

STATE OF MICHIGAN.



MINES

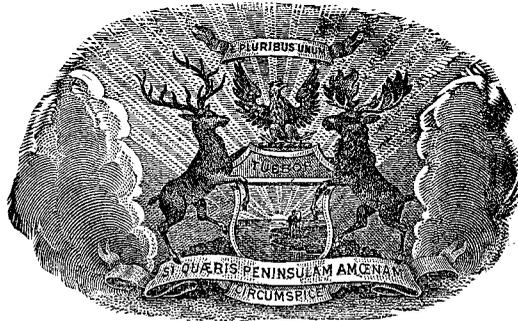
AND

MINERAL STATISTICS

BY

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BY AUTHORITY.

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STATE OF MICHIGAN,
OFFICE OF THE COMMISSIONER OF MINERAL STATISTICS, }
Lawton, Michigan, June 15, 1887.

HON. CYRUS G. LUCE,
Governor of the State of Michigan:

SIR,—In fulfillment of the duties of my office, I have the honor to submit herewith the following report upon the mines and mineral interests of the State.

Respectfully your obedient servant,

CHARLES D. LAWTON,
Commissioner of Mineral Statistics.

STATE OF MICHIGAN
OFFICE OF THE COMMISSIONER OF MINERAL STATISTICS
LAWTON, MICHIGAN

THE MINING INDUSTRY.

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There has been great improvement in the mining industry since one year ago. This is especially true of the iron mines. The advance in the price of copper from 10c per lb. to 12c, which occurred during the past year and which price still prevailed early in the present year, caused a feeling of relief in the copper district; the outlook became far more hopeful and increased activity prevailed. But copper mining in Michigan has become a very uniform industry; prices may vary but the work at the mines goes on steadily with little apparent change. There is all the while a gradual increase in the magnitude of the operations, resulting in an increased production and a corresponding lessening of cost.

Comparatively few comprehend the scale on which all the work is carried on at our great copper mines. They do not realize the fact that the rock from which the copper is eliminated must be mined far underground, at a depth of from hundreds to thousands of feet, and thence be raised to the surface, taken to the rock house and passed through breakers, whence it must go to the stamp mill, perhaps several miles away, and there be pounded into fine mud and sand which in turn is run over the system of sieves and jiggers and slime tables, undergoing an elaborate process of mechanical manipulation by which the separation of the copper from the sand is effected, after which the copper must be taken to the smelting works and be cast into ingots, when it is ready to be sent to market.

Few, even mining men, who have not acquainted themselves with the details of the work at our Michigan copper mines, are ready to give credence to the statement of the results which are obtained. They do not readily comprehend how all the various manipulations, which I have indicated, are accomplished at so low a cost. It seems to be a little difficult for mining men in this country and in Europe who have not visited our copper mines to credit the fact that rock which has a gross value of but \$1.65 per ton, that is, rock which contains less than 15 lbs. of refined copper, on an average, to the ton, can be mined at a depth of more than 1000 ft. below the surface, hoisted, broken, stamped,

washed, and separated, smelted and taken to market and sold for \$1.65 and still leave in the hands of the company, after accounting for the cost of all these successive manipulations, a net profit of 22 cents on every ton of rock so mined and treated! Yet such was the year's result at the Atlantic in 1885 and it is equally favorable for 1886, only I have not at this writing the exact figures for data.

Not only was the rock mined and treated, etc., at the total cost of \$1.43½ per ton but a sufficient profit accrued so that a dividend of \$1.00 per share was paid to the stockholders.

In order to accomplish this, 800 tons of rock were raised and stamped per day. Each year, as the price of copper has diminished, the daily production has been increased in order to reduce the average cost. Ten years ago, when there were but 230 tons of rock mined and treated per day, the average cost was \$3.90 per ton at the mine. The cost of stamping and washing was then 88 cents per ton, while now it is but 30 cents. The total average cost per pound of copper obtained at the Atlantic mine ten years ago was 22 cents, in 1885 the same was produced for 9½ cents. The mine is no richer now than formerly; in fact there has been, practically, no change in the quality of the rock. The advantage gained is due to improved facilities for mining and manipulation and to the better comprehension of the work. The problem has been studied in all its details and no effort has been spared to meet all the exigencies which the work demanded. The Atlantic mine has been referred to simply for illustration. There are others which afford an equally favorable showing, and altogether these results make it apparent that no business in the land of equal magnitude is more systematically and carefully conducted than is the copper mining industry of Michigan. There is none more legitimate, scarcely none that rests upon a more substantial basis or that is conducted with more freedom from speculation and from those manipulations of stock which unfortunately too frequently characterize mining operations in many localities.

Lake Superior copper mining, as an industry, falls into the category of those regular, uniform enterprises that are understood as being not unduly risky or greatly liable to fluctuation and ruin. No enterprise, no business can be wholly exempt from danger, and copper mining in this State can be made and is made as certainly profitable as are other undertakings requiring large expenditure of money. The mineral lodes are pretty well understood, it is known, generally, what they will yield, the conditions are understood, the elements of the problem are in hand. The leading mines have demonstrated their ability to meet all the conditions, to so conduct their operations that an annual profit shall accrue with accurate regularity. Mining, like other enterprises, can be carried on with such recklessness and extravagance that utter ruin must result, and if there

are conspicuous instances of failure in the recent history of the copper country, the unfortunate results may be traced to causes that were readily foreseen. The final outcome could have been predicted in advance with all reasonable certainty; while good management, in all instances where the conditions are favorable, has been attended with success.

The progress which has characterized the copper mining industry has also in an equal degree entered into the work in the leading iron mines. Copper mining, of necessity, requires a great preliminary outlay, the work cannot be successfully prosecuted otherwise. The rock, after it is mined, unless it is mass copper, must be crushed and stamped to great fineness and washed to separate the copper from the rock, and the copper finally smelted before it can be sold. All these successive manipulations require the procurement of mechanical appliances that are very elaborate and costly. Great skill and experience are essential on the part of those who have the direction of such work. No copper mine in Michigan can be successfully operated otherwise than by all this necessary outlay. As soon as the deposit has been proven, that is, as soon as it has become established that the lode is sufficiently good to justify its permanent working then the rock house and stamp mill must be provided for. Hundreds of thousands of dollars must be thus judiciously expended before the mine becomes established as a working, paying enterprise.

Not so with iron mines: some of these in their earlier stages are the simplest of excavating work, a mere open pit in which the ore is dug out and loaded into cars. Generally, even when the ore is thus mined from an open cut, more or less stripping must be done before the ore can be reached, that is, the overlying dirt and rock must be first removed. But this sort of mining is only applicable to soft ore mines—hematites—and to these, when true of them, only in the first year or two. Very frequently there are difficulties met with that to be overcome require the exercise of skill, experience and improved appliances to insure economical production. Still the ore only has to be mined, there is no subsequent manipulation required on the part of the mining company to render the ore marketable.

Thirteen years ago all the iron mines in the State, with one small exception, were wholly open to daylight, and the aggregate production was 1,000,000 tons; now nearly all are worked under ground and the aggregate production, annually, has mounted up to 3,000,000 tons. Great change has taken place in the iron mines in the last few years, in the large mines, as the Cleveland, Lake Superior, Republic, Chapin, etc. The old and inadequate machinery has given place to that of the most costly and powerful character—for hoisting, for pumping and for drilling. The wooden buildings in which the machinery was formerly held have been supplanted by stone structures with iron roofs, which are safe,

substantial, spacious and elegant. Ponderous steam engines, air compressors and immense winding drums that have nearly the intricacy and perfection of workmanship, combined with the certainty of results desired, that pertain to the chronometer, are the order of the day and such are found in all our great iron mines. The use of the electric engine for lighting the buildings, the surface and the interior of the mines is becoming general; the electric bell for signalling is rapidly coming into use, securing rapidity and greater certainty in announcement.

At the Chapin, Ludington, Vulcan, Lake Angeline, Lake Superior Hematite and Barnum mines, which have vertical shafts, cages are used instead of the skip ordinarily employed. In one particular, at least, the use of the cage in shafts is an important change for the better, since the men are thereby enabled to get into and out of the mines without undergoing the excessive labor incident to descending or ascending the ladders. The danger is also greatly lessened. There is very little liability to serious accident in using the cage. The machinery is so perfect, so easily controlled that the cage is run with great steadiness. The best steel wire rope is used of a strength that eliminates nearly all possibility of its breaking; but even if this should occur, the frequent tests that have been made have demonstrated the fact that the safety-clamps with which the cages are provided will act to stop it instantly. The men are taken down into the mine or brought up from it without loss of time and without labor; thus the cage is not only a saving of labor to the men but it economizes time. Ordinarily, where the miners have to "climb the ladder" 500 feet or more to get to the surface they are obliged to "knock off" from work 15 or 20 minutes before the "blowing of the whistle" to begin the ascent from the mine, and this ascent, after a hard half day's work, is a serious matter. And the same is true in going down; they reach the bottom of the mine pretty well tired out. Whereas, with the cage, they gather at the shaft at the different levels in which they are working and stand upon the cage, usually nine men for a load, the signal is given and in less than a moment they are at the surface; a brief space suffices to take up all the men, and with the same economy of time they are let down to their work. Climbing the ladder is one of the most laborious parts of the miner's work, and thus the introduction of the cage is in this respect a change for the better.

Another important innovation has lately been made in the work in the iron mines, which is the practice of filling up the spaces from which the ore has been extracted. Until within a year or two no instance of this method was to be found in our mines; now it is practiced at a number of them and it is a notable advance in mining.

In all of the hard ore mines and in some of the hematites the walls are kept

in place where the ore has been extracted by leaving pillars of ore; these are of such size and in such position as in his judgment the mining captain shall deem necessary. Occasionally stull timbers are added to hold fragments of rocks in place. In some hematite mines, where the inclosing walls of rock are uniform, with little tendency to fall, and where the ore also is hard and compact and remains firm in the pillars large rooms are left, sometimes of great breadth and height, and this is done with entire safety, the nature of the rock and the ore being such that they will stand.

Frequently, however, a good deal of the ore is left in the mine in the pillars and floors to the levels, which latter also serve as pillars to sustain the walls. Especially is this the case where the shafts are in the ore, then usually heavy ore pillars are left upon either side of the shaft in each level to insure its permanence and safety. More recently it has become the practice to seek to have the shafts in the rock and avoid having them in the ore. When it can be done the foot wall is the side selected, since a shaft in the foot wall has no liability to disturbance. When the shafts are in either wall of the vein the ore is reached by tunnelling through the rock to it, which drifts are termed cross-cuts.

In many hematite mines, which are worked underground the walls are supported by timbers arranged on a plan after what is termed the Nevada system. This system is very simple and when the timbers are suitable and well placed it is very effective—far better than any other plan of timbering that has been devised. It consists of posts and caps, either round or square. The former are generally 7 feet long and have a square 4-inch tenon in the center of each end; the latter are 9 feet long and are squared at the ends so as to be fitted on the posts. They are put up in what are termed "sets;" starting from the foot wall the posts are set in the line of greatest pressure, to which the plane of the caps will be at right angles, that is, they will lie approximately, parallel with the walls of the ore deposit. The posts are set as the work progresses, exactly one over the other, so that they form a straight line and the caps, the ends of four of which rest on each post, radiate at right angles so that each line of caps is a straight one. The joints are made to fit with precision so that there is no give nor play in them, and the outside timbers are "shored" firmly against the walls. It will thus be seen that each "set" incloses a rectangular volume 7 feet x 9 feet x 9 feet, one set exactly over another, timbers and rooms all placed in line. Thus there can be no swaying or knuckling when firmly placed and can give way only by crushing.

Most generally when this system of timbering is used it is combined with ore pillars, that is, the ore body is worked in rooms or headings regularly alternating with ore pillars which are left. Openings 18 feet wide across the ore are made, which are separated by pillars of ore of equal width.

The openings are timbered in sets and the sides of the pillars are lagged up, the lagging being wedged firmly between the ore and the uprights.

When the ore is soft and will not remain in place only as it is held there, the heading is made by advancing from the foot wall side with one line of sets; as fast as it is opened ahead far enough for a set, the timbers are put in place. If the ground is so "bad" that it will not hold up the length of a set, temporary timbers are used a little way in, to be removed when the full set is completed. Generally, in advancing the headings in these soft hematite deposits it is necessary to hold up the "back" of the drift ahead of the timbers. This is done by laying a timber on top of the final cross cap and then thrusting poles ahead, which rest on top of the cross piece and incline downward back into the drift. They are driven ahead as the work advances and protect the workmen from any fall of the ground. A second line of sets alongside of the first is in like manner opened out in the same heading; the sides against the pillars are lagged up between the ore and the timbers and short pieces are set against the walls at either end of the heading, and thus the pressure is provided for in all directions. These two sets constitute the width of the heading—sometimes they are three sets wide and even four; but two or three sets wide is the usual number; leaving an eighteen feet pillar.

When the bottom sets are completed they are covered over on top and the ground above is worked out in the same manner and a second series of sets is formed directly over the first. The tram cars, which run on the track that branching from the one in the main drift, come in on the bottom of the heading below, receive the ore which is run down into them through suitable openings. And thus in succession, one series of timber sets above another, the ore is mined out up to the level above until, if no "floor" is left, the ore is all taken out and the timbers come up exactly beneath those which are already placed above. Surveys are made so that the headings are started directly beneath those above.

It will be seen that very much ore is left in the pillars, generally about one-half; sometimes when heavy floors of ore are left two-thirds of the ore remains in the mine. It is of course the intention to remove this ore subsequently, and at some mines this work of mining out the pillars has already begun. Valuable experience has thus been speedily acquired. As a general fact it has been found that these ore pillars cannot be removed with safety without first filling the rooms with sand, etc., and rock. At several important mines this operation is in progress—extracting the ore by first filling the rooms and then cutting away the pillars, either proceeding in the same manner as when making the original headings or filling up the vacant space as fast as the ore is removed—thus virtually filling the whole mine.

Wherever filling is practiced it is meeting with general favor, it insures per-

fect safety, the saving of all the ore and is not usually more expensive than other methods; probably in the long run in all large mines it is far the most economical plan.

The method of extracting the ore and filling the mine is naturally varied to meet varied circumstances. Where the ore body is not too wide or where the ore is dry and stays well in its place, the stope is carried the whole width of the vein and the space filled up to near the "back," the filling is leveled off and planked over to receive the ore that falls upon it, then another stope is carried forward to a suitable height, the ore and plank removed as the work progresses, and the filling brought up again to near the "back," and so on the work proceeds.

It is well to state that a main drift is first made in each level, as it is reached by the shaft. This opening drift is ordinarily along the foot wall in the ore and is well timbered and made secure for permanence and safety. As the ore in the level is mined out it is run down into the tram cars in this drift through openings that are carried up through the filling as the work proceeds. These shuttes are termed "mills" and the work is designated as "milling down the ore." Similar "mills" left through the filling in the level above suffice for avenues through which to run down the rock and dirt as required.

Where the ore body is wide or of such a character that it will not hold up very well the filling must follow close upon the stoping and the back be kept blocked up.

To accomplish this the ore body is first opened by cross drifts from the main drift to the hanging wall made at suitable distances apart, 50 ft. to 100 ft., and carried at about 8 ft. high and as wide as the ground will bear. Then along these drifts breast stopes are carried forward each way lengthwise with the deposit, and as the stoping progresses the space behind is filled up to the back. In the same manner on top of this filling other stopes are afterward opened and the ore is mined out and the filling proceeds as before. "Mills" best for running down the ore and for receiving the filling are built up and kept open along the main drift.

Still another method is to mine out the ore and "let in" the overlying earth and rock to the surface. There are several ways by which this is accomplished, but essentially this plan consists in drifting from the shaft to the extremity of the ore and securing the drift, then working a stope of suitable height and advancing towards the shaft allowing the "surface" to come in in the rear. In this manner the level is worked from the top downward, the stoping being all the while under the filling.

No system of timbering, however well done, will hold a large mine for any considerable depth; it must be either filled or wrecked.

As before stated, there is constant progress in all our mining region, obsolete methods speedily give way when something better is devised. Our mining men are ever on the alert to appropriate whatever is new that is to their advantage. There are no men in any great industry who keep abreast with the times, in their business, more thoroughly than the mining men on Lake Superior. Not only is the great improvement in the machinery used more powerful, more rapid and more perfect in its action, but everywhere, in every department of the work, one meets with changes, with improvements with many ingenious contrivances that betoken energy and intelligent forethought; generally, too, one observes those indications which suggest good management.

Sometimes mining work is very simple, discoveries of ore are made and a mine opened by simply "stripping" off the covering of earth, sand and gravel, etc., which if the deposit prove to be large and the ore of good quality, a good deal of money may be made the first year or two, or until the mine reaches considerable depth, when powerful machinery and other expensive appliances are required. But ultimately mining becomes difficult work. And it is only by large outlay, judiciously made, long experience and skill in the work, energy and economy that success is met with. I have already stated what is accomplished in the great copper mines, and the same intelligence, energy and progress are in an equal degree manifest in the iron region—in the work in the leading iron mines. The old mines have attained to considerable depth and the ore must be brought from far below the surface, but the result is accomplished without additional relative cost. The ore is sold cheaper and is mined cheaper than formerly, notwithstanding the increased depth which the mines have attained. More powerful and improved machinery, high explosives, air drills, greater energy, intelligence and economy of working have increased the output and lessened the cost.

The quality of the ores is a matter that enters more and more into the matter of this production. Ores are sold now on their determined qualities. It is no longer a matter of assertion, of estimate, but the average percentage in iron, phosphorus, silica, etc., of the product of the mine, must be known to a certainty. This fact is ascertained by analysis of specimens—not one but many—so collected as to represent, as nearly as possible, the average of the stope, stock pile or cargo. Nearly all the large mines now have a laboratory and chemist at the mine, and in some cases analyses are constantly making. At one of the mines in Ishpeming, in the past five months, 300 analyses have been made of the ores of the mine.

At the rolling mills and furnaces in Chicago, Cleveland and Pittsburg chemists are also employed, and the ores undergo equal scrutiny at that end of the line. Skillful furnacemen now buy their ores by analysis with reference to the

manufacture of certain kinds and grades of pig metal. They know from the analysis what proportion of ores of different mines to purchase and what proportion of each to use in the mixture to obtain the kind of metal required.

Owing to the rapid increase in the use of Bessemer steel for the manufacture of rails the demand for ores suitable for Bessemer pig metal has greatly extended. The first demand regarding the quality of any newly found ore is, whether it is Bessemer? what is its percentage of phosphorus? Iron and silica contained are of minor consideration. The most important question—the one that settles the value of the ore—is whether the relative proportion of phosphorus and iron contained is such as to place the ore within the Bessemer limits. The lower the percentage of phosphorus in proportion to the iron contained the more valuable the ore.

GOGEBIC.

In the last year or two the limits of production of Bessemer ores in our State have been greatly enlarged. Some new deposits have been discovered in the Marquette district, while the opening of the marvellously rich Gogebic range has added several new mines which are large producers of this class of ore. The list of this class of mines is rapidly extending.

Exploration is very active in the Gogebic range; new companies are daily forming, and important discoveries of ore are frequently made, and the number of producing mines in another year will perhaps be double that of the past year, and to what limit the range may extend it is impossible to decide; it has already been explored with very promising results, both east and west, far beyond the originally prescribed limits.

The Gogebic range is divided between the States of Michigan and Wisconsin, that portion lying west from the Montreal river being in the latter State. The most productive mines thus far discovered, are in Michigan, and from these mines, lying in Michigan, there was shipped the past year nearly 700,000 tons of ore.

This ore is all Bessemer, is well up in iron, and much of it is otherwise exceedingly valuable in the fact that it contains a good percentage of manganese. Manganese in low phosphorus ores is esteemed a desirable combination by the steel makers. 1886 was the first full year in which shipments were made from the Gogebic range; they began in the fall of 1885 on the completion of the Milwaukee, Lake Shore and Western Railway from Ashland to the mines, and a limited amount of ore was sent to market ere the close of navigation. The railroad rate to Ashland is 80c per ton and the lake freights thence to Cleveland averaged about \$1.54 per ton for the past season. The Gogebic ores sold in the Lower Lake markets the past season for \$5.00 per ton

average; probably they will sell fully a dollar on a ton higher in 1887, but there will also be an increase in the lake freights to lessen the margin of the gain in the price. The Gogebic range is a very pleasant region of country; far to the north is seen the high broken lands of the trap range which bound the iron-bearing series in that direction, and to the south is the granite. The rocks in which the ore deposits are included are deeply covered with drift, which constitutes an excellent soil for the support of vegetable products. Between the granite and the mountainous trap range the land is gently rolling and covered with a fine forest of hard wood timber, chiefly sugar maple. It is good farming land and in time must become a fine agricultural region.

The only thing against it is the climate, which is of course severe, but to offset this are the advantages of a good market due to the large mining population which this region will be sure to contain. The extraordinary development that has been made in the Gogebic range in so brief a time is surprising. No one could have conjectured that the ore deposits which have been developed should have proved to be of such magnitude or of such excellent quality.

The towns on the range which have grown up so quickly have a substantial character. Some of them are better than are usually found in a mining region, even when of much older date than is this newly settled section. One can scarcely realize that it is barely two years since almost the first blow was struck; yet there are hotels and private residences of elegance rarely excelled or equaled in the northern country.

The extraordinary success which has attended some of the mining ventures of this range, the fortunate outcome of many of the explorations that have been made and are constantly making, the uniform general excellence of the ores that are found, have stimulated in a high degree the hopes and enthusiasm of nearly everyone who has any interests in the region. Many fortunes have been realized. Scarcely a day passes but some new "finds" of ore are announced, and accounts of sales of property are reported by which fabulous sums accrue to the fortunate vendors. Stocks advance with a rapidity that one must catch them on the whirl if he designs to become a possessor. The fabulous sums, which, rumor asserts, represents the purchase price of some important mines that have recently changed owners, are enormous.

It seems hardly credible that a property comprising 40 or 80 acres of land which within so brief a time was forest primeval wherein the wild deer browsed undisturbed, should suddenly develop hidden wealth that multiplies its value thousands of times! That the simple lease of an estate, of such dimensions, from the surface of which the forest has scarcely been removed should sell in the market for more than a million of dollars is astonishing beyond measure. But such is the expectation of profit, faith in the continuity of the deposits, and

speculative fever, that these reputed transactions doubtless really occur. Certainly there are sales made of mining properties at astonishing figures; and stocks are quoted and sometimes sold of mines, when, in some instances, but a meagre development has been made, at prices which represent an aggregate value of hundreds of thousands of dollars!

But while the fever of speculation runs high there is much that is real for a foundation for all this seeming exaggerated hope and expectation. There are some, apparently, immense deposits of excellent ore; these can be seen and examined, and furnish solid facts to be used to "boom" much that is unreal or imaginary.

The whole length of the range so far as it has been explored is dotted with so called mines; there is a mine on nearly every "eighty" for a length on the range of 20 miles. Many of these are thus far merely explorations, mere beginnings, where they have either not yet reached the ledge with their sinking, or have not succeeded in finding ore. Some have got ore, but as yet in small quantity.

It takes time to open a mine; certainly where there are no exposures, where the ledge is covered with thirty feet of drift, the work of development of discovery even, is slow, expensive and uncertain. But unfortunately, or fortunately, according to the way one looks at the matter—as his interest lies—zeal for investment does not seem to be dependent on any such tedious process. Gogebic mining stocks are bought and sold very extensively. Parties are eagerly seeking for opportunities to invest and new "locations" are made, "options" and leases obtained, companies organized and stocks issued to meet the demand. Not unfrequently there is nothing apparent but this fact that the land is on the "range" and is crossed by the ore formation—imagination does the rest. It seems that there are not a few people who are abundantly endowed with this faculty, who possess a sufficient amount of fancy to enable them to see beneath the overlying surface magnificent deposits of ore of which the Colby is but the counterpart.

There is much to keep up this hope, in all honesty; discoveries are constantly making along the range and many good "finds" of ore have been made—enough, certainly, for the basis of large expectations.

The formation of the Gogebic range is more regular, at least it has that appearance so far as it has been developed, than are those of the Marquette and of the Menominee iron districts. And this fact, notwithstanding the many difficulties connected with exploration even here, makes the work of discovery more easy and certain than it is elsewhere in the iron region. The ore formation here seems to partake somewhat of the regularity of the copper rocks—the trap—which bounds it on the north. To the south is the granite, and

thus the iron bearing rocks are situated, for a portion of the extent of the range, between the trap on the north and the granite on the south dipping north at a steep angle. The deposits of ore thus far discovered seem to be between a so-called quartzite foot and a slate hanging. Explorations with favorable indications and results are pushed with great zeal and rapidity both east and west, west into Wisconsin and east into Michigan. A year ago the limit of discovery in the latter direction was in the vicinity of Sunday Lake, but exploring work has been extended many miles east of that point, and it is likely from what has been found so far east as Marensco and Watersmeet, that ore in paying quantity exists.

An important matter connected with the Gogebic range is the fact that the Chicago & Northwestern railway company is now at work extending its line from Iron river northwesterly to the Gogebic mines. By a glance at the map it will be seen that this extension follows the same general course of the railroad along the Menominee range.

Geographically the Gogebic range mines are in the line of the prolongation of the axis of those of the Menominee range. This extension will intersect the Milwaukee, Lake Shore and Western—the line which now supplies the Gogebic mines—at Watersmeet. When the extension is completed the Gogebic ores may be sent to market by the way of Escanaba on Lake Michigan.

The villages of Bessemer, Ironwood and Hurley are the most considerable towns on this range and they show a great deal of prosperity. The latter has a fine hotel, one of the best in the northern counties. This region has received a good deal of attention lately through the press and at the hands of the courts that has given it an unenviable notoriety, for the alleged immoral condition of its society. However, one sees outwardly a great deal of activity and apparent prosperity, with such mingling of the debasing elements as unfortunately too frequently pertain to mining towns in the earlier period of their growth.

The Gogebic range, as well as the whole upper peninsula, is sure to be greatly benefited through the completion of the railroads, now under construction, from Duluth along the south shore to Ashland and then through the peninsula to the Sault de Ste. Marie. This road will afford an outlet for the minerals and timber—hard wood, pine, cedar, etc.—both to the northwest and to the seaboard. It must thus greatly accelerate the development of the mining country.

During the past year the Milwaukee and Northern has completed its line from Menominee to Iron Mountain and is now engaged in building a further extension to Republic and thence to Ishpeming. This company will carry ore over its road directly to market, using large ore cars holding 20 tons each, the same capacity as those used in the Gogebic range.

