derricks of the open Pascoe pit, reminding one of a small ship yard. Southeast of the Pascoe pit only a short distance is a building which contains a hoisting plant of four six-foot drums of "Merritt's patent internal gear." The plant is a fine one, and will doubtless accomplish all that is required of it. West of this, say 200 feet, is another building in which is placed a large pumping engine, similar to that just noted, which will raise the water from the Ely, Pascoe, and Morgan pits.

Laid along the general line of the pits is a boiler-iron pipe 15 inches in diameter, painted red, which conducts the compressed air from the compressors to the hoisting engines, pumping engines, power drills, etc. The compressors are located on the Michigamme river, below the bay, about one mile southwest from No. 5 shaft. At this point is a fall, altogether, of 16 feet in the river, which drives two of Swain's 66-inch turbines, which in turn operates four compressing cylinders, two feet in diameter by five-foot stroke. The power of the turbines with the 16-foot head of water is rated at 700 horse power.

The original outlay of this pneumatic plant was large—$100,000; but its advantages are great. The success of the undertaking is entirely due to Mr. David Morgan, the president of the company, who personally supervised the putting in of the plant, and construction of the accessories from first to last. In front of the pits may be seen the trestles upon which are laid the tram roads that lead towards the bay to the large stock piles of ore and ore pockets, or to the waste dumps of rock, while along in front of the stock piles and ore pockets curves around on a slightly ascending grade, the main railroad track with its diverging branches leading into the different openings. Below this, still nearer the bay are the dwellings of the miners, the company's offices, warehouses, wagon and smith shops, barn, etc., and below these again skirts the shore of the bay, beneath which, down into the unexplored depths of the bedded rocks, will probably be found the continuation of the Republic vein, where the miners, no doubt, at some future will be drilling, blasting and sending ore to the surface.

Having now taken a hasty glance at the location on the surface, and wondering our outcome from ways that are dark, we place ourself again under the careful guidance of Capt. Pascoe, and pass into the adit of No. 10 pit. This adit is driven 200 feet northeasterly into the side of the hill, cutting through the hanging wall of gray quartzite and intersecting the vein of ore about 75 feet below the outcrop. The vein here is narrow with quartzite on the foot wall side. The adit at this point divides, or rather a branch of it leads to the right along the narrow vein of ore for a short distance, where the vein widens out to ten feet. At this point they have stoped out an open place 50 feet long by 50 feet deep. The main adit is driven through the apparent foot wall of quartzite, and within a few feet intersects another narrow vein of specular slate ore, averaging less than six feet wide. The point of this spur of quartzite is to the southeast where it divides the vein of ore; it is over 500 feet in length, but it will probably cut out as greater depth is attained.

Geologically this double lock split or spur of quartzite into the ore vein possesses much interest, but practically, to the miner at least, its features are decidedly of a negative character.

Southeasterly from No. 10 adit we pass the mouth of No. 9 adit. No work is being done here at present, but during the past winter a party of scrammers* have taken out a small stock pile of ore. The vein in No. 9 is narrow but bids fair to widen further down. We will pass it by and enter No. 8 adit. The sole of this adit is 72 feet above the bay. No. 8 pit is mined out to the second level or 130 feet below the adit. On the northwest side it is stoped out for 110 feet from the shaft. The roof comes down from just above the adit on a northwesterly pitch, which apparently corresponds to that of the vein, that is, the vein is gradually widening as they go down, but the parallel lines of a plane intersecting the foot and hanging walls of the ore vein have a steep northwesterly pitch. They are now sinking the shaft to the third level. To the southeast on the second level it is 263 feet to No. 7 shaft, and the ore from this level between the shafts is all stoped out to the surface with the exception of the supporting pillars. Eighty feet southeast of No. 8 shaft they have cut through the jasper horse, on the hanging wall side, and into a six-foot vein of specular slate ore, but have not proved it up. This is the same jasper horse we noted two years ago. The floor of the second level for 15 feet down will be left to form a roof for the lower levels. To the northwest of No. 7 shaft, just before reaching the limit of this pit with No. 8, is a winze sunk in a deposit of ore which lies apparently within the foot wall. On either side of No. 7 shaft, are left pillars of ore which will extend from level to level with the exception of archways cut through at the sole of each level. Southeast of No. 7 shaft the vein is mined out from second level to outcrop. Descending now 45 feet to third level, which is 100 feet below the bay, we find a drift 70 feet in length driven to the southeast; 35 feet from the shaft the drift branches to the left and passes around the northwest point of jasper horse. This is the same jasper horse we described two years ago, 75 feet above the third level. It was then 100 feet from the shaft, but the northwesterly pitch brings it nearer the shaft at every level as we go down. The vein of ore varies on either side of the jasper from four to seven feet in thickness. To the northwest of the shaft we pass along for 70 feet and enter a chamber 64 feet long. The vein in this chamber varies from 5 to 15 feet wide. At the northwest end of the chamber is a drift 19 feet long.

We ascend now to the adit level of No. 7 shaft. The sole of this adit is

*Scrammers, a small party of skilled miners who take contracts for mining out ore in places where it is usually too expensive to work on company account.

75 feet above the bay. The ore from No. 7 pit was formerly raised to the adit level by a single cage lift, which has now been changed to a skip road; but owing to the nearly vertical dip of the vein, the skip is constructed like a long iron box on wheels, the lower end or bottom of which is beveled from the back side to the front side, so that when the skip is raised just above the nicely fitted opening at the adit level and the trap-door on the front side and near the bottom of the skip is unfastened, the ore slides out into the tram car. It is certainly a very practical method of emptying the skip where there is not sufficient room to dump it.

Out of No. 7 adit we go 410 feet southeasterly to the double cage lift of Nos. 6 and 5 shaft. The collar of this shaft is 107 feet above the bay. We take our places on the elevator, and very quickly are lowered 297 feet down to the sixth level, or 190 feet below the bay. On either side of the shaft from the third level down have been left continuous pillars of ore, 40 feet thick, extending from foot to hanging wall, and are cut through at the sole of each level to form a passage way to the workings beyond. The vein of ore on the sixth level in the shaft will probably average 90 feet thick, and the shaft sunk in this solid block is perfectly safe, even should a large fall of rock ever occur in the openings to either side. The shaft is sunk to the seventh level. This is accomplished, as was described in our report for 1878, by sinking a winze on the hanging wall side of the shaft. When the shaft is sunk the timber work for the cages is made ready, so that all that remains is to knock out the false bottom and make the connections, which is usually accomplished in a few hours. From the shaft we will first proceed northwest through the arch made in the pillar, and enter a chamber which is 30 feet with the vein and 60 feet wide across the vein. In the south corner of this chamber is a winze which will be connected by a drift with the shaft at the seventh level. From this chamber we continue northwest through another arch on the hanging wall side and enter the second chamber. In this chamber they are now stoping out the ore across the vein from hanging to foot.

The general plan of working the vein of ore as long as it maintains its present width will be to leave the 40-foot pillars of ore as above described, and then to leave at every 30 feet alternating chambers and pillars of ore. To do this will require the sinking of a winze in the south corner of each chamber from the level above and driving a drift to connect with the winze. Besides this there will be left at every three or more levels a roof of ore, and where necessary large stulls will be set across the chamber and lagging be laid on them to prevent any loose rock from falling upon the miners below.

In the southeast of the shaft, on the sixth level, the foot wall preserves its course past Nos. 5, 4 and 3 pits, a distance of 340 feet, but the hanging wall turns from the shaft sharply to south, so that in the first chamber it is 160 feet from foot to hanging walls. This is all ore, with exception of a ten foot seam of chloritic schist, which occurs about two-thirds of the way across from foot to hanging and separates the specular slate ore on foot wall side from the magnetic ore on the hanging wall side of the vein. The first chamber on this side of the shaft is nearly worked out, and they are opening a second chamber. The method of working this side of the shaft is similar to that already described for the northwest side, the only difference being in springing longitudinally across the middle of each of the chambers to prevent any lateral movement of the pillars.

We return to the shaft and ascend on the cage to the fifth level, which is 58 feet above the sixth level. To the northwest of the shaft on this level the workings are very similar to those in the level below, only that the ore is stoped out of the second chamber and they are driving a shaft next to the hanging wall, between the quartzite and a jasper horse, which latter just comes through into the northwest end of this chamber. In the southeast of the shaft the first chamber is worked out, but in the second one only partially so, and the third chamber is only just begun. They are also mining out a ten-foot vein of ore which occurs inside of jasper on the foot wall side.

The magnetic ore on the hanging wall side is all mined out, with the exception of the heavy arching pillars to the foot of No. 3 skip road, which is about 190 feet from the shaft. This skip road, continued down on its present angle, will probably pass in front of the shaft between the ninth and tenth levels.

Ascending now to the fourth level, 50 feet above the fifth level, or 81 feet below the bay, we find the first three chambers mined out on the southeast, and the fourth one partially so. The magnetic ore and a portion of the specular ore is mined out to the south end of No. 3, or what we described two years ago as the fault, which forms the division between Nos. 2 and 3 pits. The plane of this fault inclines at a high angle to the north. The ore from this level passes up No. 3 skip road to the surface. Between fourth and third levels is a strong, solid roof of ore. To the northwest side of the shaft on the fourth level are two tanks 32 feet long by 6 feet wide. The water from the lower levels is pumped into these tanks by small steam pumps, and is then raised to the surface by a 12 inch plunger pump, which is known among the miners as a "Cornish lift."

In passing through the mine we cannot fail being impressed with the enormous quantity of ore left for supports, aggregating fully one-half of the entire deposit. The apparent loss is not alone in the ore left standing, but also in the extra cost of sinking, drifting, and opening out anew, in order to get around the pillars and arches. At first glance it does seem as if some method might be devised wherein the greater portion of the vein could be taken out, and I have no doubt that, with our modern appliances, some way would be found to do it were it not that it is now purposed at some future day to leave a strong floor of ore between two levels, so that mining operations may be continued below, then to begin and take out the pillars, excepting those on either side of the shaft, to the first level about the floor. When this is accomplished to mill in rock and dirt, filling up the space; then to begin and take out the supports to the next level above, filling in again the space with rock and gravel, and so repeating the operation until the upper levels are reached. This, I believe, could be safely and economically done in some way so that the cost of mining the ore would be no greater than that first taken out.

From the main shaft, or No. 5, we go south about 550 feet to No. 2 shaft, the collar of which is 91 feet above the bay. The formation here has a strike of southwesterly, and dips northwesterly 55°. Taking a seat in the skip we are soon landed upon the fifth level, 230 feet below the surface, or 139 lower than the bay. To the northeast side of the shaft they are driving a drift and sinking a winze from the fourth level, leaving a pillar at the shaft 20 feet thick. To the southwest side the winze and drift are already connected, and they are now stoping out the ore. On the fourth level to the northeast side it is stoped out to 125 feet away from the shaft and there remains now only 20 feet more before the fault is reached, giving a total distance of 145 feet northeast from No. 2 shaft. One hundred and forty feet above the fourth level it

was 120 feet from the shaft to the fault, which shows clearly the northerly pitch of the plane of the fault. The vein on this side of the shaft varies in width from 7 to 12 feet. To the southwest side of No. 2 shaft we pass over on the fourth level and then down onto the fifth level of No. 1 pit, which is not as low by 15 feet as the fifth level of No. 2 pit. On this level they are sinking to either side of the shaft pillars, and are also sinking the shaft to the sixth level. Northeast of No. 1 shaft it is stoped out on the fifth level beyond the pillar to 72 feet from the shaft, where there is a stope 40 feet high by 18 feet thick. The vein of ore has gradually widened from the surface down. The walls, however, are composed in part of a chloritic schist, which requires considerable timbering to secure them. Southwest of No. 1 shaft it is only a short distance to the sharp southeast turn toward the Gibson pit. On the whole, Nos. 1 and 2 pits have greatly improved within the past two years.

One hundred feet southwest of No. 1 shaft is the Gibson pit. The ore vein from No. 1 pit takes an abrupt turn to the southwesterly, and at the Gibson makes a sharp, spur-like fold on itself into the foot wall, the banded jasper conforming to it. The ore is mined out to 210 feet below the collar or 120 feet below the bay. The body or lens of ore pitches to the northeasterly at an angle of about 45°. Back of this lens, along the spur, the vein narrows, in fact nearly pinches out, but at 75 feet it again widens out, forming another lens of ore which is worked out for 30 feet long to 100 feet deep. This south lens has about the same pitch as the north one. The ore is a fine quality of specular slate. The plan of working the Gibson pit is to sink the shaft, say 50 feet, and then to stope out all of the available ore to that level.

Southwesterly from the Gibson pit about 400 feet, is the Ely pit. The formation at the Ely dips 55° to the northwest. The collar of the shaft is 87 feet above the bay. We now enter the skip and quickly reach bottom, or, the sixth level, 212 feet below the surface. From the third level to near the bottom jasper came in on the northeast side of the shaft, crowding it all the way down, but now on the sixth level the ore appears to be cutting under the jasper. To the southwest side of the shaft in the sixth level it is 30 feet to the foot of a stope of specular which averages 25 feet wide and extends back 84 feet on the fifth level. Northeast on the fifth level the jasper is cut through and the ore is stoped out for 75 feet from the shaft. This opening is well secured by heavy timbers and a solid roof of ore above.

From the Ely we pass westerly a few steps to the open Pascoe pit.

This pit has an irregular crescent shape with its convex side to southeast, but its general trend is northeast and southwest. It is about 175 feet long by 75 feet wide. The east half of the pit is 60 feet deep, and the west half 24 feet below the surface. At the southwest end of the pit are two spurs of ore making into the foot wall, and near the northwest corner they are now sinking an 8x14 shaft, which will afford room for two skip roads and a ladder way. The shaft is all in ore and is sunk on an angle of about 55° to 29 feet lower than the bay, or 104 feet below the original surface; 132 feet westerly from from the shaft of the Pascoe pit is the shaft of the Morgan pit.

The collar of the Morgan shaft is 76 feet above the bay. Again entering the skip we are lowered to the fourth level 149 feet below the surface or 73 feet lower than the bay. Either side of the shaft are 26 foot pillars of ore which will be continued down with the shaft. To the east side of the shaft we pass through the arch of the shaft pillar and enter a chamber 30 feet wide and 48 feet across the hanging wall deposit of ore. A drift was driven into the apparent foot wall of jasper, but within a few feet it struck ore again. To the east of this chamber is a 30 foot pillar of ore extending across the vein, and then comes a second chamber which is now being worked out. The plan of working this pit is similar to that of No. 6 already described. West of the shaft beyond the pillar on the fourth level has been stoped out a chamber 40 feet wide. On the third level to the east the two chambers are nearly mined out and they are now driving a drift to connect with the Pascoe shaft which they expect to within 25 feet east of the second chamber. This block of ground will be left to form a pillar on west side of Pascoe shaft. The hanging wall vein in the first chamber from the shaft is 43 feet wide, the jasper 12 feet and foot wall vein 40 feet, while in the second chamber the jasper disappears and we have 65 feet of first-class specular. The jasper in the first chamber is probably a horse of rock which may cut out below. The chambers of the third and fourth levels are connected by winzes. Looking down these winzes the vein of ore appears to be flattening out in its dip. To the west side on the shaft the ore is stoped out for 75 feet.

Westerly about 200 feet from the Morgan shaft is the Perkins pit. This pit is about 75 feet long by 95 feet deep. The ore in this pit is divided into two veins by a longitudinal run of chloritic schist. The veins are irregular, varying in thickness from four to ten feet. At the time of our visit to this pit last winter, they were then preparing to test the ground with the diamond drill.

The Kingston pit is another of the Republic Company's openings. It is located on the west side of the river, about 1,900 feet northwest of No. 10 pit, and is within 200 feet of the No. 1 pit of the Columbia mine (formerly known as Kloman). The pit is about 110 feet deep by 100 feet long, the vein varying in width from four to eleven feet in thickness. The ore resembles the Republic, but is not quite as rich, and in other respects not quite as good.

WEST REPUBLIC MINE (APRIL 12, 1881).

This company was organized October, 18, 1880. J. N. St. Clair, President; E. G. St. Clair, Secretary and Treasurer; and Geo. A. St. Clair, Superintendent. Their property embraces lots 4 and 6, Sec. 7, and lots 2, and 8, Sec. 18, T. 46 and R. 29. These lands were entered by William Backus in 1851. In 1872 O. S. Bond, of Toledo, O., purchased Mr. Backus' interest and organized the Toledo Iron, Lumber and Water Power Company, which company did some exploring in 1873 and 1874, but failed to find anything of value. Last year that company leased its property to the St. Clair brothers for a term of 30 years at a low royalty, also conceding an undivided one-half interest in the property. The St. Clair brothers then organized the West Republic mine.

The St. Clairs have done more or less exploring on lots 4 and 6, Sec. 7, for the past three or four years, but as soon as they obtained the above lease they began to explore on a more extensive scale, and, after considerable hard, persistent work, finally succeeded in unearthing a solid ledge of specular ore similar in every respect to the Republic.

The "new find" is located in the southwest part of lot 4, and is about 1,600 feet west northwest from the Perkins pit of the Republic mine. Their No. 1 shaft is about 250 feet east of the Michigamme river, and, say 50 feet north of the south line of lot 4. The shaft, 8x12, is sunk 27 feet through earth and then 49 feet into the ledge, composed of specular ore, some jasper and a little chloritic schist.

From near the bottom of the shaft a 6x6 drift has been driven northwesterly, which is all in ore with the exception of a narrow run of chloritic schist. A winze has been sunk in this drift, which will connect with the shaft at a lower level. The strike of the formation is N. 80° W. and the dip high to northerly.

About 100 feet northwest of the shaft is a test pit sunk to the ledge of quartzite, and from the bottom of the pit a drift has been driven southerly 42 feet across the quartzite, where a ledge of specular ore was struck; the drift was continued for 31 feet farther across the vein of ore and then came upon jasper.

One hundred and sixty-four feet westerly from No. 1 shaft, along the course of the vein No. 2 shaft has been sunk 23 feet through earth to the ledge of specular ore. A short cross-cut to the south shows 20 feet of ore at this point. The collar of this shaft is 15 feet above the water in the river, and the collar of No. 1 shaft is 25 feet above the same level. This makes the surface of the ledge in both shafts below the water level in the river, or bay; still there is not much water, at present, coming into either shaft, which is a little surprising, considering that No. 2 is not more than 75 feet from the water's edge at the river.

It is the intention of the company to thoroughly explore the property the coming season. Across the river to the west they are now sinking test pits on lot 6, but have not, as yet, discovered anything new.

KLOMAN MINE.

This mine is located about 300 feet northwest of the Kingston pit of the Republic. Its workings are on the southwest slope of a side hill, and are 1,320 feet in length. The general trend of them is N. 40° W. The mine was first opened in 1872 by the Kloman Iron Company and was worked by that company with considerable vigor until 1874, when operations were suddenly stopped. The mine was allowed to fill with water and nothing more was done there until last winter, when Messrs. Campbell, Wilkinson, and Spear of Marquett obtained a lease and began pumping out No. 1 pit. Shortly after this, however, they sold their lease to Messrs. Shumway, Wicker & Co., who continued the work of unwatering the mine and began mining ore. Subsequently the Columbia Iron Company was organized.

The workings of the old company consisted of four open pits and two shafts, which were numbered from southeast to northwest, the shafts being at the northwest end. The southeast end of No. 1 pit is at the south line of section 6, town 46, range 29, and is 1,300 feet east of the southwest corner of that section. On the surface the pit is about 200 feet long and 20 feet wide. Last summer it was 100 feet long in the bottom by 79 feet deep, and there were about 9 feet of first and second class ore. Since that time they have sunk some 30 feet deeper and report an increase of the width and an improvement in the quality of ore. No. 2 pit is 47 feet northwest from No. 1. It is a small opening only 55 feet long with a short run of ore in the bottom. No. 3 opening, 140 feet northwest from No. 2, is 218 feet long and 110 feet below the surface. Vein of ore is said to vary from 5 to 13 feet in thickness. Nos. 3 and 4 pits are only 20 feet apart, and are separated by a pillar of mixed and good ore. No. 4 pit is 113 feet long by 200 feet deep. In the bottom is only 5 feet of ore. From No. 4 to No. 5 shaft is 462 feet. The shaft is 133 feet deep. On the southeast side of it little or no work has been done, but on the west side it is stoped away from 20 to 30 feet. The vein varies from 2 to 7 feet in thickness. No. 6 shaft is 142 feet northwest from No. 5. The

lens of ore in this shaft pitches to the northwest on an angle of 40°. The workings extend northwest of the shaft for 150 feet and under the bay. The lowest level is about 100 feet below the surface of the bay. In the southeast end of the bottom level is reported 10 feet of ore.