There are other railroad extensions in contemplation in the Upper Penin-

sula which, if carried into effect, will also have an important influence in promoting its prosperity. Altogether it is quite probable the coming year will be a period of great activity in the Northern Peninsula in this line of business.

In view of the fact that there were upwards of 8,000 miles of railroad built in the U. S. in the past year, and that this amount will probably be exceeded in 1887, it is apparent that were it not for the large production of the Gogebic and the new Minnesota districts there would be a dearth of Bessemer ores.

But the newly added districts will doubtless enable the Lake Superior mines to keep the supply of this ore up to the demand. Thus timely discoveries seem to be made to meet the increasing needs of the country. The demand has changed from iron to steel, but our native resources are such—an abundance of the requisite raw material—that the industrial stability resting thereon is not likely to be disturbed.

During the past year an unusual number of valuable discoveries have been made in the iron region. A more than average amount of good fortune has attended the efforts of explorers, and not a few men who began the year 1886 poor in purse are now comparatively rich; having succeeded in uncovering deposits of ore on lands secured by options, which claims they have, under such circumstances, been able to sell, in some instances, for large sums of money.

A great number of fortunes have been realized in this way in the past year, in the Upper Peninsula.

One of the features connected with these discoveries is the fact that some of them have been made upon lands among the earliest occupied in the settlement of the country; upon lands that have been used for years by persons who had no suspicion that by digging a few feet beneath the surface they could find bodies of ore that would insure their fortunes.

But in point of fact the iron bearing rocks of Michigan are of great extent, much greater than was originally assumed. Territory that has been laid down on the maps as Laurentian is really Huronian, and consequently iron yielding, and as time goes on it is likely that iron mining districts will be increased and extended.

The price of ore has varied, of course, according to quality.

	Average Price.
The best hard bessemer, specular, has sold in Cleveland in 1886	\$6 00 to \$6 25 per ton.
Best hard specular ore, non-bessemer	5 20 to 5 50 “ “
Best hematite bessemer	5 00 to 5 25 “ “
“ “ non-bessemer	4 00 to 4 65 “ “
High phosphorus hematite	3 00 to 3 50 “ “
Ore freights to Escanaba from Ishpeming	80 cents per ton.
“ “ “ Marquette “ “	55 “ “ “
“ “ “ Escanaba “ Iron Mountain	80 “ “ “
“ “ “ Ashland “ Bessemer	80 “ “ “

Lake prices from Escanaba to Lake Erie ports.....	\$ 90 to \$1 75 per ton 1886.
“ “ “ Ashland “ “ “	1 00 to 2 00 “ “ “
“ “ “ Marquette “ “ “	1 15 to 1 50 “ “ “

The following table, furnished to me by Mr. W. B. Linsley, division superintendent of the Chicago & Northwestern R. R. Co., is of interest and value. It shows the ore shipments from Escanaba from 1865 to 1886 inclusive:

Year.	Tons.	Year.	Tons.
1865.....	31,072	1876.....	412,372
1866.....	116,868	1877.....	424,040
1867.....	196,831	1878.....	527,957
1868.....	273,405	1879.....	847,209
1869.....	331,660	1880.....	1,242,100
1870.....	413,786	1881.....	1,529,000
1871.....	447,253	1882.....	1,815,000
1872.....	481,982	1883.....	1,485,324
1873.....	453,416	1884.....	1,401,206
1874.....	321,402	1885.....	1,269,605
1875.....	299,827	1886.....	1,569,606
Total.....			15,890,962

In describing the iron mines I shall speak of them as they occur in succession along the several ranges, commencing with the Penn Iron Mining Co., at the eastern extremity of the Menominee range.

THE PENN IRON MINING COMPANY

was formed in 1881 and is the proprietor of several mines, consisting of the East Vulcan, West Vulcan, Norway, Cyclops and Quinnesec, all of which mines were opened by the Menominee Mining Co., and sold to the present owners in 1881. The purchase was made not as a matter of speculation, but because the buyers wanted the ores to work up in their own furnaces and the iron in their own mills in Pennsylvania. Consequently the ore is sent from the mines to Johnstown.

The ore is nearly all Bessemer of the best quality of soft specular and the mines are in excellent shape, showing no discouraging features. The Vulcan mines and the Norway have as much ore in sight now as at any time since the present owners have held the properties. The last year's product of 243,000 tons of first class ore, is suggestive of the capacity of the mines.

The mines of the Penn Iron Co. are exceedingly well managed. The officers

are experienced men in the iron business and understand its details in all departments of the work. During the past year the general management of the mines has devolved upon Mr. J. E. Hagey, through the retiring of Mr. Wm. R. Babcock. Mr. Hagey having been an officer of the company for some years past merely assumes a position of increased responsibility, the duties of which he has already demonstrated his fitness to discharge. The Penn is among the best iron companies in the State. Everything shows thoroughness, efficiency and good management. The men are well paid and are contented. The buildings are substantial and conveniently arranged. The surface is clean and orderly; the ore docks are commodious and ample; the shafts are in good shape; the mines are well opened underground, safe and well ventilated. The men are relieved from the toil and loss of time incident to climbing ladders, since they are taken down into the mines and brought again to the surface on cages, which are nearly as safe and convenient as the elevators in hotels, etc. Changes for the better have been gradually made at the mines of the Penn company ever since they have been in possession, until now they are in the foreground in appearance, in mining work and in equipment. It gives me pleasure to speak thus favorably of these mines, for I am able to contrast their present thrifty appearance with the wild and primitive look of a few years ago. This matter of improvement is especially noticeable at

THE EAST VULCAN MINE,

which is situated in the S. $\frac{1}{2}$ of the S. $\frac{1}{2}$ of Sec. 11, T. 39, R. 29, and is the most easterly of the Menominee range mines that is operated.

It is a very singular mine and can never have been a profitable one to work. It is in most excellent shape in all respects; but it has cost a good deal to make it so and the ore deposits have never proved large enough to afford a very great remuneration.

The ore is of the best quality, it is too good to abandon, the company wants it for its own furnaces, and for this reason the proprietors probably find recompense for the outlay.

There are three shafts—three separate mines—but the middle one, No. 1, it is called, is the principal ore producer.

No. 1 is a chimney of blue ore of variable dimensions, but generally about 90 feet horizontal measurement either way. It is 500 feet deep, vertical, with cage to bottom. The ore deposit went down vertically about 200 feet, when it abruptly took an inclination to the west of about 27°, so that at the bottom the cross-cut from the shaft to reach the ore is 425 feet long. As the inclination of the ore body continues the cross-cut in the next level, 200 feet further down, would be upwards of 800 feet long. The ore body in the bottom is 90 feet by

110 feet, it is clean, beautiful ore of the best quality and shows indications of widening. It certainly is not growing smaller, it may do so of course, as that is a matter that can be known only so far as the ground is "proved." The plan heretofore pursued will probably be discontinued; it is too big an undertaking to sink 200 feet in the rock and then drift 800 feet to reach so small a body of ore. The plan contemplated is to sink a new shaft from the surface. That the ore continues is shown by the diamond drill boring now in the bottom of the mine; the drill is in 114 feet, all ore.

It is far better to sink a new shaft. The cost would not be greatly in excess of sinking the present shaft and making the long drift, and then all the ore would have to be trammed through this cross-cut. The new shaft would go through ground to the west that has not been explored and might cut a new lense of ore. There are reasons for supposing this to be quite probable. The new find, to be spoken of hereafter, may hold down in the direction to be cut by the new shaft. Capt. Curnow, superintendent of the mine, who is a thorough miner, has many original plans in doing his work. Among others a method of shaft-sinking which he follows, as he states, to advantage.

He sinks through the rock, puts in the timbers, air and water pipes, etc., in fact completes the shaft as it goes down. This he accomplishes by providing for the cage to descend to the bottom as the shaft is lengthened. A bucket is taken up or lowered, as required, by being suspended to the bottom of the cage. In this way the loose material is got rid of. The men work in the shaft in safety; the hoisting, too, goes on above them without exposing them to special danger. The timbers are suspended in the shaft by long hooks in the corners. When a new section is added below it is held in its place by these hooks attached to those above.

In this way No. 1 and No. 2 shafts have been sunk and he is thoroughly convinced of the advantages of his method.

Capt. Curnow states that No. 1 shaft sunk in rock, size 17 feet x 8 feet, cost, completed, timbers, ladder-way, pipes, cage, etc., \$24.25 per foot. He says he can sink the new shaft within a year at a cost equal to or not greatly in excess of the above figures.

There has been a great deal of exploratory work done in this mine, which adds to the cost of the ore. There does not seem to be any way to avoid it, drifts have been made in all directions in search of ore, sometimes they have led to good results but oftener they represent so much that is loss. Still this work must be done, without it the mine would long ago have stopped. It is plain to see, in examining the mine, that these costly drifts have been the means of keeping it alive.

The lense or chimney of ore has corkscrewed its way through the ground

and finally taken a roll to the west in such a way that it was only by a good deal of drifting that it could be kept track of.

In my last report on the mines I have described the method of timbering in the East Vulcan. There is none better anywhere. I doubt if there is any mine in the State in which the timbering is as well done as in this. There is no give to it anywhere; it is all in perfect shape in every part of the mine and the ore is all taken out; not a scrap of it left in any form. They even use wire screens to save the ore, that is in freeing from rock the ore that is found along the sides, etc. The great secret of Capt. Curnow's success in his timbering is that he watches it all carefully himself. He allows no weak pieces to go in. The timbers are all nicely fitted at the joints, put firmly in place, exactly in line in all directions in which the timber runs, securely held so that it cannot give in any way without crushing. "Put the timbers exactly where they belong and secure them there, horizontally and vertically, so that they cannot move," is the motto, and that this is true at the East Vulcan accounts for the fact that the timbers remain as they were placed. It is quite possible that in some mines the collapse of the timbers is due to the giving way at some weak place. It is generally true that in structures of this sort the whole is no stronger than the weakest place, and thus, if the work is ever so well done as a general fact in any mine yet a few defects must render the whole comparatively valueless.

Capt. Curnow has guarded against any defects, and thus his timbers are as well in place as when they were first set.

In this shaft they reach from the bottom 500 feet up to the surface rock. The rock that is broken in the mine is left on the timbers, and in some places also immense masses of the hanging rest on the timbers also.

There is not very much of interest to be said of No. 1 mine in addition to what I reported last year of the underground workings. Since my last report they have drifted in the third level—350 feet down—100 feet west on the west side of the shaft, and made a rise in the ore 110 feet. Here they have a small body of ore in which they are now stoping east and west. In this level there is no ore east of the shaft. They also in this level—350 feet—drove south 175 feet.

In this cross-cut, at a point 86 feet south of shaft they "drove" west 75 feet, much of the way in ore, and at the end of the 175 feet cross-cut they also drove west 61 feet, and a third westerly drift 48 feet long was made at a point 110 feet south from the mouth of the cross-cut.

In the second level on the south side of the shaft they drove a cross-cut 110 feet long and found a body of ore 110 feet long and 25 feet wide. Also they drifted from this ore east 25 feet and 20 feet west; found only rock. They also sunk in the ore body a winze 25 feet deep, but it proved inexpedient to

continue on account of the water. They made a rise up to the first level in the ore and have worked it all out "up to the grass roots."

The bottom is ore and yet remains to the third level to be stoped. West of the shaft in the second level for 215 feet are the old workings, but from the west end a drift to the south, which was made led into a body of ore that they have worked out up to the surface capping. From the west end of this working they have driven west 160 feet and the end of the drift is in ore and rock. There is a stream of water carried from the breast of the drift which is esteemed a good indication of the proximity of ore in quantity.

West of the shaft, above the workings just described, up 152 feet from the bottom of the level, they drove west 42 feet in jasper and then struck a new body of ore, which has been worked up to the sand rock that forms the horizontally bedded capping to the ore.

They have stoped out a space 95 feet by 90 feet, 13 feet high, and the ore continues north. They have drifted 160 feet from the end of the stope, following the ore under the sandstone. It is probable that this ore will continue down, following the roll in the formation. It lies in the soap rock and it should continue with the soap rock down. The jasper lies on the south side of it and they are stoping north, east and west. They have thus far—January 1—mined about 600 tons in this deposit, all of which is in stock, at the mine. They use a compressor and power drills.

The water in No. 1 is raised with 10" plunges 370 feet and a 12" draw lift 165 feet, which latter goes to the bottom.

No. 2 shaft, lying east from No. 1, 1,700 feet, has been opened up new the past year. The shaft is vertical, 241 feet deep, and is worked with a cage. The cage, pump, new engine house, machinery, etc., have been added in the past year. The pump is 12" plunger, 146 feet to first level and draw lift 110 feet to bottom of dump. In the bottom level they have drifted east 95 feet and struck the ore at 65 feet; are now in ore. They then drove south 18 feet and made a rise of 10 feet and "holed" into the old workings, or what was once called the Isabella mine. It was opened two years ago by Capt. John R. Wood and furnished about 375 tons of ore. This property is now held by the Penn Co. and is a part of the East Vulcan mine.

They will open out here and then proceed to stope the ore. In the first level they drove north 400 feet, and at a point in this drift they have gone west 365 feet, all in jasper. They hope to come in under the ore which was found, formerly, in the north vein and was worked six years ago. Here were two good stopes at that time, and the drift will come under the ore body in which they were worked, so that there is no reason to doubt of a favorable result. All this is new work, done in the past year. The more recent workings in No. 2

are those in the bottom to the east which I first mentioned. The bottom level was only opened in the last of the year. The opening work thus begun will be continued and drifts will be extended under all the ore bodies that have been found above.

No. 3 shaft is on the hill 1500 ft. west of No. 1. It is 273 ft. deep, is also vertical and worked with a cage, has the same kind of machinery as the others only the pumps are 7 plunger, drums, 5 diameter, Warner's pattern. They are preparing to pump out the water from the mine. It has been idle for 3 years. There is a good body of ore in the mine but it is not Bessemer and the company has not cared to mine it until now. The ore is run from the shaft down to No. 1 ore dock on an incline.

All shafts, as before stated, have single cages; their advantage is great, save the men from climbing long ladders and save time. The men gather at the shafts when the whistle blows and are speedily transferred to the surface. It is also safe. Capt. Curnow has tested them by loading the cages with material and finally with men, having previously attached a hemp rope which he caused to be severed. The safety clutches stopped the cage quickly without the least harm being done. The men feel assured of perfect safety now. The cages run very smoothly and are light. They weigh 825 lbs. and the car 700 lbs. so that there is not much dead weight.

The product of the East Vulcan in 1886 was 37,049 tons.

The company employs a chemist and there are many analyses made of this and of the ores of the other mines. I was shown several analyses of East Vulcan ore that showed a percentage of iron above 68 and of phosphorus .030 per cent.

The mine is too good to give up but not good enough to pay largely. The expenditures, which are heavy, make the ore cost too much. The timbering in this and in the West Vulcan costs 37c per ton of ore; this seems a large sum. The mine gives employment to 135 men.

There may be a better future in store for the East Vulcan. The limited deposits may open wider and the hoped for period of prosperity may be ultimately realized.

Capt. John U. Curnow still remains superintendent of the mine.

THE WEST VULCAN MINE.

Going west somewhat more than a mile we reach the West Vulcan, which at present is the largest producer of the Penn. Company's mines, and which is perhaps, considering the quality of its ore, the best one in its list. It is certainly a good mine, and although it yielded 106,181 tons of ore the past

year, it is looking, underground, fully as well to-day as it has at any time in the past five years.

There have been many improvements at the West Vulcan lately. The new vertical shaft has been completed, 568 ft. from collar to bottom. It is 10x16 feet inside the timbers, is divided into four compartments and is double cage. The new engine-house is completed, machinery all in place and working. A fine ore-dock has been made to the east of the new shaft. The new pump is in operation, and all the facilities for a more concentrated and economical working of the mine have been completed. The new upright shaft is in the hanging wall of the south deposit, and so placed and equipped that it may suffice for the work of the whole mine. At present in it and in No. 2 all the hoisting is done.

It will be remembered that the West Vulcan has been worked in two separate deposits, both running east and west, and being opened in the side hill that slopes to the south, in which direction the ore also dipped, especially the north deposit, which underlays more rapidly, so that at the bottom they are 200 feet nearer together than they are at the surface. All the machinery, etc., for operating these mines was situated on top of the hill from the surface of which the shafts started. When the mine had reached a depth below the horizon of the bottom of the hill, the hoisting and pumping, etc., through this additional elevation was all dead work. To obviate this useless hoist and to concentrate the machinery, and thus quicken and cheapen the work, is the purpose of the new shaft. As the dip of the south ore body is now nearly vertical, the fact of the shaft being in the hanging wall is not greatly objectionable. All the shafts in the north deposit have been abandoned, the ore is brought out through a cross-cut into the south mine.

The bottom is the eighth level which has recently been reached, but as yet (January 1) is not much opened. The ore deposit has neither shortened nor narrowed in the lower levels. On the contrary, it has somewhat lengthened, as for instance, in the sixth level it measured 570 feet in length; while in the seventh it had increased to 600 feet. The eighth is not fully opened, but the indications, so far as I could judge, favor the continuance of the increase by lengthening westerly. The average width is about 25 feet. They still pursue the same method of mining as heretofore, that is, they work out the ore in rooms, and put in the Nevada system of timber sets. The ore pillars are left 100 feet apart, and as the ore is stoped out in headings across the deposit, the timber sets are put in; but an important modification to the plan heretofore pursued, is rapidly progressing, to-wit: they are filling the mine in the old rooms in the upper levels with all possible diligence. A good deal has already been accomplished in this way, and it is expected that, perhaps, in another year the timbering will be entirely abandoned and the filling process will be begun from the

bottom and carried on side by side with the stoping. As yet they are filling up the rooms above and stoping away the pillars of ore, and also filling the space thus made vacant. In the first, second, and third levels the floors and pillars of ore have been taken out and the space filled in with sand and rock, etc. In the fourth level in the east part of the mine there were three of these pillars of ore to remove, and also the floor of 140 feet in length near No. 2 shaft. This ore mined in the fourth level finds its way out of the mine through No. 1 shaft which is kept open solely to accomplish this particular work.

In the fifth level the pillars have been mined out, but the floor on the whole length remains and will also be removed. Between the fifth and sixth are three pillars and the bottom of the sixth, 22 feet thick, to mine. In the seventh level are three pillars still all the best have been mined out through to the bottom of the sixth level.

A fine addition to the productive ground was found the past season in the west end of the mine. They opened into a branch that gave a length of 90 feet, as wide as the main ore deposit, and it seems to be probable that it will extend up—possibly to the surface. A winze has been started from the surface to come down into this level of the mine, to be used to run down rock.

The mine is now pretty well finished—down to the fourth level—between the fourth and fifth and between the fifth and sixth. In mining the floor in the fifth level they are back stoping the ore and standing on the filling. They are filling between the sixth and the seventh, preparatory to mining the pillars and the floor of the sixth. The great drawback to the work is that there is no lessening to the amount and the cost of the timbering. They are doing just as much work and doing it just as well as ever they did. When they get the mine filled up down to the bottom and are able to dispense with this costly timbering the ore will certainly cost less, even if they do not get it out quite as fast. The company needs the ore and claims to be obliged to adhere to the present method in order to keep up the product. It is expressed as the intention to abandon timbering as soon as the mine is filled, which it is thought will be accomplished when the ninth level is reached, or at the end of 1887.

In the north vein they have mined out all the pillars above the fifth level and the mine has crushed in with the exception of No. 4 shaft, which is sustained by the shaft pillars. During the past year a cross-cut has been driven between the mines, starting from the new downright shaft at the sixth level and intersecting the north mine in its eighth level. East of the cross-cut in the north mine is a body of ore 28 feet wide, 100 feet long, and extending at least to an equal height. One of the purposes for which the cross cut was

made is to be a conduit for the water to the new shaft, where all the water of the mine is pumped to the surface.

The downright shaft is named the Babcock. Above the sixth level the mine is all to the east of it, but below that point it begins to extend west of it also. The shaft is 60 feet south of the ore in the seventh level and in the eighth level it is but 50 feet. The ore body from the second level to the fifth dips about 85° with the horizon; at that point the formation takes a roll to the south and the ore goes down at an angle of 78°.

No. 2 shaft is 350 feet east of the upright. It is in the foot wall and is thus secure, and requires no ore pillars for protection. It dips to the south at 73°, and in the eighth level it is 30 feet north of the ore. It is single skip, and was formerly also used as a pump shaft. Its length is 700 feet. These two shafts divide the mine nicely.

The new pumping machinery, while not sufficient for the water of the mines at a depth of 1,000 feet and more, comprises a double Cornish plunger pump 16"—10 foot stroke. This pumping plant is the duplicate of that at the Norway mine, and designed by the company's master mechanic, Mr. J. B. Lyon. The new pumping engines are 38x28" each. Two hoisting engines, Corliss, each 12x36", two 5 feet drums, Webster, Camp & Lane. The great gear wheel for the pumping engine is 30' 8" diameter.

The new shaft house is 75 feet high, or 85 feet to the ridge, and is covered on the outside with sheet iron. The engine house for pumping and hoisting machinery to the new shaft is just west of it, size, 44x74', with boiler house attached, 52x46'. In the latter are five new boilers, each 16'x56". The new trestle is 40 feet high, and the old one from No. 2 shaft is 78 feet. The new dock has a capacity of 50,000 tons, while the old one is of equal extent.

They have no compressor, but this deficiency will be supplied very soon. The ground is not excessively hard. The rock drifts cost but \$4.50 to \$5.00 per foot, even with hand drills.

The West Vulcan ore is all Bessemer. It ranks with best of the soft blue ore, for which some of the Menominee Range mines have from the first been noted. It averages about 60% in iron, and .035% in phosphorus. Some analyses give 69% in metallic iron. It is equal to any on the range.

The West Vulcan is not a large mine, as compared to some of our greatest producers, but it is an exceedingly good one. It is concentrated and compact. The ore is mainly in one deposit that holds its uniformity of dimensions. The mine furnishes an annual product of 100,000 tons, and the ore is all Bessemer, and first class.

The force employed consists of an average of 450 men, two-thirds of whom are Italians and Austro-Italians. The superintendent esteems them as quite

faithful workmen. The company has had several years' experience with a large number of men of this nationality, and the officers speak of them in excellent terms. Capt. E. S. Roberts still continues as superintendent at the West Vulcan.

The Vulcan mines were opened in 1877, and have yielded as follows:

Year.	Tons.	Year.	Tons.
1877.....	4,543	1882.....	94,042
187.....	31,239	1883.....	79,874
1879.....	57,350	1884.....	101,722
1880.....	72,405	1885.....	124,120
1881.....	85,671	1886.....	143,930
Total.....			794,836

THE NORWAY MINE

has produced in the last year 93,878 tons of first-class ore, all but 5,000 tons of which were Bessemer. This fact indicates that the mine is not yet exhausted. In truth it is looking well. I have visited the mine twice in the last year and each time I was favorably impressed with the outlook. If they were to mine also this B.B. ore, which is non-Bessemer, the output could be largely increased. In 1880 the yield of the mine was 198,765 tons, and while it is not probable that this product will ever again be reached, the mine is certainly good for an estimate of 100,000 tons annually.

It is a long mine extending from No. 10 shaft, the most westerly one, away up the hill, east a continuous opening, 1940 feet to the east line of the property. They are now drifting west from the bottom of No. 10. At a point 360 feet west a drill hole, which was made, discovered ore. The formation here has a capping of sandstone horizontally hidden; at the west end it is 70 feet thick, gradually thinning to the east, where it is reduced in thickness to ten feet.

The controlling rock in the formation at the Norway and adjacent mines is the limestone. This belt is here in the underlay of the ore and is greatly folded; it sometimes also lays flat and thus cuts out the ore and then again dips abruptly into a deep fold, where a fine deposit of ore is found. Half of the mine, the west half, is open to the sunlight. It is simply a deep, wide synclinal in the limestone, coming down from the north and making a deep fold where the mine is and rising on the opposite side in another fold and again descending, probably passing beneath the swamp to the south.

Were it not for the deep minor folds in this foot wall limestone the store of

ore would be far more quickly exhausted. The many depressions, cavities and folds are filled with ore, and if these are exhausted at one point others are found elsewhere, so that the supply of ore is kept up and no pressing anxiety is felt. Sometimes the limestone is on the south, on the hanging wall side, a fact that in instances led to the supposition that they were north of the limestone. It is pretty well understood now by the miners, who have the intelligence to comprehend the matter, that this anomalous position is due to the folding in the formation. The ore is found in pockets and these occur with much irregularity, affording strong inducement to search with a constant expectation of success.

No. 10 shaft, the west one, was sunk 135 feet through the sand rock and soap stone and a cross-cut made south 100 feet to the limestone. Recently they have made a rise in this cross-cut and found ore. The ore was first encountered by a drill boring near the shaft and its position with reference to the cross-cut conjectured, so that the rise was made to verify the supposition. The ore lies on the soap rock and they have it, 20 feet wide, where they are now stoping. It has been but recently found and seems to curve to the south, following the folds of the formation.

From No. 8 pit, further east, a drift has been made west which comes into this same deposit of ore. From No. 6 to No. 10, a distance of 900 feet, the mine is practically all open cut. The ore in this end is all Bessemer. The workings are wide and irregular, for a long distance extending to a depth and width of a hundred feet. No. 8 pit is perhaps the deepest and widest pit, and thence on to No. 5, where the mine is all underground. The underground portion of the mine has a length of 1,000 feet from No. 6 pit to the east line. But little has been done here for two years past. The mine has been all the time partially full of water, waiting for the time until the new machinery, the new shaft and the water adit from the south should be completed, when it could be pumped out. The mine is no deeper than it was five years ago; when the Penn. Co. bought it it was thoroughly opened. There was a great amount of stoping ground ready to work and since that time the company has been able to keep up its product without sinking a foot.

The Norway mine has been worked out in very large chambers. The ore and the jasper formation in which it occurs stand remarkably well. The ore yet remaining in the mine is mostly the B. B., or Stephenson ore, as they designate it, but when relieved of the water and they can again work in the bottom, another level will be opened. The occasion of the condition of this part of the mine was, as explained in my last report, due to the caving in of the east end. About 300 feet in length of the part next to the Perkins went in from the top to the fourth level, leaving the fifth level still intact. It is plain to see that this underground opening must take all the water from the west end

of the Norway, and also a still greater amount coming from the east from the Perkins and Stephenson mines, which are in condition to gather a great deal of water. There is not much water in the mine now, only at the bottom level. It would have been all out ere this had it not been for a break in the gear of the pump. They are having a steel gear-wheel made which it is assumed will endure the strain that one of iron has proved unequal to sustain. The pumping plant is the counterpart of that at the West Vulcan, double acting pump, 16" plungers, 10' stroke, discharge pipes between the rods, one plunger rises as the other descends and the flow of water is constant. The machinery is in a new stone engine-house which is 40x100'. The big gear-wheel between the engines, to which the rods are attached, is 30' 8" in diameter. The engines are low pressure, each 28x38". Also two new boilers 18' by 72". They are still using but one plunger, for the reason that the water was cut in the drift from the new shaft, and thus came in flooding the bottom before pumps were ready for it. They have been using a 10" plunger as a substitute in relieving the mine of the water, and it is the gear-wheel of this latter that is broken.