Explorations to the northwest of No. 6 shaft have demonstrated that the same vein of ore upon which they are now mining extends in that direction for nearly three-fourths of a mile, but as yet they have not found the vein of sufficient thickness to warrant opening it for mining operations.

In their main openings, which we have just described, the present lenses are apparently becoming exhausted, but they will undoubtedly find others near at hand, and with this in view they are now boring some diamond drill holes in the vicinity of the old pits. The ore is a fine-looking specular slate variety, resembling that of its near neighbor, the Republic, though not of quite as good a quality. Possibly other lenses of it which they have not reached may be fully as good as the Republic.

The officers of the Columbia Iron Company are as follows: President, P. B. Shumway; Secretary and Treasurer, B. H. Jones; General Manager, C. M. Wicker; Sales Agents, A. B. Meeker & Co.

HUMBOLDT IRON COMPANY.

The chief attraction at this mine now is their so-called "new find," which was discovered last summer. It is located 1,300 feet southeasterly from the workings of the old Washington, and from 300 to 400 feet easterly from the Republic branch railroad; or is near the southeast corner of the N. W. ¼ of the N. W. ¼ of Sec. 11, T. 47, R. 29.

The main opening is now, March 18, about 30 feet deep and 100 feet long. The strike of the formation is S. 10° E., and the dip is 49° to the west. The greater portion of the ore is a rich specular, schistose in structure, often friable, and sounds leaden when struck with the hammer; another portion is a granular specular, more or less magnetic and resembles a magnetic ore, but it affords a brownish red powder (martite). The hanging wall is a conglomerate and the foot wall a banded jasper. In the bottom of the pit it is about 25 feet horizontally from foot to hanging walls. On the north end of the opening considerable stoping has been done. One hundred feet to the south a shaft has been sunk some 80 feet on the foot wall side of the vein. It is all ore in the bottom of the shaft and as the shaft does not extend to the hanging wall it is impossible to say how wide the ore vein is at this point. The ore from the shaft is nearly all of the first described variety of the main opening; it is, however, often wavy.

Ninety feet further to the south is another shaft 30 feet deep. This shaft is connected with the first one by a drift which follows the ore. To the southwest is a large swamp, but the top of the ledge is above the swamp level so that but little, if any, water comes into the workings from that source. The company are busily employed building an engine house, erecting derricks, and other preparatory work in anticipation of a good business this season. About 600 feet west of main shaft they are now sinking some test pits, and have found some very fine looking granular specular ore.

From the magnetic attraction it appears that the ore vein extends to the northwest and also continues to the southeast, and probably unites with the "new find" forming one and the same stratum. The dip, therefore, of this northwest belt will, no doubt, be to the northeast, which would give us a syn-

clinal, converging to the south, between the new opening and the above test pits. A diamond drill hole put down midway between these points would soon prove or disprove this theory. If it were found correct the fact would be of much value in determining the future plan of working the mine.

The only other work now being done by the Humboldt Iron Company, is in the main opening of the old Washington, which is down 300 feet on the dip of the vein (60° to the northwest).

The strike is nearly east and west. The vein in the bottom varies from 10 to 12 feet thick, but the ore is somewhat mixed in places. The bottom is now about 100 feet long. The ore to the east end on the bottom suddenly narrowed. To the west it appears to have "jumped into the hanging wall," as the miners term it.

Immediately south of Clarksburgh more or less exploring has been done for the past ten years. Several deposits, or lenses, of specular slate ore have been found, but were soon worked out. Some eight years ago Captain James Tobin relates that, during the prosperous days of the Michigan Iron Company, he had a small force of Cornishmen test-pitting south of Clarksburgh. A large number of test pits were sunk, when one day the men came in with the cheering news that they had found a fine body of specular slate ore, which covered the entire bottom of the test pit. The men were quite jubilant and demanded a keg of beer, which was willingly furnished. The beer drank, the men again resumed their work, but all to soon exhausted the promised mine.

In one opening located on the S. ½ of the S. W. ¼ of the S. W. ¼ of Sec. 7, T. 47, R. 28, the Michigan Iron Company mined out about 2,000 tons of ore, which they used chiefly in their own furnaces. The opening is 100 feet long by 22 feet deep, and has a trend S. 30° E., which corresponds to the strike of the formation. Near the center of this opening the

CONRAD IRON COMPANY,

which was organized in 1880, sunk a shaft last year to 38 feet below the bottom of the old opening, or 60 feet below the original surface. The shaft inclines to the northeasterly on an angle of 70° from the horizontal. After sinking some 18 feet of the shaft they drifted about 14 feet to the southeasterly and then carried this entire length down with the shaft, forming a chamber, including the shaft, of 20 feet long and, say, 30 feet high. On the northwest side of the shaft it was all rock (quartzite and soapstone), but to the southeast side, at the far end of the chamber, it was 12 feet wide, all ore, it was claimed, except one two-foot run of rock. The larger portion of the ore is a granular-specular variety, containing considerable magnetite, also finely disseminated chlorite. The other variety is porous, rather soft, brownish-red hematite ore. They have taken out of the shaft about 200 tons of the above ore.

Early last fall the Davids brothers traced the vein and sunk a test pit about 500 feet southeasterly from the above-described opening, and discovered a ledge of fine-looking specular slate ore. They supposed they were on the N. E. ¼ of the N. W. ¼ of Sec. 18, but when a survey was made it was found that the test pit was located 25 feet across the line on the N. W. ¼ of the N. W. ¼ of Sec. 18, the property of the Conrad Iron Company.

The strike of the formation here is S. 75° E. and the average dip is 55° to the south. The foot wall is a quartzose rock, impregnated somewhat with chlorite.

At the date of my last visit, February 21, there was a trifle over four feet of ore in sight in the shaft, measured at right angles to the dip, but a drill hole had been put into the hanging wall side some 10 or 11 feet on a downward angle of about 10°, and it was claimed that it was all in ore. A cross-cut drift which they propose driving into this new discovery will soon determine this question. The ore in the bottom of the shaft was in three or four strata, which were separated by soapstone varying in thickness from one inch to one foot. The aggregate thickness of the runs of ore have gradually increased from the surface down, and from present appearances promises fairly good, but it would not surprise me if the lenses proved small.

The Davids brothers, after finding that the discovery they had made was not on their own property, proceeded at once 50 feet further east, and there sunk another test pit, this time on their own leasehold. Their shaft was down, February 21, about 45 feet. Some days they have from two to three feet of specular slate ore and again within a few feet it pinches out entirely. The present season will be an interesting one in the history of this range.

NORTH RANGE.

This north or middle iron range is considered the eastern extention of the Michigamme east of Michigamme lake, and the eastern extension of that portion of the Ishpeming range west of the Excelsior mine. For several years past the existence of this middle range has been generally believed in, but exactly where it passed was not so well known as now.

During the summer of 1879 Messrs. O. J. & M. E. Davids discovered hard specular ore of a superior quality on the present site of the Boston and Sterling mines. The openings of these mines are located about one and one-half miles northeasterly from Clarksburgh on the south half of the southwest quarter of section 32, T. 48, R. 28. In the winter of 1879–80 Messrs. J. C. Morse, James Pickands, and others obtained a lease of the M. H., & O. railroad company of the east half of the southwest quarter and the west half of the southeast quarter of section 32, and began soon after systematic explorations on the same. After digging a number of test pits and sinking a couple of shafts several feet down into the ledge, they felt warranted in availing themselves of a proviso in their lease which entitled them to a purchase of the property by an appraisal. This done the "Boston Mine" as a company was organized.

Explorations were now continued on a more extensive scale. Wagon roads were built, an ore dock 100 feet wide by 300 feet long was constructed, side tracks were graded, 5,000 cubic yards or more of earth were removed to uncover about 250 feet of the ore vein, buildings were erected to accommodate the miners, and such other work performed as is necessary on an entirely new mining location.

The strike or general trend of the ore vein and the associated rock is N. 75° west, and the dip is 80° to the south. The vein or stratum of ore at the surface of the ledge varied in thickness from one to six feet, but in the present workings it is from six to fifteen feet. The greater portion of the ore is a fine, steely-grained bluish-colored, hard specular, which averages high in metallic iron, is low in silica and contains the smallest percentage of phosphorus of any ore yet discovered in the Marquette iron district.

The following are all the analyses of the ore that the company have in their possession:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Metallic iron	67.12	67.70	67.75	67.357	69.02
Phosphorus	.027	.017	.015	.016	.018
Silica	1.40	1.35	1.19	-----	1.15
Insoluble residue	-----	-----	-----	3.785	----

No. 1, samples taken by myself across the vein at the surface as an average; No. 2, some 50 pieces taken from the stock-pile by Messrs. Tuttle & Co. as an average; No. 3, some 250 pieces collected by D. H. Bacon, superintendent of Cleveland mine as an average of stock-pile and mine; No. 4, by Lucy Furnace Company; No. 5, by Wheeler Iron Company. First three analyses were made by myself.

The above analyses show how well the ore is adapted to the manufacture of Bessemer steel pig iron.

The hanging wall of the vein is a gray quartzite, very similar to that of the Champion and Michigamme mines, and the foot walls is a banded jasper. Prof. R. Pumpelly, in charge of the mining department of the United States geological survey west of the Mississippi river, this winter examined carefully the Boston and Sterling mines and their associate rocks, and pronounced them identical with those of the leading hard ore mines of this district, which view entirely corresponded with my own.

Actual mining was begun at the Boston mine with a small force of men about the middle of May of last year.

The Marquette, Houghton & Ontonagon Railroad Company, as soon as they were satisfied that the Boston and Sterling mines were of a permanent character, began the construction of a branch, two miles in length, to these mines, and on August 23 the first train reached the ore dock at the Boston mine. At this date the Boston mine had about 3,000 tons of first-class ore in stock pile. Before the close of navigation the shipments aggregated 6,478 gross tons. Since that time they have put in a large tubular boiler and hoisting engine, with four four-foot drums. Two of the drums are Merritt's improved internal friction, which for simplicity of construction, adaptability to the work required, and ease with which they are operated under all conditions, are certainly ahead of anything of the kind which has yet come under my observation.

The ore vein on the Boston mine property has been explored and found good for 600 feet or more, and has been traced to the east with the dip needle and solar compass for as much farther. The mine at present (March 1) employs 50 miners, and is taking out daily over 100 tons of first-class ore. The main shaft is over 80 feet deep, which affords two 25-foot stopes to the east and a 30-foot stope to the west. The product for this season will probably reach 15,000 tons. The officers of the company are J. C. Morse, President; Alex. Grant, Superintendent.

THE STERLING MINE

adjoins the Boston immediately to the west, and embraces in its lease the W. ½ of the S. W. ¼, Sec. 32. The workings of the two mines are separated by a pillar of ore only. The ores, therefore, as well as the associate rocks are the same. Operations were begun there by the lessees, Messrs. A. Kidder, of Marquette, and J. Outhwaite, of Cleveland, in the spring of 1880, but have not been conducted on such an extensive scale as at the Boston mine. Their present opening is about 70 feet long by 40 feet deep. Mr. Kidder is now sinking a boiler iron caisson, five feet in diameter, in the swamp 200 feet on the strike of the vein from their main opening. The ledge at this point is 28 feet below the surface, and it is proposed that when the caisson is down to the ledge to keep the water pumped out, and then to sink a large, well-timbered working shaft. The result of this undertaking will be noted by our mining men with considerable interest, as many of them have the same problem to solve. The task, however, is in good hands, and I shall be greatly surprised if Mr. Kidder, with the assistance of Capt. James Pascoe, of the Champion mine, does not bring it to a successful issue. The company intend to put in hoisting machinery this season and to increase their mining force so as to make a fine shipping record for 1881. The shipments for 1880 were 1,198 gross tons.

For the past three year or more considerable exploring has been done between the Boston and Excelsior mines by the Iron Cliffs Company, the Davids Brothers, C. F. Conrad and other, but as yet with no satisfactory results. The Union Iron and Steel Company is now exploring with the diamond drill, the west half of Sec. 3, and the east half of Sec. 4, T. 47, R. 28, or about two miles easterly from the Boston mine. Its intention is to explore the property by completely cross-cutting the formations with a series of diamond drill holes. The formation has an east and west trend and the dip is nearly vertical. The latter feature is rather unfavorable to the above plan operated from the surface.

West of the Sterling mine a couple of miles other parties are exploring on Sec. 36, but the results as regards iron ore are, so far, of a negative character. Six miles to the west and one mile to the north of the Boston and Sterling mines is the Dalliba mine, which is now being opened by the

DALLIBA IRON MINING COMPANY.

The property includes the S. ½ of the N. W. ¼, and N. ½ of the S. W. ¼ of Sec. 29, R. and T. 48, Michigan.

Extending through the south half of the above last described eighty, in an east and west direction, is a wide shallow valley which descends gradually to the west. Explorations were begun on this property about a year ago; several test pits were sunk which demonstrated the fact that the south side of the shallow valley was underlaid by a deposit of hard hematite and brown iron ore, which averages well in metallic iron, is low in silica, but contains too much phosphorus for Bessemer steel purposes. The formation has a strike of nearly east and west and dips apparently to the north, but at what angle it is impossible to say.

The present workings (March 28), consist of an open pit 160 feet long east and west by 75 feet wide. The opening varies in depth from 7 to 15 feet, which represents the amount of earth covering resting on the ledge of ore. No attempt has been made to break any ore. The ore pockets and engine house are located on the south side of the opening. A branch from the M., H. & O. R. R. will come in from the west and pass along the south side of the pit. The skip roads, now in course of construction, will extend from the pockets down into the pit, and as soon as these are in operation it is purposed to sink a skip road cut into the ore of sufficient depth to afford workable stopes to either side of the skip road. The bottom of the pit is about 60 feet across north and south, and is composed, as far as can be seen, of ore and rock, the former, however, predominating. The stripping will be carried on with the mining of the ore

during the shipping season, so that the mine can ship several thousand tons of ore this season. The officers of the Dalliba Iron Mining Company are President, James H. Dalliba; Secretary, W. S. Pollock; Treasurer, D. Z. Norton; Agent, Ed. A. Skinner.

About two-thirds of a mile west of the Dalliba mine is the first opening of the

NORTHAMPTON MINE.

This opening is near the center of S. E. ¼ of Sec. 30, R. 29, T. 48, Michigan. The mine is being opened by the Champion Iron Company. It was purchased by this company about a year ago from the Morgan Iron Company. The owners are now busy removing the earth, which varies from 3 to 6 feet in depth from the ledge of ore. The ore is very similar to that of the Dalliba mine. Four hundred feet to the west of this work is the main pit of the Northampton. The opening is 130 feet long, east and west, by 60 feet wide. From one small stope about 2,000 tons have been taken out. Near the northeast corner of the pit a shaft has been sunk 30 feet into the ore. The entire bottom of the pit is nearly all ore. The strike of the formation is about east and west, and the dip apparently to the north. A short distance to the southwest is located the engine house, now (March 28), nearly completed. It is purposed to erect ore pockets at the west end of the main opening along side of the M., H. & O. branch, and from there to run the skip down into the pit. The outlook of this mine is very good, and should the demand for this class of ore warrant it, a large amount of ore can be mined and shipped this season.

With the Boston and Sterling mines to the east, the Dalliba and Northampton to the west, it will be surprising if that portion of the north range between these points is not pretty thoroughly explored in the near future.

THE CHAMPION MINE (MAY 1st).

This mine comes to the front as one of the leading mines in the district and proves its name to be no misnomer. Its output in 1880 of 112,408 tons, with the certainty of increasing the yield the present year to at least 150,000 tons, places this mine only fourth in the list in point of production, of the iron mines of the district. The Champion Iron Company was organized under the general mining laws of Michigan in 1869, with a capital stock of $500,000 divided into 20,000 shares. The mine is situated on the south half of section 31, T. 48, R. 29 W., at an elevation above the M. H. & O. R. R. at the Champion depot, which is about a mile distant to the northeast from the mine, of 130 feet. The surface appearance about the mine is unusually pleasant. A number of attractive dwellings are to be seen, with handsome yards and well cultivated gardens. From the elevation at the mine a fine view is presented over the surrounding country. An excellent road connects the mine with the railroad depot, bordered the entire distance with a substantial plank sidewalk.

The discovery of the mine was made in 1867, and a small amount of ore was mined and shipped the following year. The strike of the formation is east and west and the dip is 80° to the north. The ore, which is of the finest quality of magnetic and specular slate, is found in lenses lying between the quartzite on the north and the greenstone on the south, a space of about 140 feet. The north lens, adjacent to the hanging wall, was until a few years ago supposed to constitute the main deposit of the mine, until drifting and the diamond drill revealed the existence of the lenses to the south. The value of the

diamond drill in mining exploration is illustrated by its use in this mine. The shafts, of which there are eight, are sunk in the deposit, near the hanging wall, and the successive levels are at a distance apart of 60 feet. The surface shows less of the great artificial chasms to be seen on many of the large mining locations, the mining work having been early conducted underground. The lenses of ore to the south are reached by cross-cuts, in which are laid the tracks for the tram cars. The mine is now yielding 400 tons per day and the force employed averages about 350 men.

The walls of the belt in which the ore occurs are quite regular, the intervening space being occupied by the lenses of ore, mixed ore and rock, and masses of chloritic schist. As before stated, the mining, until within a few years ago, was carried on in the ore immediately underlying the hanging wall, until the diamond drill penetrating what was supposed to be the foot wall, discovered the lenses to the south. In exploring in this direction the drill is withdrawn as soon as it reaches the greenstone; and in one part or another of the mine it is kept constantly at work. The south lenses have a northeast inclination to the main or north lens, which latter is parallel with the quartzite.

"A" shaft, the most westerly one, is worked out, unless future exploration shall discover some hidden deposits at present unknown. No. 1, 500 feet west from "A" shaft, is opened down to nearly the third level, but is now idle; a diamond drill boring inclining to the north at an angle of 45° from the bottom of this shaft struck a fine lens of ore, and a shaft has just been sunk to it. No. 2 shaft, 300 feet to the west, is down to the sixth level; a diamond drill hole to the east from this level, after passing through 117 feet of barren ground, struck a lens of ore, which is probably the same that was intersected from No. 1. Three lenses of ore are worked to the south of No. 2, which are reached by four cross-cuts. The north deposit has an average width in the fifth level, from No. 2 shaft, of about 25 feet. A southeast deposit, reached by a cross-cut 110 feet east from the shaft, in the third level, has a length of 100 feet and a width of about 30 feet. Another south deposit, nearer the shaft, is reached by cross-cuts in the fourth and fifth levels. The productive portion of the mine, at present, extends east of No. 2 to No. 5 shaft, the greater proportion of the ore being hoisted from No. 3 shaft, near which it is mined, and which is 200 feet west of No. 2. The ore at No. 3 is mainly got in the sixth, seventh and eighth levels, though the shaft is down to the ninth level, 540 feet from the surface, though the skip road only reaches the eighth, the hoisting from the bottom to the eighth level being done with a bucket and derrick. In the sixth level the ground to the west has been stoped out a distance of 238 feet, the vein showing 40 feet wide; to the east there is also no standing ground. The length of the opening in this direction is 160 feet. Of the south deposits there are two lenses reached from No. 3 shaft by cross-cuts in the sixth, seventh and eighth levels; one of these lenses starts from near the surface east from No. 2 shaft and extends downward, inclining to the west, reaching the plane of the shaft at about the eighth level. The other, a much larger deposit, which has contributed greatly to the production of the mine, is first reached by a cross-cut in the fifth level, just east of the shaft. In the sixth, seventh and eighth levels the cross-cuts to this deposit are near the west side of the shaft. Two winzes sunk either way, 30 feet from the shaft, connect the seventh and eighth levels. The former level is opened to the west 200 feet, and the vein in the stope at the end shows a width of 40 feet; to the east in the same level the drifting in the vein has reached a distance of

150 feet. In the eighth level the opening extends about 80 feet west and the vein has an average width of 42 feet. A cross-cut to the south leads into a deposit of equal magnitude. The walls of the chamber, which has been formed by removing the ore, are being taken down on the east, south and west sides, and the ore trammed through the cross-cut to the skip.