In the level ground below the hill, just east of the new stone engine house, a downright shaft has been sunk and through this all the water of the mine will be raised. It is pumped up to within 100 feet of the top when it runs off through an adit 1,200 feet in length, driven up from the south.

The new shaft is 9'x16', single cage, but divided into four compartments. It is down 25 feet below the sixth level, which latter is 355 feet from the collar of shaft.

A cross-cut has been made from the shaft, at a point 270 feet down, to the fifth level and they are also engaged in driving one from the sixth level to the shaft, which will be 150 feet in length, the bottom of the shaft being that distance south of the vein. Old No. 3 shaft in this part of the mine is still used, but there is a liability of its going in some time, and in anticipation of such a contingency they are raising up in an old shaft north of No. 3, securing it with rock, so if No. 3 gives way they will have this one to fall back on.

They are also sinking a new shaft, to be a permanent one; it is located 100 feet from the west line and is sinking wholly in the foot wall, where it will be entirely safe whatever may happen in the mine. From this they can explore the old workings, take out the pillars of ore that are left, can sink deeper and go under the whole and all the while have a line of exit, etc., that no collapse can injure. There is much good ore in the pillars still, which will be ultimately secured. The sixth level also, although partially opened, has not been stoped in to much extent. In the fifth level at least one-half of the ore is standing. A stretch of ground 500 feet in length is yet untouched. There

are two lenses in this part of the mine. The south is Bessemer, the north vein is the B. B. or Stephenson ore. As previously stated, the latter quality of ore predominates in the east part of the mine; at least it comprises the major part of what is now standing in the stopes.

During the past year there were about 5,000 tons of this B. B. ore mixed with the Bessemer and still the mixture was kept within the limits for steel making. The product the first year has been taken from Nos. 3, 5, 8, and 9. In No. 3 the ore comes from some pillars that were removed. Also about 10,000 tons were taken from the shallow pit just northwest from the office, adjoining the Cyclops. There is some ore in this pit still in the bottom, but it is not clean, not wholly free from rock, nevertheless it will afford some ore still. It would seem to be good ground to explore east of this pit and also south. No doubt there are other "finds" to be made that may prove equally as valuable as this has been.

No. 8 pit furnished 20,000 tons of the product of 1886. The product of the Norway for each year is as follows:

Year.	Tons.	Year.	Tons.
1878.....	7,533	1883.....	114,836
1879.....	73,540	1884.....	71,515
1880.....	198,765	1885.....	57,741
1881.....	137,558	1886.....	93,878
1882.....	165,084		
Total.....			919,620

The working force consists of 320 men, including those working at the Cyclops. The men are mostly Swedes, and are pronounced by the officers as being a first rate class of workmen. The best of feeling seems to exist between the officers of the mine and the men.

The Superintendent, Capt. John Oliver, has all the requisites of a capable mining man, including the ability to direct with advantage a large force of men.

Of the

CYCLOPS MINE

there is just now but little to be said. Capt. Oliver is trying to find some ore, and, unless he succeeds in developing something to advantage beyond what now appears, the mine is not likely to produce much in excess of about 5,000 tons in 1887. In Dec. the product was but 518 tons. They have small amounts of

ore in several places but no large body of it in sight anywhere, and they have as yet no knowledge of the existence of any. However, five years ago, when the Penn Co. purchased these mines, the Cyclops was rated as of little value. It looked as unpromising then as it does now, but it has since produced 164,391 tons of the finest ore, probably the cheapest ore that the company has obtained in any of its mines. It has been a standing remark that the profit on the Cyclops ore has served to even up the excessive cost of some of the ores obtained elsewhere. The Cyclops joins the Norway on the west, but it has never been an expensive mine, very little machinery or other plant has ever been required. The simplest outfit is all that has been necessary to secure the ore. Just now some exploring work is in progress and other important "finds" may be made.

Capt. John Oliver superintends the operations at this mine also. It is so near the Norway that the two mines are practically one and the same thing.

The following table shows the yearly product:

Year.	Tons.	Year.	Tons.
1878.....	6,275	1883.....	22,675
1879.....	46,442	1884.....	24,099
1880.....	14,368	1885.....	49,897
1881.....	12,214	1886.....	37,189
1882.....	18,287		
Total.....			231,476

The only other mine owned by the Penn Company is

THE QUINNESEC,

which was formerly one of the important mines of the "Range." It is an underground pit 500 feet deep, and of an equal length, but practically an exhausted mine. In fact, the mine was abandoned two years ago. The pumps were taken out and the mine filled with water. Subsequently an examination by Capt. Oliver resulted in a partial resumption of mining work, and a product of about 14,000 tons of ore has been obtained each year since. This ore has been mainly derived from the pillars, floors, and from behind the lagging. However, there is not much more to be got from these sources; probably 5,000 or 6,000 tons will constitute the product for 1887—got from old No. 3 shaft, at the west end of the mine. They have only worked down to the third level; below that the mine is filled with water. They are pumping it out to get down to the fourth level, as there are some pillars left between the third and fourth levels at No. 3 shaft.

Some years ago the Menominee Mining Company, the former owner of this mine, bored a hole 266 feet deep at a point 285 feet west of No. 4 shaft, and claimed to have found 25 feet of ore. Recently the Penn Company has driven to this one from No. 4, and at the time of my visit they had just got into it. They were too near the sandstone capping, however, and the ore as found was not of a marketable quality. It may prove better when further developed.

The Quinnesec mine has produced as follows:

Year.	Tons.	Year.	Tons.
1878.....	26,467	1883.....	21,676
1879.....	42,127	1884.....	16,994
1880.....	52,357	1885.....	14,101
1881.....	43,606	1886.....	13,442
1882.....	44,240		
Total.....			274,719

The Penn Company is exploring west of the Ludington mine, on the N. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ of section 25, T. 25, R. 34. They have sunk 235 feet, and have driven north and encountered limestone. Have also drifted south 225 feet, and come to quartzite, then into lean ore formation, in which they are now drifting, January 1, 1887. The shaft is 80 rods south from the old Ludington.

THE PERKINS MINE.

A year ago when I visited this mine I found them engaged in removing the machinery preparatory to abandoning the property. It had been held since 1879 by the Saginaw Mining Co., by whom it had been continuously worked up to the close of 1885. The mine was declared to be exhausted, with the exception of a few ore pillars that it would be a matter of much difficulty to obtain. The Stephenson mine, which lies north of it, in the foot wall of the Perkins, had caved in and this collapse had also carried down the latter with it. The mine was a total wreck. All the levels and the shafts were in ruin. The machinery was nearly all gone. Thus altogether it was about as forbidding a location as one ever saw. When it was said that Capt. Perkins was going to work the mine as a personal venture, it was generally thought to be an unpromising undertaking. However, after the lease was given up by the Saginaw company, Capt. Perkins obtained possession of the property and has been working the mine on his own responsibility during the past year, and has succeeded in mining and shipping 12,856 tons of first class ore.

It must be remembered that Capt. Perkins has had charge of the mine since

it was first opened, seven years ago, and thus was entirely familiar with the situation. He knew the exact position of all the ore pillars that remained, and was able to conjecture as to the probability of the continuance of the ore body in any portion of the mine—information that, under the circumstances, was of much pecuniary value.

He has sunk in the "crush" at the west end down into the old workings, and it is here in the west end along the north line of the property that he has obtained the ore. It was really much safer to work here now than before the mine had crushed in. Before that it was dangerous, impracticable to do further work. The constant liability to crush in made it unsafe. Now it is all right. They can advance with confidence through the crushed ground, merely necessary to timber the openings which are made. In the west shaft from the surface down to the bottom of the open pit it is 44 feet, and thence to the bottom of the slope it is 141 feet. Capt. Perkins has opened two levels to the west and is stoping in both. He is also drifting east from the bottom in the direction of a shaft that he has sunk through the crushed bottom at a point about midway from the east and west limits of the old mine. The drift follows the ore.

He is prepared to hoist from the two shafts, and estimates the product for the coming year at 15,000 tons. I am inclined to think that it will exceed that amount. The ore is of two varieties, yielding on the average about 58 % in iron and within the Bessemer limits in phosphorus. It was mainly sold to the Cleveland Rolling mill, and was worth in Cleveland about \$5,000.

There are two new hoisting drums (W. C. & Lane) four feet in diameter. No pumps are required, as all the water drains into the Norway. The mines have been worked to about the same depth; but Capt. Perkins has not yet gone to the bottom. He employs about 30 men. The bottom of the mine is limestone, which comes down from the north, back of the Stephenson, and forms a synclinal, or fold, and then dips beneath the swamp to the south.

The Perkins mine cannot be ever again, in this part of it at least, a large producer, but it is likely to prove a pretty profitable undertaking for the present proprietor.

The yearly product of the Perkins has been as follows:

Year.	Tons.	Year.	Tons.
1874.....	13,492	1883.....	76,514
1880.....	49,433	1884.....	38,120
1881.....	60,706	1885.....	18,023
1882.....	73,648	1886.....	12,856
Total.....			342,786

The estate comprises the S. W. $\frac{1}{4}$ S. W. $\frac{1}{4}$ section 4, T. 39, R. 29, situated in the village of Norway, Mich.

CAPT. JOHN PERKINS,
Manager.

THE STEPHENSON MINING CO.

is a new organization recently made to operate the Stephenson mine which adjoins the Perkins and the Norway. It is owned by the Lumberman's Mining Co., and was opened in 1879 and was worked up to 1882, when it closed down for the reason that all the available ore, it was deemed, had been taken out. There was some ore left in the pillars, etc., which could not at that time be reached with safety. Since then the mine has fallen in, as have also the old workings of the Perkins mine, which, in a measure, rested upon it. Some gentlemen in the vicinity, noting the success of Capt. Perkins as previously explained, leased the Stephenson property and have sunk through the crush north of the west shaft in the Perkins and have shipped 1,018 tons of ore besides having a like amount in stock at the mine. The shaft at the time of my visit (Jan'y 6) was down 100 feet and they were mining and hoisting about 25 tons per day, working a force of 25 men. They had two small hoisting drums of a very ancient pattern that were very inadequate to rapid work. In the mine they had a run of ore about 75 feet in length and 20 feet wide. The mine is in the foot wall side of the Perkins and the formation, including the ore deposits, is governed by the limestone which is much contorted and folded, so that instead of dipping south it is folded back so as to dip north. Something of this kind appears in the Stephenson, the ore, which would speedily go to the Perkins by crossing the boundary line if it continued dipping south, is found to widen out and grow larger through the northerly inclination of the walls. The ore is of two varieties, Bessemer and the Norway B.B. ore. The work is in charge of Benj. Tretheway. Though not much can be accomplished until some expenditure is made to procure machinery with which to hoist. Of course there is no water to pump, as it all drains into the Norway. The officers are N. A. Phillips, Prest., Chicago; J. Bergeron, Treas., Norway; H. G. Fisk, Gen'l Manager, Iron Mountain, Mich.

An analysis of the ore recently made gave 63% in iron .040% phosphorus. Though of course this by no means can represent the average of what they are now mining. The estate comprises the N. W. $\frac{1}{4}$, S. W. $\frac{1}{4}$, S 4, T. 39, R. 29, and the yearly product has been as follows:

Year.	Tons.	Year.	Tons.
1879.....	798	1881.....	10,856
1880.....	23,341	1886.....	1,018
Total.....			36,013

It is reported that the mine, or a controlling interest in it, has been sold in Milwaukee for \$100,000, or at that rate.

THE CURRY MINE

which adjoins the West Vulcan on the west and being in the N. E. $\frac{1}{4}$, N. E. $\frac{1}{4}$, S. 9, T. 34, R. 29, has been wholly idle during the past year. There is a lense of soft blue ore that pitches to the west rapidly, the dip being south. The bottom is now so far from the shaft that it has become expensive mining.

Controlling interest is held by J. H. Outhwaite, Cleveland, Ohio.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1879.....	13,010	1883.....	3,676
1880.....	21,741	1884.....	10,074
1881.....	17,504	1885.....	4,897
1882.....	13,374		
Total.....			84,281

THE BRIAR HILL MINE

joins the Curry on the west and is very similar, having a limited lense of soft blue ore. The proprietors are Youngstown, Ohio, capitalists, the owners also of the Iron River, Youngstown, etc., mines. It is the best of ore, the only drawback is the limited quantity. The mine was worked two years and yielded an average product of 14,982 tons.

THE INDIANA MINE

was shut down last summer. Some of the personal property was seized and advertised to be sold at sheriff's sale.

The mine is a wet one and the ore has never developed in quantity sufficiently to make the undertaking a success.

The estate is the N. E. $\frac{1}{4}$, S. 27, T. 40, R. 30.

The President and General Manager of the Indiana Iron Mining Co. was R. P. Travers, of Chicago, though it is reported that the mine has changed hands. The product for each year has been as follows:

Year.	Tons.	Year.	Tons.
1882.....	4,280	1885.....	2,738
1883.....	4,360	1886.....	5,854
1884.....	616		
Total.....			17,871

The officer in charge of the mine is Capt. James Waters, and it is reported that work will be again renewed soon.

THE CHAPIN MINING COMPANY.

No finer body of ore has ever been found in the State than the Chapin. It is so large, of such uniformity, of such excellent quality, so easily broken in the mine, so fully tested, with no diminution, that it certainly is not excelled, if equalled, by any other deposit that has ever been found in the Lake Superior region.

But with all its great advantages the mine has not attained the success that even many lesser concerns have met with. The method of mining originally adopted and until recently adhered to has proved unfortunate. The company has been forced to abandon it utterly and to pursue a wholly different plan, in fact to open a new mine underneath the former one at a great expense. It is also forced to resort to expedients to obtain the ore remaining in the old openings that of necessity add to the cost of it. Some of this ore also will never be obtained.

Portions of the mine have caved in and the ore has in a measure become mixed with the overlying sand and gravel so as to render it valueless.

The old method of mining was fully described in my last and previous reports and the difficulties that had been encountered were also sufficiently explained, it thus only remains to describe the operations for the past year.

The Chapin mine, as is well known, is a wide deposit of ore trending east and west and dipping to the north. It lies in the hill that slopes to the north and west to the low land, which was originally a cedar swamp, and on the opposite side of which the land again rises. In the opposite slope on the west side of the swamp is the Ludington mine. The easterly portion of the Chapin

is up on the top of the hill, while the west end is in the low swamp level. The magnetic bearing of the westerly portion of the ore deposit is north, 70° west, and thence east the bearing is nearly east and west.

It forms a long curve, with the concave side to the north. The foot wall of the ore is on the south side and the hanging wall of winze on the north. The angle of the dip varies from 65°, with the horizon at the east end to 80° and 85° at the west end.

The maximum length of the mine is 2,400 feet, and at the east end there are two parallel deposits called respectively the north and south deposits. The latter is the main one. The north deposit is relatively so small compared to the other that it is little considered in estimating the mine. This deposit, as does the other also, pitches to the west at an angle of about 30°, and as the deposit widens in its descent into the earth each successive level increases in length. In the first level the ore gave a length of 150 feet, but each level has regularly increased, so the sixth is 600 feet in length. This lengthening has gone on more rapidly since the fourth level by reason of the foot of the lense going down more sharply than the hanging. The average width of this north deposit in the sixth level is 45 feet for a length of 520 feet, the maximum width being 100 feet. The ore is choice; there is no jasper in it. It is not only lengthening but widening also, since in the level above it only averaged about 30 feet in width.

The main ore body also has a westerly pitch; its average dimensions at right angles to the axis is 1,000 feet. Its average width, in the fifth level for instance, is 55 feet for a length of 1,500 feet of entirely clean ore. The sixth level is not fully opened yet, but possibly it may be found to narrow slightly, to tend to wedge out as the north deposit wedges in, *i. e.*, it may be that as the north deposit seems to be set with its small end up, the south one has the reverse of this position.

The east end of the mine has greatly improved in the past year through the fact that a fine deposit of ore was found which was heretofore unknown. It was worked in the third, fourth, and fifth levels, giving in each a length of 150 feet, and an average width of 20 feet. In the sixth it has not been largely opened yet, but it is found to continue all right. They have mined out all the ore the full width of the deposit and filled the room with rock. They fill up, lay a floor on the filling, and back stop the ore, causing it to fall on the floor, where it is gathered up and sent to the shaft. This small deposit being so short and narrow as compared with other portions of the mine, they are able to take out the ore without observing such precautions as are requisite elsewhere.

From the fifth level up the greater portion of the pillars are still standing.

Between No. 6 and No. 7 shafts in the fifth level the ore has been mostly all taken out and the mine filled, and west from No. 6 to No. 5 many of the pillars are gone. Still there is a great deal of ore left in the mine in these pillars; actual estimate shows it to be 8,712,000 cubic feet or 871,200 tons of ore. This is the amount of ore still in the pillars above the fifth level and exclusive of the "caves." How much of it will be got out is a question; but I judge that most of it will be, practically all of it. If they continue to work systematically and fill in between the pillars before disturbing them, get the mine filled up, make it all solid and safe, then they can attack the pillars with perfect confidence.

A year ago, when I was previously in the mine, they were working at some pillars, rising up in them—undercutting them and filling—but it had to be abandoned, the ground would not stand. That method can be followed if the rooms between are filled clear up to the top. Then they can rise up and back stope the pillars and fill in as they advance.

The buildings which stood over the mine have all been removed, and to a considerable length over the widest part of the deposit they have stripped the ore and run the dirt, etc., down for filling and are now mining the pillars underhand in open cut, hoisting with derricks and buckets. This work will be continued at least through the winter while the ground is frozen. It is probable that in this way the pillars can be mined out down to the second and possibly to the third level. I do not know that it is the present intention to continue this work so far down as that, but it could be done where the vein is so wide and the walls stand so upright. They have nearly ceased to hoist in the old shafts; a little is yet done in No. 7, but will be discontinued in a few weeks.

Some account has to be made of the water at the Chapin, it is so large a mine; but they have always kept it well opened ahead, so that the ore would be dry. The water is taken through the fifth level to the pump shaft in the east end of the mine where is the pumping machinery operating four plungers, two 12" and two 17", 200 feet "lifts," 10 feet stroke. The plungers alternate, that is in the second 200 feet lift a 12" plunger works opposite a 17", the positions being reversed from what they are in the first lift from the surface. From the sixth level the water is raised with steam pumps to the fifth. The mine is well supplied with large steam pumps to take the water in case of accident to the plungers. One is a Wells pump, 13"x14", and the others are two No. 12 Camerons.

The new plans have assumed shape, and instead of stating as I did a year ago what it was proposed to do, we may now describe what they are doing—a system that is in actual operation.

The two new vertical shafts—sunk in the hanging wall—are down to the sixth level, the bottom of the mine. They are sinking to the seventh. B shaft is 1,050 feet from the west end of the mine, and is 240 feet deep. C shaft, 775 feet west of the former, is in lower ground, and thus is only 374 feet deep to the same horizon at the bottom. These shafts are each 9'x12' inside the timbers, and each is double cage, pump ladder way, etc. 1 $\frac{3}{8}$ " steel wire rope is used for hoist.

Each engine house is of stone—sandstone found on the location. C engine house is 49'x117', including space for electric light engine, and for four boilers each 5'x16'.

B engine house is 49'x77'. The walls are heavy and start from the solid ledge. In each house is a double hoisting drum for operating the cages. Each is 10 $\frac{1}{2}$ ' diameter at the ends, and 14 $\frac{1}{2}$ ' feet in the middle. Thus each one is "coned" from the ends to the center, and thus are 10 foot face, *i. e.*, 5 feet from center each way. They were built by the Bullock Manufacturing Company, and can be locked instantly, to work together, or be with equal facility thrown apart to work separately.

In this particular they are an advance upon any similar machinery in use in the mining region. They have the Lane band friction. The most striking improvement being the facility with which either engine may be thrown out of gear to work either half of the drum separately.

The cages work with great rapidity, smoothness, and freedom from danger. The automatic safety clutches afford ultimate security in case of accident. The ascent is made in $\frac{1}{2}$ a minute, or even in less time.

Each shaft has a capacity of 1,000 tons per day, without especial crowding. Each engine house is near its shaft, just north of it, and along on the south side is the fine new ore dock, which is 1,000 feet long, raised to the proper height above the railroad by a wall of sandstone laid in masonry.

B shaft at the fifth level is 120 feet north of the ore, and C is 275 feet at the same depth. The latter is in the limestone, which at the Chapin overlies the ore. It will continue in this for two "lifts" more before the dip of the formation carries it north of the shaft.

Cross-cuts from each shaft have been made to the ore in the third, fifth and sixth levels. It was the plan to connect these cross-cuts by drifts in the hanging, driven along about 20 feet from the ore. But the results of such a drift made in the sixth level have demonstrated the non-feasibility of this plan. The ground will not admit of it, it crushes in. The drift is timbered, but the timbers are all out of shape and cracked and broken, the effects of the pressure in the hanging rock.

Drifts in the hanging wall have therefore been abandoned, and the method

resorted to in its stead is to cross the ore body and make the connecting drifts in the foot wall. In the sixth level at C shaft a cross drift through the ore has just been made, 7'x8', and built of masonry—sandstone blocks laid in cement mortar. It is, of course, arched and made very substantial to withstand any possible pressure which future exigencies may require. The masonry only reaches through the ore which here is 62½ feet.

The longitudinal drift is making in the foot wall just in from the ore; at each 50 ft. space along the main drift ore chutes will be made, and at intervals of 100 feet will be located the rock mills for running down material for filling. These rock mills are made circular, 2½ feet in diameter; they are built up of blocks made after a pattern, at the mill, being cut out with the saw. They are thus practically indestructible, as the blocks are held in place by the filling which surrounds them, and the descending rock through the mill impinges against the ends of the blocks.

The method of mining will vary according to the conditions met with in different parts of the mine; where the ore body is very wide they make a drift through the ore at each 50 feet and stope each way from these crossings, filling in behind with rock up to the back, blocking up to make all firm. The stope is carried about 7 feet high. When a section of the ore body is thus removed another rise is made and a second section is mined, the ore falling upon the filling, which is covered to receive it. The advance is made in the same way as before, by filling behind up to the back of the stope. As they rise the ore is run down through the chutes below and the rock comes down from above through the mills.

Timbering is wholly abandoned; hereafter wherever ore is extracted the space will be filled with sand and rock. The ore will be all taken out.

A third shaft is to be sunk—D. It will have to be in the low, wet ground where it is 100 feet to the ledge, and it is likely to be a matter of much difficulty to reach it. The point selected for this shaft is 1,100 feet west of C and 600 feet from the west line of the property, but it is on the south side of the ore, on the foot wall side. It is in contemplation to freeze the ground in sinking the shaft. This course is pursued in Europe but has not, I think, been resorted to in this country. The work of sinking the shaft will be begun in the spring.

The new hoisting engines are 30"x60"—four of them. They are run by compressed air brought in pipe from the hydraulic works at the Quinnesec falls, but steam is provided and can quickly be resorted to, to furnish the power in case of accident to the water-works, etc. The average speed of the compressors for the year was 29.4 revolutions per minute. Average pressure 60.8 pounds per square inch, and produced during the year 1,826,744 cubic feet of

air of 60.8 pounds pressure. This for the 3 pairs of compressors at the hydraulic works. The Chapin mine is thus fully equipped with double power—water and steam—either sufficient to operate all the machines.

They have an abundance of filling material in the sand stone ledge on the high ground at the east end of the property; it is easily quarried and transported to the shafts. At present they are using the dirt also that deeply overlies the ore.

It should be remarked that D shaft, when completed, will be also double cage, etc., and in addition will be the pump shaft; the water will go to the west end of the mine instead of at the east end as now. It is intended to make it 21' diameter to the ledge.

The tram cars in the main halls will be run by wire rope, the machinery for operating which will be placed in the cross-cuts near the shafts.

It may also be said that a fourth pair of compressors will soon be supplied at the hydraulic works—36"x60"—the others are all 32"x60".

There will be in stock at the mine at the opening of navigation in the spring 80,000 tons of ore, and the coming year's product will not fall short of 250,000 tons.

The ore is all the beautiful soft blue ore so greatly prized by the makers of Bessemer pig metal. It averages above 60% in iron and within the Bessemer limit in phosphorus. It sold in Cleveland the last year at an average of \$5.20 per ton.

The Chapin has heretofore been controlled by the Menominee Mining Co., but recently a new organization has been made to operate this mine,—The Chapin Mining Co.

About 800 men are employed.

John H. Van Dyke, Vice Pres., office Milwaukee, Wis. The local officers remain as heretofore: C. H. Cady, Supt., Iron Mountain, Mich.; Wm. Oliver, Mining Capt.; Per Larsson, Mining Eng., etc.

The annual product of the Chapin has been as follows:

Year.	Tons.	Year.	Tons.
1880.....	34,556	1884.....	290,865
1881.....	134,717	1885.....	177,978
1882.....	247,505	1886.....	198,871
1883.....	265,830		
Total.....			1,350,322

ANNUAL REPORT OF THE
THE HEWITT MINING COMPANY.

Close to the Chapin at the west end and in its foot-wall is the Hewitt mine. The company has mined for several years in several small lenses of ore, which are now practically exhausted. At the time I last visited the mine—in December—there were a few miners at work in the mine, and they were also sinking a test shaft over the hill to the south of the mine, which had just reached the ledge. It was understood that unless something should be found of more promise than was at that time apparent, the mine would be soon shut down. The location is in the N. W. $\frac{1}{4}$ N. E. $\frac{1}{4}$ S. 41, T. 40, R. 30. C. H. Jones, Sec. and Treas., Menominee, Mich.; W. P. Bice, Mining Capt., Iron Mountain, Mich.

The annual product of the Hewitt has been as follows:

Year.	Tons.	Year.	Tons.
1881.....	4,352	1884.....	7,927
1882.....	9,677	1885.....	4,627
1883.....	7,516	1886.....	5,517
Total.....			39,606

THE LUMBERMAN'S MINING COMPANY.

Across the valley in plain view from the Chapin is the Ludington mine, which for a few years past has been a large producer of first class ore. The product in 1886 shows quite a falling off from the previous year's output, but this shortage was due to the crippling of the hoisting facilities, to the caving in of the mine which occurred in September last.

This fall of ground took in No. 1 shaft and reached down to the second level, but the company caused it to extend to the fifth level for safety. Its area covered about 100 feet square of the mine—about the extent of three rooms. They are making no change in the plan of working the mine. The ore is mined out in rooms, leaving pillars of ore between, and the rooms are timbered, after the western system, using heavy timbers placed in sets, frequently heretofore described. To get out the large product which the Ludington has been made to furnish, has caused the mine to deepen rapidly, and the recent catastrophe has illustrated the fact that this cannot go on indefinitely with safety.

At the east end of the mine where the crush occurred the ore body is very wide—80 to 90 feet maximum—but at the west end it is split in two by a horse

of rock that has continued down from the surface, and this pillar helps greatly to support the mine.

Just now they have two working shafts, the downright and No. 5. They are rising up in No. 1 through the crush, and will also soon be ready to hoist again in that shaft.

It is all safe again for a time, being solid down to the fifth level.

Above the fifth level the ore is in pillars, and below, in the sixth, not much mining has been done. They have this ore for the coming year's stoping.

No. 5 shaft is in the north branch of the ore deposit. At the west end it is to the bottom, to the sixth level, 525 feet deep from collar of shaft to bottom; it is single skip. Its distance from the south end of the cross-cut at A shaft is 290 feet.

The vertical—A shaft—is in the hanging wall, 175 feet from the ore at the bottom. It is 500 feet deep, 300 feet of the distance being in limestone. The shaft is sinking to the seventh level. It is double cage and also the pump shaft. The sixth level is but 470 feet from the collar of A shaft.

The cages are each $4\frac{1}{2}' \times 5\frac{1}{2}'$. They are now—December—putting in rods for the pumps in A shaft. The plungers are 18" and 9 feet stroke. Five strokes per minute will take all the water of the mine. I judge that the mine looks just as favorable as it did one year ago. It is not as easy to get about in the mine underground, owing to the fact that the connections are not fully made with all parts of the mine and the new shaft as yet. The ore is reached from the A shaft through a long cross-cut in the sixth level. The length of the mine east and west is 800 feet. It is lengthening somewhat to the west on the inclination of the lense. The dip is slightly to the north, but the ore lense also inclines to the west, and widens out as it descends in that direction. The average width in the fifth level of the ore body is about 60 feet, being about 40 feet in the narrowest place. They make two grades of the ore, the distinction being the amount of phosphorus contained. About 40% of the product is Bessemer. The non-Bessemer runs about .035% in phosphorus, and above 60% in iron.

An analysis recently made of a collection of samples of Ludington ore gave:

Dried at.....	210° temperature
Metallic iron.....	67.10%
Phosphorus.....	.033%
Silica.....	1.88%

The average price at which it sold in Cleveland was \$4.87.

The Milwaukee & Northern R. R. Co. is building its track along by No. 5 shaft, and a large ore pocket will be erected to discharge into its cars. Also

the C. & N. W. R. W. Co. is grading its track so as to come under a large double pocket at A shaft. The Milwaukee & Northern will be provided with large twenty ton cars for transporting ore, *i. e.*, cars which will hold twenty tons.

No. 1 shaft will be used mainly for letting down timber into the mine—800,000 feet of timber—or, including lagging, 1,200,000 feet are used annually in the mine.

The Ludington is now one of the best equipped mines, in the matter of machinery, in the State. The fine new engine house, founded on the solid ledge and built of sandstone, with iron roof, has been fully completed; it is 110x50 feet. The hoisting machinery comprises four drums—W. C. & Lane—each 12' diameter. The wire hoisting rope is 1½" diameter. The engines are two—Hamilton Corliss 24"x48", also electric light engine and five new boilers. It cannot burn up, for all is of stone and iron. As with the Chapin, the power is compressed air, furnished from the hydraulic works. The engines and boilers are ready to be used in an emergency.

The company employs 250 men now.

They are working in the old Ludington also, which is 906 feet west of No. 5 shaft. It is called old No. 2. Work was begun here in November last. They have a deposit of Bessemer ore about six feet wide and are down below the surface 130 feet. The difference in the surface level between it and No. 5 shaft is 30 feet. This No. 2 shaft is operated with a four foot Rochester hoisting drum.

The officers remain without change; Geo. E. Stockbridge, Gen'l Manager; A. D. Moore, Supt., Iron Mountain, Mich.; Henry Davis, Mining Capt.

The Ludington mine has annually produced as follows:

Year.	Tons.	Year.	Tons.
1880.....	8,876	1884.....	101,165
1881.....	3,365	1885.....	124,194
1882.....	52,519	1886.....	76,983
1883.....	102,632		
Total.....			469,734

The mine is in the northeast corner of the S. ½, S. E. ¼, S. 25, T. 40, R. 31.

THE HAMILTON ORE COMPANY

is the corporate name assumed by the company that is sinking the shaft adjacent to the Ludington and Chapin mines.

The location of this celebrated shaft is 40 feet from the Ludington line, in the S. W. cor. of the N. W. ¼, S. W. ¼, Sec. 30, T. 40, R. 31. The Chapin mine on the south and the Ludington on the west. The remarkable feature about this shaft is that it was undertaken with the full knowledge that it would have to be sunk 800 feet before the ore would be found. The purpose was of course to intercept the Chapin and Ludington deposits in their underlay on the Emmet company's property.

The work of sinking was begun four years ago, and this year the shaft appears in the list of producers. The shaft is 9'x12' inside the timbers and is timbered to the bottom, 960 feet from the collar, vertically down. Several drifts were made from the shaft on the way down. At 440' from top they drifted to the north 30 feet and south 80 feet, both in jasper. At 580 feet a drift was made south 60 feet, also jasper. At 843 feet a drift south 100 feet was in ore the south 20 feet. At the bottom the shaft is in ore and a diamond drill boring was made 2x5 feet in the direction of the dip of the formation. The boring is said to have been all in ore. Mr. Foster estimates the width of the ore at bottom at 100 feet.

At the present writing the shaft is idle, work having temporarily ceased a few weeks ago. I was told that Mr. Kimberly was east negotiating for a plant of machinery that would be adequate not only for sinking the shaft but to open a mine and to resume mining work on a large scale. I understand that there is an immediate necessity for more powerful pumping machinery in order to prosecute the work of sinking, etc., to advantage.

The Hamilton shaft has been a good exploration for the Chapin company, since it demonstrates the continuance of the ore far below the bottom of that mine. The Chapin people have the assurance of the continuance of the ore body to at least twice the depth to which they have penetrated in it.

It is probable that during the coming year efforts will be made to equip this new shaft to open up a mine and to make it a producer of ore in considerable quantity. At least such it is declared, by those in charge, is the design.

Eight hundred and seventy-two tons of ore were shipped from the mine in 1886.

P. L. Kimberly, V. P., Cleveland, Ohio; R. Williamson, Sec. and Treas., Chicago, Ill.; E. T. Foster, Agt., Iron Mountain, Mich.

THE CORNELL IRON MINING CO.

The Cornell mine, about a mile and-a-half from Iron Mountain, has been worked in a moderate way for a year past by the new company. The old mine, opened and worked six years ago, consisted of an open pit about 300 feet long and

60 feet wide and of an average depth of about 60 feet. Mr. Friedrich, the superintendent of the company, began work at the northeast corner and also in the southwest corner. The trouble is that the ore is not concentrated; the formation is banded; that is, the ore alternates with belts of soap rock, both of about an equal thickness, but never wide enough to be mined to advantage or with profit. The formation bears about N. 55° W. and dips southerly. The same peculiarity is observable across the bottom of the pit—ore and rock in succeeding layers. In the east end, where they are now stoping, at about 50 feet below the surface, they have good ore, but it is only 2 or 3 feet wide where there is rock and again ore; they have mined ore along the north side of the pit by separating it thus from intervening rock. They hope by driving further north and east to find ore in greater body. There is ore enough if it were concentrated together. Possibly it will be found to be so at greater depth. Their plan is to drift in northeast across the formation and then "open out."

At the southwest corner of the pit, or a little southwest of that end of it, they are sinking a shaft; are down 120 feet. They drifted west from bottom of the pit 50 feet and sunk a winze 70 feet.

The ore so far is proved to a depth of about 100 feet and a length of 150 feet, showing a width of 8' to 12 feet.

The shaft is going down so as to reach this ore in the west end; when it is completed they will be ready to mine and hoist ore. So far the ore has been taken from the east end and the sides of the open pit.

The ore is of fair quality; as a whole, it is non-Bessemer, though samples have been analyzed, which placed the ore within the Bessemer limit. A branch of the C. & N. W. R. W. Co. extends to the location and the mining company has reasonably good facilities for handling ore. The machinery consists of three hoisting drums, two of them 4' diameter and one 3 feet, with the requisite power to operate them. The officers are: President, Joseph Flesheim; Hugh McLaughlin, Secretary; P. A. Van Berger, Treasurer; John Freidrich, Superintendent, Iron Mountain, Mich.

The description of the property is the E. $\frac{1}{2}$ N. W. $\frac{1}{4}$ S. 20, T. 40, R. 30. The mine was worked three years, producing in

1880.....	30,856
1881.....	11,816
1886.....	4,566
	47,238 tons.

THE ANDERSON.

Near the Cornell a party of Swedes is engaged in sinking a shaft; are down about 100 feet, but at the time of my visit they did not have ore.

TRADERS' MINING CO.

is an organization made to develop and work a property near the Cornell, being S. $\frac{1}{2}$ S. W. $\frac{1}{4}$, S. 17, T. 40, R. 30. There is an iron formation extending from Lake Fumeé in section 26 northwest through sections 27, 21, 20, 17, 18, in which a good deal of exploring has been done. The only working mines that have ever been opened in it are the Indiana and the Cornell, and these have not thus far developed any great quantity of ore or proved profitable mines. The Traders is in this ore belt. The ground has been a good deal explored in years gone by, as is evidenced by the numerous test pits to be seen in looking over the surface. The recent efforts are deemed more promising than any that have heretofore been made. The ore found is not as yet very clean or high in iron, but it is believed to be Bessemer, and if it shall prove to be so on further investigation, the ore will have a market value that will pay for raising it.

At the time of my last visit, about January 1, they were at work in two shafts; easterly one 86 feet and the westerly one 55 feet deep. They are upon the top of high ground, which slopes away to the south and east. The shafts are about 350 feet apart. At the bottom of the east one they had drifted north into the foot wall 12 feet; hard, slaty jasper, with a percentage of ore. They were drifting south in a lean, hard hematite ore. In the other shaft they had not cross-cutted yet, but were in a lean, hard hematite all the way. One analysis which I have seen of this ore, sampled to give an average, gave 48.9% metallic iron, .008% phosphorus. This low percentage in phosphorus is what gives the main value and interest in the work.

Six hundred feet northwest of the east shaft is an old test pit said to be 100 feet deep, which Capt. Dunn had just begun to pump out with the view to testing the ground in the bottom. There are an engine and boiler and two small hoisting drums used in this exploratory work.

The general business office is in Milwaukee. Officers are W. A. Dunn, F. A. Bates, H. S. Benjamin, N. D. Moore, C. F. Rand. The work is in charge of W. A. Dunn, Agent Iron Mountain, Mich.

THE COMMONWEALTH MINING CO.

owns in fee simple a large estate lying in the Menominee range west of Iron Mountain and in the State of Wisconsin.

The mine has been from the beginning under the superintendence of Capt. W. E. Dickinson and has continued to ship ore each year since it was first opened in 1880.

This work the past year has been in the old pits in the S. W. $\frac{1}{4}$ of Sec. 34, T. 40, R. 18 E.

The underground work done in the past year shows great irregularity in the form of the ore deposit. There is a main run of ore north and south 225' and 25' to 75' feet wide; from this there are three important branches of ore extending to the east and west, those east are 100 feet long, the south one 25 feet, and the middle branch 20' to 75' feet wide. In the northwest part of the underground workings is a pit 50 feet by 70 feet, the bottom is 330 feet below the datum of the mine, to the fifth level. The east of the mine is to the fourth level, 275 feet down. The ore pitches west and at least maintains its magnitude if it does not increase in length. The shafts are designated B & C and are vertical. A new plant of machinery is soon to be obtained; in fact the contract has been let to the Marinette Iron Works Co. to build for the Commonwealth two drums each 10 feet diameter, with such other machinery as will fully equip the mine for getting out a large product.

The company has done a good deal of diamond drill work. Has bored 29 holes of a maximum length of 700 feet, and an average of 400 feet, at an average cost of \$2.35 per foot. The formation is reddish and black slate, the former to the north and the latter to the south of the ore.

The estate comprises 4,000 acres of land in one body.

The ore the past season was sold on a guarantee of 60% iron. It is non-Bessemer. It is picked over carefully, requiring one man to about four cars in loading to sort out the rock.

The mine has produced each year as follows:

Year.	Tons.	Year.	Tons.
1881.....	97,410	1884.....	34,622
1882.....	115,865	1885.....	42,947
1883.....	21,943	1886.....	51,189
Total.....			363,976

W. E. Dickinson, Superintendent Commonwealth, Wisconsin.

THE FLORENCE MINING CO.

The Florence mine shut down in 1883 and has since been idle until a few months ago, when the property was purchased, or a three-quarters interest in the realty by parties in Youngstown, Ohio,—The Briar Hill Coal Co.,—the same gentlemen who own the Iron River, etc., mines; the remaining fourth interest is owned by H. D. Fisher, of Florence, for which he receives six cents per ton royalty for all the ore mined.

The new company began work under the direction of M. J. N. Porter by pumping out No. 4, the new shaft, which was 170 feet below the surface. At the bottom is a cross-cut west, which shows 300 feet of ore, two-thirds of the length of which is clean and first class, averaging 60% in metallic iron and .25% to .30% in phosphorus.

They are sinking No. 4 shaft for another level, when it is believed the ore will improve in quality.

This shaft is 500 feet west from No. 3, with which it is connected underground by a drift.

The portion of the mine to the east of No. 4, Nos. 1, 2 and 3 shafts, has not yet been disturbed, but preparations are making to pump it out, and it is expected that this work will begin before the end of the present winter. A new pumping plant will be secured for this purpose.

From No. 1 shaft, the most easterly one to No. 4 west, it is 1,200 feet. There is continuous opening the entire distance.

I went through the mine in the summer of 1883, a short time before it closed down, and I was impressed with the great amount of ore in sight. In all the shafts are large workable stopes. It seemed to me then that all that was required was a market and the mine could be made to afford a very large product. The operations of the present company in working the mine will be governed by the demand for ore. If the owners can sell it at a profit they will no doubt "push things" to the utmost.

The mine has produced each year as follows:

Year.	Tons.	Year.	Tons.
1880.....	14,113	1883.....	160,155
1881.....	100,501	1886.....	840
Total.....			315,871

Henry Tod, President, Youngstown, O.

J. N. Porter, General Manager, Stambaugh, Mich.

O. C. Davidson, Superintendent, Florence, Wis.

Edward Ball, Mining Captain.

THE IRON RIVER CO.

The Iron River mine is in excellent shape. It has been well handled from the beginning. During the past year considerable activity prevailed. The mine was practically idle during the winter until about the time of the opening of navigation, when it became apparent that the ore could be sold; then the work

began to be pushed, and a product of 78,591 tons of ore were gotten out and shipped.

The work is now confined to the north and south extremities of the section. It will be remembered that the property lies along the section line in sections 35 and 36, T. 43, R. 35, the openings now worked are in section 36, or at the north end, the underground workings may, slightly, at one point cross the line into section 35. All the openings are in the side of the hill sloping to the west to the Iron River, which courses south.

The north mine workings have a length, underground and surface cut, of 1,200 ft. The south part of the north mine is now mainly underground and designated as the Cyr pit.

The bottom is the second level 200 feet vertically down. The first level is 90 feet. The main feature, which distinguishes the manner of the working of the Iron River mine, is the fact that all the underground openings are filled. No timbering is resorted to, but the mine is filled with rock as fast as the ore is extracted. The mine is filled for a length of 400 feet and a depth of 90 feet. The ore body is about 12 feet wide at the ends and 48 feet wide for a length of 200 feet. The rock for filling is mined from the open pit, from the foot wall and hanging of the open cut, and "milled" down into the bottom.

This experience in filling is as favorable as can be desired. It really costs less than timbering; it is perfectly safe and enables them to take out all the ore. The filling becomes nearly as compact as the ledge itself. By the settling and the squeezing of the walls the material is so pressed together that it shows no tendency to slide down when they have come up under it. The main shaft, No. 1, is vertical from the surface down. It is double skip shaft and also the pump shaft. South of it the ore branches, the west branch going towards the river and the other making east into the hill. It is, perhaps, more simply a large "horse of rock" in the lense. About the first of the year they started a new shaft, 600 feet north from No. 1. It will be sunk to the proper depth and they will drive each way in the ore, will timber a drift securely and mill all the ore from the stope, as they rise into it to tram to the shaft.

They carry breast stopes fifteen feet high and fill up, building up to the mills for running down the ore, as they rise and fill in. The present underground working reaches 300 feet north of No. 1. The "mills" are fifty feet apart. "Mills" through the ore will also be made for sending down the filling material. The mills are 4'x4' and made of poles locked together at the corners. Those coming up through the ore serve as pockets in which ore is stored in the summer when there are no cars. When there are cars the ore is drawn out and hoisted.

No. 1 shaft is near the $\frac{1}{2}$ post, 1,320 feet south from the n. w. corner of sec.

36, and for a long way north, nearly to the section line, it is an open cut mine. The first is designated as No. 3 pit, about 32 feet to the bottom, and the ore being of about an equal width. It is in this pit that the new shaft—No. 3—is sinking. The shaft is in the hanging wall and vertical, 8x12 feet inside the timbers. The ore will dump from the shaft skip directly into the pockets above the railroad track. When this shaft is down and "opened up" the underground length of stoping will be 800 feet. In the winter, while the ground is frozen, they are cleaning the ore from the walls of the open cut. Such work can be done in the coldest weather with safety.

After the ore is thus all saved rock from the walls will be used for filling. The walls dip west 80° to 85°. The foot is far better than the hanging. They were, in January last, mining 200 tons per day, working about 140 men, 100 of whom are employed in the north mine and 40 in the Isabella.

The ore is clean, free of rock, 58% to 61% in iron, and averages .48% in phosphorus. The phosphorus is the objection to it.

The Isabella pit at the southwest corner of the section is looking first rate. The ore is now clean, free of rock. Near the surface, when the mine was opened, the ore was capped over with rock and was somewhat mixed; now, however, it is clean. The Isabella as it now stands is a great round cavity 115 ft. deep, 115 ft. long north and south, and an average of 70 feet wide. At the north end a stope 27 feet wide has been worked in 20 feet, and thence on is a drift in ore 76 feet, at the north end of which they are sinking a winze that will ultimately become a shaft; 56 feet south of this winze is a cross drift west 25 feet and in ore. This represents the width of the ore at this point. It has gradually narrowed from being 80 ft. wide at the north end of the open pit until here, 40 feet from the main breast, it has become 25 feet wide. The narrowing is mainly from the foot wall side. This west stope is 50 feet high and 50 feet wide at the south end and 25 feet at 40 feet further north.

The bottom of the pit is ore. South from the open pit the ore makes off in two branches. The new shaft will be in the foot wall. It will go down below the bottom of the open pit and they will drift from the shaft below the present workings.

The ore will be hoisted on the east side of the mine and will be run over to the west to the ore dock. A new plant of machinery is to be erected. That at present in use at this mine is entirely inadequate to handling a heavy product.

There will be a new engine house on the foot wall side, with three five foot drums, new engines and two new boilers 16'x60".

The ore is about of the same quality as that at the north end. An average of a great many analyses gives

Metallic Iron.....	61%
Phosphorus.....	.48%
Silica.....	3.50%
Lime.....	.46%

The pit produced 31,000 tons the past season and will probably easily afford 50,000 in '87.

The Co. has a laboratory and employs a chemist at the mine and the ore is constantly sampled and analyzed.

The annual product of the Iron River mine has been as follows:

Year.	Tons.	Year.	Tons.
1882.....	29,115	1885.....	55,693
1883.....	100,369	1886.....	78,591
1884.....	52,584		
Total.....			316,352

Robt. McCurdy, Treasurer, Youngstown, Ohio.

James N. Porter, Superintendent, Stambaugh, Mich.

THE SELDEN MINE

is a small pit opened and worked to a limited extent, near the water tank, on the east of the railroad track at Stambaugh, 200 feet north of the south line of the property and 350 west of the east line, being the N. E. $\frac{1}{4}$ S. E. $\frac{1}{4}$ S. 35, T. 43, R. 35.

The ore was uncovered by the railroad company in building its track and the option was held by the Iron River Co., who relinquished it last year, when it was taken by Messrs. Polderman and the St. Clair Brothers. The Iron River Co. expended on this property in option fees and in exploring work \$1,500. The owner's terms were excessive, requiring the company to pay 50 cents a ton royalty, and to mine 5,000 tons a year or pay royalty on that amount. As the ore is poor quality, high in phosphorus and low in iron, there was no sale for it, and the Iron River Co., tired of paying \$2,500 a year, threw up the lease.

The present holders are preparing to organize a company and provide the machinery for working the mine the ensuing year.

The shipments in 1886 amounted to 790 tons of ore.

Geo. A. St. Clair, Superintendent, Ishpeming, Mich.

THE BETA MINING CO.

This property lies adjoining the Nanaimo—east of it—being the N. E. $\frac{1}{4}$, S. W. $\frac{1}{4}$, S. 26, T. 43, R. 35. They have simply mined out a small pit about 50 feet across and 50 feet deep from which 2,000 tons of ore have been taken out and shipped.

Capt. Thomas Luxmore, who is directing the work, states that he has traced the ore for a length of 600 feet.

The ore was mined and sold by John McDonald, of Iron River, who held a lease of the property.

The mine will be operated by the company during the year 1887. There is a small plant of machinery on the ground.

The officers are: H. O. Fairchild, President, Marinette, Wis.; D. C. McKinnon, Secretary and Treasurer, Iron River, Mich.

THE NANAIMO MINING CO.

is now engaged in operating its mine. A year ago it was idle and there was no product to report.

They are working in the old pit. The south one is the one nearest the river. This is the pit from which the first ore was taken. The work is all underground, mainly in the second level, 180 feet below the surface. A shaft goes down at the east end, dipping 65° westerly. The first level had a length of ore of 200 feet of a variable width, but attaining to 90 feet maximum and averaging about 40 feet. The second level has not been fully opened but affords every evidence of being equally as good as the first. They are also mining out the pillars left in the first level, letting the top all in and making it an open pit, hoisting from it with bucket and derrick.

The north pit is full of water. The mine is pretty well equipped with machinery—three hoisting drums—each 4 feet diam.; 4 boilers, 16'x4'.

A trestle connects the mine, with the furnace built on opposite side of the river, 1,200 feet away. But the anticipation that this furnace would use all the ore of the mine failed to be realized. They did not for some time succeed in making the ore work well in the furnace alone; they found it necessary to mix it.

The unfortunate destruction of the furnace by fire in August last put an end to the consumption of the Nanaimo ore from this source and rendered the long trestle useless.

The ore is of about the same quality as that of the Iron River mine—possibly a little lower in phosphorus.

The company employs now 60 men. There are 5,000 tons of ore in stock and perhaps 10,000 tons in sight in the stopes.

The officers are: J. C. Wedge, President; John Spence, Secretary and Treasurer, Fond du Lac, Wis.; Wm. Bond, Mining Captain, Iron River, Mich.

The product of the mine for each year has been as follows:

Year.	Tons.	Year.	Tons.
1882.....	2,250	1884.....	38,766
1883.....	29,221	1886.....	5,400
Total.....			74,721

THE YOUNGSTOWN MINING CO.

has recently resumed work. The mine is at Crystal Falls, in Sections 19 and 20—N. E. $\frac{1}{4}$, S. E. $\frac{1}{4}$ of Sec. 19 and N. W. $\frac{1}{4}$, S. W. $\frac{1}{4}$ of Sec. 20, T. 43, R. 32. The mine is in what was originally a cedar swamp at the foot of a hill which rises up steeply on the south. The mine was first worked in section 19, and the engine house was built near the west line of the property. Further exploration to the east developed the fact that the ore in larger body existed near the line between the sections than had been found to the west. The testing that was done led to the inference that the ore existed in two veins, parallel with each other, running east and west, and the plan was devised of sinking a shaft in the rock between them, intending to work the ore in the deposits each way from the shaft. The shaft is designated as No. 4. It is a short distance east of the line in section 20, and is 120 feet below datum at the bottom. No. 5 shaft is 160 feet east from No. 4 and is but 63 feet deep. The two are connected by drift below the surface. The deposit is 200 feet wide all clean ore, and even yet no well defined walls are found, though the extreme limits on the north and south are mixed, rock and ore.

They have worked east from the shaft 100 feet and west 125 feet. The openings are in ore—east of No. 4. The ore is high in manganese.

The following analysis indicates the quality of the ore from the shaft:

Metallic Iron.....	54.5 %
Phosphorus.....	.57 %
Silica.....	3.00 %
Manganese.....	4.50 %
Lime.....	2.50 %
Aluminum.....	1.30 %
Water.....	6.00 %

The ore is compact and hard, and stands well in the mine, so that it can be

mined out, leaving large chambers. In this respect it is like the Norway. The roof does not show a disposition to fall out. They are opening the mine in such a way as to afford a number of stopes, which will enable the company to make a large output the coming year. If the ore can be sold at a profit there will be no difficulty in securing the supply.

A new plant for operating No. 4. shaft has been contracted for, which includes hoisting machinery, compressor and air drills. The latter are needed in this hard ground; with them the ore can be mined far more cheaply and rapidly. A fine ore dock extends the whole length of the mine, and the railroad track has the inclination requisite to allow the cars to run down along the dock—away when loaded and to come down as required. The ore must be elevated to a considerable height to be above to the stock pile.

Work was begun, after an idleness since 1887, on the 1st of May last, making the first shipment on the 2d of June. The average working force since July has been 90 men. They mined and shipped 25,000 tons and intend to have in stock by the opening of navigation in the spring 20,000 tons. The product for 1887 will be about 50,000 tons. It may exceed that amount if the ore can be sold.

The average of the analyses of the ore shipped in July gives in iron 56%.

“ “ “ “ “ “ “ “ “ “ August “ “ “ 57%.

“ “ “ “ “ “ “ “ “ “ Sept'r “ “ “ 57%.

The average in phosphorus was .41%.