The ore, while dipping to the north, pitches to the west, and gives every indication of increasing width and of indefinite extension in this direction. The lens of ore recently struck by the diamond drill from No. 1 and No. 2 pits, undoubtedly conforms in direction to the westerly lenses and underlies them. The discovery of this lens greatly enhances the value of the mine, since giving greater extent of working ground and showing that lenses may be found approaching the surface at the east, and while dipping to the north pitch also to the west, having a good width and being persistent in depth.

From the bottom of the pit east of No. 4, 250 feet below the surface, a downward drill hole showed, after passing through 158 feet of rock, 86 feet of ore. This is about 320 feet west from No. 3 shaft and shows that the shaft is in a deposit that will keep its machinery employed for some time to come. No. 4 shaft is 420 feet west from No. 3. It is sunk partly in an open pit that has been worked out from the surface. The shaft is sunk to the sixth level. In the fifth level the ore has been mined out to a distance west of the shaft of 246 feet to a heading of mixed ore. Above this level the ore has all been taken out. In the sixth level they are mining in a stope 200 feet west from the shaft, the vein being 30 feet wide. No. 5, 350 feet west of No. 4, is mined out to the fourth level. The shaft is part way down to the fifth level and 100 feet west of the shaft a winze has been sunk in the ore the depth of a level. The vein shows a width of about 20 feet. No. 6, 150 feet west of No. 5, is only down to the second level, 120 feet, is really a surface winze. West of it the ore is of mixed character, not suitable to mine. Between No. 2 and No. 7,—which latter is the most westerly pit,—a distance of 680 feet, there is a surface outcrop of ore 30 inches wide, but the ground has not been opened. The bottom of No. 7 is 130 feet below the surface, but the deposit has been worked out, leaving an underground opening 200 feet long, 100 feet high, and 20 feet wide. In the fourth level, reached by Nos. 2, 3, and 4 shafts, there has been mined out a total length of 700 feet and an average width of 26 feet. In the fifth level, reached by Nos. 3 and 4 shafts, the length of the opening is about 400 feet and 36 feet wide. In the seventh level, reached by No. 3 shaft, the width becomes about 40 feet, and in the other about 42 feet.

In the working part of the mine, Nos. 2, 3, 4 and 5 shafts, there is an abundance of ore in sight, and the stopes are admirable arranged for facility of mining and securing a large product. The appearance of the mine certainly indicates rare skill on the part of the Superintendent, Capt. James Pascoe, who, for the past seven years has had charge of the mine. Just now they are complaining of the accumulation of ore at the mine, which the railroad fail to remove. A branch from the main line reaches the mine from the east.

The machinery at the mine impresses one as being amply sufficient for the purpose required.

The hoisting apparatus comprises six drums of 7-foot diameter each. Placed in No. 1 engine house and worked by the same engines which operate these drums, are two Delamater 14x40 inch compressors, and a duplex Rand compressor with 10x20 inch air and steam cylinders. The power drills comprise eight Waring, 15 Rand and two Ingersoll, Capt. Pascoe preferring the latter.

The freedom of the mine from water shows the effectiveness of the pump by the large engine in No. 1 engine house. The necessary machine shop, carpenter shop, etc., the machinery of which are operated by steam power, are also included in the surface plant.

Undoubtedly the prosperous career of this mine and the present favorable condition of the company's affairs, are largely due to the excellent management of the agent, Mr. A. Kidder, who, to business talents of the first order, adds a good degree of skill acquired by many years of experience in mining affairs.

KEYSTONE MINE.

About one-half a mile east of the Champion is the Keystone mine. This mine was first opened by the Keystone Iron Company, during the winter of 1872–73, and in 1873 12,701 gross tons of ore were shipped. For the next three years, owing in part to the panic of 1873, the mine was not worked very strong, but in 1877 it shipped 14,496 tons of ore. The past two years it has been worked by the Saginaw Mining Company under a lease from the Keystone Iron Company.

The outlook of the mine to-day (March 28) is not very bright, but I hardly think it just to attribute this condition altogether to the mine itself. The formation is a little irregular, but it appears to me that with a liberal and systematic use of the diamond drill, a good, paying mine might be developed on this property.

Nos. 1, 2 and 3 shaft are all on the same vein. No. 1 shaft, the most easterly one, is 150 feet deep. For the first 120 feet down it is stoped out to the east only 20 feet, but to the west it is stoped out to 65 feet. The vein varied from 6 to 12 feet thick, and to the east of the shaft it became very narrow and the ore mixed. Below the 120-foot level the vein narrowed and in the shaft was only two feet thick. One hundred and seventy-five feet west of No. 1 is No. 2 shaft. Down to the bottom of this opening, a distance of 130 feet the ore is stoped out 100 feet to the east and 150 feet to the west. The vein of ore varied from 2 to 6 feet wide. Again 230 feet west of No. 2 shaft is No. 3. This is the only shaft worked at present. The first 75 feet of this shaft is sunk vertical, but the remainder of the distance, 150 feet, it pitches to the west on an angle of 45° degrees from the horizontal.

In the bottom of the shaft the vein of ore was 12 feet wide, but it proved to be only a short lens, for within 10 feet to either side it narrowed to less than three feet. To the south of Nos. 1 and 2 shafts, 200 feet, a new discovery was made the past season, which for a time promised large results. Considerable work has been done at this point. The present opening is 75 feet long, southeast and northwest, and is 50 feet wide by 40 feet deep at the lowest point. The ore on the surface of the ledge was from 30 to 40 feet wide, but now in the bottom it is only 6 to 10 feet wide. Whether this new find is a spur from the main vein or is a part of the same separated by a horse of rock is not determined. The question has an important bearing on the future of the mine, for if the latter is the case the two deposits will probably unite as depth is attained, or possibly in the direction of the strike.

The ore of the Keystone is very similar in appearance to the Champion mine but contains considerable more phosphorus and will not average so high in metallic iron.

MICHIGAMME IRON COMPANY.

The Michigamme mine is situated on the north side of the west end of the lake of the same name, on the south half of sections 19 and 20, T. 48, R. 30, the company owning here a body of land comprising 1,400 acres.

The mine openings are in the side of the bluff, which descends from the greenstone ridge on the north to the lake, the formation dipping to the south at an angle of 60°.

The company was organized in the winter of 1870–71, and began work in the following year, commencing the shipment of ore immediately upon the completion of the railroad, and of the ore dock at L'Anse, which latter work was accomplished in 1873, the company shipping that year 29,107 tons. The previous year, however, there were sent away 141 tons.

One of the first operations of the company was the building of a saw mill, supplied also with planer, machinery for the manufacture of sash and doors, etc. This was done partly for the purpose of facilitating the construction of houses, increase the sale of lots, etc., on the plat which the company laid out at the west end of the lake, adjacent to the mine. The village grew with exceeding rapidity, attaining, in a few months' time, a population of nearly 1,400.

Very sanguine expectations were at that time entertained regarding the future yield of the mine, some of the more hopeful believing that it would rival the Republic; but while these too large anticipations have not been realized, the mine has nevertheless annually given a reasonable return, and has ever maintained a favorable outlook.

The veins or lenses of ore, which were first worked in the west part of the mine, have not possessed great degree of width, and have lacked persistence in length and in depth; the quartzite has too frequently come in to cut off or to dislocate the deposits. As a consequence, this portion of the mine is now practically abandoned; all west of No. 4 shaft is idle. The old mine, that has cost a great deal of money to make, is apparently exhausted, and in working to the east the company are in reality opening a new mine, which will afford an extent of vein, between No. 4 and No. 1 (the Barnum) shafts of 800 feet. Two sets of operations are thus necessitated at the present time, the carrying forward of the new openings and getting out the annual product of ore. When the new shafts are completed and furnished with skips, and the vein sufficiently opened for stoping ground, the mine will be in admirable shape. The width of vein that can then be worked will enable the company to double its annual product. The main portion of the product is now obtained from No. 4 pit, in the fifth and sixth levels. In the fifth level the vein is opened to a distance, to the east, of 260 feet from the shafts, the opening showing a width of from 20 to 40 feet. No. 3 shaft is lowering to meet this level, when it will be used for hoisting also. Between No. 4 shaft and the head of the drift to the east is a winze furnished with skip worked by a small hoisting engine and drum, which runs the ore up to the level above, whence it is trammed to the shaft.

To the west of No. 4, 250 feet, the vein is cut square off by a heading of jasper which extends down from the surface. The vein has been recently opened to the sixth level, 380 feet down, and drifted each way in it a distance of 50 feet. The hanging wall is widening out, while the foot wall preserves its uniform angle, thus increasing the width of the vein with the increase in depth. From this shaft they are now hoisting about 150 tons per day.

No. 3 will soon be ready for the skip road down to the fifth level, and No. 2, still further to the east, is down about 200 feet, and at this depth they are now stoping in a very wide portion of the vein, the opening showing a width of 30 to 40 feet and a length of 75 feet each way from the shaft. The stopes at the heads of the drift are equally wide, as is also the bottom. No 1 is sinking at an angle of 60° to the south to the vein, which is 138 feet below the surface and 27 feet in thickness, as shown by the diamond drill. The shaft has just reached the ore and a drift will be cut to the hanging wall, when a level will be sunk in the ore and the shaft carried down to it against the hanging wall.

The ore is the best quality of specular and magnetic. In working eastward the mine is gradually approaching the lake, and it is possible that in the course of time it may extend beneath it. The shafts are all worked and the hoisting will continue to be done from the main engine house, which is a substantial, commodious stone structure, supplied with a hoisting engine 28x36 inches, four winding drums eight feet diameter, six feet face, capable of holding 1,300 feet of one and one-eighth inch wire rope. The machinery was manufactured at the Hodge Works, Detroit. In this building are also placed the compressors—one National duplex, 16x24, steam and air cylinder, and one 14 inch Delamater.

The pumping engine is 14x26 inches, Corliss pattern, working two six inch lifting pumps; 1,800 feet of wire rope are required for the transmission of the power from the engine to No. 1 shaft; two diamond and 13 power drills are employed, and the boilers comprise two large stationary and two portable. The company employs about 200 men, as industrious, quiet, effective force of laborers as can anywhere be found.

The general oversight and direction of affairs is under the supervision of Mr. J. C. Fowle, who has been on the ground, in the company's service, since the first blow was struck, three years as cashier and five years as superintendent. The working of the mine is in the immediate charge of Capt. Christopher, who has held this responsible position for five years past, and has shown himself competent for the duties devolved. In fact, the working of the mine, the plans for its extension and future development, and everything pertaining to the company's affairs, as seen about the location, betoken excellent skill and management, and lead one to entertain a high opinion of the business and mining abilities of the superintendent and mining captain. The present officers are Hon. Wm. H. Barnum, President, Lime Rock, Conn.; James Rood, Secretary and Treasurer, Chicago, Ill.; J. C. Fowle, Superintendent, Michigamme, Mich.

SPURR MOUNTAIN MINE.

This unfortunate company that began working in 1873 with such extraordinary promise, obtaining from the mine the first year 31,933 tons, and the following year 42,068 tons of ore, came to a total collapse in 1878, through what is generally held to have been the mismanagement of those who had its affairs in charge. The mine is situated on the S. W. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of Sec. 24, T. 48, R. 31, being distant nearly two miles west from the Michigamme mine. The mine was opened a distance east and west on this vein of about 1,000 feet, and with four shafts or pits having a depth of from 50 feet to 200 feet. The machinery, still in place, comprises a hoisting and pumping engine and four winding drums, four feet in diameter. The mine has been recently sold on a mortgage and bought in by the mortgagés, who have reörganized the company and resumed work at the mine. The work is in charge of Mr. A. C. Davis, well known in the copper district as an experienced mine agent. At this date, June 10th, the mine is nearly full of water. The parties owning the mine are residents of Detroit, Mich.

CASCADE RANGE.

PITTSBURG AND LAKE SUPERIOR IRON COMPANY.

This organization, recently formed and now nearly perfected, includes the franchise and holds the realty of the company heretofore known under the name, together with the mines and lands that were owned by the old Cascade Company. In all the new company own in fee simple upwards of 21,000 acres of land. The Palmer, as it has been called is the only one of the company's mines that is now working at what is known as the Cascade. This mine has proved successful and seems likely to become of increased value. Through the sale of its products and by an economical administration of the affairs of the company Mr. Kirkpatrick, the agent, has been enabled to pay every dollar of the $220,000 of indebtedness which was assumed at the time of the resumption of operations, so that now the new company, owning an immense landed estate, a well equipped and productive mine, a large number of houses and other buildings at the location, etc., are free, as Mr. Kirkpatrick states, of any indebtedness whatever. The "Palmer" is the most westerly of the mines that have been opened on the Cascade, and is the only one that has furnished merchantable ore in any considerable quantity. The mine is furnished with three working skip roads descending into open pits and thence extending underground. Three of these incline to the east, following the foot wall at an angle of 55° in a pit that runs north and south, being about 250 feet long. At the south end of this pit the formation bends to the east and the dip is to the north, and in this easterly pit is the fourth skip, descending in like manner beneath the surface after reaching the bottom of the open portion.

The underground workings are now extended 300 feet from the surface, measured on the inclination of the vein. The average width of the workable portion of the vein in the north pit is about 27 feet; in the east pit it is narrower, but is again widening out to the east, and promises to become of equal dimensions to the west portion. The vein possesses a good degree of uniformity in regard to the quality of the ore, and its walls are well defined, hard and firm. The ore is a specular slate and granular specular, of a quality so good that it is rapidly redeeming the bad reputation which the ore of this range have unfortunately possessed in the eastern markets. Mr. Kirkpatrick is now at work with a diamond drill exploring the ground east of the mine for the purpose of proving the vein in that direction. It is more than probable that the deposit of ore will be found in this level ground between the foot wall bluff of jasper rock on the south and the parallel range of quartzite lying two hundred feet to the north. The drill has only recently been procured and the working of it just begun.

The average daily product of the mine is now 150 tons of ore, which is transported to Escanaba over the N. W. R., a branch of which comes into the Cascade, and extends westerly to the Saginaw and to the other mines of that range. An excellent highway connects the mine with Negaunee, which is four miles distant to the north.

The company employ 200 men in the mine and about the location, and have 93 good dwelling houses for their occupation. A good store, meat market, etc., are also conducted by the company, and are kept supplied with everything necessary for the wants of the population, and the materials thus dispensed are furnished to the people at as low a cost to them as they can procure those articles elsewhere. Mr. Kirkpatrick states that his invariable practice is to buy everything procured for cash, and thus endeavor to secure his goods and other materials at the lowest possible price.

As predicted in the Commissioner's report of 1878, the output of the mine nearly reached to 40,000 tons in 1880, and in the present year will doubtless exceed that amount.

The four drums which hoist and lower the skip cars in the shafts, by wire rope transmission, are placed in the same building with the engine which operates them. Two large boilers supply the steam.

The office of the company is at the location, Cascade, Mich. Joseph Kirkpatrick, Esq., Managing Director and General Agent.

THE WHEAT IRON MINING COMPANY.

This company hold on a lease secured from Dr. Wick, of Cleveland, Ohio, the S. E. ¼ of Sec. 29, T. 47, R. 26, adjoining the Lake Superior Iron Company's location on the east. The mine was first worked, to a slight extent, in 1873, producing like the other mines on this range worked at that time a small amount of ore of an inferior quality.

Recently the lease of the property, as above indicated, has been secured and mining work resumed by the new company under the intelligent supervision of Mr. Amos H. Wheat, who has had a previous experience in mining on this range.

The mine work now being prosecuted is on the north half of the quarter section, at about 200 feet south of the branch railroad track which reaches the mine. The formation here, for a short distance, runs north and south, and then to the south makes an elbow and extends east and west, the former, probably, being a spur of the general trend, which is east and west.

A pit has been opened in the foot wall where it dips to the west, and is down in the ore a distance of 40 feet; to the west, about 100 feet, a vertical shaft has been sunk which is 60 feet in depth and has reached the ore. Further to the south, 150 feet distant, a shaft had been previously sunk, also on the foot wall, but dipping to the north. This shaft is down 75 feet, and from it considerable ore has been hoisted; the vein in this shaft is about 14 feet thick.

An engine, two small winding drums and a pump are now on the ground and will soon be in place and put to work to supersede the primitive method by bucket and windlass now being used.

The ore is similar to that of the Palmer mine, and is carefully selected and picked over, so that the shipping product is of an excellent quality; an analysis made by the commissioner, of average specimens selected by Mr. Wheat, gave a little over 65 per cent metallic iron. An analysis of a single specimen, made in Cleveland, gave 64 per cent. Mr. Wheat expects to ship, the present year (1881), 10,000 tons.

Further to the south, on the low ground, the company have also some hematite openings, but these are not now worked. Thirty-five men are employed, and sufficient accommodations provided for housing them. The officers are Daniel McGarry, President, Cleveland, Ohio; Thomas Axworthy, Secretary and Treasurer, Cleveland, Ohio; Amos H. Wheat, General Agent, Cascade, Michigan.

MENOMINEE RANGE.

FLORENCE MINE.

Since our report for 1879, a great change has been made in the appearance of this mine and in the immediate surroundings. At that date there was only one log house on the mine site and another rough board house about one-half mile to the east, on the west shore of Fisher lake. Between these two points is now the village of Florence. Many of the buildings are attractive and some of the streets are well graded. The hotels are excellent, a rare exception in some of our frontier mining towns.

The railroad track, coming in from the southeast, passes along the southwest side of the village and then curves around to left, passing to the north of the main opening of the mine and abreast of the ore pockets and docks. The railroad track at this point is 722 feet above Lake Michigan. On the north side of the track is a large stock pile of second-class ore which will probably be smelted in some future charcoal blast furnace in this vicinity. From the top of the ore pockets, 40 feet above the railroad track, a double tram road, 500 feet in length, leads south into the main opening of the mine. The mine is located on the north slope of an oblong shaped hill or short ridge.

The first that attracts attention in going into the mine through the open tram road cut is the deep sand drift overlying the ledge. This earth covering is fully 35 feet thick on the west side of this open cut. At the point where the cut intersects the vein of ore, and to the west side is a shaft sunk 50 feet below the tram road level. The strike of the formation is N. 55° W. and the dip 70° to the northeast. The shaft is therefore on the hanging wall side of what is known as the north deposit. The main opening is about 250 feet long by 150 feet wide. On the foot wall are series of hematite schists, and lean ore interstratified with some good ore. This is well shown in an open cross-cut trench on the south side which we mentioned in last year's report, and also in a drift driven 50 feet south into the foot wall from the tram road level.

In the main opening we have two veins of ore; the north one already noted is 35 feet wide opposite of the tram road cut, and the south deposit is 58 feet wide. These two veins are separated by a stratum of plumbaginous schist which is from 20 to 30 feet thick. The south side vein of ore is widening to the west, but how the north side will open out is impossible to say. They are now sinking an open cross-cut into it. In the south deposit a 20-foot stope, from the tram road level down, is being carried from northwest to southeast, taking with it the entire width of the vein. The upper edge of this stope is about 125 feet from the southeast end; midway between these two points and on the north side of the south vein a shaft has been sunk to 50 feet below the tram road level. From the bottom of this shaft a drift is driven north to con-

nect with the shaft on the hanging wall side of the north deposit. They are now sinking around the south shaft an open cut which will be gradually enlarged to the southwest. The water of this opening passes down the shaft and along the drift of No. 1 shaft, where it is pumped out. In the north corner of the main pit they are now sinking another small open cross-cut to 30 feet below the tram road level, and when this is done they will have a stope of ore of this height 35 feet wide.

The ore of the south deposit is nearly all of an excellent quality. It is becoming harder as they go down, and I am told averages somewhat lower in phosphorus than it did at the surface. I am also informed by furnace men who have used it that it is well adapted to car wheel or malleable iron purposes; that it smelts readily in the furnace and affords an easy working cinder. The ore of the mine is raised by means of four derricks, operated by four of Frazer & Chalmer's three-foot drums. To the northwest about 125 feet from the main pit, a shaft has been sunk through 50 feet of sand drift to the ore. Immediately south of the main pit the surface of the ledge, as can be seen on the exposed face of the foot-wall, has an elevation of 60 feet above the tram road level, but it pitches down to the north on an angle of about 30°. The surface of the ledge conforms in a measure to the contour of the hill, and at the northwest end of the ridge pitches to the northwest. It is very probable that the vein of plumbaginous schist separating the two deposits will cut out in depth. The mine employs at present about 200 men and should occasion require it could easily work many more without crowding the mine.

The Florence mine is operated by the Menominee Mining Company, who also own a three-fourths interest in the fee simple and have a lease of the other one-fourth for a term of years. This company also own in fee simple or lease the Chapin, Quinnesec, Cyclops, Norway, Vulcan, and Lowell mines. The respective products of these mines for the last year are as follows:

	Gross tons.
Florence	13,936
Chapin	34,556
Quinnesec	52,237
Cyclops	14,368
Norway	198,165
Vulcan mines	72,571
Lowell	14,571
	400,358

These mines are among the largest and best of the Menominee range and their shipments aggregated last year 70 per cent of the entire Menominee district. The mines of this company are for the most part in excellent condition. Everything about them betokens good management and thorough discipline. The remark is often made that the Menominee Mining Company has the "cream of the range." That the company has its share cannot be questioned. Too much credit cannot be accorded to Dr. N. P. Hulst for his good selections of mining properties and Messrs. J. J. Hagerman and A. C. Brown for having secured these properties to the company.

The officers of the company are: J. J. Hagerman, President, Milwaukee, Wis.; J. H. Van Dyke, Vice President, Milwaukee, Wis.; Geo. D. Van Dyke, Secretary and Treasurer, Milwaukee, Wis.; A. C. Brown, General Agent, Vulcan, Mich.; N. P. Hulst, General Superintendent, Vulcan, Mich.; Jeff. D. Day, Assistant Superintendent, Vulcan, Mich,

COMMONWEALTH IRON COMPANY.

This company own in fee simple Secs. 32, 33, 34, the S. ½ of Sec. 31 and the S. E. ¼ of Sec, 28, T. 40, R. 18, Wisconsin; also the N. ½ of Sec. 4 and N. W. ¼ of Sec. 5, T. 39, R. 18, Wisconsin. Within the past year the Chicago and Northwestern Railway Company have extended their Menominee River branch to the mine workings on Sec. 34, but owing to the elevation of the mine the main track passes about one-half of a mile north of the mine. A switch track, however, leaves the main line a short distance east of the Commonwealth railway station, and then on an ascending grade extends westward of the mine for say one-third of a mile, and then by means of a "Y" branch returns on an easterly course with a still ascending grade past the ore docks and pockets, located about 300 feet north of the main opening of the mine. The surface of the ground at the mine has an elevation of 1,000 feet above Lake Michigan. The top of the ore pockets is 38 feet above the railroad track. Opposite of the ore docks are three railway tracks. The first one nearest the mine is used for loading the cars from the ore docks; the second track for loading cars out of the pockets, and the third, or outer track, for a switch. By this method, the stock-pile men loading from the ore docks are independent of pocket men. This point is frequently overlooked at many of our iron ore mines.

There are now, May 1st, 17,200 tons of ore on the docks awaiting shipment, and to this they are adding a little more than 2,000 tons per week. The ore in stock pile looks well, and is quite free from rock.

Leaving the stock pile for the mine workings, we note on our way several tram road tracks leading to the stock pile, or to the waste dumps of rock and earth stripping. The removal of the earth from the ore ledge is now being vigorously pushed, so as to have as much ore uncovered as possible in advance of the mining, that the one may not interfere with the other. The strike of the formation is about east and west, and the dip varies from 65° to 70° to the south.

The mine at present consists of one large open pit, 238 feet long by 90 feet wide at the center. The trend of this pit is southeasterly and northwesterly, and is therefore diagonally across the formation. It is 40 feet deep on the north side, from the surface of the ledge, but in the bottom as we go south and west there are three stopes of ore which are now being carried from foot to hanging. In the bottom, on the foot wall side, are two shafts, 100 feet apart, sunk 30 and 35 feet. When the present stopes have reached a certain distance away from the foot wall the shafts will be enlarged and opened out to the east and west to form new stopes of ore for the next lower level. The ore is improving in quality as they go down; some of it in the bottom is very hard, has a bluish-black color, a velvety texture, and a conchoidal, splintery fracture.

The product of the mine at present is raised to the surface in large iron buckets by three derricks, operated by steam power, and are then swung around and dumped directly into tram cars. They are now erecting three more derricks. The three veins of ore of 36, 10 and 60 feet wide, noted in last year's report, are now merged into one, that is all of the same quality.

The hanging wall side vein of 14 feet, mentioned in last year's report, has not been reached as yet by the main open pit. About 200 feet west of the

main pit a cross-cut trench has been opened, exposing the ledge north about 400 feet to railroad track and south for 100 feet. One hundred and seventy-five feet south from the track was uncovered 32 feet of fine looking yellow ochre. Two hundred and sixty-two feet farther south was found 42 feet of ore similar to that of the main pit. This new find is located 200 feet west and 100 feet south of the main open pit. It is probably another lens of ore lapping onto the southwest end of the other, not touching it, however, but with a bar of rock intervening. The trend of this lens is probably a little to the north of west. I also believe that there will be found another lens of ore to the east and north of their present opening. If this should prove to be the case we may expect to find a series of lenses in going westward occurring about in this same order. The workings to the west of here, in Sec. 32, are nearly in the same condition as they were a year ago, little or nothing having been done there.

The development of the Commonwealth is still in a crude state, but for the amount of work done it is certainly the largest showing of ore on the Menominee range. After the mine is properly opened it can produce as much ore and as cheaply as any other mine in this district.

The mining plant of machinery consists at present of four of Frazer & Chalmers' wooden friction drums. They propose soon to put in several power drills, which will largely take the place of hand drilling. The officers of the Commonwealth Iron Company are as follows: President, Alex. Nimick, Pittsburg, Pa.; Vice President, W. U. Masters, Cleveland, O.; General Manager, H. A. Tuttle, Cleveland, O.; Secretary and Treasurer, W. H. Harvey, Cleveland, O.; Agent, W. E. Dickinson.

The company is to be congratulated for having secured the able services of Capt. Dickinson. They can be well assured that the mine will have, as far as lies in the power of an agent, full justice done it.

THE CHAPIN MINE.

another of the Menominee Mining Company mines, and like the Florence has changed "greatly" within the past year. A little more than a year ago five exploration shafts were being put down, but to-day it is the largest ore producing mine of the Menominee range within the State of Michigan. The ore, a soft specular blue variety, averages high in metallic iron and is low in phosphorus and silica, qualities which recommend it to the Bessemer steel trade. At the time of our visit (May 3d) there were 40,000 tons of first-class ore in the stock piles awaiting shipment.

The Chapin mine embraces the south half of the southwest quarter and the southwest of the southeast quarter of section 30, town 40, range 30, Mich. The mine is located on the northerly slope of a hill, and is just north of the south line of the southwest quarter. The drift or earth covering is very deep, averaging about 55 feet. The formation has a strike a little north of west. At the east end of the mine the dip of the formation is 75° to the north, but in the west end it is nearly vertical or a very little to the south, which latter I am inclined to believe should be the true course of the formation.

No. 1 shaft is the most easterly and No. 8 shaft the most westerly one. The workings are confined chiefly to Nos. 3, 5, 6, 7, and 8 shafts. No 4 shaft is to the north of a direct line between Nos. 3 and 5 shaft, and is used to lower timber into this part of the mine. The distances between the shafts are respectively as follows: From No. 3 to 5 it is 300 feet; No. 5 to No. 6 325 feet; No. 6 to No. 7 330 feet; No. 7 to No. 8 225 feet. The elevation of the collar or surface at each shaft about the railroad track abreast of the ore pockets, which latter point is 569 feet above Lake Michigan, is respectively as follows: No. 3, 100 feet; No. 5, 87 feet; No. 6, 68 feet; No. 7, 47 feet; No. 8, 35 feet.

In front of Nos. 6 and 7 shafts are two other shafts for lowering timber. The mine workings, owing to the heavy drift, are entirely under ground. We will begin our examination of these workings and go down No. 7 timber shaft to the second level, which is 45 feet below our datum* or 80 feet below the surface at this point. From the bottom of this shaft is a drift driven westward to connect with No. 8 shaft, and for 10 feet beyond it. The formation at No. 8 dips 80° to the south. Seventy feet west of No. 7 shaft is a chamber 20 feet wide, crossing, cutting the vein. It is now 28 feet long north and south, with chloritic slate on the south side and soft specular blue ore on the north. Directly north of No. 7 shaft is cross-cut drift 65 feet long, which is still in ore. The entire distance was in ore except a 3½ foot run of rock which the drift cut through about 30 feet from the shaft. West of the shaft a longitudinal drift is now in 100 feet. Ascending now the first level, 40 feet above the second, we find that no work has been done on this level to the west; we therefore go 50 feet southeasterly to No. 7 hoisting shaft. This shaft is to have a double skip road. Twenty-five feet east of No. 7 hoisting shaft is cross-cut drift driven south into a jasper; a short distance farther east is another cross-cut driven north. Nos. 7 and 6 shafts are connected on the first level by a drift 330 feet long. West of No. 6, towards No. 7, are four cross-cut chambers, which prove the vein of ore to be 55 feet wide. The first one is 30 feet west of No. 6, and is driven from the apparent foot on the south to the north. Each chamber is 20 feet wide, with 18 feet of unbroken ground between them. The ground is "very poor," that is, will not stand in the pillars, nor can it be trusted in the roof without being firmly secured.

The method of mining out the ore and timbering in this mine is known as the Nevada system. It may be briefly described as follows: A drift is first driven from the shaft along what appears to be the foot wall; a pillar or block of ground is then left on either side of the shaft from 20 to 30 feet thick. Chambers 20 feet wide, more or less, by eight feet high, are then started outside of these pillars and are mined out from foot to hanging. As soon as a chamber is opened ahead 12 or more feet, depending on the nature of the ground, a 12 inch flattened stick of timber is laid along the sides of the chamber; a "set" or "bent," consisting of a cross-sill, posts and a cap, is then set up across the chamber. These bents rest on the flattened subsills and are placed as near the breast of ore as practicable. Lagging timbers are then laid from one set to the other as the work progresses. The narrow space between the roof of the chamber and the top of the lagging is filled in as well as well as possible with wedges, etc., to prevent any giving way of the ground above. On the sides between the posts and the pillars it is closely laced up with lagging to protect the surface of the ore from the action of the atmosphere. An exposed surface of this ore very soon disintegrates and falls away. To mine the stope above this chamber the bents are put in in the same manner as below, and are placed directly over the lower bents. In this way the ore between the levels is taken out.

To continue, we go easterly on the first level 325 feet to No. 5 shaft. Immediately west of No. 5 shaft are four chambers now being worked out

*Datum is the level of track abreast of the ore pockets.

upwards. From the first level to surface at No. 5 shaft it is 92 feet. East of this shaft to No. 3 the usual system of supporting the roof by long stulls was attempted, but the result was a bad cave in of a portion of the walls and roof; fortunately, however, it did not extend to surface. The first level is terminated at No. 3 shaft by a heading of rock which comes down with a steep westerly pitch. We will descend now to the second level again. The dip of the formation at No. 3 is 45° to the north. Westward from No. 3 we pass first through a well timbered drift say 1,200 feet, and then past four chambers, which are just begun, to No. 5 shaft. Nos. 5 and 6 shafts are also connected on this level by a drift, but there is only one chamber, just commenced, and that immediately east of No. 6. West of No. 6 the drift extends 200 feet, which leaves between the easterly drift from No. 7, already noted a distance of 30 feet. There is only one chamber west of No. 6 on the second level. The shafts are being sunk to the third level, and it is the intention of the company to keep at least one level, with its drifts and cross-cuts, opened ahead. This will drain the water from the ground they are working upon above and no doubt but that it will then stand far better in the pillars and roof. The thickness of the vein of ore at Nos. 5 and 6 shafts is 55 feet, and at No. 4 shaft it is 30 feet wide, while at No. 7 shaft it is 65 feet wide at present, but no hanging.

The entire length of the workings from No. 8 shaft to No. 3 shaft is about 1,200 feet, and the difference of the elevation of the surface of the ground at these two shafts is 75 feet. In Nos. 3 and 6 are single skip road shafts. In No. 5 is an eight inch Cornish lift pump and a single skip road. No. 7 is to be a double skip road, and No. 7 timber shaft has at present a single drop bottom skip similar to the one already described in the description of the Republic mine.

Abreast and on the north side of No. 5 shaft is the head of a double incline tram road which transports the ore from Nos. 3 and 5 shafts down to the pockets or ore docks. The angle of this gravity road is only six degrees.

About 50 feet south of No. 5 shaft is the hoisting engine house. In the building are four five-foot umbrella friction drums and two Merritt's five-foot internal friction. West of No. 7 shaft is another building containing six of Frazer and Chalmer's 30-inch drums, which are used for sinking the shafts and winzes. Also west and south of No. 8 is a large engine house now in course of erection, which will contain a large plant of Lane's patent drums. The mine has machine, wood and smith shops; in fact all of the buildings required to operate a large mine, with perhaps the exception of some more dwellings to accommodate the miners with families.

The mine at present, May 2d, employs 670 men, and during the shipping season no doubt will increase the force to 800. Capt. Rundle, the mining superintendent, appears to appreciate the difficulties he has to meet in the mining of this soft ore with unstable foot and hanging walls, and no doubt will accomplish what he has undertaken.

The product for 1880 was 34,566 gross tons, and this season will probably reach 200,000 gross tons.

Diagonally across the valley to west and north about one-third of a mile are the now idle workings of the

LUDINGTON MINE.

This mine is operated by the Lumbermen's Mining Company. The ore, a soft blue specular when properly assorted, is of an excellent quality, but the lens-shaped masses of it, in which form it occurs, have thus far proved to be small.

The company are now engaged in putting down a series of diamond drill holes from south to north with a view of completely cross-cutting the formation from the mine workings south across their property. The mine site has a fine elevation above the valley. It is 138 feet higher than the railroad station at Iron City, or 687 feet above Lake Michigan. It is not reasonable to suppose that this mine has been worked out, or that its largest lenses have been found. The product for last year was 8,876 gross tons.

The next mine we visited was the

KEEL RIDGE.

This mine, under the management of the Emmett Mining, the present owners, has improved very much within the past year. We enter the mine now in an adit which is 47 feet above the branch railroad switch to the mine. To the right of where the adit intersects the vein is No. 2 shaft. From this shaft the adit level extends westward along the vein for 200 feet. Descending to the first level, 60 feet below the adit, we find little or no work done east of No. 2 shaft, but to the west is a high broad chamber. On the south side of this chamber is a vein of red ore 20 feet thick, and on the north side comes in a blue ore. Our chamber is very soon divided by the east end of a wedge-shaped horse of rock. They have now mined out the red ore for 35 feet west of the east end of the horse, and the soft specular blue ore for say 50 feet west along the north side of the horse. The vein of blue ore is about 14 feet thick, and the red ore, on the south side of this horse, 20 feet thick; but the south wall has not been touched. This horse of rock will probably cut out on the lower levels, or possibly the red ore may. The adit level, noted above, is driven in on the red ore vein and is therefore on the south side of the horse of rock. At the west end of this level 200 feet from No. 2 shaft a drill hole was driven north into the horse of rock, and within 35 feet it struck the blue ore. The formation in the mine has a strike of N. 75° W., and nearly a vertical dip. Captain M. Harrington, an experienced miner, is the mining superintendent. The future prospects of this mine are much better than they ever were before, and I understand that it is the intention of the company to develop the mine and get new stoping ground ready as rapidly as possible. The blue ore makes a splendid fix and for that purpose commands an extra price.

The location of the mine is very favorable for mining purposes. It is on the south slope of a side hill. The elevation of the adit above the main track gives an easy down grade to the ore pockets and ample height for the pockets. The hoisting plant is a small one, hardly sufficient for this season's work. To the east of the adit they are now putting down a diamond drill hole to prove the vein at a lower depth in that direction.

The officers of the Emmett Mining Company are; Samuel Kimberly, President; Geo. Boyce, Vice President; R. Williamson, Secretary and Treasurer; E. P. Foster, Agent; M. Harrington, Superintendent.

QUINNESEC MINE.

The surface surroundings at this mine remind one of some of the older Lake Superior mines where but few changes are made. The ore now (May 3) is all raised to the surface and then passes down the double inclined tram road to the pockets or docks as desired. Within the past year No. 4 shaft has been sunk to the third level. The shafts are numbered irregularly. No. 3 shaft, the most easterly one, is sunk on the foot-wall side to the sixth level, or 206 feet vertically below the surface level. No. 1 shaft, 150 feet west of No. 3 shaft, is also sunk on the foot-wall side to the sixth level. No. 2 shaft, 120 feet west of No. 1 shaft, is sunk on the hanging wall side to the fifth level. The collars of Nos. 1, 2, and 3 shafts are all on the same level, which is 118 feet above the railway station at Quinnesec, or 449 feet above Lake Michigan. The collar of No. 4 shaft, which is 300 feet west of No. 2 shaft, is 70 feet higher than those of the other shafts.

We will now go down No. 3 shaft and note what changes have been made in the underground workings. The third level is 93 feet, the fourth level 118 feet, the fifth level 156 feet, and the sixth level 206 feet vertically below the surface. The rock which the shaft cut nearly two years ago, between the fourth and fifth levels, has continued down. It pitches to the west on an angle of about 70° and as yet no ore worthy of mention has been found to the east of this heading of rock in the Quinnesec mine. On the sixth level the first ore is struck 30 feet west of the shaft. The drift continues to 70 feet from the shaft. A winze is sunk from the fifth to 6th levels at 30 feet west of the shaft which gives a fine stope of ore to the west of 20 feet thick and 40 feet high.

We go up the shaft now to the fifth level and pass over to No. 1 shaft, and find that the vein holds its width of 20 feet between these shafts. Descending again to the sixth level in No. 1 shaft, we have a drift driven 54 feet east; vein 20 feet wide with a narrow horse of rock near the foot wall side; another drift is driven 50 feet to the west. Vein for 30 feet west is 21 feet wide, but at this west point the hanging wall approaches the foot and narrows the vein to six feet wide. Ascending again to fifth level, we find that considerable ore remains in the roof of this level between Nos. 1 and 2 shafts. A drift extends west of No. 2 shaft 106 feet, and 30 feet from the shaft in the same direction is a winze connecting the fourth and fifth levels which gives a fine stope of ore eight feet wide by 38 feet high. On the fourth level, 100 feet west of No. 3 shaft a cross-cut drift was driven to the north into jasper on the hanging wall side of the vein, but within 20 feet a fine quality of blue specular ore similar to that of the main deposit was struck, and at this point north it is 20 feet thick. A chamber has been opened out in this north deposit and a drift driven east to nearly opposite of No. 2 shaft. The deposit, however, narrows to less than one-half its width in going east. What there is to the west of where the cross-cut crosses the north deposit is not known. Between the third and fourth levels to the west of No. 2 shaft some ore still remains.

On the third level for 200 feet west the ore is stoped away to roof under the tunnel level. Vein at third level averages about eight feet wide. At the west end of this a drift connects on the third level with No. 4 shaft. West of No. 4 shaft no work has been done. The shaft is now being sunk to the fourth level. The vein of ore varies here from 3 to 6 feet wide.

The Quinnesec vein, with its east and west strike, and dip averaging about 70° to the north shows now a decided pitch of the main body of the ore to the west. On the whole, there is fully as much ore in sight as a year ago, and its future prospects are apparently fully as good. The mining operations are ably conducted by Captain E. Marcom, the superintendent of the mine, and Dr. N. P. Hulst, the agent of the Menominee Mining Company.