The officers are: J. N. Porter, general manager, Stambaugh, Mich.; E. J. Gilbert, superintendent, Crystal Falls, Mich.; Thomas Ball, mining captain, Crystal Falls, Mich.

The mine has yielded as follows:

Year.	Tons.	Year.	Tons.
1882.....	6,198	1884.....	8,343
1883.....	15,292	1886.....	25,638
Total.....			55,469

THE PAINT RIVER MINING CO.

is also actively engaged in mining work, after a period of idleness into which, in common with many other mining companies, it was forced to remain; it is now preparing for a season of prosperity. The new “find” described in my last report is turning out well—all that was anticipated—and will afford the Paint River Co. a large output.

This new deposit was struck at a point 400 feet north and 600 feet west of the main shaft in the old mine. It is near the west line of the property and extends into lot 6, section 20, which latter property has been also secured by a lease to members of the Paint River Co. and will be worked by the company as a separate concern. This ore seems to be the easterly continuation of that at the Youngstown mine which is on the same section on the opposite side of the Paint River.

In the new mine are two shafts 200 feet apart. The west one is 84 feet east from the west line and 100 feet deep, and they are sinking for another lift December 20th. The ore body is 75 feet wide and they have bored in the bottom 200 feet down, all in ore. Borings have also been made on the north and south sides of the shaft to test the width of the ore, so that they have it sufficiently proved to assure a good mine at least for present purposes. The plan is to fill the mine and not use timber. The ore does not vary much from that of the Youngstown; runs 58% to 70% in iron and .20% to .70% in phosphorus, low in silica and has a percentage of lime. It has a low density. It is expected to mine 30,000 or 40,000 tons the coming year. Capt. C. T. Roberts, who has had charge of the mine since it was first opened, in 1881, has the mine now, on lease; that is, he mines the ore for a certain price per ton—90 cents—paying all the costs himself, the company making the improvements, etc. Capt. Roberts, who has heretofore resided at the mine, has moved to Mastadon, and Mr. C. T. F. Scaddon will act as superintendent. Frank Rahe and others have a sub-contract for mining the ore. Between the Paint River and the Youngstown are the falls in the river which could be cheaply utilized for operating mining machinery as at the Chapin, etc. No work is doing in the old mine.

The Paint River mine has produced annually as follows:

Year.	Tons.	Year.	Tons.
1882.....	4,615	1885.....	2,374
1883.....	5,971	1886.....	13,933
1884.....	11,546		
Total.....			48,433

M. R. Hunt, General Manager, Chicago, Ill.

THE FAIRBANKS MINE,

which joins the Paint River on the east, has been wholly idle for some years.

The mine produced in 1882 8,131 tons of ore. Joining the Fairbanks on the east is the Great Western mine, the property of

THE IRON STAR CO.

One year ago when I visited the mine it was idle and full of water. Captain Hooper was then engaged exploring with the diamond drill and reported excellent results. Subsequently the mine was "pumped out" and matters put into shape for the active prosecution of mining work, and the result has been that 25,725 tons of ore have been mined and shipped during the past year.

They have hoisted from two shafts, Nos. 1 and 3, and have sunk the former an additional "lift" of 92 feet to the 4th level, which has not been very largely opened yet. It will be available for the coming year's work. No. 1 is the westerly shaft, 170 feet east from the west line of the property, and No. 3 is about 220 feet east of the former and is down to the 3d level; they hoist in it with bucket. No. 1 is a cage lift to the 3d level. In the 3d level the mine has a total length, underground, of 510 feet, commencing at about 100 feet west of No. 1 and extending east. The ore is found in several lenses or pockets, succeeding one another east and west and separated by "bars of ground."

No. 1 was formerly an open pit, but has been filled and the shaft left open through the filling; the last level—the 4th—the shaft was sunk in rock, and they have cross-cutted to the ore. The ore looks well in all the stopes, though it is by no means everywhere alike in the mine. They have a fine blue ore that is of most excellent quality. Much pains is taken in keeping the ore clean and free from rock, and this care, with the good qualities of the ore itself, has given it a good reputation among furnace men recently and created a demand for it. The following analyses of 12 samples of the Iron Star ore were made by Mr. C. E. Wright, of Marquette, and illustrate its qualities. They were taken and made at different periods.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.	No. 12.
Iron.....	64.02	62.86	62.93	62.92	63.08	61.85	64.31	64.57	65.96	63.21	64.62	64.20
Phosphorus.....	.076	.058	.102		.102	.130		.076		.087	.107	.079
Silica.....	1.62	1.29	2.82		3.118					3.67	2.55	2.85
Aluminum.....		2.67										
Lime.....				1.08			1.10					

The mine is timbered after the Nevada system and is in fair shape. The most unpleasant feature connected with the mine is the over abundance of water. It is an exceedingly wet mine. I hardly see why the upper levels and stopes should be so wet; but everywhere, in all parts of the mine, the water is

dripping from the "back." Generally, in mines, the water finds its way to the bottom, leaving the upper levels dry, but in the Iron Star the first level is as wet as the fourth, at least, it is as disagreeable in this respect to examine. To raise the water the force of a No. 10 short stroke Cameron at No. 1 shaft and a No. 11 long stroke Cameron at No. 3 are brought into requisition. It is the plan to run the water to No. 3. A launder 700 feet long conducts the water from the shafts in the direction of the river. The total force employed is about 100 men. It has always been understood that the Iron Star ore was of better quality than that of most mines in the Crystal Falls district when properly selected; and the care which the present company exercises, in this particular, leaves nothing to be desired.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1882.....	587	1884.....	20,722
1883.....	22,825	1886.....	25,725
Total.....			69,859

The location is about a mile in direct line from the village of Crystal Falls, in section 21, T. 43, R. 32.

V. K. Moore, Sec., Detroit, Mich.; Wm. Hooper, Supt., Crystal Falls, Mich.

THE BERTIE

is an exploration that is now making by Capt. W. A. Dunn, east of the Iron Star. The work was but recently begun and ore has been already struck.

THE KIMBALL IRON CO.

is a recent organization with Mr. Henry R. King President; Secretary and Treasurer, J. P. Whaling, Milwaukee, Wis. The estate is the E. $\frac{1}{2}$, S. E. $\frac{1}{4}$, Sec. 29, T. 43, R. 32, close to the village of Crystal Falls, near the saw-mill, and near the Sheldon and Shafer railroad branch. The exploration was formerly known as the Juniette, work having been done here by Mr. S. D. Hollister in 1882. It appears now that the earlier work was done too far north in the north "forty" in a banded ore formation. Recently Dr. H. C. Kimball, of Crystal Falls, secured an option and has now thoroughly tested the location with excellent results. He has sunk six test pits in the south "forty," north of the slope, which forms the foot wall of the ore. The formation runs

east and west and dips north. A particular description of the pits will indicate what is the prospect for a mine, and how much has been done to prove it.

No. 1 pit is 67 feet deep, 44 feet of which is in the rock. At the bottom is a drift south 17 feet to the foot wall and one north 9 feet. Pit No. 2 is 45 feet deep, is in the hanging wall, 3 feet north of the ore. Nos. 3, 4 and 5 pits are in ore and No. 6 is in the foot wall. No. 1 pit is 126 paces from the south line and 240 paces from the east line. The pits are 80 feet apart east and west except No. 2, which is 46 feet north of No. 1.

In No. 1 they have cross-cutted in the ore and have ore 40 feet, and have thus proved by the pits a length of 400 feet. It is a fair quality of ore, showing, by the samples that they have had analyzed, a percentage in iron of about 60% and of phosphorus of about 12%. Some analyses gave a lower percentage in phosphorus. The land is owned by the St. Mary Ship Canal and Land Co., by whom it is leased to Laurus Silverman, of Chicago, and in turn by the latter to Dr. Kimball, and he again has transferred his right to the Kimball Iron Co.

No doubt a mine will be opened and operated the coming year.

THE DUNN MINING CO.

has the most promising exploration in the vicinity of Crystal Falls; it is in Section 1, T. 43, R. 32.

There has been a great deal of exploring work done on this section in years past. The parties who now hold the property have "shown up" enough of ore to insure a mine. The formation runs north and south and dips west. Along the slope of the hill, which inclines to the east, the company has stripped the ore for a length of 40 feet. It was covered by nearly 20 feet of sand and gravel.

They have sunk near the north end and drifted east so that they have shown thus a width of ore 60 feet. The ore is similar to the Mastodon, about 60% in iron and somewhat high in phosphorus. The work done is 80 rods north from the south line of the property. A little way south of this south line considerable exploration has been done but nothing of value found. A track will be made by extending the Mastodon branch north to this location two miles.

The land is owned by Geo. Sheldon and Luke Welch and is held on a lease by Messrs. J. H. King, W. A. Dunn *et al.*, Cherry Valley Iron Works, Ohio, who have organized the above named company.

THE BLANY IRON CO.,

S. $\frac{1}{2}$, S. W. $\frac{1}{4}$, Sec. 27, T. 43, R. 32, about one and a half miles from Crystal Falls. The land is owned by the Canal Company. There has been a great deal

of exploring work done on this property with not very satisfactory results. Much money has been spent, and it by no means appears that there is ore enough anywhere to pay for mining. The land is level and deeply covered with drift, through which numerous pits have been sunk. One pit is 90 feet deep and they have drifted in its bottom 90 feet, with a lesser length south, in more or less mixed ore. They have nowhere found a considerable width of clean ore. Near the south side of the property they were sinking a shaft at the time of my visit, which was about 90 feet down. The plan was to continue 20 feet further and then drift north and south 100 feet. At the bottom about half of the shaft was in ore, the rest rock. The ore is of good quality; samples analyzed have proved to be Bessemer, and the fact serves to sustain the expensive effort which is making to find a body of it.

The indications are good—ore is found in many of the pits, but in no large quantity. The work now doing is altogether south from the earlier explorations. The line of pits is north and south, but where they are at work it seems that the formation tends east and west. Captain John Morrison, an experienced mining man, has charge of the work.

On Section 22, T. 43, R. 32, Mr. H. D. Fisher is conducting an exploration that promises well.

THE SHELDON AND SHAFER MINE

has been worked during the past year. Mr. Sheldon was getting ready to pump out the pit at the time I visited the mine in October, 1886. The work has been confined to the old pit, which then was about 200 feet long east and west, 80 feet deep and 30 feet wide on top, narrowing to about 12 feet at bottom.

The cut has not been deepened, but has been worked out at the east end, north and south, so that here the pit is much enlarged; a drift at the bottom has been made 100 feet east and one also of an equal length north; 400 feet east on the south side of the railroad track they were sinking a test pit when I last visited the mine, December. This test pit was bottomed in ore and looked favorable, but the ground is wet and they were making slow progress on account of the water. The ore is of pretty good quality if it could be got free from rock with which it is mixed.

It not unfrequently happens that this mixed character of the ore deposit is confined to the part near the surface, and when greater depth is attained the ore becomes uniform and free of rock. I think it would be an excellent plan at this mine to sink deeper; go down to at least twice the present depth and then cross-cut the formation.

The new engine-house has been built and suitable machinery provided. A

double skip road is built down on the south wall of the pit. The land is owned by the estate of R. Sheldon and J. F. Shafer, and the mine is operated by the owners, C. D. Sheldon acting as agent. There are 320 acres, a fine body of land, being the N. W. $\frac{1}{4}$, S. 31, and S. W. $\frac{1}{4}$, S. 30, T. 43, R. 32.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1882.....	15,947	1884.....	6,774
1883.....	4,334	1886.....	14,282
Total.....			41,337

THE CALEDONIA IRON MINING CO.

This exploration was fully explained in my previous report, and there is but little to add. The location is in Sections 17 and 20, T. 43, R. 31 W., on the west bank of the Michigamme river, near which the work has been done.

The dip is west at a steep angle. The company sunk, about three years ago, two shafts—one of them in the line between sections 20 and 17, 83 feet deep, 65 feet of which was in the ledge, mixed ore and rock. At the bottom they cross-cutted 25 feet in ore. A second shaft was sunk north and west respectively from the former 200 and 100 feet. It is 90 feet deep, 8' by 16' in size. They drifted from the bottom 13 feet east in rock and then intercepted clean ore, in which it is stated that they continued for 30 feet without finding the wall. Nothing further was done until last summer when parties from Negaunee sought to pump out the shaft to examine it with the view to purchase, but, being provided with inadequate machinery, failed to accomplish it. The 1st of November, however, Messrs. Moore, Benjamin & Co., of Milwaukee, having taken an option on the property, engaged Captain C. T. Roberts, of Paint River mine, to free the shaft of water. This Captain Roberts succeeded in doing in short time. He suspended a pump in the shaft with a wire rope, and then using rubber steam hose, he pumped the water all out in nine hours after the pump started. He completed the drift for a length of 15 feet, and the analysis showed the ore to be within the Bessemer limits—63 % in iron and .008 % in phosphorus.

It is this fact of the percentage of phosphorus which gives interest to the property. The extension of the Milwaukee and Northern railroad west goes near the property and when this road is built no doubt the mine will be worked. It is eight miles from Crystal Falls, to which place there is a good wagon road. Messrs. Moore & Benjamin are still further exploring the property. The work is done under the supervision of C. T. Roberts.

Since writing the above it is announced that Messrs. M. B. & Co have relinquished the lease and ceased work.

MASTODON MINING CO.

From Crystal Falls to the Mastodon mine is one of the best hardwood sections of country to be seen anywhere, It does not end at either of these termini, but continues uninterruptedly, fine hardwood forest. It is a pleasure to ride through it in summer or winter.

When I visited the Mastodon mine, in October, 1886, it was full of water—nothing was doing except with the diamond drill. They are boring at the north end of the mine—had made two holes, one to the east at an angle to the horizon of 60°, 276 feet deep; the other, which was then boring, was from the same station, but was turned to the west at an angle of 65°. Both of these holes missed the ore—it lay between them, and the fact of its existence was made manifest when the third hole, a vertical one, was bored, stopping in ore after going through 200 feet of it. The pit was soon after pumped out, and the work of stoping and hoisting ore begun. Captain Roberts stated that under the water the bottom was all ore—100x180 feet, and he did not exaggerate, for they have mined out and sold from this pit the first season 41,640 tons and there is all of that amount in sight in the mine. The long way of the ore is north and south. The whole product is hoisted in one skip. The skip load descends to the west into the open pit and then flattens and goes still further west into the open chamber, where they are now stoping. The ore is capped with a thick deposit of sandstone, horizontally bedded; it is clean—entirely free from rock, hard and compact. I know of no hematite that stands better. There is practically no water to contend with.

At 220 feet north from No. 1 skip road they are sinking a vertical shaft, which is now, December, 80 feet deep, following the drill hole. Here they bored in 200 feet of ore and are thus sure of soon opening up a fine pit. A new plant of machinery has been secured and will be placed to operate this shaft.

Captain C. T. Roberts has taken the contract for two years, to mine the ore at 90 cents per ton. The company provides the machinery, sinks the shaft, and also builds some necessary houses, etc. He estimates that he can furnish the coming year, 100,000 tons, and I see no reason to doubt it. The company does not agree to take that amount, but will accept all it can sell. The minimum amount fixed on is 40,000 tons. Analysis of the drill core gave 64% in iron, .119% in phosphorus, 2.20% silica.

Hon. Edward Breitung, president; Joseph Austrian, general manager, Chicago, Ill.; C. T. Roberts, agent, Mastodon, Mich.

The mine has produced as follows:—

Year.	Tons.	Year.	Tons.
1882.....	3,477	1885.....	11,773
1883.....	18,577	1886.....	41,640
1884.....	18,020		
Total.....			93,451

The estate is the S. $\frac{1}{2}$ N. E. $\frac{1}{4}$ S 13, T. 42, R. 33 W.

THE DELPHIC IRON CO.

At the close of the year the Delphic mine was not promising in appearance. The ore was exhausted, or nearly so, and they had not at that time succeeded in finding anything that afforded much encouragement for the future.

Since my visit to the locality, I understand, better results have been met with and that further efforts in the exploring work are now in a fair way to be rewarded with success. The mine is in Sec. 24, N. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$, T. 42, R. 33. The control was held by the late Samuel J. Tilden, of New York, and this interest was devised to W. W. Whittlesey, who is one of the distinguished gentleman's legatees.

It is operated by W. W. Whittlesey Bros. & Co., Florence, Wis., lessees of the Delphic Iron Co. The mine has produced:

Year.	Tons.	Year.	Tons.
1883.....	3,410	1885.....	9,843
1884.....	508	1886.....	17,684
Total.....			31,445

The ore is of a good quality of non-Bessemer hard hematite. The plan is to use a diamond drill.

The other explorations in the Mastodon range have been described in previous reports, and at none others than those herein mentioned has any work been done in the past year.

THE MARQUETTE IRON RANGE MINES.

The oldest, and among the best, iron mines in the State are found in the Marquette district. It was the mines of this range that established the reputation of Lake Superior ores. They are the pioneers and began the struggle in

that early day when Lake Superior was practically far remote from civilization and the markets of the world.

They were wonderful mines, those earliest worked. Deprived of the seeming advantages of location possessed by other iron mining districts of the country, but solely through the surpassing value of the ores, the great extent of the deposits, the intelligence, enterprise and perseverance of those who devoted themselves to their development they established for this region a reputation that secured its ultimate success and prosperity and placed it in the foreground with the chief mining districts of the nation.

It is no wonder that the early residents of Lake Superior—"the old timers"—hold in especial regard these old mines, so identified with their early struggles in the country, the ones on which they so greatly depended for ultimate success, and through which that success was finally achieved. There is sentiment in these matters everywhere, and in Lake Superior, owing to the extreme isolation of the country for a long period, these local attachments had peculiar opportunity for development. The new generation can scarcely appreciate the feeling with which the early resident of the copper region regards the old Minnesota and the Cliff—the enthusiasm with which he will recall those early days in copper mining, and in the Marquette region, as well, there are mines which the old mining men are ever ready to praise and of which anything favorable gives to them unusual satisfaction.

And well may these old mines be regarded with favor. They were the first to establish the reputation of the ores of the region, and have ever maintained it. The old mines are still leaders in quality and in quantity of production. The Marquette range is still the largest producer of ore. It is the only producer of hard ores, magnetic and specular ores.

Though the oldest of the mining districts, there is nothing obsolete about it. It is a region of wonderful enterprise and progress. Old fogyism in mining work finds no resting place among the old mines of the Marquette range. Nowhere in the world is this industry more nearly abreast with the times than here. Visit one of the old mines, the Cleveland, Lake Superior, etc., and see what magnitude and perfection of equipment. The buildings and shaft houses are of the most substantial kind—the important ones of stone and iron. The machinery is all of the most powerful and latest construction.

One is impressed with the fact that he is examining a mine; a mine in the largest sense of the term. If he goes down into the mine he may descend hundreds of feet into the earth and traverse long drifts, view the gloom of immense chambers and caverns from which has been extracted the ore that for thirty years has unceasingly flowed through these drifts and shafts. He beholds stopes of ore that suffice to assure him that there will be no diminution in the

supply of mineral which the mine has been accustomed to afford. The valuable record established by so many years of intelligent management, of unflinching richness of ore and uniform greatness of production, is precisely the record that there is the best evidence will continue to be maintained in the future.

There are many mining locations in other more newly developed localities where a large product of ore is obtained and where one sees little of the outlay and preparation for mining observed at the older mines. Some of them are mere cavities, open to the surface, where the ore is mined in the simplest possible way, only such machinery being used as is essential to operate derrick and bucket or simple skip way. In after years it is probable that the newer mining sections will assume the appearance which the older one now has.

They will profit by the experience of the pioneer mines; they have already done so. The old mines have been schools for educating miners. The most of the mine managers, mining superintendents and captains of the new mines are men who were formerly employes of the old companies. Men who got their knowledge of the work in the old mines. The new mines start with the experience of all the previous years and have available at the outset the latest improvements and methods.

There is nothing new or valuable in iron mining that will not be found in use in the leading mines in the Marquette districts, and nowhere will one find a more progressive spirit or more intelligent management. In describing the mines of the Marquette range I shall, as is usual, speak of the older ones in their chronological order, and thus begin with

THE JACKSON IRON CO.,

a namesake of the important city of that name in southern Michigan. The original company was formed in that city by men residing there who first obtained title to the property and did some incipient mining work. The first ore taken from the mine was taken to Jackson and there worked into iron at a country forge, the first iron ever made from Lake Superior ore. It was also, prior to this, that in running the west line of the Jackson mine the U. S. surveyors made the discovery of the existence of iron ore in place in this country. All this early history has been fully gone over in previous reports and will not be reiterated here; the subject has been exhausted and there is nothing to add.

In 1872, when the gentlemen who were engaged in this early enterprise were still living, as were also most of the members of the government surveying party that ran out the lands referred to, I gathered from them by personal interview and by letters all the evidence bearing upon the subject and thus wrote out the history in brief for the State geological survey of the iron region. I only mention these facts because I am sometimes asked for information regarding the

early history of the iron mines, and also that I occasionally meet with statements in the papers which are at variance with the facts. A brief historical sketch of the discoveries and early development in the iron regions is embraced in the State Geological Report of 1873, and also in the first report of the Commissioner of Mineral Statistics, 1877-78.

In my last report, written a year ago, I gave a long description of the Jackson mine. I spent several days at the mine, going through all parts of it with Capt. Merry, and wrote it up, as I termed, fully. I shall, therefore, confine myself mainly to what has transpired in the last year. The open cut and underground workings of the Jackson mine extend almost continuously the whole distance east and west through the south half of Section 1, T. 47, R. 27, and upwards of half a mile north and south. Almost the entire area of the S. E. $\frac{1}{4}$ is filled with these mine openings. Great rocky chasms artificially formed, and vast caverns, far beneath the surface, where the ore has been extracted in years gone by; innumerable drifts cut through the rock, winding in every seeming direction, connect these underground chambers, forming a labyrinth so extensive and intricate that only such a thread as the experience of Capt. Merry constitutes, will serve to guide you through in safety.

Many of these old openings still afford places where ore is mined. A man can start in almost anywhere and find ore. There is a great deal of this "scramming" done at the Jackson. Quite a proportion of the annual product comes in this way. Not unfrequently one of these "scrams" leads to the finding of a large deposit of ore. Some of the best pits that have been had in recent years were discovered in this way, as the No. 7, No. 8, the Merry pit, etc., and even now, at the present writing, they are developing such a "find" that was recently made, and which is promising finely. The discovery was made in old No. 1 pit, where a miner had a contract for scrambling all the ore he could get in the sides of the pit. He worked a little in the bottom and found what he knew to be a body of larger size. Carefully concealing his discovery, he went to Capt. Merry and wanted his contract enlarged so as to include the entire pit, the bottom as well as the sides. The Captain has become so accustomed to this sort of thing that he surmised as soon as he saw the man that he had found some ore, but he declined to enlarge the contract. The company is now working in this ore in the bottom of No. 1 pit, and is also driving towards it in No. 9 pit, which is to the northwest. This stope in No. 9 is the best thing in the mine, in sight, at the present time. They are 162 feet below the tunnel level, and the ore is of the best quality, of fine, hard ore, 14 feet to 25 feet wide. No. 6 pit, which for many years has afforded the best hard ore stopes, is becoming exhausted.

No. 7 and No. 8 pits, and the South Jackson, are all looking exceedingly

well. The former has not been sunk any deeper during the last year. When I went into the pit a year ago, the bottom level had but recently been reached. It was not then promising well. So far as opened, it was mostly rock. Drifts below the ore body, where a continuance of the ore was expected, showed the ground to be rock. Further development, however, proved that the ore body, though somewhat changed in position, had not diminished in magnitude, and several of the largest stopes were worked in this pit. Ore is now to be seen in the bottom of No. 7. The pit produced last season 15,000 tons, and will do equally as well the coming year. Its depth to bottom is 207 feet.

No. 8 is also looking even better than it did a year ago, and at that time I stated that it was the best pit in the mine. The skip level down the north side is 200 feet east of No. 7 shaft, and is 100 feet deep, one level below the bottom of the open pit. No. 8 is becoming a hard ore pit, and the ore is of the best. The product of this pit last year was also 15,000 tons, and it is sure to duplicate the amount in 1887.

South Jackson has not looked so well at this season for several years as it does now, and the ore has become, Capt. Merry states, of better quality than formerly. However, the ore in the east end of the mine was always higher in phosphorus than that found in the west part, and it is here that they are working, and where the ore has been mined that went into last year's product, 18,330 tons. They are now sinking for a new level for the coming year's product.

About midway to this mine east and west is a tunnel, which goes in south. Through this tunnel is laid the railroad track over which the ore goes from the mine. The new workings just mentioned are west of this tunnel. East of it, near the east line of the section, they have a run of ore 250 feet long, 10 feet and upwards in width. The South Jackson is in the southeast corner of section 1, and behind it, in section 12, five or six hundred feet, rises the greenstone cliff to which the workings in both mines extend—that is, they have worked up to the greenstone both in the South Jackson and in Section 12 mine, particularly in the latter, which is, however, one of the Iron Cliff Company's mines.

The Merry pit, so fully described last year, shows some improvement from what appeared then. A drift in the hanging near the top opened into a body of ore that is of some value.

Altogether the Jackson mine will easily afford as large a product the ensuing year as the last. If required it could be much increased.

The company employs an average force of 200 men.

The most surprising thing connected with the Jackson Co. is the recent sale of the controlling interest in the stock. A change in the management of this old corporation is a genuine sensation. The purchasing parties are Capt. Sam.

Mitchell, of Negaunee and the Cleveland Rolling Mill Co. It illustrates the opportunities which our country affords for bettering one's circumstances, that Capt. Mitchell, who came to Michigan from England not many years ago a poor miner, and by his honest industry and intelligence should acquire such a fortune as to enable him to become a chief owner of the great Jackson mine. The original company was formed in 1845. Subsequently, in 1848, an act was passed by the Legislature incorporating the company under the title of the Jackson Mining Co. of Mich. In the following year the charter was amended by which the name was changed to the Jackson Iron Co. I understand that no changes have since been made. The company has been a very conservative one and its affairs have been well managed. It has probably made more money, returned more to the stockholders, than any other mining company in the State except the Calumet and Hecla.

The stock is divided into 12,000 shares and in the recent transfer the price per share was fixed at \$125.

In the estate is included the lands and furnaces at Fayette on Lake Michigan. Capt. Merry informed me that he should withdraw as soon as the transfer was completed. He has other matters to which he wishes to give his time.

Two fatal accidents have occurred in the mine the past year.

The officers are Henry Merry, Supt. etc., Negaunee, Mich. Fayette Brown, Gen'l Manager, Cleveland, Ohio.