Northwest from Quinnesec about four and one-half miles on the north side of Lake Antoine, and in the east half of the N. W. ¼ of section 20, town 40, range 30, Mich., is the

CORNELL MINE.

It is one of the most picturesque and attractive mining locations on the Menominee range. The wagon road from Quinnesec passes along the north shore of the lake. To the west across the lake is the railroad track skirting the shore in easy curves, to connect the mine with the main line. To the southeast is the west slope of Iron mountain, densely covered with forest trees, which, with their deep green foliage, form a strong contrast to the pine barrens on the west shore of the lake. On the north shore among the houses several trees have been left standing to break the cold winter winds and to afford an agreeable shade in summer. On nearly all mining locations the first object appears to be to destroy everything organic, and then after a year or so to begin and plant trees, or to replace in a small way what has been thoughtlessly destroyed.

The railroad track alluded to above comes in from the west side of the lake and continues along the north side on an ascending grade to the east of the location, and then returns by a Y switch in a northwesterly direction on a still ascending grade to the ore pockets and docks located to the south side of the mine workings. The railroad track opposite the pockets is 624 feet higher than Lake Michigan, or say 55 feet above Lake Antoine. Climbing to the surface level of the mine, 88 feet above Lake Antoine, we find the tram road tracks leading to the mine opening. On this upper level and between the ore pockets and mine are located the smith and wood shops and engine house. The hoisting plant consists of two of Merritt's four-foot internal gear drums, which give the best of satisfaction.

We will now pass on to the mine opening. Ore was first discovered here in the fall of 1879 by Captain John R. Wood, the present mining superintendent, and early last season it promised to rival any of the soft specular ore mines of the Menominee range. There was then a forty vein of ore at the surface of the ledge of an undetermined length; but now the outlook is not as flattering. The workings consist of one large open pit 300 feet long by 75 feet wide at the surface of the ledge, and 110 feet deep at its northwestern end. The strike of the formation is N. 55° W., and the dip 70° to the southeast. The surface stripping is about 25 feet deep. From the southeast end of the pit on the surface of the ledge, the bottom pitches down from this point to the northwest on an angle of 25°, and along this bottom to the lower end of the pit the vein of ore is from 2 to 12 feet wide.

In the northwest end face the lens of ore appears to be pitching under the heading of rock that lies above it, and a drift driven a short distance northwesterly and a winze at the end of it sunk 40 feet in the lay of the formation is looking very well. It is hardly reasonable to suppose that this is an isolated lens of ore, or that another will not be found near at hand, and when found the wonder will be why it was not discovered sooner.

NORWAY MINE.

The Norway is another of the Menominee Mining Company's mines. More open pit mining is done here at present than at any of the Menominee range mines. The surface workings and explorations extend from near the branch railway at the ore pockets to the northwesterly for a distance of more than a quarter of a mile. The general trend of the workings is N. 60° W. by the magnetic needle. The natural surface of the ground northwesterly from the ore docks ascends gradually for about 1,200 feet in that direction, and at No. 8 exploring shaft it has an elevation of 108 feet above the railroad track at the ore docks. The shafts and open pits are numbered consecutively from southeasterly to northwesterly. In describing the working we will assume for our datum or bench mark of levels the level of the railroad track abreast of the ore pockets which point is 430 feet above Lake Michigan.

No. 2 shaft, just east of the railroad, and about 100 feet west of the east line of this property, is sunk to the second level, 100 feet below datum. The first portion of the shaft is vertical, but the lower part of it is on an angle of about 60° to the southwest, which angle corresponds to the dip of the formation. On the first level, 60 feet below datum, is a drift to the east of the shaft 30 feet long which opens into a large chamber. In this chamber the ore is practically all mined out for some distance east beyond the limits of the Norway mine and also upwards on the dip of the vein. In the southwest corner of this chamber is a winze sunk to the second level. From this winze it is purposed to stope out the ore between the first and second levels, leaving, however, a strong roof or back of ore to support the hanging, and to prevent any fall of rock in the chamber from passing down to the second level. The vein of soft specular blue ore on this side of the shaft averages about ten feet thick.

On the first level a drift has been driven westerly. At 25 feet is a winze which is sunk to the second level, and ten feet beyond this is a fault in the formation which can be distinctly traced in the level below. The drift continues from the fault in a course of N. 60° W. for 170 feet, while a branch from it, leaving it a short distance from the fault, turns to the northwesterly and gradually curving to the right until it reaches a course of nearly, if not quite, due north. The latter drift is in 230 feet from the fault. The vein of soft specular blue ore to the northwest of the fault is very irregular. On the second level of No. 2 shaft drifts are driven to the southeasterly 60 feet, and to the northwesterly 70 feet. The vein of ore (Stephenson vein) averages about 10 feet thick, and between the first and second levels it is not stoped out. About fifteen feet easterly from No. 2 shaft a cross-cut drift is driven 45 feet southwesterly, where it intersects another vein of soft specular blue ore seven feet in thickness. A short drift has been driven easterly on this vein. The cross-cut continues southwesterly and within a few feet cuts a vein of hard hematite ore, which is no doubt the Perkins vein. A drift on this vein has been driven to southeasterly 100 feet to the boundary line between the Norway and Perkins mines. This drift has been opened out into a chamber and shows a width in the chamber of 30 feet. The cross-cut is continued and within a few feet is met the same fault noted on the first level. This fault appears to have a course nearly north and south, and pitches to the east at a high angle. The veins west of the fault are very irregular. The cross-cut, after passing the fault, terminates in a longitudinal drift which is driven northwesterly through rock to No. 1 shaft. This drift represents the second level of Nos. 1 and 3 shafts, and is 93 feet below datum. The drift continues northwesterly 200 feet to No. 3 shaft. The ore from No. 1 to No. 3 shafts, between the second and first levels, is all mined out and the space stulled, lagged and partially filled with rock, which has been milled in from the surface. The vein of ore mined out varied from 10 to 18 feet in thickness. On the first level a drift is driven southeasterly 150 feet. This is probably the same vein intercepted between the Stephenson and Perkins by the southwest cross-cut from No. 2 shaft. No. 1 shaft is used exclusively for pumping purposes, the product of Nos. 1 and 3 shafts passing up No. 3 shaft.

West of No. 3 shaft, second level, is a drift leading to the northwest. About 180 feet from the shaft is a branch drift to the left 20 feet in length leading into an opening which is 50 feet in diameter. South of this opening, only a short distance, is another small surface opening, in what is supposed to be the Perkins vein. There is, however, no underground connection between these two workings.

About 75 feet north of the branch drift the main one terminates in a chamber which is about 35 feet across, and is probably in the Stephenson vein.

Along the north side of Nos. 4, 5, 6, 7, 8 and 9 pits, a distance of 800 feet, are tram roads leading easterly to the ore pockets and stock piles. The tram cars pass abreast or under, as the case may be, of the small skip pockets from which they are loaded. The tram roads have a light ascending grade east to west. Nos. 4 and 5 pits are open down to 109 feet below the tram road level or 32 feet below our datum. These pits are practically one pit with an arched pillar left across the center. In the east end of this open pit is sunk a shaft 60 feet deep or 93 feet below datum, which nearly corresponds to the second level of Nos. 1 and 3 shafts. From the bottom, drifts are driven eastward and westward. They are now stoping to the eastward, but to the westward the ground is unbroken. The west drift extends over 200 feet under No. 6 pit.

The elevations of the main working levels of Nos. 6, 7 and 8 open pits, are respectively as follows: East side of No. 6 is 22 feet above datum; west side of same 33 feet, which elevation extends westward to midway between Nos. 7 and. 8 pits. No. 8 is 48 feet above datum. From east end of No. 6 to west end of No 8 it is about 550 feet. The foot wall along this distance at some points appears to be coming in rapidly, but the hanging, or better, the south side of the deposit on this main level, has not been reached, and it is questionable if it can be without taking down a large quantity of the overhanging rock. From the east end of No. 6 to the west end of No. 7 the bottom is nearly all ore, with occasional small lenses or bunches of rock. The ore to the west side of No. 7 is more or less mixed, but on the hanging wall side a spur of good ore appears to be making in that direction. This mixed ore extends to within, say, 50 feet of No. 8 skip road. At the west end of No. 8, about 200 feet from the skip road, is the east end of a large horse of rock, which apparently divides the vein one branch making around to the west on the foot wall side, and other portion on the hanging wall side. The skip road of No. 6 has been sunk to 12 feet above datum, affording a stope on the east side of 12 feet, and on the west of 20 feet. Some rock appears mixed with the ore in bottom.

No. 7 skip road is down to three feet below datum; stopes to east and west are 40 feet high; good ore to east and hanging wall sides. No. 8 is down to 18 feet above datum; stopes of ore on all sides except foot wall are 30 feet high. This skip road opening at the top is about 100 feet east and west and 75 feet north and south. West of No. 8 considerable work is now in progress, removing the earth and the nearly horizontal imbedded sandstone from the surface

of the ore. Northwesterly from this stripping, about 30 feet, is a vertical shaft sunk 80 feet. From the bottom of it a drift is driven to the south 30 feet, where it cuts a vein of specular blue ore that dips 75° to the south. The collar of this shaft is 112 feet above datum. Three hundred feet farther to the northwesterly is the Oliver shaft, which is sunk 80 feet, and will strike the blue ore in 10 feet more.

This comprises all of the important workings of the Norway mine. There is not as much of the red ore in sight as there was a year ago, but on the other hand the quantity of the soft specular blue has materially increased. It is hardly possible that any annual product of this mine will ever exceed that of 1880. The future ore of the Norway, I believe, will ultimately consist entirely of the soft specular blue variety. The mine is well equipped with machinery. The large Corliss engine house, located a short distance to the north of No. 7 pit, contains four of Frazer & Chalmer's 5-foot drums and two of Lane's 5-foot drums, which are operated by a 20x40 inch Corliss engine. To the northeast of No. 4 pit, a few steps, is another engine house with six of Frazer & Chalmer's 30-inch drums. Near No. 1 shaft is a small engine house which has one 5-foot Lane drum and an engine that operates it, and a 7-inch Cornish lift pump. Old No. 1 engine house, located just north of No. 8 pit has been deprived of four of its 30 inch Frazer & Chalmer hoisting drums, only two remaining.

The machine shop is well supplied with lathes, planers, drill presses, etc., but is rather crowded for want of room. The wood shop is also well supplied with wood working machinery. Captain John Olliver, well known in the Marquette district as a thorough and experienced miner, is the mining superintendent.

From the Norway mine, in company with Captain Olliver, we went about 1,000 feet southwesterly to the old workings of the

CYCLOPS.

The outlook of the mine is very different from what it was two years ago. The fine lens of soft specular blue ore which they had in No. 1 shaft is practically pinched out in the bottom, and the large amount of timbering which was put in to support the walls and roof of No. 2 shaft failed to do its work. In fact, the northeast end underground workings are gradually falling in. To the northwest of the old mine and up the steep side hill about 200 feet distant, has been recently discovered a six foot vein of hard steely specular ore, and 150 feet farther to the northwest is a shaft down 75 feet in a 40-foot vein of soft specular blue ore of superior quality. Sixty feet from the top of the shaft is a drift driven northwest which passes through 38 feet of this ore. Each of these veins have been traced some distance to the northeast. The dip is 71° to southeast. It was a matter of surprise to me that the Menominee Mining Company was not pushing these explorations with more vigor, for it seemed that this fine "show of ore" was not having justice done it. In our next year's report we hope to have something better to chronicle of a mine which within 30 days of its first discovery was mining and shipping 150 tons of ore daily. We will now return to the Norway mine and pass over to the

STEPHENSON MINE.

This property embraces the N. W. $\frac{1}{4}$ of the S. W. $\frac{1}{4}$ of Sec. 4, T. 40, R. 29. The southwest corner of this forty is about 150 feet northeast from No. 2 shaft

of the Norway mine. The strike of the formation is N. 70° W. and the dip high to the south. The vein of ore at the surface of the ledge crossed the west line of the Stephenson about 130 feet north of the southwest corner, and the south line at 500 feet west of the same point. This with the southerly dip rapidly exhausted the quantity of ore as they went down into the deposit. There is now only a few thousand tons of ore remaining in their present workings which will be mined out early this season. I am still of the opinion that north of these workings, and within the limits of this property, will yet be found a vein of ore with a northerly dip. The Stephenson and Ludington mines are owned by the Lumbermen's Mining Company, the officers of which are: President, Hon. H. Ludington, Milwaukee, Wis.; Vice President, Hon. S. M. Stephenson, Menominee, Mich.; Treasurer, Isaac Stephenson, Marinette, Wis.; Secretary, Joseph Fleshiem, Menominee, Mich.; General Manager, Geo. E. Stockbridge, Quinnesec, Mich.

Immediately south of the Stephenson mine is the

PERKINS MINE.

The lease of this mine is owned by the Saginaw Mining Company. The present outlook of the mine is rather better than it was a year ago. There is probably less of the red flaggy ore, but the richer soft specular ore is more than making good the decrease in the former. The old derricks and buckets, so well adapted for open pit work down to a certain depth, are being replaced by permanent skip roads. In the engine house are now four of Lane's four-foot drums, which give good satisfaction. The pits are numbered from west to east. No. 1 skip road is down to the third level, or 120 feet below the surface. Opening of third level extends 20 feet to either side of skip road; vein averages 30 feet wide.

Between third and second levels, west of the above opening, the ore is unbroken to the west line of Perkins mine, which is 110 feet west of No. 1 skip road. Above the second level, at 70 feet west of the skip road, there is a 20-foot stope of ore, which also extends to the west line of the property. On the east side of the opening of No. 1 is a pillar 20 feet wide on the strike of the vein, which extends to above the first level; this will be stoped out between the second and third levels, which brings us to the east into another opening 125 feet below the surface, by 40 feet long on the strike of the vein and 35 feet across from foot to hanging; on the second level, however, in this same opening, it is 40 feet from foot to hanging, with the soft specular blue ore on the foot wall side. In this opening there is a seven foot horse of jasper near the center of the deposit. On the east side of this opening is another 20-foot pillar, which extends up to the second level, a distance of 40 feet. This opening will soon be connected on the third level with No. 2 hoist.

No. 2 opening is down 135 feet below the surface. The vein of ore averages about 30 feet thick from foot to hanging walls; has some jasper in center of vein. To the east of No. 2 opening is another pillar, and from the east side of it the vein decreases in width, on the third level, from 30 to 16 feet in going to No. 3 skip road. No. 3 is about 300 feet east of No. 1. The east side of No. 3 opening is more or less mixed with jasper. This run of poor ground appears to be pitching down from the east.

No. 4 shaft is 225 feet east of No. 3. On the first level, 81 feet below the surface, there is 35 feet of ore at the shaft, which width holds good for 40 feet east of the shaft, where the west end of a jasper horse is encountered that

divides the vein, and in the aggregate lessens the quantity. The vein on the north side of this horse is a fine quality of soft specular blue ore, and has a width of 12 feet on the north side of the horse as far as they have stoped, but at a point 60 feet east of the end of the horse in a cross-cut driven north from a drift on the south side of the horse, the blue ore vein shows a width of 20 feet.

West of No. 4 shaft the vein gradually narrows, and at 65 feet is met by the same run of mixed ore and jasper as was encountered east of No. 3 shaft. The shaft is being sunk to second level, when there will be some fine stopes of ore to either side.

The mine employs about 125 men, and with Captain Samuel Mitchell, the agent, and Captain John Perkins, the superintendent, both thoroughly competent mining men of long experience, cannot fail of having complete justice done it. From the Perkins mine, about one mile southeast, is the

CURRY MINE.

The north open pit which we described in last year's report is now down to 83 feet below the old cart road cut leading into the main pit. We now go down a shaft inclining to the north at an angle of about 45°. The ore in the bottom is apparently pitching to the west at an angle of 20°. The dip of the formation, however, is to the north. To the west is a fine stope of ore. The vein is about eight feet wide at right angles to the dip. The long open cut to the southeast is now worked as an underground mine. It is 210 feet long by 95 feet deep in the center, 70 feet deep at the east end, and 60 feet at the west end; vein of ore in east end 10 feet wide, and at the center it is 12 feet wide. On the surface but few changes have been made during the past year. The management is the same as then. Adjoining the Curry forty on the east is the No. 3

VULCAN MINE.

In our report for 1879 we noted the large force of men to work in the open pits, but now the miners have all disappeared. The heavy but muffled sounds from the blasts in the underground workings denote only too clearly where they have gone. In company with Capt. Jerome Schwartz, the superintendent, we will first examine old No. 1 Vulcan which is located about 500 feet to the southeast. On the surface everything presents a familiar aspect. We enter the mine through the same adit we did three years ago. In the open pit we note but little change. The derricks and buckets have been replaced by two skip roads. All the mining is now done underground. One of the skip roads goes down obliquely across the dip of the formation to the west and the other on the dip of the formation to the south at an angle of 60°. We will assume for our datum of elevations the adit level, which is 445 feet above Lake Michigan. The first level is 68 feet below datum. The workings extend west from the shaft sunk on the dip of the formation for 360 feet. In the east end is a chamber cross-cutting the vein from foot towards the hanging wall. The chamber is 20 feet wide east and west, and is 80 feet north and south with ore still in the south end. The ore is a very superior quality of the soft specular variety. The walls being rather insecure they have adopted the Nevada method of timbering already described in our description of the Chapin mine.

To the west of this a wide drift has been driven along the foot-wall side and above it considerable stoping has been done. At 210 feet west of the chamber a cross-cut drift shows the vein to have a width of 40 feet. Sixteen feet further along is another chamber which is similar to the first one. The vein here is 45 feet from foot to hanging wall. From this chamber west the vein rapidly narrows and 130 feet in that direction practically pinches out. This, however, is easily explained by the westerly pitch of the lens of ore. The south shaft is being sunk to the second level. The product of the mine at present passes out of the adit, but very soon a shaft about 250 feet west of where the adit enters the main pit will be sunk to the first level, when the ore from that portion of the mine will pass out of this shaft.

We will now return to No. 3, Vulcan, and examine there the underground workings. The shafts, three in number, are numbered from east to west. To go to No. 1 shaft we pass through an adit. This adit is about 75 feet above the adit of the old No. 1 Vulcan. We will assume this upper adit as the datum for our elevations. No. 1 shaft is sunk on the dip of the vein to the third level, 110 feet below datum. The dip of the formation varies from 40° to 50°. The first level is 42 feet below datum and the second level 86 feet. On the third level, to the east and west, drifts have been driven to 80 feet from No. 1 shaft. In the east drift the vein of ore is eight feet wide, while in west end of the west drift the vein is 20 feet wide. Some stoping is being done to either side of the shaft. On the second level a drift has been driven 325 feet east from the shaft. At the shaft the vein was 10 feet wide, which increased to 14 feet in going east a short distance, but very soon it narrowed to four feet, while at the extreme east end the vein of ore is only two feet wide. This drift passes to the north of the west end workings of old No. 1 Vulcan, and is, therefore, in a separate lens of ore. It looks very much as if there might be a regular system to the occurrence or position of these lenses of ore, which will be, no doubt, understood in the future.

From No. 1 shaft it is 180 feet west on the second level to No. 2 shaft. The vein between these shafts averages about 20 feet thick. Above the second level the ore is all mined out, with the exception of a few pillars.

West again, 120 feet, on the second level is No. 3 shaft. The vein of ore gradually narrows in going west, being 12 feet at No. 2 shaft and six feet at No. 3. No. 2 shaft is down to the third level. A small opening has been made to the east from the bottom of No. 2, which shows the vein to be 18 feet wide.

Returning to the second level again we have a drift 270 feet long, driven west on the vein. The good ore soon pinches out and we have chiefly mixed ore and rock. Nearly all of the available ore is stoped out above the second level. The increase in the thickness of the ore vein from the second to the third level is very noticeable.

Four hundred feet west and 100 feet north of No. 3 shaft is No. 4 shaft. This shaft is down 50 feet in a soft specular blue ore. On the side of the shaft is a strong face of sandstone. At the bottom of the shaft a small chamber has been worked out to the south.

This embraces all of the important workings of Nos. 1 and 3 Vulcan mines; we will, therefore return to the village of Vulcan, and proceed to the East Vulcan mines, located about one mile east of Vulcan, on the S. ½ of the S. ½ of Sec. 11, T. 39, R. 29. A branch track from the main line, leading northeasterly from a point a short distance east of Vulcan station to these mines, affords

ample shipping facilities. This track skirts along the base of the south slope of a steep side hill. The first workings we see are those of No. 3 pit, which are to north of the track a short distance up the face of the hill. The east opening of this pit is down 40 feet. Vein of ore varied from 10 to 12 feet wide, but in the bottom the red slates come in with a northerly dip, and practically cut out the ore. Westerly from the east end of this opening about 50 feet, and 23 feet lower down, is a drift running in a two foot vein of ore, for some 50 feet more at which point a heading of rock is met. The drift continues 22 feet through this and comes into a vein of soft specular blue ore, 15 feet in thickness. What is singular about it is that the vein has nearly a north and south strike. There are short drifts cutting this ore in different directions. A little further to the northwest is the so called middle shaft, which is 130 feet west, northwest from No. 3 opening.

On the next and lowest level of the middle shaft, 124 feet from the surface, considerable drifting has been done, which shows to the north a short run of ore with an east and west strike, cut off to the east and west by a crossing of rock having a north and south strike. This crossing is 11 feet thick, and on the west side is a 9-foot vein of soft specular blue ore, having also a north and south strike. Whether these abrupt changes in the strike of the formation have been caused by faults or sharp turns, I did not determine. They are far more vexatious to the miner than interesting. Three hundred and twenty-five feet west of the middle shaft is the west shaft, which is down 35 feet in an 8-foot vein of soft specular blue ore, but now there is rock in the bottom of the shaft.

About one-fourth of a mile east-southeast from the east opening of No. 3 pit are the workings of what was known last year as the Lowell. A little less than two years ago ore was discovered here by Captain Jerome Schwartz, and a lease was taken subsequently of the property by the Menominee Mining Company. When the pit was first opened there was from 15 to 30 feet of soft specular blue ore in sight. The open pit is about 150 feet long by 30 feet wide and, say, 50 feet deep. Near the center of it a shaft is sunk 110 feet below the surface. From the bottom drifts are driven to north and west, each 40 feet in length. The former struck a vein of soft blue ore from three to six feet in thickness. A drift is driven to east on this for 40 feet and to the west 20 feet. The west drift from the shaft was mostly in lean ore. On the level above the bottom one, 85 feet from the surface, is another drift to the north, which at 40 feet, the same distance from the shaft as the lower one, cut the vein of soft blue ore. At this point of intersection, drifts extend to the east and west, the former 15 feet and the latter 50 feet. The vein of ore varied from six to eight feet in thickness.

About 40 feet north of the west end of the open pit is a shaft. At this place there was on the surface of the ledge what appeared to be a small bunch of soft blue ore, but it has subsequently proved to be the top of a rounded lens of ore pitching nearly vertically downwards. On the first level of this shaft, 65 feet below the surface drifts, cutting the lens in different directions proves the lens to be about 30 feet north and south and 33 feet east and west. On the next level 90 feet below the surface, it is 50 feet north and south and 55 feet east and west. On the next and last level 112 feet down, the lens of ore is about 60x60, showing a gradual enlargement from the surface down. There is jasper on the north and chloritic slate on the south side of the lens. About 75 feet southwest of the shaft is another shaft down to the first level. Thirteen hundred feet east of the Lowell is a shaft which is sunk altogether 73 feet. The first 25 feet feet was earth. Surface of the ledge pitches at a steep angle to the north. Fifty feet from the collar of the shaft they drifted 15 feet northeast and struck soft specular blue ore, but after driving six feet in this they came into sandstone. They are now sinking to another level when they will cross-cut again to the north. South of the shaft about 350 feet is an open pit 75 feet long by 50 wide east and west and 70 feet deep. On the surface there was a fine show of ore but in the bottom it is badly cut up by horses of rock. From the bottom a drift runs north 55 feet in lean ore and ends in red chloritic slates. Another drift is driven west 30 feet in rock and small lenses of soft specular ore. In east end of opening a shaft is sunk 15 feet in what appears to be a small lens of ore. Captain John Schwartz, a miner of long experience, has charge of the East Vulcan and its explorations.

We did not visit the Emmett or Breen mines as they are idle and partially filled with water. I understand that the lenses upon which they were mining have been nearly exhausted, but it certainly is not reasonable to infer from this that the mine is exhausted or that other lenses do not ex ist within the near vicinity of the old ones. A liberal use of the diamond drill would, no doubt, return a handsome profit.

It would be well for this company to remember how well their pluck was repaid at the Keel Ridge mine, and go ahead on the Emmett and Breen.

On the Felch Mountain Range in Secs. 31 and 32, T. 42, R. 28, the Metropolitan and Northwestern mining companies are each at work mining ore, and expect to ship considerable this fall, should the promised line of railroad reach there in time to do so. Other parties are exploring in this district, and report very favorable prospects. In the Paint River district are the Mastodon and Sheldon and Shafer explorations, where large deposits of hard hematite ore are said to exist. From the Chicagon Lake district are reported several promising discoveries.

On the undeveloped Agogebic Range reliable parties who have done some work are very sanguine. Some of the ores from that range which I have analyzed average well in metallic iron, and its phosphorus is within the Bessemer steel limits. A branch from the Menominee Range railroad will probably reach the Mastodon and Sheldon and Shafer properties this season.

STATISTICAL TABLE Showing the Total Number of Gross Tons of Iron ore Shipped from Lake Superior Iron Mines. By Chas. E. Wright, M. E., Commissioner of Mineral Statistics.

	Marquette District.	Menominee District.	Totals.
Years Unknown	75,083		75,083
1854	3,000		3,000
1855	1,449		1,449
1856	6,790		6,790
1857	25,646		25,646
1858	22,876		22,876
1859	68,832		68,832
1860	114,401		114,401
1861	49,909		49,909
1862	124,669		124,169
1863	203,055		203,055
1864	247,059		247,059
1865	193,758		193,958
1866	296,713		296,713
1867	465,504		465,504
1868	510,522		510,522
1869	639,097		639,097
1870	859,507		859,507
1871	813,984		813,984
1872	948,553		948,553
1873	1,195,234		1,195,234
1874	899,934		899,934
1875	881,166		881,166
1876	993,311		993,311
1877	1,014,724	10,405	1,025,129
1878	1,030,986	96,597	1,127,583
1879	1,149,969	270,776	1,420,745
1880	1,379,725	592,288*	1,971,913
Total gross Tons	14,214,966	969,966	15,184,932

* Includes Commonwealth and Florence Mines.

1875.	1876.	1877.	1878.	1879.	1880.	Totals.	NAMES OF MINES.
129,881	145,661	151,554	143,320	113,108	187,234	2,129,134	Cleveland.
87,283	98,480	80,340	83,121	112,921	120,622	2,067,197	Jackson.
119,365	110,570	127,349	109,674	174,747	204,094	2,378,674	Lake Superior.
9,642	3,333	16,545	23,921	18,204	14,727	459,195	Humboldt (Washington).
70,102	58,863	55,581	21,903	57,367	58,512	924,766	New York.
30,282	22,539	19,113	28,161	25,420	14,794	513,750	Lake Angeline.
1,635						18,341	Iron Mountain.
12,804	19,420	10,591	10,353	5,455		224,029	Edwards.
						110,506	New England.
56,877	66,002	70,883	73,464	93,203	112,410	829,661	Champion.
40,914	37,750	38,314	26,680	24,911	24,921	459,160	Barnum.
847	125			4,8 4	1,209	106,025	Foster.
10,357	17,282	19,691	30,180	28,962	31,028	224,312	McComber.
33,638	50,997	38,901	30,773	9,637	15,172	214,034	Rolling Mill.
750	456	3,307	4,674	2,737	2,063	35,271	New York Hematite (Grand Central).
3,088		1,659	4,596	1,019		115,164	Marquette.
8,622	27,236	12,549	23,740	27,050	45,247	208,8 9	Winthrop.
4,070	15,324	20,211	4,704	24,142	38,597	208,024	Palmer (Cascade).
4,571	20,510	37,868	52,155	39,770	22,387	195,559	Salisbury.
3,029	2,688			4,358		11,844	Excelsior.
188	225	8,433	16,924	17,831	13,201	79,576	Chesnire (Smith).
			1,225	491	285	26,021	Howe (P. & L. S.).
119,726	120,095	165,836	176,221	135,151	235,387	1,191,533	Republic.
	5,596	3,897	4,259	11,450	12,753	54,403	Mitchell (Shenango).
44,756	70,074	28,238	58,622	56,935	52,944	385,894	Michigamme.
368	52	196				2,998	Rowland.
						4,756	Miller.
						2,206	Howell-Hoppock.
						2,610	Teal Lake.
						2,380	Carr.
				3,244		4,592	Albion & Gilmore.*
1,718		503	7,517	3,992	11,181	31,247	Goodrich.
						2,065	Himrod.
3,348	7,715	14,496	5,401	4,029	10,221	62,791	Keystone.
23,095	20,276	22,801	2,225	1,409		143,504	Spurr.
						9,347	Allen.
52,006	57,122	44,006	54,097	43,310	35,772	387,406	Saginaw.
				3,366	1,529	14,477	Green Bay.
8,059					6,633	70,311	Columbia (Kloman).
						4,439	Michigan.
			2,103	10,869	669	27,582	Manganese (Negaunee).
	732	634	9,317	19,500	18,846	49,030	Cleveland Hematite.
						139	Hungerford & Harlow.*
		992	1,690			2,987	Steward.
144	6,801	10,127	8,506	21,681	18,347	65,606	Bessemer.
	6,329	10,082	3,754	6,860	7,232	34,257	Cambria.
	1,058					1,136	Erie & Magnetic.*
		5,812	4,796	1,463	5,359	17,440	Breen.
		4,593	31,129	57,350	72,405	173,477	Vulcan.
			26,467	42,147	52,357	120,951	Quinnesec.
			12,397	22,474	31,136	66,007	Emmet.
			7,533	73,590	198,165	279,288	Norway.
			6,275	46,472	14,368	67,115	Cyclops.
			3,385		3,959	7,344	Pendill.
			4,191	33,769	29,043	67,003	National.
				13,010	21,741	34,751	Curry.
				13,492	49,433	62,925	Perkins.
				798	23,341	24,139	Stephenson.
				850	3,324	7,404	Wheat (Home).
						3,599	Gribben.
				949	2,415	3,364	Chicago.
				501		501	Orion.
				5,026	330	5,356	Section 12.
				941	13,142	14,083	Milwaukee.
					30,856	30,856	Cornell.
					1,110	1,110	Taylor.
					6,478	6,478	Boston.
					1,197	1,197	Sterling.
					14,571	14,571	Lowell.
					34,556	34,556	Chapin.
					8,876	8,876	Ludington.
					11,445	11,445	Keel Ridge.
					709	709	Indiana.
881,166	993,311	1,025,129	1,127,583	1,420,745	1,948,334	15,161,353	Grand total.

THE IRON AND STEEL INDUSTRIES OF THE UNITED STATES IN THE CENSUS YEAR 1880.

BY JAMES M. SWANK, SPECIAL CENSUS AGENT TO COLLECT STATISTICS OF IRON AND STEEL.

NUMBER AND CAPACITY OF THE IRON AND STEEL WORKS OF THE UNITED STATES.

The following exhibit shows the number and capacity of the blast furnaces, rolling mills, steel works, forges, and bloomaries in the United States at the close of the census year, May 31, 1880:

Blast furnace establishments	490
Completed blast furnaces	681
Rolling mill establishments	324
Single puddling furnaces, each double furnace counting as two single furnaces	4,319
Rotary puddling furnaces (Sellers)	1
Danks puddling furnaces	19
Hammers in iron rolling mills	239
Heating furnaces	2,105
Trains of rolls in iron rolling mills	1,206
Nail machines	3,775
Steel works	73
Bessemer steel converters	24
Open hearth steel furnaces	37
Pot holes for crucible steel	2,691
Trains of rolls in steel works	136
Hammers in steel works	219
Forges and bloomaries	118
Forge and bloomary fires	495
Siemens' rotator	1
Hammers in forges and bloomaries	141
Daily capacity of blast furnaces, in net tons	19,248
Daily capacity of rolling mills, in net tons	16,430
Daily capacity of Bessemer steel converters, in net tons	4,467
Daily capacity of open-hearth steel furnaces, in net tons	827
Daily capacity of crucible steel works, in net tons	445
Daily capacity of forges and bloomaries, in net tons	520

The whole number of establishments in 1880 was 1,005. In 1870 it was 808. The percentage of increase in the ten years was 24.38. The size and capacity of the establishments were, however, much greater in 1880 than in 1870. As the capacity of blast furnaces only was given in 1870, no complete data are available for a comparison of the capacity of all the works in the two periods. The daily capacity of the blast furnaces in 1870 was 8,357 tons, and in 1880 it was 19,248 tons—an increase of 130.32 per cent. A comparison of the number of the various works in 1870 and 1880 is given below:

	1870.	1880.
Blast furnace establishments	386	490
Blast furnaces	574	681
Rolling mill establishments	310	324
Steel works	30	73
Forges and bloomaries	82	118

CAPITAL INVESTED IN THE IRON AND STEEL WORKS OF THE UNITED STATES.

The whole amount of capital invested in the iron and steel industries of the United States in 1880 was $230,971,884; in 1870 it was $121,772,074; increase, $107,199,810, or 89.68 per cent.

PRODUCTION OF THE IRON AND STEEL WORKS OF THE UNITED STATES.

The total production of the iron and steel works of the United States in the census year 1880 was 7,265,140 tons; in 1870 it was 3,655,215 tons; increase, 3,609,925 tons, or 98.76 per cent. The following table shows the production of each branch of our iron and steel industries in 1870 and 1880, with the percentage of increase or decrease in the latter year:

IRON AND STEEL PRODUCTS.	Census Year 1870. Net Tons.	Census Year 1880. Net Tons.	Percentage of increase in 1880.	Percentage of decrease in 1880.
Pig iron and castings from furnace	2,052,821	3,781,021	84	
All products of iron rolling mills	1,441,829	2,353,248	63	
Bessemer steel finished products	19,403	889,896	4,486	
Open-hearth steel finished products		93,143		
Crucible steel finished products	28,069	70,319	151	
Blister and other steel	2,285	4,956	117	
Products of forges and bloomaries	110,808	72,557		35
Total	3,655,215	7,265,140	99	

Of the pig iron and furnace castings produced in the census year 1880, there were produced with cold-blast charcoal, 79,613 tons; with hot-blast charcoal, 355,405 tons; with anthracite, 1,112,735 tons; with bituminous coal and coke, 1,515,107 tons; and with mixed anthracite and coke, 713,932 tons. The furnace castings amounted to 4,229 tons. The total production was 3,781,021 tons, of which 12,875 tons were spiegeleisen.

In the following table is presented a comparative statement of iron rolling-mill products in the census year 1870 and 1880:

KINDS OF IRON.	1870. Net Tons.	1880. Net Tons.
Bar iron	488,834	663,211
Rod iron	26,087	145,626
All kinds of plate iron	284,702	437,139
Sheet iron	74,753	94,992
Iron rails	531,605	466,917
Skelp iron	2,217	128,321
Muck bar made for sale to other works	33,631	64,469
Other products		352,573
Total	1,441,829	2,353,248

The item of muck bar is an unavoidable duplication, as it undoubtedly reappears as finished iron to be counted a second time. Further details of the rolling-mill products in the census year 1870 than have been given above can not be ascertained.

The 352,573 tons of "other products" in the column for 1880 include 96,810 tons of structural iron; 2,630 tons of rolled axles; 96,843 tons of hoop iron; 48,345 tons of fish plates and miscellaneous forms of rolled iron; 82,358 tons of railroad spikes, wire, horse-shoes, rivets, etc., made in rolling mills that rolled the bar and rod iron of which they were manufactured, but which iron is not duplicated in this statement; 21,884 tons of hammered axles; and 3,703 tons of forgings.

In the Bessemer and open-hearth steel works of the country the following finished products were produced in the census year 1880:

FINISHED PRODUCTS.	Bessemer Steel. Net Tons.	Open-hearth Steel. Net Tons.
Rails	741,475	9,105
Bars	76,710	43,296
Rods	49,064	1,134
Shapes	557	80
Sheets		1,700
Plates	1,475	11,034
Other forms	20,615	26,794
Total	889,896	93,143

The Bessemer and open-hearth steel works in the census year 1880 produced 985,208 tons of Bessemer steel ingots and 84,302 tons of open-hearth steel ingots.

GEOGRAPHICAL DISTRIBUTION OF THE IRON AND STEEL INDUSTRIES OF THE UNITED STATES.

The whole territory of the United States may be regarded as comprising four grand divisions—the Eastern States, the Southern States, the Western States and Territories, and the Pacific States and Territories. Assuming that the Eastern States comprise all of the States lying north of Delaware and east of Ohio, that the Southern States comprise all of the late slaveholding States

except Missouri, and that the other divisions require no explanation, we present the following comparative statement of the development of the iron and steel industries in each of the grand divisions in the the census year 1880:

GRAND DIVISIONS.	No. of establishments.	Capital Invested.	Hands employed.	Wages Paid.	Net Tons Produced.	Value of all Products.
Eastern States	556	$149,507,461	82,842	$34,361,660	4,671,808	$192,696,010
Southern States	218	29,145,830	20,595	6,261,344	649,153	25,353,251
Western States and Territories	224	50,755,990	36,663	14,512,587	1,912,689	76,933,686
Pacific States and Territories	7	1,562,603	878	311,194	31,490	1,574,738
Total United States	1,005	$230,971,884	140,978	$55,476,785	7,265,140	$296,557,685

In 1870 there was 25 States engaged in the manufacture of iron and steel. Of these, South Carolina does not appear in the statistics for 1880. Its total production in 1870 did not aggregate 500 tons. The iron industry in this State has been practically abandoned. Since 1870 three States have for the first time engaged in the manufacture of iron, namely, Colorado, Kansas, and Nebraska; also two Territories, namely, Utah and Wyoming. Utah did not, however, make any iron in 1880. It made a small quantity in each of the years 1874, 1875, and 1876, and it will make a larger quantity in the near future. California and Washington Territory have made arrangements since the close of the census year 1880 to manufacture iron. New Hampshire made iron many years ago, but it does not appear in the statistics for 1870; it reappears in the tables for 1880. Oregon and Texas each built a blast furnace in the decade preceding the census year 1870, but they did not make any iron in that year; they appear, however, in the statistics of production for 1880. The District of Columbia once had a blast furnace in operation, but in 1870 it had no iron industry whatever; in 1880 the United States Government owned and operated a small rolling mill at the Washington Navy Yard. Minnesota appears in 1880 for the first time among iron-manufacturing States, but its statistics relate only to the preparations that have been made to embark in the business. Thirty States, the District of Columbia, and Wyoming Territory actually made iron in 1880.

COMPARATIVE PRODUCTION OF ALL THE STATES IN 1870 AND 1880.