The Jackson mine has produced annually as follows:

Year.	Tons.	Year.	Tons.
Previous to 1856 (estimate).....	25,000	1871.....	132,297
1856.....	417	1872.....	114,910
1857.....	12,442	1873.....	130,131
1858.....	10,309	1874.....	94,708
1859.....	28,377	1875.....	87,283
1860.....	41,295	1876.....	98,480
1861.....	12,919	1877.....	80,340
1862.....	46,046	1878.....	83,120
1863.....	77,237	1879.....	112,921
1864.....	83,905	1880.....	120,622
1865.....	65,505	1881.....	118,939
1866.....	92,287	1882.....	93,670
1867.....	127,491	1883.....	71,278
1868.....	130,524	1884.....	76,626
1869.....	125,908	1885.....	67,657
1870.....	127,642	1886.....	89,525
Total.....			2,584,892

THE CLEVELAND MINING CO.

No mine in the country gives one a stronger impression of a great mine than does the Cleveland. Its fine stone buildings for hoisting machinery, machine shop and pump house, so elegant, large and commodious; its magnificent machinery, of the latest and most powerful pattern; its great shaft buildings, imposing and strong; the fine, smooth location, ample in size, convenient and attractive; the air of neatness, order and good management which everywhere prevail, quickly inspire the beholder with admiration and confidence. There is nothing ruinous or antiquated to be seen; all is fresh, substantial and to the purpose. The outlay is for the maximum work of a great mine and impresses one accordingly. The Cleveland is a large mine. It covers a good deal of space above ground and far more than the usual area under ground. Measured horizontally there is no mine in the district that has so great an extent of opening. It is a long, flat mine, much of it, that spreads a great way east and west and north and south. The Incline pit from the extreme west end to the top of the skip road where the ore reaches the surface is 1,240 feet, and 320 feet wide in widest places. The ore has narrowed at west end so that the extreme west stope is not more than 50 feet wide. The pit has not increased in depth very much, being only 300 feet below datum at lowest point. The Incline has been worked for many years, and has been, always, the chief pit of the Cleveland Co. A few years ago the ore was clean, 80 feet high and the full width of the pit. But now the ore is mixed with jasper, that is, it is banded, a few feet of ore and then rock; the stopes of ore being not more than four feet wide of clean ore. The stope is about 30 feet high. The ore has to be picked over carefully, as considerable rock gets mingled with it when it is broken in the stopes, so that in order to make it first class it has to be looked to carefully.

The ore for years has been trammed from the stopes to a big pocket in the mine, which is 450 feet west of the shaft horizontally. 440 feet from this point west is a skip road over which the cars are hauled up to the level of the pocket. The inclination of this skip road is 12° with the horizon. From the top of the skip way the ore is trammed to the pocket.

South from the east part of the Incline pit they have a scam of good ore which furnished a small product. This ore is 70% in iron, and .023½% in phosphorus.

No. 3 pit, which also extends east and west, lies north of the Incline, and along the north line of the property. It is limited by the New York mine on the north. The skip level in No. 3 is a quarter of a mile long, it is also deeper than the Incline, being 550 feet deep at west end.

The pit is larger than the Incline, the skip way starting from the surface at the west end goes down 300 feet to the point where it goes under ground;

then for a distance of 550 feet it lays pretty flat, following the lay of the ore, varying in its inclination from 11° to 21° with the horizon. At this point the skip road turns down at an angle of 57° , and at the same time bends horizontally 23° , following the ore. The fold in which the ore lays inclines to the south and west, so that it is possible that it may come into the Incline on the upturn of the fold. But I hardly think that. I think rather that it is a separate underlying fold. The ores are wholly different; still both have quartzite hanging and soap-rock foot-wall. The west end pitches down more sharply to the southwest. The width of the workings north and south is 300 feet. There are 6 or 7 levels, and the greater portion of the ore is left in the mine in pillars, etc. At least two-thirds of it is yet standing in the levels that have been passed. They take out a stope 20 feet high, leaving 40 feet of back in each level. In the bottom working level the ore is about 80 feet wide. It is not first class. They designate it as Scotch ore. It is a hard hematite that yields about 60% in iron, and is non-Bessemer. No timbers are required. So much ore is left that there is no danger of the mine falling in. It will be seen that the great length of the mine necessitates a change in the plan. The ore all goes to the surface at the east end. The ore must be hauled over all this distance, 1,300 feet from the west extremity. To obviate this they are now sinking a vertical shaft from the surface to strike in the mine at the "knuckle"—the point where the shaft turns down as above explained. The vertical distance to sink is 177 feet. The shaft is 18x6' inside. The timbers will have two skips, three even if it be found necessary. No. 3 mine is, naturally, much wetter than the Incline, being deeper and hematite.

Recently they have made a "new find" in the northeast corner of the N. W. $\frac{1}{4}$ N. W. $\frac{1}{4}$ section 11, about 80 rods from the southeast corner of the New York mine. It was found last spring by one of the workmen in his garden. For such service the company allow the men 25 cents royalty on the ore that may be taken out up to a limit of 40,000 tons. They were mining here 25 tons a day when I saw it, but the deposit did not promise to hold out. They were boring with the diamond drill at the east a short way; had already bored two holes across the formation for some length without finding any amount of ore.

The skips usually hold two tons.

The Moro pit, formerly called K shaft, is looking far better now than it was a year ago. Then there was very little ore to be seen in the mine except that found in the south lense, which was reached by a long cross-cut from the shaft through the jasper. Now the ore in the shaft has become a body of considerable magnitude and is good ore. The shaft is 600 feet to the bottom from the surface. It goes down vertically 305 feet, when the ore was cut, then it

inclines to the west at an angle of $45^{\circ} 10'$. The bottom is in rock. The ore lies north of it and west—mainly north. In the two levels above the bottom they are stoping in a fine body of hard ore which is reached by short cross-cuts from the shaft.

The deposit is a chimney of ore which starts at the first level north of the shaft, where it is small; it pitches down to the west at the same angle as the shaft and widens and lengthens as it descends. At 50 feet above the bottom—550 feet from surface—the ore is 50 feet wide and they have opened a length of 60 feet carrying a stope 70 feet high. In the level above they will soon drift to the top of this stope which they are now working to secure ventilation. The pit will furnish 25,000 tons of ore next season easily. The shaft is a long distance from the main engine house and still further from the main pumping building to the shaft, the latter about 2,000 feet. Until recently the pump at K shaft was worked from the main pump by wire rope transmission. The plan has not proved satisfactory and has been abandoned; instead an independent pumping plant has been placed at K shaft and a building constructed there for the purpose. A fine brick smoke stack is among the things erected in the past year at K shaft.

THE CLEVELAND HEMATITE mine, owned and operated by the Cleveland Mining Co., is in the company's estate contiguous to the city of Ishpeming, but a mile north from the north limit of the mines just described. It is one of the important mines in the series of what comprises the Teal Lake range. It has been a valuable mine, but is not looking as well just now as it has formerly. They have really at present but one lense of ore and that is shortening somewhat. Besides the distance from the shaft has so greatly increased that it is very expensive to reach the ore, making its comparative cost heavy.

The shaft is vertical 500 feet deep and the bottom is 500 feet north from the ore. At 355 feet deep, the distance to the deposit was 230 feet. At 405 feet down it was 395 feet. All this long distance through the rock must be tunnelled. A vast amount of drill work—which cost \$20 per foot to drive—with hand drills, the only ones they have employed until lately. Now they are working a compressor and four power drills and must be able to cheapen this rock work, which seems to have been excessively costly. The compressor was put in in December, 1886. They have also put in a new plunger pump, Knowles' new duplex which "throws" the water from the bottom to the surface. The ore body at the bottom of the mine has a width of 60 feet and a length of about 70 feet.

The method of mining described in my last report has been modified in the past year, and the change seems to be a good one, and altogether the plan of

mining now in operation is well adapted to the purpose. The modification consists in using timber sets to serve a temporary purpose. The whole method in brief is as follows: The shaft is sunk a level below the one on which they are stoping and the cross-cut to the ore is made. The two cross-cuts are connected by winzes about 60 feet apart, one on the foot and one on the hanging wall side, through which to run down the ore into the tram cars in the lower drift that takes it to the shaft. It may be well to state that the main drift cross-cut crosses the ore near the end of the deposit, and the winzes are sunk one at foot wall and the other at hanging wall side. From the main entrance a drift extends east and west on either side of the ore, in fact is made to surround the ore following near the the rock entirely around it. The drift is on top of the ore, close up under the filling above. Then parties on each side of the ore body working from the two drifts advance towards each other across the ore, commencing at the far end.

They take off a cross stope drift seven or eight feet wide and put in the sets, tramping the ore to the drifts and thence to the shutes through which it descends to the cars, 70 feet below, whence it goes to the shaft and up to the surface. They thus cut off the top of the ore, working off these sections from the far end in succession towards the main drift.

The object of the timber sets is to hold up the back so that all the ore can be got. When, heretofore, they worked under the filling without timbers they lost some of the ore, now it holds up long enough to let them get it all out. The timbers are very light, just strong enough to suffice for the purpose. They are expected to crush in when the ore is gone. They use no filling, but let the surface come in, follow them down. The stopes are under this surface crush. The ground above comes down soon after they have worked the ore out from under it. Heretofore, before the timber was used, this top came in too soon, now it holds up till the ore is all out.

Some years ago they had two deposits here, designated as the north and the south veins, now there is but one, the south deposit. It is a very soft clay-like ore, which sometimes runs like a partial semi fluid. Ordinary methods of mining do not suffice for such deposits as this. There is employed at the mine a force of 65 men, under the immediate supervision of Capt. Geo. Williams.

As everywhere else about the Cleveland, the Hematite has everything in good shape, engine house and hoisting plant, compressor and pumps, all that is required.

There are now, January 10, 7,000 tons in stock in the mine.

The several mines or pits of the Cleveland Co. produced last year as follows, from Nov. 1885, to Nov. 1886:

Name.	Tons.
Incline Pit.....	78,788
No. 3.....	62,853
Moro.....	18,477
Scrammus.....	972
No. 4.....	1,174
Hematite Mine.....	41,117
Total product.....	203,886

That taken from No. 3 pit was 92% Scotch ore.

The Incline pit ore is very hard specular, that has always been liked by furnacemen except that it is wearing on the crushers.

The total force employed by the company varies from 500 to 800 men. The men are liberally treated. During years of acquaintance and observation at the Cleveland mine I have failed to detect any just cause of complaint by the men, in fact complaint is seldom made. The Cleveland, in common with the Lake Superior and other leading companies, has decided to raise the wages of the men 15%, to take effect the first of March. This is one of the results of the increased prosperity of the iron trade.

Three men have been fatally injured in the company's employ the past year.

The officers are Fred. A. Morse, Sec. and Treas., Cleveland, O.; D. H. Bacon, Agt., Ishpeming, Mich.; James Williams, Mining Captain.

The Cleveland Co. has shipped annually as follows:

Year.	Tons.	Year.	Tons.
1854.....	3,000	1871.....	142,658
1855.....	1,444	1872.....	151,724
1856.....	6,343	1873.....	133,265
1857.....	13,201	1874.....	105,855
1858.....	7,909	1875.....	129,881
1859.....	15,787	1876.....	145,661
1860.....	40,041	1877.....	151,554
1861.....	11,794	1878.....	143,320
1862.....	40,394	1879.....	113,108
1863.....	46,842	1880.....	187,234
1864.....	49,954	1881.....	197,843
1865.....	33,355	1882.....	204,341
1866.....	42,680	1883.....	218,219
1867.....	75,864	1884.....	224,479
1868.....	102,112	1885.....	218,632
1869.....	106,133	1886.....	203,386
1870.....	133,884		
Total.....			3,495,028

ANNUAL REPORT OF THE
THE LAKE SUPERIOR IRON CO.

Enjoys the reputation of being one of the best managed mining companies in the State, conservative and yet progressive; nothing of possible value in mining escapes the attention of the Lake Superior management, and, when of assured advantage, no innovation is rejected. The Lake Superior Company is a powerful corporation; its estate is a very large one, comprising about 20,000 acres of land, among which are some of the best portions of the iron region. It has an assured future for long years to come, for, as the ore becomes exhausted at one point, other deposits are almost certain to be found elsewhere on the property, lying as its land does contiguous to the best mines in the Marquette district. The mines which are now operated by the Lake Superior Co. are in the city of Ishpeming, in land adjoining the Cleveland, Barnum and Lake Angeline mines.

The Lake Superior Co. produces annually the largest amount of ore of any company in the State and its aggregate product exceeds that of any other.

The good fortune of the Lake Superior Co., arising out of the position of its lands, is illustrated by very recent developments.

At the Detroit mine, that company has extended its underground workings west until they have encountered the line of lands owned by the Lake Superior Co., a survey of the mine which has just been made having established this fact. The Lake Superior Co. is preparing to open a mine west of the Detroit. They are now placing suitable machinery and will soon sink a shaft. Thus the fact of the extension of the ore on its property, and the position of the ore, its extent, *i. e.*, its width, were all determined by the work in the Detroit mine. Again, the recent development at the Lake Angeline mine has made it probable that the ore in that mine extends west until it passes into the Lake Superior Co.'s land. Acting on this supposition, the agent, Mr. Hall, is now boring with a diamond drill just west of the Lake Angeline mine. At 80 feet west of the line a shaft was sunk 129 feet, and from the bottom several borings were made, the last one of which went into 30 feet of fine ore. The drill was stopped temporarily owing to the caving in of the shaft. At the present writing this work of drilling has been resumed at the same place. The boring now is on an angle north of the former. When satisfied that a sufficient body of ore exists to justify the undertaking, a shaft will be sunk.

An interesting feature connected with this work—in this and the Lake Angeline mine—is, that there is found to be a dike of eruptive rock—a variety of dolerite, probably diabesite—extending east and west, north of the Lake Angeline mine and across the Lake Superior Co.'s lands. Its width is about 100 feet and they have proved it for a length of 600 feet.

The most important mine of this company now is the HEMATITE, which lies south of the hard ore mine and west from the northwest corner of Lake

Angeline. The extreme length of the underground workings in this mine is 1,400 feet, and the maximum width is 360 feet.

Formerly they had two veins, or the deposit was so designated, the north and the south vein. The former had its foot wall on the north and hanging on the south, the south vein having its walls in the reverse order. Now the ore is mainly in one body, the mine having reached the bottom of the fold of which the two veins formed the upturn. In the widest place of this trough the ore is about 150 feet on the bottom, and 200 feet wide across the top, with a height of forty feet. These vertical sections of the ore body are in the form of a trapezoid, generally, but some of them are in the shape of a triangle with vertex down.

The mine is extending east, and borings made with the diamond drill east of the mine show the existence of the ore still further on, but so far as determined in that direction, it seems to lay very flat, and to be in comparatively thin folds. In my last report I mentioned that a new shaft would be sunk near the main line of the Marquette, Houghton & Ontonagon railroad track. This work has been undertaken and completed. It is vertical, single cage, and 1,200 feet from the engine house, and 600 feet east from No. 1 shaft, and 444 feet deep. Between these two shafts the mine is opened up in rooms. The rooms are numbered from No. 1 shaft east, and also to the west of it in the order in which they occur. The rooms are two "sets" of timbers wide—18 feet—each set being 9 feet, and between is a pillar of ore also 18 feet. There are 25 of these rooms laid off, in 20 of which work is progressing now, eight of them west of No. 1, and the rest are to the east of it. Their method is to run a drift along both walls of the deposit, and to lay off the "headings" from these drifts. Commencing in the bottom level they cut the heading through the ore across the deposits two sets wide, one of which is filled with rock and the other strongly timbered, to be kept for a tramway out to the main drifts. On these as a floor the back of the heading is stoped to the height and width for two more sets, the ore being run down into the cars in the cross-drift below. As they rise up with the sets in succession, the "mills" for running down the ore are built up at suitable distances apart. When they start to stop out the third tier of sets, they at the same time commence to fill up the second, so that as the third are completed across, the second are filled up. There is but one line of sets across the vein open at a time. The mine is solid, either with ore or rock.

The rock for filling these openings is brought down from the surface. They are now making a shaft about midway between the two, used for hoisting, for running down rock and timbers into the mine. It will be seen that when a room is stoped out it will be filled with rock from the bottom up, and the

plan is that all the headings that shall be made in the mine shall be thus filled. After the rooms are filled, then in turn the pillars can be attacked, and the ore removed precisely in the same manner as before—as fast as a line of sets is made through the pillars those below it will be filled up with rock. The filling will stand as well as the ore does. The timbers are heavy and well put together. Great care is exercised to place them right, and to stay them well against the walls of the vein, and against the pillars of ore. They are set one over the other in perfect line, vertically, and the caps are equally in straight, horizontal line, and they all hold their place excellently well.

The ore is very soft, and will not stand when left to itself. It, of course, being in a broad synclinal, lays very flat in the bottom, as does also the roof. In advancing the stopes the ore will not generally remain in place long enough to advance the length of a cut. To keep it from falling on the heads of the men they run lagging ahead over the cap. Sometimes they put in a “false set,” *i. e.*, upright and cap of light timber, half the distance between the posts.

The greatest trouble experienced is in “taking up” the timbers in the workings formerly made, before the present system was fully formed and acted upon. It is the plan to have the entire mine on the system now pursuing. The old workings and the old timbers do not conform to the new system. However, the Captain is taking out these old timbers and substituting the new sets in good shape. It is only a matter of care and patience. The best part of the mine is the portion between the shafts. It is completely opened. They have gone to the bottom of the fold, 445 feet down, and have most of the ore above to take out. A large product can be made if desired—at least, they have a great amount of ore in sight. Another shaft, No. 3, will be sunk still further east. Its location is not yet fixed, but it will be beyond the present openings of the mine.

The ore is of good quality, about 63% in iron, and .068% to .085% in phosphorus.

In going through this mine one is impressed with the magnitude of the mine, and with the general excellence of the method of mining as adapted to this kind of ore, and with the thorough and systematic manner in which the work is done. The great advantage of the cage is also noticeable. I was present at the bottom when the men were brought up at noon. It was quickly and safely done, and there was no tiresome climbing of long ladders, and loss of time. The men knock off five minutes to 12 before the whistle, and are soon transferred to the surface. The electric bell is used in signalling in this, and all through the mine. It proves of great advantage.

In the hard ore pits they were mining in Nos. 2, 3, 7, and in A shaft. The

former is the chief hard ore mine. They are working in ten levels, but the bottom just now does not afford a very promising outlook for the long continuance of the pit in the downward direction. The lowest is the 720 foot level, which has just been reached. The 640, however, is fully opened.

There are no new features beyond those described in my last report. The most significant fact is that they have stopped sinking No. 2 shaft. This has not occurred in many years before—not since the shaft was started. It is not stated that the shaft has reached its final depth; it may be sunk lower, but the work is crowded. The deposit has become short and narrow, with a good deal of jasper. The present length is only about 150 feet, while at the 480 foot level it is now above 600 feet long.

The best stopes are in the 480 foot and 520 foot levels, though this matter varies from month to month. There are fine stopes in this mine, but the bottom is short and narrow, and presents no encouraging features. No 3 pit is better, it is working west along the Barnum line, having good stopes in the west ends of the 360 and 417 foot levels, and is first class ore.

A chimney of ore between No. 2 and No. 3 has opened finely in the 480 foot level, and No. 3 shaft is sinking to mine it. The length of the level in this chimney is 100 feet, and its width 50 feet.

They find in the No. 3 pit, a gray ore which is somewhat high in phosphorus, but makes with A shaft ore a separate grade. All the other hard ore is first and second class. In these two pits, Nos. 2 and 3, 10,000 to 12,000 tons of ore per month are mined.

No. 7 pit was also, some years ago, a fine mine, but it has fallen off greatly. The shaft is down to the 480 foot level. The bottom is looking better than the mine has done above, lately. It furnishes about 1,600 tons per month. The dip is north.

“A” shaft is 287 feet deep below datum, 230 feet below surface. There is only one level, about 200 feet long, varying from 10 feet to 30 feet in width. The dip is north 60°. Are sinking for another level.

At the Hematite mine the pumping plant has been removed to the old engine house to give needed room to the hoisting machinery, which has been fitted up.

Mr. Sturtevant, the mining engineer, has constructed a table of elevations showing the height of all important points above or below the datum of the engine house floor.

The force employed is about 600 men. The wages have been raised by voluntary act of the company 15%, to take effect March 1.

The officers are Joseph S. Fay, Jr., treasurer, 37 Franklin street, Boston, Mass., C. H. Hall, agent, Ishpeming, Mich.; John McEntee, mining captain;

Hard ore mines, James Trebilcock, mining captain; Hematite mines, H. B. Sturtevant, mining engineer, etc.

The amount of No. 1 hard ore furnished in 1886 was as follows.....	144,702
Essex ore.....	23,642
Hematite ore.....	98,191
Total.....	268,035

The hard ore sold at the mine last year at an average of \$3.75 per ton, the hematite ore at \$3.00.

It speaks a good deal for the care for the men that is taken by the officers in charge and for the safety of the mine, that in the past year but one fatal accident has occurred, and this in a mine that produces the most ore of any mine in the State and is one of the oldest and deepest. They also had but one fatal accident in 1885, which occurred July 7th, 1885. The one first spoken of happened March 6th, 1886. So that at the date of this writing, February 1st, 1887, there has been but one fatal accident in the Lake Superior Co.'s mine in a period of nineteen months out of a force of 600 men, and the mine working constantly day and night. Both men were killed in No. 3 shaft, and these two are the only fatalities which have occurred in that mine in a period of thirteen years.

Lake Superior mine yearly products:

Year.	Tons.	Year.	Tons.
1858.....	4,658	1873.....	158,428
1859.....	24,668	1874.....	104,311
1860.....	33,015	1875.....	119,365
1861.....	25,145	1876.....	110,570
1862.....	37,704	1877.....	127,349
1863.....	78,976	1878.....	104,674
1864.....	86,773	1879.....	174,747
1865.....	50,201	1880.....	204,094
1866.....	68,002	1881.....	252,235
1867.....	114,935	1882.....	296,504
1868.....	105,745	1883.....	200,799
1869.....	125,560	1884.....	204,796
1870.....	166,582	1885.....	226,040
1871.....	158,074	1886.....	268,035
1872.....	145,070		
Total.....			3,837,088

THE PITTSBURGH AND LAKE ANGELINE COMPANY

is one of the old companies, that holds in fee simple a valuable estate and is now operating one of the best mines in the State. The present mine is comparatively a new one, as it was opened only four years ago. It lies west a few hundred feet from the old open pit workings, wherein the company mined for so many years. It seems now a little surprising that the mining captain had never gone into the west with an exploring drift, and discovered this ore long before. It was found by a deep test pit, sunk many years ago, and used as a well, but the ore was thought to be mixed. In 1882 the pit was enlarged into a shaft, and this body of ore was found to be of great magnitude, and the ore of the best quality.

The mine was described in considerable detail in my last report; but important progress has been made in the past year. As then stated, the mine lengthens to the west, due to the pitch of the ore lens in that direction.

The greatest length of the mine, east and west, is on the second level, which is 1,500 feet. It may be said that the ore exists in the mine in separate lenses, the west one of which is hard ore, which pitches to the west at a very upright angle. The second lense is a brown ore that pitches westerly under the hard ore. The third lense is blue ore which inclines beneath the former, and the fourth is a yellow ore, which lies the furthest east, and underlays to the west the blue ore. This westerly inclination applies to the ore lenses, which are said to "pitch" in this instance to the west. The dip of the formation is north.

These lenses are separated one from the other by spaces of rock. The rock intervening between the blue ore and the brown is 150 feet. The latter was the first that was opened into, and the others have been subsequent discoveries. The yellow ore has been found only recently. It has been proved to a width of 60 feet. It was found in the first level but a short distance in north from the open pit. The color of the ore varies to a reddish tinge in the second level. It is quite different from the other ores found in the mine, both in color and as to quality. It is about at the Bessemer limit, but is low in iron—below 60%.

In the last year a third shaft has been started and is still going down. This shaft has one important distinction; it surpasses every other in size, being 38'x42' outside measurement; it is divided into six compartments—2 cages—pump, ladder, timber ways. It is only, at present, to the second level, 200 feet deep. It is far in the foot wall at the west end of the mine and is sunk to reach the hard ore deposit. It is south of the ore in the mine 100 feet, and they are cross-cutting the formation to reach the shaft from the mine. South and west of the shaft is a body of hard ore that has been found with the diamond drill. They bored through 100 feet of this ore. They found hard ore

first in the second level and have followed it, are still in it, having stoped along the foot wall west, and are drifting to the body of hard ore found by the drill, which lies west and south from the shaft.

This hard ore is very rich; it averages—the average of many analyses—67½% in iron and .022% in phosphorus. There are a few feet in thickness of ore lying on top of the main body, which is equally low in phosphorus as the other but is also 3% lower in iron. This ore carries about that percentage of silicate of aluminum.

The hard ore has been mined to but a limited extent. They expect to reach the main body of it and to have it opened fully by the time the new shaft is completed and in readiness to hoist.

The A shaft, which is the main shaft of the mine, is vertical, is 400 feet deep to the sixth level. B is to the fifth; it is in the foot wall, south and east of A shaft, its angle of dip to the north varies, being 62° to the fourth level and thence 70°. It is now used mainly for timber, etc.

The ore, blue ore, is the best; it averages 67% in iron and .034% in phosphorus. The length of the levels in this deposit is 300 feet, and the average width 20 feet to 25 feet. The brown ore has a great width; in the first and second levels it is 180 feet wide, and in the fourth and fifth it is 160 feet.

In the sixth level it has not opened fully yet to show the width, but it shortens somewhat on the west owing to the upright position of the hard ore, which overlies it. From 300 feet it has shortened to 150 feet, while the width does not much vary.

The mine is thoroughly opened. From the fourth level down but a small portion of the ore has been removed. Drifts have been opened through the ore at the points where many of the headings will come, and thus made ready to stope. There is probably standing in the mine from the bottom level up, a million tons of ore.

The method of mining was explained last year, but a modification is now included. The rooms are 20 feet wide and 40 feet high, timbered up four sets high and two sets wide. The pillars between the rooms are 18 feet wide. The levels being about 52 feet. There are also left between the top set and the floor above 12 feet of "back of ore." They are now to some limited extent removing the ore pillars by first filling the rooms, after which they drive a tunnel through the pillar lengthwise, then enlarging the drift on one side sufficiently for a set of timbers. They stope out from the other side of the drift in the same manner and put in the second set of timbers. After advancing the length of a few sets in the pillar they leave some of the ore—the length of two sets—and go on in the drift beyond it and stope out either way as before to the filled room and put in the sets. After the space opened in the pillar has been filled, then the ore which was skipped by is also mined out. The material

for filling is obtained from the old open pit into which the mine has been opened at the second level. In some parts of the mine, when the surface is not needed, the top is left to come in and filling in these places is not resorted to.

The ore in all parts of the mine is tested continually and they work out these headings, which are sufficiently low in phosphorous. Mr. Carl O. Lagerfelt, the chemist employed at the mine, collects samples from every stope three times a week and weekly from the stock pile and analyzes them. Three hundred and fifty analyses have been made by himself and others of this ore in the past six months. Many of these analyses were made at the office of the State Geologist in Marquette.

To the machinery the company has added in the past year a compressor, Rand, 18" x 32," which runs six drills; they are used in sinking the new shaft and in driving the rock tunnel towards the hard ore. The main hoisting machinery house is of stone, and the plant is as fine as any in the country of its power—six winding drums—each six feet diameter—two of them for each shaft. The machinery is the manufacture of the Iron Bay Foundry, Marquette, Mich. The estimated product for 1887 is 175,000 tons of ore. The new compressor house is of brick. Through the resignation of Capt. Harvey Diamond, so long superintendent of the mine, Thomas Walters has been promoted to the command. He has previously proved his efficiency for the position both at this mine and at others where he has held charge.

The mine is within the limits of the city of Ishpeming, west from Lake Angeline and along the south margin of the water. At one-half mile east of the mine, in the south margin of the lake, some ore has been uncovered.

The yearly product of the mine has been as follows:

Years.	Tons.	Years.	Tons.
1864.....	19,500	1876.....	22,539
1865.....	20,151	1877.....	19,113
1866.....	24,073	1878.....	28,161
1867.....	46,607	1879.....	25,420
1868.....	26,651	1880.....	14,794
1869.....	39,644	1881.....	18,000
1870.....	53,467	1882.....	14,518
1871.....	33,645	1883.....	27,259
1872.....	35,221	1884.....	87,018
1873.....	43,933	1885.....	111,051
1874.....	30,499	1886.....	131,384
1875.....	30,281		
Total.....			903,040

Alfred Kidder, Esq., Agent, Marquette, Mich.

ANNUAL REPORT OF THE
THE IRON CLIFF CO.

is one of the strongest and most conservative mining corporations in the State. The company was organized in 1864 with a capital stock of \$1,000,000, divided into shares of \$25 each. Among the incorporators were some very distinguished men—Samuel J. Tilden, William B. Ogden, *et al.* These gentlemen purchased the lands, lying in Marquette county, of the St. Mary's Ship Canal and Mineral Land Co., comprising 38,000 acres in round numbers.

Two years later, through the absorption of the Pioneer Iron Co. by the Iron Cliff, the estate was increased to 40,000 acres. It is needless to state that comprised in these lands are some, undoubtedly, among the most valuable mineral lands in the State. The estate is so large and covers so much of the mineral range that there is always a probability of finding deposits of ore within its borders.

For twenty years the company has been an iron manufacturer as well an ore producer. It has operated continuously since 1866 the Pioneer furnace of Negaunee, the oldest on the lake. Its mines are the FOSTER, BARNUM, SAULSBURY and PIONEER. In addition to the above there are several old openings made by this company, which have long been abandoned. Of these are the TILDEN and OGDEN, situated respectively on sections 13, 23 and 24, T. 47, R. 27. The OLD PARSONS, CLIFF PARSONS, section 21, same town and range. The MILLER, from which some ore was shipped the past season, taken from the old stock pile, mine joins the Old Parsons.

The oldest mine is

THE FOSTER,

which has been worked since 1865. It is situated in sections 22 and 23, T. 47, R. 27. The ore is a soft hematite, not of the first quality, *i. e.* averaging about 53% in iron and .094% in phosphorus. It makes a desirable mixture for the manufacture of car wheels and similar grade of iron, and is mostly used at the Pioneer furnace. The mine is looking better now than it has for some time past. The company is working one shaft in which an additional lift has been sunk in the past year; it is now 350 feet deep. This pit is under ground, no timbering being required, as the ground stands sufficiently well to hold up by, leaving a proper amount of pillars.

The product the last year was 5,544 tons, and the aggregate production is 154,336 tons. General Manager, A. Maitland.

The most important mine of the Iron Cliff Company is

THE BARNUM,

situate in the west part of the city of Ishpeming, adjoining the Lake Superior

mine. "The Old Barnum" was opened in 1868. It is close to the line, which separates it from the Lake Superior Company's No. 3 pit. It has become of very small dimensions, but still the company continues to work this mine, and obtains from it annually a small amount of ore—in 1886, 11,144 tons. They are working along the line to the west. The trouble is that the stopes are getting too far from the shaft, etc., and it costs too much to obtain the ore. It seems a doubtful enterprise to sink a new shaft, but it may have to be done. The ore from this mine is specular, and of excellent quality, first-class, non-Bessemer, hard ore.

North from this mine, across the valley through which run the lines of the railroad, on the slope of the hill opposite, is the

CLIFF SHAFT,

until recently known as the New Barnum, or A and B shafts.

This mine has at least one pleasant feature. It is an easy mine to examine, although it is 472 feet to the bottom level, with a winze 96 feet further down, and 1,400 feet in length. The shafts are vertical. B, the west one, is 420 feet deep. They are double cage, and are connected under ground, so the mine is easy to enter, or to get out of, as you ride in the elevator, and it is airy and well ventilated. These facts are important matters in operating a mine. Men like to work in the Cliff for these reasons. To illustrate: The mine was idle two months in 1886. The miners were scattered over the country, working in other mines, mainly in new hematites. When the company had decided to resume mining work, it gave notice of the fact through the papers, and at the proper time nearly every one of the former hands was on hand to resume his old place.

The shafts have not been sunk any additional distance for two years. The shafts are 834½ feet apart, center to center. The underground workings reach west from B 70 feet, and east of A 500 feet. There is a good deal of water, 500 to 700 gallons per minute, in the two shafts.

All below the main level is full of water, above it are two levels. In these they are mining ore, at the present writing, Jan. 18, 4,000 tons per month. This product will be increased, if possible, to 8,000, as it certainly must in order to realize the estimated product of 80,000 tons for the ensuing year's shipments. The total force employed is 200 men, which number will also be added to.

The ore body is in a synclinal, and the shafts at bottom are a little way north of the lowest line of the trough.

The cross-cut through the ore is 157 feet long in the first level, north and south, while in the bottom it is but 70 feet.

At both ends of the cross-cuts the ore upturns. A fine illustration of this change in the direction is seen in the upper cross-cut, where, for a length of 100 feet, the surface of the overlying rock is exposed finely, showing the curved surface down to the bottom of the fold, and then up the other way.

At one place in the mine, the whole side on the foot wall is polished as smooth as glass.

West from A shaft 110 feet, is a crossing of soap rock, which is found in both levels, narrowing as it goes down, being 30 feet in the bottom and 45 feet wide in the top.

Capt. Sedgwick states that the drill rods when passing through the ore are highly magnetized, while before or after reaching the ore belt, they are much less so.

East of A shaft there is an abundance of red ore, somewhat like the Scotch ore in the Cleveland No. 3 pit. In places the ore makes wide, but it again narrows up, and is frequently headed off by jasper.

In the first level a cross-cut north, after reaching the ore, they find that instead of the expected upturn in the ore, it goes off flat to the north, favoring the supposition that the formation makes an anti-clinal, going down again a little further north; or possibly it is simply a flattening in the upturn. The ore here is only 4 feet wide. Generally the ore has a good width, but it cannot be depended on; that is, it neither holds in size nor in purity; it becomes cut up with soap rock and jasper. There is a good deal of ore to be seen in the mine—some good stopes—but there is rock everywhere as well as ore. The rock cuts out the ore or mixes with it to such an extent as to make it slow, troublesome work to mine it, to effect a complete separation of the ore and rock. This is illustrated by the fact that the company had accumulated a stock pile of 2,300 tons, which was found to be unsalable. It was sold recently to the Cleveland Iron Company for about the cost of mining. An average of this stock pile gave:

Metallic iron	53%
Phosphorus097%
Silica	4.03%

This was the red ore of low grade.

The following analyses are of samples of the ore from every stope in the mine:

Metallic Iron.	Phosphorus.	Silica.
66.159 per cent.	.100 per cent.	2.21 per cent.
60.74 "	.127 "	3.44 "
64.58 "	.093 "	2.20 "
50.13 "	.122 "	2.12 "
58.03 "	.078 "	2.12 "
64.02 "	.105 "	1.42 "
60.514 "	.098 "	2.39 "
65.93 "	.125 "	1.89 "

At 140 feet south of A shaft, it is 300 feet from surface to the ore; at 650 feet south, it is 120 feet.

B shaft is 420 feet deep. At 700 west of it, it is 520 feet to the ore. At A shaft the dip is south; at B it is north. The dip is about 4 to 1.

They are building a new house over this shaft.

The Barnum has produced each year as follows:

Year.	Tons.	Year.	Tons.
1868.....	14,386	1878.....	26,680
1869.....	37,503	1879.....	24,911
1870.....	44,793	1880.....	24,921
1871.....	45,939	1881.....	27,281
1872.....	38,381	1882.....	41,424
1873.....	44,368	1883.....	62,752
1874.....	40,255	1884.....	67,782
1875.....	40,914	1885.....	47,458
1876.....	37,750	1886.....	82,686
1877.....	38,314		
Total.....			788,743

Wm. Sedgwick, superintendent, Ishpeming, Mich.; Tom. Barge, clerk, Ishpeming, Mich.; Alex. Maitland, general manager, Negaunee, Mich.

The Iron Cliff Co. shipped 1,716 tons of ore from the OLD MILLER mine, an abandoned location, but having an old stock pile of low grade ore.

THE PIONEER

is a new mine in the N. W. $\frac{1}{4}$ S. W. $\frac{1}{4}$ of Sec. 4, T. 47, R. 26. The opening is close to the west line of the property. In fact it is a continuation of the Mitchell mine that was found and explored in the adjacent 40 to the west.

Work began here last summer. I first visited it in August. They had just begun the work of stripping the ore and of preparing to stope it. Now, after about five months, they have a pit 200 feet long east and west, and at the deepest point it is about 85 feet down. The ore body is, apparently, about 30 feet wide; though it does not seem to be altogether clean, *i. e.*, free of rock.

They are at this time—winter—further removing the capping of rock, getting ready to stope in the spring at the opening of the shipping season.

The ore is a good quality of hematite, that proves to be Bessemer so far as the analyses have been made to test it. The dip is to the south; further west, half a mile at the Buffalo, the dip is north.

The pit is on the section line 600 feet south of the $\frac{1}{4}$ post. The product shipped the past season was 5,140 tons. Alex. Maitland, general manager of the Iron Cliff Co., directs the operations.

The company has done no work at the SEC. 12 MINE the past year. But at

THE SAULSBURY MINE

operations have continued as usual, with the usual excellent success. The Saulsbury has been a good mine and still remains such. For a small mine it furnishes a large product of good ore at a moderate cost. The mine lies on the south side of the high greenstone bluff that separates it from the Lake Angeline. Formerly the mine consisted of two great open pits that were worked out to considerable depth and width, close to the greenstone. Now there is little doing in the open pits, but the ore all, or substantially all, comes out of a shaft that descends into a deposit situated south of the old pits about 200 feet. The shaft is 360 feet long. It is somewhat unique, as it has several bends. The skip road descends from the ore pocket and elevated track, to the north to reach the mouth of the shaft, thence it goes down vertically to the first level where it again changes its direction and descends to the south at an angle of about 45°.

The ore reached by the shaft is in two lenses lying parallel with each other east and west. The north lense is non-Bessemer ore and the south one is Bessemer. Of course they are naturally bothered considerably for hoisting facilities. The one crooked shaft—single skip—is inadequate to sending up a large product, especially when the same shaft has to be used for taking down the timber into the mine. They plan to sink another shaft further south but have delayed, awaiting until the ground in that direction has been more fully explored that the position of the shaft may be determined with reference to the future working of the mine to the best advantage. A drift has been started south. The rock

through which they are cutting is identical with that of the whole formation in which the ore is found, a broken jasper. This cross-cut is 55 feet long. It was begun and stopped some time ago, and as soon as the new compressor is ready to work it will be again pushed forward—more rapidly with the aid of power drills. An addition has been made to the engine house for compressor room and the machine is nearly ready to work.

The mine has improved in the bottom; certainly it looks as well as it did a year ago. There seems to be less rock. This bottom level has not been stoped in yet much, but has been recently opened. They have drifted 50 feet each way east and west from the shaft and cross-cutted the ore 50 feet to the rock which separates this lense from the Bessemer ore south of it. The Bessemer deposit in the level above was 50 feet wide and 250 feet long; the north deposit has about the same width and is 350 feet long. In the bottom they have not crossed to the Bessemer ore yet.

The formation between the high ground both on the south and the north holds these pockets by ore, which, if not very large, are very good indeed. The openings under ground are timbered after the Nevada system, and the mine is made entirely safe.

During the winter they are scrambling in No. 2 old shaft. It goes down to the north on the side south of the open pit and thence goes under ground, in all, its depth is 200 feet. Also in No. 3 they find a little ore, which a few men are now working out. It is 275 feet deep.

They make two grades of the ore, Bessemer and non-Bessemer. The former is about 18,000 tons, though Capt. Buzzo thinks the product will increase to 25,000 tons in 1887. They are working in two levels and will soon sink for another; will begin when the compressor is ready to work. The ore in stock—January 24—8,000 tons at the mine.

The Bessemer ore analyzes about 60% in iron, and .040% phosphorus. The whole mine averages about 60% ore. It is said to grow cleaner as they go down.

The local officer in charge is Capt. Thomas Buzzo. Mr. Alex Maitland General Manager Iron Cliff Company.

The following table shows annual product:

Year.	Tons.	Year.	Tons.
1872.....	545	1880.....	22,387
1873.....	11,023	1881.....	41,888
1874.....	6,730	1882.....	42,019
1875.....	4,571	1883.....	17,028
1876.....	20,510	1884.....	23,171
1877.....	37,868	1885.....	29,503
1878.....	52,155	1886.....	51,231
1879.....	39,770		
Total.....			403,734

It will be seen from the above table that the product of last year was nearly double that of any previous year.

At about a mile and a half south and east of the Saulsbury are

THE WINTHROP AND MITCHELL MINES,

now and for a few years past operated by the Winthrop Hematite Company as lessees of the Winthrop Iron Company, and of the Mitchell Mining Company, of these two contiguous mines.

These are working in the same deposit of ore. The line between the properties crosses through the main ore bodies and through the engine house of the Winthrop mine. The Mitchell lies east of the former, and its workings are nearly wholly under ground.

There are three working shafts, the west one of which is designated as A shaft. It is the main shaft of the mine, the one that affords the most ore; is 315 feet in depth, inclining to the north. In the first level 90 feet south-west of the shaft, they have recently found a new deposit, which is 6 feet to 25 feet wide. It runs up to the sand and as the stock pile lies over it, they cannot just at present work it.

Going down to the 165 foot level we find them working in three lenses. In the first one the ore is 40 feet wide, and they are stoping east and west in it, showing well. The other lense is 15 to 40 feet wide, and 100 feet long, and the third is about the same.

In the 217 foot level a drift 100 feet long through rock, going northeast from the shaft, comes into a deposit of ore 20 feet wide; below, the same deposit shows itself to be 54 feet wide.

All this which I have mentioned is new opening. The old openings in this shaft were fully described in my last report.

In the 315 foot level this new ore has also been found, so they are sure of good stopes the coming year.

In the old workings they have standing from the 315 feet level up 60 feet in height of ore, which is 20 to 50 feet wide, with a length of 250 feet east and west. Just at this writing, January 10th, this ore is not available, owing to the water in the bottom of the mine which the pumps are not equal to the task of freeing the mine from. They are gradually getting the water under control, however. The ore obtained from A shaft the past year has been from entirely new discoveries; from these has been mined 25,000 tons in the past year, and it is safe to predict that the shaft will yield no less amount in the year to come. The ore is in sight, only requires mining out. Mr. St. Clair estimates the product at 5,000 tons per month. They do not do much timbering in this mine. The ground stands well when the water is drained out of it. They employ in this shaft about 40 men. Below the 217 feet level they are not working. The old Mitchell mine workings stopped at the 165 feet level.

The most easterly shaft is D; it is 200 feet deep; it is vertical, 6½x24. It descends through the ore in the first two levels, but is finally in the foot wall, so that the bottom, in the fifth level, it is 32 feet to the ore to the first vein. They are working about 40 men in this pit also, working in all the levels. In the upper ones they are stoping mainly under the old crush. The workings extend east of the shaft 175 feet, and west they connect with those of C shaft. The lenses of ore are separated by horses of rock. The south lense is blue ore, which in the bottom level is small; it has been diminishing in size with each level until it is now about 6 feet wide and 30 feet long. The mine looks better than it did a year ago. It surprises me to find so much ore in sight. They have begun to sink another level. The ore makes north and east, dips north and lengthens east. The width is from 0 to 40 feet, and even wider in places. But the deposit is very irregular. It is impossible to particularize. They estimate that D shaft will give 20,000 tons of ore the coming year.

West from D is C shaft. It has been sunk an additional lift in the past year and is nearly connected with D in the third level and in the fourth. Just now they are delayed owing to repairs going on in the shaft. There are six levels in this shaft, one more than in D. The three upper levels are nearly exhausted. In the bottom level they have drifted to the north ore, but have not "opened up" in it yet. In the fifth, the ore was 80 feet long and 20 to 30 feet wide. The ore body does not appear to be diminishing in size at least. The cross-cut to the ore is 40 feet and the shaft is 240 feet.

The mining captain is Samuel Roberts; Geo. A. St. Clair, Supt.

The Winthrop mine lies west of the former, embracing the S. W. $\frac{1}{4}$ Sec. 21, T. 47, R. 27. "A" shaft workings and those of the Winthrop open together, "A" shaft being but 278 feet east of the Winthrop line. The most striking feature at the Winthrop is the immense open pit about 300 feet long, 200 feet wide on top and of about an equal depth. To a timid person this great chasm has its alarming features, especially in the night, when standing upon the surface and gazing down upon the busy scene in the bottom, partially revealed by the twinkling lights of the workmen. It presents a weird aspect which tends to disturb weak nerves. The mine does not appear to vary from year to year. It looks now precisely as it did a year ago, notwithstanding that 50,000 tons of ore have since been taken out. The depth is 265 feet to the bottom and the ore has a width of 20 to 60 feet east to the Mitchell line.

The method of mining has been to let the top "come in," taking out all the ore. Now they have begun in the bottom level to room out and timber in sets. In No. 4 shaft they are working three veins which are 10 to 30 feet wide. The length of the mine east and west is 500 feet. At one point the ore is 80 feet wide and then wedges out; coming in again further on with a width of 30 feet.

The mine will produce as much as it did last year, perhaps as ore is higher, they may get out more of it. About 80 men are worked in the mine—both mines employ 250 men.

Geo. A. St. Clair, Supt.; Norick Anderson, Mining Captain, Ishpeming, Mich.

The Mitchell mine has produced annually as follows:

Year.	Tons.	Year.	Tons.
1872.....	197	1880.....	12,750
1873.....	8,552	1881.....	20,964
1874.....	7,699	1882.....	33,394
1875.....		1883.....	
1876.....	5,596	1884.....	29,883
1877.....	3,897	1885.....	7,415
1878.....	4,259	1886.....	42,044
1879.....	11,450		
Total.....			188,106

The ore is non-Bessemer, but close to the limit.

The Winthrop has produced annually as follows:

Year.	Tons.	Year.	Tons.
1870.....	2,469	1879.....	27,050
1871.....	7,314	1880.....	45,247
1872.....	14,239	1881.....	43,900
1873.....	31,150	1882.....	23,259
1874.....	8,248	1883.....	50,143
1875.....	8,642	1884.....	53,077
1876.....	27,236	1885.....	63,915
1877.....	12,549	1886.....	44,274
1878.....	23,740		
Total.....			487,437

THE SAGINAW MINE

was abandoned by the Saginaw Mining Co. some years ago, but some parties have recently secured a lease of the property and are now exploring it. The mine was once a large producer of ore. It was opened in 1872 and closed down in 1883. The total output was 439,328 tons. The ore is specular, but varied greatly in texture and structure, being a fine steely to coarse granular or a slaty ore; but it was all good ore. The mine is in the N. W. $\frac{1}{4}$ S. E. $\frac{1}{4}$ Sec. 19, 47, 27. Adjoining it on the west is

THE ALBION,

another old location, which was opened at considerable cost by the St. Clair brothers in 1871, but soon after abandoned. Recently the same gentlemen have renewed the work on this property, but up to the present writing have not succeeded in finding merchantable ore in any quantity. The ore is specular, and the amount shipped years ago was 1,168 tons. Immediately west in the N. W. $\frac{1}{4}$ N. W. $\frac{1}{4}$ S. 19, T. 47, R. 27, is

THE GOODRICH MINE,

another abandoned location, which parties are again exploring. Shipments were made from this mine first in 1873, and annually thereafter until 1882. The total output was 51,479 tons.

THE NEGAUNEE MINING CO.

is the name of the new organization, which has been made to work the mine east of Negaunee, on the farm of Messrs. Mitchell, Maas and Longstorf, that for the past two year they have been endeavoring to open. The trouble has

been to sink the shafts to the ore. They have two shafts. No. 2 is 250 feet northwest of No. 1. The latter is now 385 feet deep, in fact has reached the depth at which it was expected that the ore would be found. It is likely that the shaft will be in ore at any time. They have had great trouble in sinking to the ledge through the 40 feet of overlying drift. The ground is somewhat low, bordering on the swamp, and is saturated with water and thus made so great pressure as to crush the timbers, etc., used to line the shaft. No. 2 shaft was sunk through 80 feet of loose drift, gravel and quicksand, and then 30 feet of hard pan clay and gravel. This is the shaft that has given the greatest trouble. The ore was struck at a depth of 165 feet. The ore is Bessemer. Work was first begun here on December 1, 1884, and has gone on without interruption ever since. One of the first things done was to construct an engine house and set up the machinery that was brought here from the National mine, which latter these same parties had decided to abandon.

The shafts are 12'x12' inside the timbers. The worst part of the undertaking is over. They will now soon be in readiness to "open out" the mine and hoist ore. The mine is but a short way from the main line of the M. H. & O. R. R., but being in lower ground, the track is made to follow the valley from Negaunee around by the Buffalo, Mitchell, etc. The mine seems to be a continuation of the Teal lake range.

President, Wm. Chisholm, Cleveland, Ohio.

Agent, etc., Capt. Sam Mitchell, Negaunee, Michigan.

THE BUFFALO IRON MINING COMPANY.

The Buffalo is the most important, as yet, of the new Negaunee mines. Its discovery was a very fortunate one for the parties who made it, since they have recently sold out for \$200,000, from which sum they realized \$125,000 clear profit to themselves. In addition to this they realized a net residue, over and above all expenditures made in opening and working the mine, of \$12,000.

The ore was discovered in June by Geo. Mitchell, and he associated with himself in working the deposit H. H. Mildner, A. A. Anderson, and Ed. Lobb. The realty belongs to the Arctic and the Pioneer Iron Companies, and comprises the N. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ Section 5, T. 47, R. 26. The company now operating the mine came into possession of it by purchase January 1, 1887. The officers are John Paulson, President, Minneapolis, Minnesota; H. H. Stafford, V. P.; C. A. Avery, Sec.; Hugh Ryon, Treas., all of Milwaukee, Wisconsin.

The former proprietors mined and sold 10,860 tons, which they sold at the mine for \$2.50 per ton. The royalty is 25 cents per ton. It is a promising mine. I am inclined to the opinion that the vendors sold out cheap enough.

The deposit is opening up finely. They have now, January 1, about 3,000 tons of ore in stock. The ore is overlaid by about 10 feet of drift, and has a width of 100 feet, following along the foot wall.

There does not seem to be any suitable hanging wall as yet, so that it is impossible to say how wide the deposit may prove to be. They are mining in open cut, about 40 feet deep. The dip is to the north 70°, and the ore runs east and west. They are stoping east in the open cut, and have a drift ahead, 80 feet, of the stope. They are preparing to sink a shaft, and will mine underground. Have engaged machinery, two 4-foot drums, and engine 14"x24". The company is working, just now, 40 men, under the supervision of Capt. Geo. Mitchell. The opening is at about midway east and west of the 40. There are several test pits to the east and west of the pit, which are in ore. When the shaft is sunk to sufficient depth they will cross-cut the ore and learn more definitely regarding it.

The ore is clean, a soft, brown hematite that cuts like clay, some of it. It analyzes fully 60% in iron, and at about the Bessemer limit in phosphorus.

At half a mile east of the Buffalo is

THE SAM MITCHELL SECTION 5 MINE,

the third in the list of the new mines at Negaunee. As heretofore mentioned, this mine is contiguous to the Pioneer. It is located $1\frac{1}{2}$ miles east of Negaunee on the N. E. $\frac{1}{4}$ of S. E. $\frac{1}{4}$ of Sec. 5, T. 47, R. 26. The mine is about midway of the 40 north and south, and on the east line. The pitch of the ore is west. The mine is underground, mainly, with two shafts. No. 1 is 150 feet west from the east line, and is 175 feet deep. No. 2 is 110 feet further west, and 170 feet deep. They are working in two levels. The two shafts are not connected underground, but are separated by a bar of dead ground.

The formation bends to the south and the ore now seems to be extending in that direction. They have cross-cutted to the wall on the north, which is quartzite and slate, have found no wall to the south.

The ore in No. 1 is about 60 feet wide—it is mixed with rock but pretty clean in the bottom. The ore stands well. They work it out in chambers and timber. No. 1 shaft goes down vertically 40 feet and then it angles 45° to 50°. They plan to sink a good working shaft in the foot wall. The ore has been traced west 1,000 feet, or rather they have sunk and found the ore in good body at 200 feet east of the west line. They are working a force of 50 men.

They have some machinery, two 4-foot drums, and a pump in each shaft.

The ore is sold to the Cleveland Rolling Mill. It is above 60% in iron and about at the Bessemer limit. The product since June up to close of navigation

was 8,263 tons. A sale of the property has just been made—April—to the Delaware & Lackawanna Coal Co.

Geo. Mitchell, Supt. C. McGregor, Mining Captain.