Twelve States made over 100,000 tons each in 1880. Pennsylvania, which for more than a hundred years has been the leading iron-producing State in the Union, made in 1870 a fraction over 50 per cent of the total product, and in 1880 it made a fraction over 49 per cent. At both periods its prominence in the production of iron and steel was virtually the same. From 1870 to 1880 it increased its production 97 per cent, or from 1,836,808 tons to 3,616,668 tons, while the whole country increased its production 99 per cent, or from 3,655,215 tons to 7,265,140 tons. Ohio was the next State in prominence in 1870, and it held the same rank in 1880. In the former year it produced 449,768 tons, and in 1880 it produced 930,141 tons, an increase of 107 per cent. The third State in prominence in 1870 was New York, and it maintained this rank in 1880, but its growth fell far below that of its two sister States above mentioned. In 1870 it produced 448,257 tons, and in 1880 it produced 598,300 tons, an increase of 33 per cent. New Jersey was fourth in rank in 1870, producing 115,262 tons, but it was fifth in 1880, although in that year it produced 243,860 tons, an increase of 112 per cent. The fourth place in 1880 was taken by Illinois, which produced in 1870 only 25,761 tons, while in 1880 it produced only 417,967 tons, an increase of 1,522 per cent. Maryland ranked fifth in 1870, producing 95,424 tons in that year, while in 1880 it produced only 110,934 tons, an increase of 16 per cent, causing it to drop to the twelfth place. The sixth State in rank in 1870 was Missouri, with a production of 94,890 tons, which was increased to 125,758 tons in 1880, or 33 per cent, giving it the tenth place in that year. Michigan increased its production in the ten years from 86,679 tons to 142,716 tons, or 65 per cent, taking the eighth place in rank in 1880. Wisconsin increased its production from 42,234 tons to 178,935 tons, or 324 per cent, giving it the sixth place in 1880. Indiana produced 64,148 tons in 1870, and 96,117 tons in 1880, an increase of 50 per cent. Of the New England States, Massachusetts shows the greatest growth in the ten years, increasing from 86,146 tons in 1870 to 141,321 tons in 1880, or 64 per cent, placing it ninth in rank. Astonishing progress was made in the ten years in several southern States. West Virginia increased its production from 72,337 tons to 147,487 tons, or 104 per cent, giving it the seventh place in 1880. Alabama increased from 7,060 tons to 62,986 tons, or 792 per cent. Georgia increased from 9,634 tons to 35,152 tons, or 265 per cent. Tennessee increased from 34,305 tons to 77,100 tons, or 125 per cent. Kentucky increased from 86,732 tons to 123,751 tons, or 43 per cent, placing it eleventh in rank in 1880. Delaware increased from 8,307 tons to 33,918 tons, or 308 per cent. Virginia increased from 37,836 tons to 55,722 tons, or 47 per cent. All the States which made iron or steel in 1870 increased their production in 1880, except Maine, North Carolina, and South Carolina. The relative rank in production of all the States in 1870 and in 1880 is given in the following table:

STATES.	Production, 1880.	Rank.	STATES.	Production, 1870.	Rank.
Pennsylvania	3,616,668	1	Pennsylvania	1,236,808	1
Ohio	930,141	2	Ohio	449,768	2
New York	598,300	3	New York	448,257	3
Illinois	417,967	4	New Jersey	115,262	4
New Jersey	243,860	5	Maryland	95,424	5
Wisconsin	178,935	6	Missouri	94,890	6
West Virginia	147,487	7	Kentucky	86,732	7
Michigan	142,716	8	Michigan	86,679	8
Massachusetts	141,321	9	Massachusetts	86,146	9
Missouri	125,758	10	West Virginia	72,337	10
Kentucky	123,751	11	Indiana	64,148	11
Maryland	110,934	12	Wisconsin	42,234	12
Indiana	96,117	13	Virginia	37,836	13
Tennessee	77,100	14	Tennessee	34,305	14
Alabama	62,986	15	Illinois	25,761	15
Virginia	55,722	16	Connecticut	25,305	16
Connecticut	38,061	17	Maine	17,138	17
Georgia	35,152	18	Georgia	9,634	18
Delaware	33,918	19	Delaware	8,307	19
Kansas	19,055	20	Alabama	7,060	20
California	14,000	21	Rhode Island	4,415	21
Maine	10,866	22	California	3,000	22
Territory of Wyoming	9,790	23	North Carolina	1,801	23
Rhode Island	8,134	24	Vermont	1,525	24
New Hampshire	7,978	25	South Carolina	443	25
Vermont	6,620	26	Kansas	----------	-------
Colorado	4,500	27	Territory of Wyoming	----------	-------
Oregon	3,200	28	New Hampshire	----------	-------
Nebraska	2,000	29	Colorado	----------	-------
Texas	1,400	30	Oregon	----------	-------
North Carolina	439	31	Nebraska	----------	-------
District of Columbia	264	32	Texas	----------	-------
South Carolina	----------	-------	District of Columbia	----------	-------

CENTERS OF IRON AND STEEL PRODUCTION IN THE UNITED STATES IN 1880.

In the following table is presented a view of the principal "centers" of production of the iron and steel industries of the United States in the census year 1880. These "centers" are divided into two classes—the first comprising all counties which produced over 100,000 net tons of pig iron and finished products, and the second comprising all counties which produced over 60,000 and less than 100,000 tons. In the first class are fifteen counties, and in the second class are seventeen counties. Six States are represented in the first class, and eight States in the second class:

Counties of the First Class, Producing Over 100,000 Tons of Pig Iron, Rolled Iron, Steel, and Blooms.		Counties of the Second Class, Producing Between 60,000 and 100,000 Tons of Pig Iron, Rolled Iron, Steel, and Blooms.	
Counties.	Net Tons.	Counties.	Net Tons.
1. Allegheny county, Pa.	848,146	1. Lawrence county, Pa.	88,443
2. Lehigh county, Pa.	324,875	2. Lancaster county, Pa.	87,019
3. Northhampton county, Pa.	322,882	3. Ohio county, W. Va.	84,767
4. Cambria county, Pa.	260,140	4. Will county, Ill.	84,094
5. Cook county, Ill.	248,479	5. Montour county, Pa.	79,789
6. Dauphin county, Pa.	223,676	6. Chester county, Pa.	78,363
7. Mahoning county, Ohio	219,957	7. Warren county, N. J.	76,622
8. Berks county, Pa.	213,580	8. Trumbull county, Ohio	73,369
9. Cuyahoga county, Ohio	210,350	9. Lebanon county, Pa.	73,149
10. Mercer county, Pa.	182,881	10. Lawrence county, Ohio	70,794
11. Rensselær county, N. Y.	177,967	11. Schuylkill county, Pa.	70,609
12. Montgomery county, Pa.	168,628	12. Baltimore county, Md.	79,944
13. Lackawanna county, Pa.	151,273	13. Blair county, Pa.	68,039
14. Milwaukee county, Wis.	128,191	14. Essex county, N. Y.	66,725
15. St. Louis county, Mo.	102,644	15. Philadelphia county, Pa.	65,983
		16. Wayne county, Mich.	63,584
		17. Dutchess county, N. Y.	61,637
Total (15 counties)	3,783,673	Total (17 counties)	1,262,894

THE CENTER OF TOTAL PRODUCTION.

The geographical center of production of the iron and steel industries of the United States in the census year 1880 has been made the subject of a very careful calculation by Mr. George W. Cope, my principal assistant in the collection of the statistics which are condensed in this preliminary report. The center of production is the point at which equilibrium would be reached were the country taken as a plain surface, itself without weight, but capable of sustaining weight, and loaded with its production of iron and steel, each ton exerting pressure on the pivotal point directly proportional to its distance therefrom.

The centre of production of iron and steel in the United States in the census year 1880 was found to be at 40° 43′ north latitude and 79° 20′ longitude west from Greenwich. This point is in the State of Pennsylvania, on the boundary line between Armstrong and Indiana counties, and about 12 miles northeast of Apollo and 12 miles west of the town of Indiana—Laufman & Co.'s rolling mill at Apollo being the nearest iron works. At the center of production thus ascertained iron has never been manufactured in any form.

MINERAL PRODUCTS USED BY THE IRON AND STEEL WORKS OF THE UNITED STATES.

It is necessary to explain that the figures of "hands employed" and "wages paid" refer to the labor directly employed at the various iron and steel works of the country and in the mining and other operations conducted in direct connection with these works. They do not include the labor employed in

independent and often remote mining operations which supply our iron and steel industries with ore and coal and other raw materials. The statistics of these operations are being compiled by other hands. If the "hands employed" and "wages paid" in these independent mining operations were added to the figures given in our tables, the total number of persons directly supported by our iron and steel industries in 1880, and the total amount of wages paid to them, would be largely increased. This will be made plain by the presentation in the following table of the quantities of mineral products used by the iron and steel works of the country in 1880:

Works.	Iron Ore. Net Tons.	Limestone. Net Tons.	Anthracite Coal. Net Tons.	Bituminous Coal. Net Tons.	Coke. Net Tons.
Blast furnaces	7,256,684	3,169,149	2,615,182	1,051,753	2,128,255
Rolling mills	363,959	.....	526,126	3,915,377	14,834
Bessemer and open-hearth steel works	7,327	.....	140,458	465,655	104,980
Crucible steel works	2,128	.....	40,392	224,657	22,791
Forges and bloomaries	79,610	.....	340	1,613	6,695
Total	7,709,708	3,169,149	3,322,498	5,659,055	2,277,555

Of the iron ore and limestone given in the table, at least one-half was purchased from independent producers; of the anthracite coal, nearly all was so purchased; and of the bituminous coal and coke, fully two-thirds was so purchased.

CERTAIN RAW MATERIALS USED IN THE MANUFACTURE OF IRON AND STEEL.

To the above are added below tables showing the quantities of all other leading raw materials used in the census year 1880 in the manufacture of iron and steel:

Works.	Bushels of Charcoal.	Mill Cinder. Net Tons.	Pig Iron. Net Tons.	Old Iron Rails. Net Tons.	Scrap Iron. Net Tons.	Ore Blooms. Net Tons.	Pig or Scrap Blooms. Net Tons.	Muck Bar Purchased. Net Tons.
Blast furnaces	53,909,828	354,048	.....	.....	.....	.....	.....	.....
Rolling mills	2,569,756	.....	1,574,693	708,534	422,282	14,147	46,861	53,754
Bessemer and Open-hearth steel works	37,552	.....	966,603	.....	13,911	16,053	250	.....
Crucible steel works	60,594	.....	17,226	.....	1,952	13,211	2,400	.....
Forges and bloomaries	13,014,361	.....	38,113	.....	8,933	.....	.....	.....
Total	69,592,091	354,048	2,596,635	708,534	447,078	43,411	49,511	53,754

Works.	Spiegeleisen. Net Tons.	Old Steel Rails and Crop Ends. Net Tons.	Bessemer Steel Ingots and Blooms Purchased. Net Tons.	Open-hearth Ingots and Blooms Purchased. Net Tons.	Scrap Steel. Net Tons.	Swedish Billets and Bars. Net Tons.	Other Billets and Bars. Net Tons.	Barrels of Oil Used as Fuel.
Bessemer and Open-hearth steel works	86,138	85,653	42,939	17,713	90,645	.....	.....	.....
Crucible steel works	.....	.....	.....	.....	19,726	10,410	16,496	.....
Forges and bloomaries	.....	.....	.....	.....	.....	.....	.....	853
Total	86,138	85,653	42,939	17,713	110,371	10,410	16,496	853

TABLE A.—*Grand Aggregate for the United States of all Blast Furnaces, Rolling Mills, Steel Works, and Forges and Bloomaries, with their Division among the Four Leading Sections.*

STATES AND TERRITORIES.	No. of establishments in the census year 1880.	Capital invested in the census year 1880.	Hands Employed and Wages Paid in the Census Year 1880.						Value of all materials used in the census year 1880.	Value of all products made in the census year 1880.	Weight of all products made in the census year 1880. Net tons.	Weight of all products made in the census year 1870. Net tons.
			Males above sixteen years.	Males below sixteen years.	Females above fifteen years.	Females below fifteen years.	Total hands employed.	Total amount paid in wages.				
EASTERN:												
Maine	3	$450,000	683	17	.....	.....	700	$141,494	$380,511	$583,328	10,866	17,138
New Hew Hampshire	2	650,000	289	1	.....	.....	290	127,690	523,355	807,340	7,978	.....
Vermont	4	410,000	190	1	.....	.....	191	50,035	240,900	392,300	6,620	1,525
Massachusetts	30	6,738,408	6,367	125	21	.....	6,513	2,576,539	6,657,232	10,288,921	141,321	86,146
Rhode Island	3	630,000	200	75	.....	.....	275	130,969	375,347	488,040	8,134	4,415
Connecticut	19	2,682,000	663	22	.....	.....	685	331,184	1,341,225	1,998,698	38,061	25,305
New York	89	21,543,221	10,697	747	.....	.....	11,444	4,099,451	13,395,229	22,219,219	598,300	448,257
New Jersey	40	9,099,050	4,711	81	.....	.....	4,792	1,808,448	6,556,283	10,341,896	243,860	115,262
Pennsylvania	366	107,304,782	54,637	3,297	12	6	47,952	25,095,850	92,267,030	145,576,268	3,616,668	1,836,808
Total	556	$149,507,461	78,437	4,366	33	6	82,842	$34,361,660	$121,737,112	$192,696,010	4,671,808	2,534,856
SOUTHERN:												
Delaware	9	$1,431,469	818	49	.....	.....	867	$344,476	$1,214,050	$2,347,177	33,918	8,307
Maryland	23	4,962,125	2,656	107	.....	.....	2,763	905,090	2,888,574	4,470,950	110,934	95,424
District of Columbia	1	89,600	18	.....	.....	.....	18	7,528	2,264	10,970	264	.....
Virginia	44	4,329,713	2,399	121	2	.....	2,522	665,432	1,496,151	2,585,999	55,722	37,836
North Carolina	20	759,400	63	.....	.....	.....	63	7,907	11,792	41,085	439	1,801
Georgia	14	1,135,900	1,266	37	.....	.....	1,303	185,489	631,707	990,850	35,152	9,634
Alabama	14	3,309,196	1,581	45	.....	.....	1,626	571,713	601,073	1,452,856	62,986	7,060
Texas	1	40,000	140	.....	.....	.....	140	27,720	23,580	36,000	1,400	.....
West Virginia	20	3,913,616	3,780	341	.....	.....	4,121	1,541,816	3,484,625	6,054,032	147,487	72,337
Kentucky	29	5,493,035	3,831	264	.....	.....	4,095	1,344,400	3,223,799	5,090,029	123,751	86,732
Tennessee	43	3,681,776	2,758	309	10	.....	3,077	659,773	1,376,059	2,274,203	77,100	34,305
South Carolina	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	443
Total	218	$29,145,830	19,310	1,273	12	.....	20,595	$6,261,344	$14,953,674	$25,353,251	649,153	353,879

TABLE A.—*Grand Aggregate for the United States of all Blast Furnaces, Rolling Mills, Steel Works, and Forges and Bloomaries, with their Division among the Four Leading Sections.—Continued.*

STATES AND TERRITORIES.	No. of establishments in the census year 1880.	Capital invested in the census year 1880.	Hands Employed and Wages Paid in the Census Year 1880.						Value of all materials used in the census year 1880.	Value of all products made in the census year 1880.	Weight of all products made in the census year 1880. Net tons.	Weight of all products made in the census year 1870. Net tons.
			Males above sixteen years.	Males below sixteen years.	Females above fifteen years.	Females below fifteen years.	Total hands employed.	Total amount paid in wages.				
WESTERN:												
Ohio	134	$25,141,294	18,885	1,171	.....	15	20,071	$8,265,070	$23,997,915	$34,918,360	930,141	449,768
Indiana	12	2,283,000	1,883	165	.....	.....	2,048	864,921	3,293,073	4,551,403	96,117	64,148
Illinois	21	6,460,620	4,887	366	.....	.....	5,253	2,508,718	14,977,145	20,545,289	417,967	25,761
Missouri	22	9,152,472	2,989	150	.....	.....	3,139	734,575	3,249,558	4,660,530	125,758	94,890
Michigan	22	4,175,386	3,054	35	.....	.....	3,089	922,597	3,279,420	4,591,613	142,716	86,679
Wisconsin	9	2,843,218	2,088	65	.....	.....	2,153	1,004,931	3,330,667	6,580,391	178,935	42,234
Minnesota	1	150,000	180	.....	.....	.....	180	25,275	.....	.....	.....	.....
Kansas	2	450,000	570	60	.....	.....	630	166,500	734,245	1,004,100	19,055	.....
Nebraska	1	100,000	90	10	.....	.....	100	50,000	114,500	82,000	2,000	.....
Total	224	$50,755,990	34,626	2,022	.....	15	36,663	$14,542,587	$53,476,523	$76,933,686	1,912,689	763,480
PACIFIC:												
Colorado	1	$100,000	125	.....	.....	.....	125	$7,000	$131,700	$225,000	4,500	.....
California	1	1,000,000	284	35	.....	.....	319	177,722	535,500	780,000	14,000	3,000
Oregon	1	100,000	247	3	.....	.....	250	46,822	33,073	78,393	3,200	.....
Utah Territory	3	150,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wyoming Territory	1	212,603	174	10	.....	.....	184	79,650	403,568	491,345	9,790	.....
Total	7	$1,562,603	830	48	.....	.....	878	$311,194	$1,103,841	$1,574,738	31,490	3,000
Total of United States, 1880	1,005	$230,971,884	133,203	7,709	45	21	140,978	$55,476,785	$191,271,150	$296,557,685	7,265,140	.....
Total of United States, 1870	808	$121,772,074	75,037	2,436	82	.....	77,555	$40,514,981	$135,526,132	$207,208,696	.....	3,655,215
Per cent of increase in 1880	24.38	89.68	77.52	216.46	.....	.....	81.87	36.93	41.13	43.12	98.76	.....
Per cent of decrease in 1880	.....	.....	.....	.....	45.12	.....	.....	.....	.....	.....	.....	.....

TABLB B.—*Production of Pig Iron, Rolled Iron, Steel, and Blooms in the United States in the Census Year 1880.*

STATES.	Net tons of pig iron, including castings direct from the furnace.	Net tons of rolled iron.	Net tons of Bessemer steel ingots.	Net tons of open-hearth steel ingots.	Net tons of crucible steel ingots.	Net tons of blister and other steel.	Net tons of blooms made from ore.	Net tons of blooms made from pig and scrap iron.
Alabama	62,336	650						
California		14,000						
Colorado		4,500						
Connecticut	18,779	16,203			2,116			
Delaware		33,918						
Georgia	23,099	11,501					102	450
Illinois	95,468	117,051	253,514	925	130			
Indiana	18,237	77,880						
Kansas		19,055						
Kentucky	58,108	65,293		275	75			
Maine	2,015	8,851						
Maryland	59,664	47,609						3,661
Massachusetts	9,543	109,252		9,475	140			44
Michigan	119,586	23,130						
Missouri	95,050	16,508	8,409				4,000	
Nebraska		2,000						
New Hampshire		4,752		4,521				
New Jersey	157,414	66,030		450	10,492		523	3,306
New York	313,368	163,538	84,160		2,585		31,580	138
North Carolina							439	
Ohio	548,712	272,094	82,811	24,712	360			
Oregon	3,200							
Penusylvania	1,930,311	1,071,098	556,314	36,944	60,303	3,135	175	24,398
Rhode Island		8,134						
Tennessee	47,873	25,381		4,000			756	345
Texas	1,400							
Vermont	620	1,590		3,000				
Virginia	17,906	35,176					58	2,582
West Virginia	80,050	67,437						
Wisconsin	118,282	60,653						
District of Columbia		264						
Territory of Wyoming		9,790						
Total	3,781,021	2,353,248	985,208	84,302	76,201	3,135	37,633	34,924

TABLE C.—*Details of Production, Embracing Certain Special Varieties of Iron and Steel Manufactured in the Census Year 1880.*

STATES	Net tons of castings direct from the furnace. — Included in Table B.	Net tons of sheet iron. — Included in Table B.	Net tons of boiler plate iron. — Included in Table B.	Net tons of other plate iron except nail plate. — Included in Table B.	Kegs of cut nails of 100 lbs. each. — Included in Table B.	Net tons of hoop iron. — Included in Table B.	Net tons of iron rails. — Included in Table B.	Net tons of Bessemer steel rails.	Net tons of open hearth steel rails.	Total production of all kinds of rails. Net tons.
Alabama						500				
California							6,000			6,000
Colorado							4,500			4,500
Delaware		5,243	1,241	2,482						
Georgia							8,673			8,673
Illinois					222,540		72,802	201,186		273,988
Indiana		6,383	51		280,760		38,600			38,600
Kansas							13,500			13,500
Kentucky	93	4,784	5,375	3,155	210,000	785	18,000			18,000
Maine					4,480	375				
Maryland	20	3,178	6,612	3,702		12	9,280			9,280
Massachusetts			1,879	23,410	490,880	3,983	5,600			5,600
Michigan	86	1,300	4,600							
Missouri								5,100		5,100
Nebraska										
New Hampshire			100		40,000					
New Jersey	80	1,150			296,060					
New York	62			2,750	12,220	3,077	34,305	57,870		92,175
Ohio	1,011	14,440	9,180	7,050	733,940	23,149	41,838	66,480		108,318
Pennsylvania	2,217	54,174	60,519	52,162	1,504,000	64,722	157,213	409,339	3,360	569,912
Tennessee	140				104,180		12,800		2,745	15,545
Vermont							1,500	1,500	3,000	6,000
Virginia	121									
West Virginia	307	4,340			101,640		3,333			3,333
Wisconsin	92				1,055,900	240	29,552			29,552
District of Columbia										
Territory of Wyoming				38			9,421			9,421
Total	4,229	94,992	89,560	94,749	5,056,600	96,843	466,917	741,475	9,105	1,217,497

STATISTICAL TABLE Showing the Tatal Number of Gross Tons of Pig Iron Produced by the Blast Furnaces of Michigan, by Charles E. Wright, M. E., Commissioner of Mineral Statistics.

NAME OF FURNACE COMPANIES.	Previous to 1872.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	Totals.
[1] Pioneer Furnaces [a]	57,577	7,020	7,388	10,708	15,202	11,205	2,801	9,768	13,169	18,269	153,107
[1] Iron Cliffs Furnace [a]	.....	.....	.....	4,784	358	.....	.....	.....	.....	.....	5,142
[1] Collins Iron Company ‡ [a]	36,566	3,431	2,000	.....	.....	.....	.....	.....	.....	.....	41,997
[1] Northern Iron Company ‡ [a]	15,059	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,059
[1] Bancroft Iron Company ‡ [a]	35,021	4,250	4,100	3,688	5,277	3,282	.....	.....	.....	.....	55,618
[1] Morgan Iron Company ‡ [a]	31,602	4,356	6,324	5,973	5,377	3,278	663	.....	.....	.....	57,573
[1] Champion Iron Company ‡ [a]	20,512	5,006	3,949	1,581	.....	.....	.....	.....	.....	.....	31,048
[1] Michigan Iron Company ‡ [a]	23,314	4,001	4,467	6,621	3,098	.....	.....	.....	.....	.....	41,531
[1] Greenwood Iron Company ‡ [a]	25,140	4,212	4,416	4,839	1,595	.....	.....	.....	.....	.....	40,202
[2] Fayette Furnace [a]	24,626	9,962	11,966	11,079	10,647	10,015	3,969	10,594	8,956	9,739	111,553
[3] Munising Iron Company ‡ [a]	7,557	2,500	2,237	6,092	4,239	2,407	3,280	.....	.....	.....	28,312
[3] Bay Furnace ‡ [a]	7,095	4,900	8,760	8,359	9,223	8,119	4,250	.....	.....	.....	50,706
[1] Deer Lake Iron Company ‡ [a]	7,833	2,720	3,447	6,524	4,615	.....	.....	.....	.....	2,591	27,730
[1] Marquette & Pacific R. M. Co.	1,610	4,954	1,138	3,238	10,940	10,514	6,856	.....	.....	2,609	41,859
[1] *Grace Furnace †	.....	.....	7,800	3,546	.....	.....	.....	.....	.....	.....	11,346
[1] Carp River Iron Company [a]	.....	.....	.....	1,431	.....	1,272	3,176	4,917	5,529	5,585	21,910
[1] Excelsior (Peat Furnace)	.....	115	509	.....	.....	.....	.....	.....	.....	847	1,571
[4] Menominee Iron Company [a]	.....	.....	2,299	4,702	5,780	4,829	5,647	3,034	6,750	7,776	40,817
[2] Escanaba Furnace Company [a]	.....	.....	2,175	5,803	70	.....	.....	.....	.....	.....	8,048
[5] Michigan Central Iron Company [a]	19,518	3,551	4,848	3,451	1,230	.....	.....	.....	.....	.....	32,598
[5] Bangor Furnace Company [a]	.....	689	3,606	6,219	8,359	10,280	10,957	11,503	11,940	13,405	76,958
[6] Peninsular Iron Company [a]	33,752	4,834	4,533	2,049	2,460	2,472	5,310	5,254	7,683	§ 7,500	75,847
[6] Eureka Furnace [a]	60,000	2,078	3,572	549	2,255	3,421	4,458	528	9,395	15,925	102,181
[7] Leland Furnace [a]	.....	.....	.....	.....	.....	3,000	2,000	.....	.....	.....	5,000
[8] Frankfort Furnace [a]	.....	.....	† 6,200	3,656	4,061	.....	.....	.....	.....	.....	13,917
[9] Elk Rapids Furnace [a]	.....	.....	.....	5,863	8,033	7,100	11,925	12,448	12,477	12,384	70,230
[6] Detroit & L. S. Iron Manufacturing Company	36,494	4,731	4,061	3,808	4,831	1,580	4,805	1,437	4,767	7,149	73,663
[6] Union Iron Company [a]	.....	1,421	4,990	1,670	2,916	3,680	4,278	5,547	8,797	4,949	38,248
Totals	443,306	74,731	104,785	116,233	110,566	86,454	74,375	65,030	89,463	108,728	1,273,772

[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 Leelanaw County.
[8] Furnace in Benzie County.
[9] Furnace in Antrim County.
‡ Swineford's History.
† Previous to 1874.
* Coal or Coke.

Caseville Furnace—No returns.
Ward Furnace—No returns previous to 1878.
Hamtramck Furnace—Not in blast since 1873.
[a] Charcoal.
§ Estimated.

TABLE Showing the Amount of Coal Produced in Michigan for 1877-78-79-80, and Total for Previous Years, Partly Estimated.

	Previous to 1877.	1877.	1878.	1879.	1880.
Jackson mines	.....	67,697	61,785	† 65,000	66,170
Corunna mines	.....	.....	22,537	16,215	12,252
Other mines	.....	1,500	1,000	800	† 1,000
Total net tons	350,000	69,197	77,715	82,015	79,422

† Estimated.

INDEX.

	PAGE.
Adams, John Q.	172
Adventure Mining Co.	99
Agassiz, Alex.	149
Agogebic Range	217
Ahmuk Mine	54
Albany & Boston Mining Co.	139
Albion Mining Co.	53
Algonquin Mining Co.	105
Allouez, Claude	7
Allouez Mining Co.	150
Amygdaloid Mining Co.	55
Analyses	173, 176, 190
Ancient Diggings	8, 38, 66, 69, 88
Arnold Mining Co.	54
Arrow Heads	38
Ash Bed	30
Atlantic Mining Co.	107, 120
Avery, Charles	13, 19
Aztec Copper Co.	101
Bacon, D. H.	159
Bakewell, Thos.	23
Ball's Stamps	42, 135
Barnum Mine	164
Barnum, W. H.	176, 197
Beecher, H. H.	45
Belle Mine	49
Bennett, A. A.	60
Bennett, Sam'l	67
Bessemer Mine	177
Bigelow, A. S.	54, 146
Bigelow, Horatio	26, 37, 127
Blake, J. W.	21
Bluff Mining Co.	53
Boston Mining Co.	14
Boston Mine	189, 190
Breen Mine	217
Breitung, Edward	179
Brooks, John	59, 43
Brown, A. C.	202
Brown, Joseph W.	95
Calhoun, Wm. C.	174
Calumet Belt Mining Co.	55
Calumet and Hecla Mine	147
Cambria Mine	176
Cambrian Mining Co.	111
Capron, F. W.	98
Carp Lake Mining Co.	110
Carver, Capt. J.	9
Cascade Mine	109
Cascade Range	198
Cass, Gen. Lewis	10
Catholic Missionaries	6
Caton Mining Co.	54
Central Vein	35
Central Mining Co.	59
Champion Mine	192
Chapin, F. N.	117
Chapin Mine	204
Chicago Mine	174
Chicago Lake	217
Chippewa Mining Co.	103
Chisholm, S. H.	170
Chynoweth, Capt. John	81
Chynoweth, B. F.	92, 95
Clark, Joseph D.	146
Clark, James G.	44
Clark, J. W.	54
Clark, L. W.	98
Clark Mine	49
Cleveland, Hematite	178
Cleveland Mine	157
Cliff, Capt. John	131
Cliff Copper Co.	19, 30
Cliff Mine	13
Clifton Mining Co.	108
Coal	218a
Coffin, Wm. C.	34, 44
Coleman, E.	151
Collins, L.	96, 98
Columbia Iron Co.	186
Commonwealth Mine	202
Conglomerate Mining Co.	48
Conrad Iron Co.	188
Cope, Geo. W.	224
Copper, Black Oxide	f13
Copper Arrow Heads	38
Copper Falls Mining Co.	36, 69
Copper Harbor Mining Co.	50
Copper Masses	8, 10, 16, 19, 69, 75, 76, 88
Copper Mining Co.	105
Copper Tools	869
Cooper, James M.	25, 34, 36, 60, 93, 99, 101

	PAGE.
Cooper, Sam'l	96
Cornell Mine	209
Corry, A. J.	127, 131
Cortez Mining Co.	107
Curry Mine	214
Cyclops Mine	212
Dablon, Claude	7
Dalliba, J. H.	191
Dalliba Mine	149
Dana Mining Co.	51
Daniels, John	146
Davis, A. C.	197
Davis, E. M.	47, 103
Davids, O. J. & M. E.	188, 189
Davis, H. C.	48
Davis, Capt. Henry	171
Day, Jeff. D.	203
Day, S. M.	46
Delano, M. A.	34, 44, 59
Delaware Mining Co.	47
Demmon, D. L.	87, 89, 90, 135, 140
Derby	109
Deveraux, J. R.	152
Diamond, Capt. Harvey	166
Diamond Drill	79, 193
Dickinson, Capt. W. E.	23, 160, 204
Dorchester Mining Co.	141
Douglass Houghton Mining Co.	105
Douglass Mining Co.	140
Dunstan, Capt. John	67
Eagle Harbor Mining Co.	50
Eagle River Mining Co.	51
Early History	5
Ely, S. P.	179
Emmerson, B. F.	43
Emmerson, G. D.	74
Emmett Mine	217
Emmett Mining Co.	217
Emory, H. F.	80
Eureka	109
Evergreen Bluff Mining Co.	96
Farr, Geo. D.	80
Farwell, O. A.	19, 21, 29
Faulke, Chas. M.	48
Fay, Joseph S.	164
Fay, R. S.	164, 177
Felch Mountain	217
Fire Steel Mining Co.	105
Flint Steel Copper Co.	90
Flint Steel Mining Co.	90
Florence Mine	201
Foley, Jas. F.	172
Forest City Mine	177
Forest Mining Co.	106
Forest Shepherd Mining Co.	109
Forest & Whitney	7
Foster, E. P.	207
Foster, Hon. J. H.	119, 132, 136
Fowle, J. C.	197
Franklin, Dr.	5
Franklin Mining Co.	105, 135
Fulton Mining Co.	54
Garden City Mining Co.	53
Gates' Stamps	46, 97
Gogebic Mining Co.	109
Goodrich Mine	170
Grand Portage Mining Co.	117
Gratiot, Col. Chas. N.	26
Gray, Joseph E.	124
Great Western Mining Co.	103
Greeley, Horace	44
Hagerman, J. J.	202
Hall, C. H.	161, 164
Hammers, Stone	38, 69
Hancock Mining Co.	141
Hanover Mining Co.	57
Hanshaw, David	26
Harlow, A. R.	159
Harrington, M.	207
Harris, S. B.	90, 99, 100, 101
Harris, Wm.	150
Hartford Mining Co.	109
Harvey, C. F.	70
Harvey, W. H.	204
Hay, J.	135
Healy, Mark	27
Heard, John T.	37
Henry, Alex.	9
Henszey, J. G.	46, 96, 103
Highland Mining Co.	140
Hill, S. W.	22, 28, 38, 47, 60, 154
Hoatson, Captain John	32
Hooper, Captain Thomas	112, 113
Houghton, Dr. Douglass	11
Howe, T. M.	14, 19, 22, 25, 34, 60
Hoyt, Geo. A.	67
Hoyt, James E.	72, 89
Hoyt, Jessie,	150
Huddleston, Captain J.	102
Hudson, E. W.	152
Hudson Mine	108
Hulst, Dr. N. P.	202, 207
Humboldt Iron Co.	187
Hunt, Wm. P.	34, 44
Hurlburt, E. H.	143
Huron Copper Co.	119
Hussey, H. G., 14, 19, 22, 34, 60, 93, 95, 99,	101
Indiana Mining Co.	154
Iron City Mining Co,	53
Iron Cliffs Co.	164, 166
Island Copper Co.	152
Isle Royal	151
Isle Royal Mining Co.	116
Jackson, C. T.	13, 26, 29
Jackson Mine	153
Jerome, Gov. David H.	3
Jesuits	7, 8
Jogues, Isaac	6
Jones, D. G.	26
Kaolite	114
Keel Ridge Mine	207
Kewenaw County	11
Keystone Mine	195
Kibbie, E. P.	152
Kidder A,	166, 172, 173, 191, 195
Kimberly S,	207
King J. H.	177
Kirkpatrick, J.	198, 199
Kloman Mine	186
Knapp, S. O.	68

	PAGE.
Lac La Belle	47
Lake Superior Co.	37
Lake Superior Copper Co.	90
Lake Superior Iron Co.	160, 169, 170
Lawton, C. D,	3
Lowthian Mine	169
Ludlow, Wm.	43
Ludington Mine	207
Lumbermen's Mining Co.	207, 213
Mackinaw	9
Madison Mining Co.	53
Maitland, A. W.	176
Mandlebaum, S.	27, 28
Manhattan	53
Marquette, Jas.	7
Marquette Iron District	153
Marsh, Clement	116
Martin, Captain Stephens	98
Mason, Thos. F.	98, 99, 100, 101, 127, 131
Mass Mine	92
Masses of Copper	8
Mastodon Mine	217
Mather, S. L.	175
McComber Mine	175
Meadow Mining Co.	55
Meads, A.	96, 103, 106, 152
Meeker, A. B.	187
Medora Mine	25
Mendota Mining Co.	57
Menominee Mining Co., 201, 204, 209, 210, 212.	
Menominee Range	201
Mercer, James	111
Merrimac Mining Co.	96
Merry, Captain Henry	154
Mesnard, Pierre	7
Mesnard Mining Co.	140
Metropolitan Mining Co.	217
Mette, August	142
Michigamme Mine	196
Mills, James M.	60, 105
Milwaukee Mine	172
Minesota Mine	68
Minesota Mining Co.	74
Minong Copper Co.	152
Mitchell Captain Samuel	168, 214
Mitchell Mining Co.	167, 170
Montreal Mine	49
Morcum, Captain E.	209
Morehead, J. K.	34, 36
Morgan, David	180
Morse, Fred A.	175
Morse, J. C.,	159, 175, 189, 190
Mott, Jordan L.	60
Muscawabic Mine	110
National Mine	167
National Mining Co.	80, 68
Native Copper Co.	57
Negaunee Range	172
Nelson, R.	178
Nevens, David	43
New York Mine,	159
Nonesuch Mining Co.	111
North Cliff Mining Co.	16, 22
North American Co.	17, 18
Northampton Mine	192
North Range	189
Northwest Copper Co.	44, 46
Northwestern Mining Co,	34
Northwestern Iron Co.	217
Norton, D. Z.	192
Norway Mine	210
Norwich Mining Co.	107
Ogema Mining Co.	95
Ohio Trap Mining Co.	108
Oliver, Geo. L.	57
Olliver, Captain John,	212
Oneida Location	106
Ontonagon District	67
Ontonagon River	9
Osceola Con. Mining Co,	143
Outhwaite, Joseph H.	166
Owl Creek	41
Page, August A.	102
Palmer, C. H.	131, 143
Palmer, Waterman	60
Parnell, Captain Ed.	32, 72, 86, 87
Parsons, E. D.	179
Pascoe, Capt. Jas.	191, 194
Pascoe, Capt. Peter	179
Paull, James	10
Pendill, J. P.	175
Pennsylvania Mining Co.	46, 47
Perkins, Capt. John	214
Perkins Mine	213
Petherick, Wm.	40, 43, 45, 82
Peterick Mining Co.	43
Petrie, C. B.	66
Pettit, Wm.	44
Pewabic Mining Co.	131
Phœnix Copper Co.	25, 27, 30
Pickands, Jas.	189
Pittsburg & Boston	22, 24
Pittsburg & Lake Superior	166
Pittsburg Mining Co.	108
Pollock, W. G.	175
Pollock, W. S.	190
Pontiac Mining Co.	140
Pope, Graham	117
Porcupine Mountain Mining Co.	110
Portage Mine	115
Pumpelly, Prof. R.	190
Quincy Mining Co.	124
Quinnesec Mine	208
Raymbault, Charles	6
Republic Iron Co.	179
Ridge Copper Co.	98
Robingson, John	60
Rockland Mining Co.	87
Rogers, P. T.	102
Rolling Mill Mine	174
Rood, James	176, 197
Rundle, Capt.	206
Ryan, Ed.	142
Saginaw Mining Co.	170, 190, 213
Salisburg Mine	166
Sault Ste. Marie	7
Schaffner, Charles	44
Schoolcraft, H. R.	10
Schoolcraft Mining Co.	149

	PAGE.
Schwartz, Capt. Jerome	214
Scott, Thomas P.	117
Seabury, C. W.	149
Sedgewick, Wm.	165
Seneca Mining Co.	54
Shapley, Justin	98
Sharon Mining Co.	109
Shawmut Mining Co.	105
Sheldon & Columbian	118
Sheldon & Shafer	217
Silver	21
Simpson, M. H.	19, 21
Slawson, John	25, 34, 60
Smith, W. Harte	50, 99, 100
Smith, Truman	117
Smith, Fred.	151
Smith, S. L.	150
Snell, Joseph	52
South Pewabic	120
Spaulding, W. H.	47
Spencer, A. W.	27
Spurr Mine	197
Stanton, John	67, 124
Star Mining Co.	50
Statistical tables	24, 152a, 223, 224, 225, 226, 227, 228, 229.
St. Clair, E. G.	169, 185
St. Clair, Geo. A.	169, 185
St. Clair, J. O.	169, 185
St. Clair Mining Co.	58
Stephenson Mine	212
Stephenson, S. M.	213
Stephenson, Isaac	213
Sterling Mine	190
Stevens, J. F.	174
Stevens, W. H.	106, 108
Stewart, W. C.	151
St. Mary's Mining Co.	141
Stockbridge, Geo. E.	213
Stone Hammers	8, 38, 69
Stonington Mining Co.	105
Summitt Mining Co.	51
Swamscott Mining Co.	22
Swank, J. M.	3, 219
Tallon, Captain M. L.	118
Teal Lake Range	176
Tecumseh Mining Co.	142
Thomas, A. P.	47, 48
Thompson, G. H.	44
Tilden, S. J.	159
Todd, W. R.	127, 131
Toltec Mine	103
Tankin, Wm.	122, 134
Towns, A. C.	164
Townsend, J. B.	88, 92
Tuttle, G. R.	177
Tuttle, H. A.	204
Tuttle, F. L.	204
United States Census	219
United States Mining Co.	107
Uren, Captain John	52
Vandyke, J. H.	202
Vandyke, G. D.	202
Vila, Joseph	104
Vulcan Mine	214
Wade, J. H. and R. P.	112
Wagner's Stamps	30
Walker, H. N.	34
Ward, C. H.	53
Ward, Joseph W.	26
Waterbury Mining Co.	50
Watson, James	22
Watson & Walls	150
Waukulla	110
Wayne's Stamps	45
Webb, Wm.	82
West Minesota Co.	106
West Republic Iron Co.	185
Wheat Mine	199
Wheeler, C. M.	177
White, F. G.	111
Whittlesey, Col. Chas.	51
Whitney, Prof. J. D.	13
Wicker, C. M.	187
Willard W.	111
Williams, Samuel	26
Williamston, R.	207
Winthrop Hematite Co.	169
Winona Mining Co.	105
Wood, J. R.	209
Wright, Chas. E.	3
Wright, J. N.	149