THE SOUTH BUFFALO

is the name given to a new mine adjoining the Buffalo property on the south, the S. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ Sec. 5, 47, 26. It is held on a lease by A. A. Anderson, Wm. F. Anderson and Chas. Sundberg. Work of exploration was begun in Nov. last. They have sunk a drill 140 feet, the last 50 feet of which is apparently clean ore, which analyzes above 62.4% in iron, 7.48% silica and .094 in phosphorus. The parties are about starting to sink a shaft following the drill hole. An analysis of the ore made by C. O. Lagerfelt gave metallic iron 63.22%, phosphorus .087%. The ore was taken at a depth of 112 feet.

MILWAUKEE IRON MINING CO.

disposed of a pretty large product last year, as will be seen by referring to the table of products. But, notwithstanding, the mine is still in good shape and affords all the indications necessary to assure the company that it will be able to mine an equally large product the ensuing year.

The dip of the ore is to the south and it pitches slightly west, so that the pits to the east have gradually worked out and the mining has more and more, each year, extended west. In this way the early pits have one by one been abandoned, and now they are robbing No. 7 and the east end of No. 8, as a year ago I stated they were depleting Nos. 5 and 6. In No. 7 they are taking out the shaft pillars and will thus get about 3,000 tons of ore.

The west part of No. 8 is good, but in the east end they are removing the ore pillars. The ore now to be seen in the mine is that just mentioned in No. 8 pit and the whole of No. 9. The latter is looking extremely well. It is well opened and is showing fine stopes of ore. Probably there are in sight—January 10—25,000 tons of ore, perhaps more. No. 9 pit is 285 feet deep; the bottom is all of ore. The length is 300 feet east and west, and it is 15 feet to 40 feet wide. East of the shaft the deposit is pockety, while west of it it is more uniform. Until last summer they had mined in open cut, or if under ground, had supported the mine with pillars of ore only, but now they are using timbers, the usual Nevada sets. Last winter the Carmichael Bros., who work the mine on a lease, had it well opened up for stoping in No. 9, but contrary to their former experience, it was found that the ground would not stand when spring came. As greater depth was attained the ore had become softer. The work was at a standstill. There seemed to be no other way but to introduce timbers, which

was accordingly done. The Carmichael Bros., who had contracted to mine the ore at \$1.00 per ton, had based their calculations on following the former methods, and the change became a matter of much disappointment and of loss to them. The coming year the price is fixed at \$1.25 per ton. The addition is to cover the cost of the timbers. They are sinking No. 9 shaft for a new "lift," 70 ft. To sink they follow the plan which I have heretofore described, which is to sink vertically in the ore far enough ahead of the shaft so that when the depth of a level is reached the bottom of the winze will be in the line of the continuance of the shaft. Then they rise up for connection. The object to be accomplished by this plan is to avoid working under the skip, as hoisting cannot, of course, be stopped.

They are sinking a new shaft, going down vertically from the surface. Its location is 305 feet south of No. 9. The depth to sink the ore is 180 feet. The shaft will connect with No. 9 when the ore is reached. It is 6'x10' inside timbers, and 125 feet deep at present writing, January. It is expected that there will be a continuous run of ore between the shaft and No. 9 pit and also to the Wheeling mine line. The Milwaukee has been a good mine from the start; but the lenses have always been short, and like all the Negaunee south side hematites, work out. The ore is of good quality, above 60% in iron. Analyses of samples of the ore shipped give a percentage in iron of 67%, and from .019 to .021% in phosphorus. But the phosphorus is about at the Bessemer limit, of from .040% to .070%.

As previously stated, the ore is mined by the Carmichael Bros., on contract, at \$1.25 per ton, for the coming year, and to all appearances they are conducting as faithfully for the interests of the owners of the mine as if they were working on a salary. The mine is ordinarily a dry one.

The force employed averages 85 men.

The mine is within the corporate limits of the city of Negaunee, about a mile south of the center of the city, in the S. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$ Sec. 7, T. 47, R. 26, and is estimated in about the center of the "40." Alfred Kidder, Agent, Marquette, Michigan.

The Milwaukee has produced annually as follows:

Year.	Tons.	Year.	Tons.
1879.....	941	1883.....	805
1880.....	13,141	1884.....	25,000
1881.....	31,354	1885.....	38,466
1882.....	41,300	1886.....	46,698
Total.....			197,501

BAY STATE MINING COMPANY,

although not an active corporation, has changed hands, and the property will be explored thoroughly the coming year. The estate is the W. $\frac{1}{2}$ N. W. $\frac{1}{4}$ Sec. 8, T. 47, R. 26, in the city of Negaunee. The royalty for the new company has been fixed at 33 $\frac{1}{3}$ c. per ton for all ore sold at the mine at \$3.00 or less per ton, and at 50c. per ton for all sold at a price in excess of that. The new officers are W. S. Coburn, Neilsville, Wisconsin, president.

THE ROLLING MILL MINE

is situated in the "40" adjoining the Milwaukee, and east. The mine cannot be said to have been fully operated for several years past. A limited amount of ore has been gotten out the past year, as will be seen by reference to the table. The controlling interest in the mine is held by Mr. Luther Beecher, of Detroit, and his son, Geo. L. Beecher, is now in charge of it.

The mine has been very fully described in previous reports, and there is nothing new to be added. The annual product has been as follows:

Year.	Tons.	Year.	Tons.
1871.....	236	1879.....	9,637
1872.....	6,772	1880.....	15,172
1873.....	13,112	1881.....	1,668
1874.....	14,796	1882.....	163
1875.....	33,688	1883.....	1,528
1876.....	50,997	1884.....	1,820
1877.....	38,901	1885.....	3,427
1878.....	30,773	1886.....	4,403
Total.....			227,403

THE WHEELING MINE

is contiguous to the Milwaukee, also, but joins it on the west. There has never been much done here. A limited amount of work was carried on in 1885, which resulted in mining and shipping 6,383 tons of ore. The pit from which this ore was obtained is close to the Milwaukee line. No work has been done in the past year, for the reason that is given, that the owners of the lease, who are well-known men residing at Negaunee, do not command the requisite funds to operate the mine. It is a good mine to explore. James F. Foley, Agent, Negaunee, Mich.

THE McCOMBER MINE,

which, after being idle for three years, has passed to the control of a new com-

pany, will be again operated under the name of the LUCY MINE. Men were set to work about the 10th of January repairing the machinery and getting it in readiness to work. The mine is in the hands of men who are abundantly able to operate it and who have other and long connection with the iron mining industry of Lake Superior. It was once an important mine, originally opened in 1870 by W. C. McComber who held it in a lease from the owner, J. P. Pendill. Mr. McComber worked the mine for two years and then sold his lease to the McComber Iron Co., which was organized August 14, 1872. This company operated the mine until 1883, when the depression in the iron business intervened, causing great financial losses to the company, and the mine closed down. The lease having been forfeited or surrendered, a new one was obtained of the Pendill estate by Mr. Wm. H. Barnum, *et al.*, who are the gentlemen comprising the present company.

It is certain that the mine is not without ore, but whether it will prove as productive and profitable as it has been is a question. It was my impression when I examined the mine the last time just before it was finally closed down, that the best stoping ground to be seen in the mine was near the west line joining the South Jackson. The ore here, however, has been found to be higher in phosphorus than it was in the pits to the west. Full descriptions of the mine and of matters of interest pertaining to it will be found in previous reports.

The McComber mine is one of the oldest of the Negaunee hematites, and one of the first to establish the excellence of these ores. There is much satisfaction expressed at Negaunee, within the limits of which the mine is situated, at the fact of the renewed effort to again bring it to the front.

The description of the land is N. W. $\frac{1}{4}$ N. W. $\frac{1}{4}$ S. 7, and S. W. $\frac{1}{4}$, S. W. $\frac{1}{4}$, S. 6, T. 47, R. 26, the mine being a half mile south of the Union depot.

Alexander Maitland, Superintendent; J. H. Rough, Mining Captain.

The following table shows the product for each year:

Year.	Tons.	Year.	Tons.
1870.....	4,856	1879.....	28,962
1871.....	15,442	1880.....	31,028
1872.....	25,080	1881.....	28,230
1873.....	38,332	1882.....	40,390
1874.....	2,642	1883.....	14,676
1875.....	10,357	1884.....	
1876.....	17,282	1885.....	
1877.....	19,691	1886.....	
1878.....	30,180		
Total.....			307,608

Of the other south side Negaunee hematites there is little to be said. None of them has been worked the past year, and all have been described in previous reports. North and west of Negaunee, about a mile and a half, commencing a little way southwest from Teal Lake and extending west, is a series of mines known as the TEAL LAKE RANGE. The most easterly of these mines is

THE CAMBRIA MINE,

which is situated in the S. E. $\frac{1}{4}$ of S. 35, T. 48. R. 27, and is worked by the Cambria Iron Co. The realty belongs to the Teal Lake Iron Co. The Cambria has continued all along ever since it was opened to be an excellent mine. It has afforded each year a product of first-class ore, high in metallic iron and sufficiently low in phosphorus to be suitable for Bessemer pig.

I have visited the mine a number of times in the fall, about the season of the close of navigation, and have invariably found some discouraging features. The bottom of the pit would be rock, or they would be contending with some large "horses" of rock, which had most inconveniently introduced themselves where ore was expected to continue. And again I have as often visited the mine in the spring when it was all opened up for the season's product, and exactly the reverse of the appearance above indicated was shown. There would be plenty of ore to be seen. When in the fall you would wonder where the ore was to come from, in the spring it would be perfectly evident that there was a certainty of an ample product.

It has so happened that I have always found the mine looking comparatively poor in the fall and extremely well in the spring. I went through the mine in December, 1885, and found the old pits practically exhausted of ore. There was little left but some pillars. The bottom was everywhere rock, but I found no apprehension on the part of anyone in charge regarding the situation. They knew where the ore was to come from and were sinking and cross drifting to reach it. The sequel to this, time has shown that their faith was well founded. A product nearly equal to that obtained in any previous year has been shipped, and the assurance for the future was never better than it is now; 40 000 tons were mined in the new shaft. Just now, while there is no rock to contend with, they have a misfortune in another way, arising from a big cave in the mine, which is giving considerable trouble. The new shaft is north of all the old pits, and the ore is north and west of the shaft and is reached by a cross-cut of 70 feet. The ore comes up to the sand, within 30 feet of the surface, and is worked out in rooms to a height of 250 feet. The shaft is now 310 feet vertically down. The rooms are timbered in the usual manner as described last year in the old pits. The rooms are small, as the ore does not stand; it

runs like dirt. No blasting, scarcely picking even is required; it can be shoveled directly out of the stope. The only trouble is to keep the ore in its place. There is no trouble in breaking it. The sets are only 5' 4" x 7' high, and it is almost impossible to get these in. They have mined out in the second level a length of 50 feet and a width of 24 feet. In the first level the length is but 30 feet, but they have not gone to the limits of the ore in any direction—ore in the bottom—to the north, west and east.

The timbers, owing to the nature of the ore, gave way and the mine caved in. They are now pursuing at this part of the mine a different plan. To get the ore in this crushed portion they have drifted from the shaft to the west, around the "crush," and rise through the ore to the top and opened drifts, securing them with timbers, through the ore in different directions, after which they cut off the ore with a 9-foot stope carried on top of the ore, letting the ground come in after them, working towards the winze through which the ore is sent down. They thus work off the ore from the top downward. The only part of the old mine in which they are working is No. 5. They drilled east of the shaft through 80 feet of ore, and are now drifting to it, going around most of the "crush." They will be into this body of ore the present winter, and will thus draw upon it for the next year's product. Two hundred and fifty feet north of the "cave" they have sunk a shaft for lowering timber, etc. Are also drifting in the second level from this shaft to the ore to connect with the workings, and have tunneled northwest 160 feet, all the way in ore, the last 40 feet of which is shown to be in ore in large body. At 200 feet down is another drift under the one above, and is cut out in the same ore body.

This ore in the new shaft is equal in quality to any ever found in any of the pits in the mine. Thus the Cambria is sure to be all right, looking better than ever, both as to quantity and quality of ore. There will be no falling off in the product of 1887.

The company is working 157 men.

Capt. Gordon Murry, the Superintendent, whose death occurred early in the year, has been succeeded by J. B. Jeffery, an intelligent and experienced mining man.

Alexander Maitland, General Manager, Negaunee, Michigan.

The mine has yielded annually as follows:

Year.	Tons.	Year.	Tons.
1876.....	6,324	1882.....	47,545
1877.....	10,082	1883.....	47,508
1878.....	3,754	1884.....	59,740
1879.....	6,860	1885.....	50,796
1880.....	7,232	1886.....	59,406
1881.....	18,837		
Total.....			318,148

THE LILLIE MINING CO.,

directly west of the Cambria, is what was formerly called the Bessemer, now the Lillie mine. The estate comprises 70 acres in the S. E $\frac{1}{4}$ of Sec. 35, T. 47, R. 27, and is also owned by the Teal Lake Iron Co., and held on a lease by the present proprietor. The formation has a strike east and west and dips about 45° to the south. It was formerly worked out in two large open pits, having been opened in 1875. In the winter of 1882 they caved in and the ore in the bottom, if any existed, was deeply buried beneath this sand and rock. The mine owners sank through the waste material expecting to find ore, but at the time of my visit a year ago they were feeling somewhat disappointed. However, the mine is looking far better now and the Lillie is in a fair way to be a good mine again. They have sunk a new shaft 200 feet south of the east pit. It is 207 feet deep and from it they have drifted to the ore, in fact have opened a drift in the ore 200 feet and sunk in it 40 feet. The ore body which they have developed between the two shafts—the new shaft and the one north of it that goes down to the south through the bottom of the open pit—is 117 feet north and south and 85 feet east and west. They have a rise in the ore in the 200 feet level that is looking well.

There are two shafts, the new one which is vertical and sunk from the surface in rock, and the No. 1 shaft that has previously also been mentioned; it is 194 feet deep. This will hoist in both. There was a third shaft further west, but the lightning struck it and destroyed it so completely that it was not thought worth while to repair it. The two working shafts are connected, and the ore is opened so as to divide the hoisting between the two. The ore body is wholly south of the old workings. It is a new find, but may be the same ore, its extension south being due to the underlay and a greatly increased widening of the deposit.

The ore is very soft and has no sustaining power; it will run from the stopes unless held in place. They will timber—room out—three sets wide, using

such precaution as becomes necessary and modifying according to circumstances. Altogether the Lillie has come to the front in good shape, apparently looking well enough to assure a product of 25,000 tons the coming year, of which amount about 1,600 tons are now in stock (January 1). There are two four feet drums, and a separate plant will be placed south of the new shaft.

The quality of the ore corresponds with that of the Cambria. The management is in the hands of Mr. Alex. Mitchell, of Negaunee, assisted by Captain Charles Koch.

The mine has yielded as follows:

Year.	Tons.	Year.	Tons.
1875.....	144	1881.....	16,718
1876.....	6,801	1882.....	28,221
1877.....	10,127	1883.....	2,172
1878.....	8,506	1884.....	2,683
1879.....	21,681	1885.....	708
1880.....	18,347	1886.....	3,957
Total.....			122,507

THE DETROIT MINING CO.

The history of the Detroit mine, which is not a very old one, presents great contrasts. Four years ago there was no ore to be seen, the mine was exhausted, while now it is a good mine, and the indications are that it will continue to be a good mine. At first the mine was a small open pit, now it is wholly under ground, reached by a single double skip shaft that descends vertically 245 feet, and then dips to the south at an angle of 45° until it attains a total depth of 350 feet. The shaft is near the east line of the property, and the 300 feet level extends to the west line, a total length of 1,200 feet. The ore runs east and west, or very nearly so, and the workings are clear across the "40," and even over the line west into the Lake Superior Co.'s land. The bottom level—350 feet—is not very much opened, and they are sinking for the 400 feet. The deposit is a good width, ranging from 4 feet to 30 feet. A drift has been made south from the shaft, in the bottom, 374 feet in length, for the purpose of reaching a deposit of ore that was discovered with the diamond drill last summer. The drill was set in the bottom of the mine and pointed south. At the above distance it passed through 58 feet of ore, which was found on analysis to be Bessemer. It was expected that the drift would intersect the ore at any moment when I was at the mine in January.

The ore is of good quality, about 60% in iron and not far above the Besse-

mer limit. The bottom of the shaft is 30 feet north of the ore. The company works 100 men. The ore is used in the Deer Lake and Vulcan furnaces largely.

Annual product of the Detroit mine:

Year.	Tons.	Year.	Tons.
1882.....	5,402	1885.....	19,755
1883.....	12,314	1886.....	39,066
1884.....	3,098		
Total.....			79,635

April 16, 1887, a stream of water was tapped by a blast which resulted in such an inward blow as to fill the mine with water far beyond the capacity of the pumps to remove. Additional pumping machinery has been procured and at the present writing every effort is making to lessen the flood of water. Probably it will not be before the middle of May to 1st of June that the mine will be in its normal condition.

Jas. McMillan, Secretary and Treasurer, Detroit, Mich.; W. J. Officer, Superintendent, Ishpeming, Mich.

East of the Detroit is the Cleveland hematite, and the land on the west is owned by the L. S. Iron Co., that is now engaged in preparing to sink a shaft with the view to mining ore.

Capt. Officer has charge of an exploration in Sec. 34, directly north of the Detroit mine, that is looking well. He has a shaft sunk 150 feet south of the west end of Teal Lake which is in ore. The dip is away from the lake.

Also they are working on E. $\frac{1}{2}$ of lot 5, and on lots 6 and 7 east of the Cambria. It is called the BEN NEELY exploration. They have been at it for a year or more and have now good prospects of a mine. The ore found is of good quality, similar to that of the Cambria mine, and I judge they are pretty sure to open a good body of it.

Exploration also is carried on east of Teal lake, with varying success. No assurance of a mine yet.

THE MICHIGAMME COMPANY.

The Michigamme mine is again actively working. The late depression in the iron business led to a temporary suspension of work in the mine.

The Michigamme is the most westerly hard ore mine that is operated in the Marquette range, or, for that matter, in the State. The mine has never come up to the expectations that were entertained regarding it at the time it was

first opened. The deposits of ore have proved to be of too limited extent—too short and too narrow, and in some of the stopes and pits the ore is not clean enough, *i. e.*, not fully free from rock. It, in such cases, requires a good deal of sorting, picking over, which adds to the cost. The ore is, in No. 4 shaft, a medium grained magnetic of superior quality, being very clean, high in iron and low in phosphorus. But in some of the other shafts, No. 5 and No. 3, the ore contains a mixture of actinolite, hornblende, which renders it objectionable to furnacemen.

Mining operations were begun here in 1872, when it was determined to change the location of the main line of the railroad from the south side of the lake to the north. The discovery of ore had been made, and exploring work began in Sections 19 and 20, T. 48, R. 30, near the northwest extremity of Michigamme lake. No mine in the district, in its early history, made more extensive or substantial arrangements with view to meet the requirements of a large and permanent mining business, than did this company at the start. The shaft houses were heavy framed and well covered. The large building for holding the machinery was made of stone with iron roof, and is even now one of the best in the region. The hoisting plant, etc., was, at the time it was placed, among the most powerful to be found in the district. Perhaps the outlay and preparation were greater than the requirements of the mine, as shown by subsequent development, proved necessary. But experience shows that it is impossible for any one to determine in advance how well a mine will develop. He knows better after it has been worked a few years, but he can only conjecture beforehand. Of course, a judgment becomes more valuable in such circumstances the better qualified a person is who forms it.

The formation at the Michigamme trends very closely east and west, and the dip is south, towards the lake, at an average angle of about 60%. The rock overlaying the ore is massive gray quartzite, and the foot wall a magnetic, ferruginous schist. A little way north of the mine is the greenstone range, which in places rises to a considerable height. South of the mine, in the low ground, are indications of the occurrence of black slate and actinolite schist. The mine is a long one—that is from No. 1, the east shaft, to No. 7, the extreme west one, the distance is upwards of half a mile, but at present they are only working in Nos. 4 and 5. The former has always been the mainstay of the mine, giving the best ore and the most of it. The length of the deposit in this shaft has averaged about 400 feet, terminating with a heading of rock at each extremity. The shaft is a very crooked one, occasioned by the fact that in sinking it they have kept in the ore, and rested mainly on the foot wall. The foot wall does not dip with any regularity. It is sometimes steep and sometimes very flat, so that, in conforming to it, the shaft changes its in-

clination at each level; and again, the ore occasionally sets off into the hanging, and in order to reach it with the skip road, the hanging wall has to be cut out at the shaft, commencing from above where the jump in the ore occurs.

Such a condition now exists in the bottom of No. 4, 600 feet down from the surface on the lay of the shaft. The ore had become very narrow—about four feet in width. Recently they cut south into the hanging wall at a point 160 feet west from the shaft and have the ore 35 feet wide horizontally, probably 20 feet wide, at right angles to the walls. The ore is the best. They are sinking in it at this point and will drift east to the shaft. At the present writing—January—this is the most promising thing in the Michigamme mine. They are now hoisting the ore from the winze and tramming it to the shaft. The hanging will be cut out for the skip road to reach this body of ore.

No. 5 pit may be entered by going north from the west end of No. 4, through either of two cross-cuts 120 feet in length, the lower one being 324 feet below the surface, or he may descend from the surface through the new No. 5 shaft, 450 feet down to the bottom. This shaft is a good one, being straight and well equipped. They are now stoping in two levels, the bottom and the one next above it. The ore is about 10 feet wide but is scarcely, as a whole, first-class. In the lower cross-cut level the length of the mine is 550 feet, 400 feet west of the shaft and 150 feet east of it. Capt Cundy has a unique way of running up the buckets in the stope from below, in this level. His apparatus consists of a wire rope suspended from the roof near the shaft, the other end attached to the hanging in the level 125 feet below, at the stope, drawn taut; a shieve runs on this rope. To this shieve is attached a rope, which passes around a single movable pulley and to this latter a hook for holding the bucket. The other end of the rope is attached to the winding drum above. When the bucket is filled the signal is given and it is speedily drawn up and its contents dumped into the car, when it as quickly descends to the stope. It is easily set up and operated and involves little expense.

In the bottom level they have worked 100 feet east of the shaft and 350 feet west of it. The mine lengthens west. At 300 feet the ore is apparently faulted to the north and goes on west at its full width. The breast is 50 feet west of this fault and within about 150 feet of old No. 6 pit into which they expect to open. They are hoisting about 160 tons daily through the winter, working about 150 men—100 miners and 50 surface men, etc.

Mr. J. C. Fowle still remains superintendent, while Capt. J. P. Christopher, so long the mining captain, severed his connection with the company to accept the superintendency of the Ironton mine, near Bessemer, Mich. He was succeeded by James Cundy, a well known miner, who has a long and successful

experience in the region. Still more recently Capt. Cundy has gone to the Champion mine and the position he held at the Michigamme has been filled by the appointment of George Orr, for a long time an employé of the company.

The annual products have been as follows:

Year.	Tons.	Year.	Tons.
1872.....	141	1880.....	52,944
1873.....	28,966	1881.....	57,115
1874.....	45,218	1882.....	43,712
1875.....	44,756	1883.....	42,533
1876.....	20,074	1884.....	28,757
1877.....	28,238	1885.....	12,372
1878.....	58,622	1886.....	48,805
1879.....	56,935		
Total.....			615,888

The estate covers 1,400 acres of land.

There have been an unusual number of fatal accidents at the Michigamme mine the past year; heretofore for several years there was but one man killed, but during the past year there have been three. And yet, after hearing all the facts, I cannot say as any blame is to be attached to the company. One of the cases was that of a boy working in No. 5 pit. He started to go down the ladder after supper to his work, and somehow fell away to the bottom; as no one was with him it is not known how. I have been up and down the same ladders and regard them as safe as such passage ways usually are. The other two men lost their lives in the mine. One by reason of a piece of rock falling out of the wall of the vein above him and striking him, and the other lost his life by the overturning of a tram car loaded with rock. I think a wheel came off just as the car was passing along by a winze where some men were working in the level below. The car overturned and the load went down the winze, striking one of the men and killing him.

THE SPURR MINE.

No mining work has been done at the Spurr the past year. The mine closed down three years ago and has since remained idle. It was contemporaneously opened with the Michigamme, and was then a very promising mine. It is a pleasant location, and the company has all the plant and buildings necessary for operating a large mine. It is a good property to explore. The company owns in fee simple the N. $\frac{1}{2}$ S. W. $\frac{1}{4}$ and S. $\frac{1}{2}$ N. W. $\frac{1}{4}$ S. 24, 48, 30, being two

miles west of the Michigamme. The mine has produced a total of 164,941 tons.

H. P. Pulling, President, 32 Congress street, Detroit, Mich.

THE NORTH RANGE MINES

have, with a few exceptions, all been idle for two or three years past. Now again there is evidence of a renewal of activity, and during the coming year nearly all will be working. The most easterly of the mines in this range is

THE ST. LAWRENCE,

which is situated about three miles from Ishpeming, in the N. W. $\frac{1}{4}$ of Sec. 5, T. 47, R. 27. The mine has not been worked since 1883, at which time I visited it. They were mining very cheaply in the shallow contiguous pits, running east and west and dipping south, the east one about 80 feet deep. The ore has a good width but did not appear to be very clean; it was somewhat mixed with rock. At best it seems a low grade ore, 53 to 57% in iron and .086 to .104% in phosphorus. A track extends to the mine from the main line of the C. & N. W. R. R.

Mr. John R. Wood, the former superintendent of the mine, recently bought a three-fourths interest in the lease of the mine for, it is said, a very moderate sum, and, as he previously held one-fourth interest, this purchase made him sole owner. It is also reported that he has sold a controlling share of the stock for \$51,000, and will himself assume the charge of the work at the mine. Some new machinery has already been received, and it is probable that work will be pushed at this mine to its utmost the coming year. The total output has been 21,963 tons.

A new organization has been made, changing the name of the mine to Nonpareil.

Sheppard Homens, New York, President; J. R. Wood, Appleton, Wis., V. P., Sec. and General Manager.

THE DEXTER MINE

will also be worked, and preparations are making to that effect. The ore is a medium brown hematite, of fair quality. Still further west, about two miles, is the

STERLING MINE

which, it is stated, will be worked again the coming year, after lying idle since 1883. The Sterling has the finest of ore, Bessemer hard ore. The property

is the W. $\frac{1}{2}$ S. W. $\frac{1}{4}$, Sec. 32, T. 48, R. 28. The mine is a small one, and has a very meagre equipment. A single shaft close to the east line of the property is the only avenue to the underground workings. Further west some diamond drill borings disclosed the probable existence of ore in larger body further west on the property where the land is extremely wet. But all this was fully described in the report of 1882, written in summer of 1883. The mine has produced in the four years it was worked an aggregate of 15,642 tons of ore. At the present writing it is not known if

THE BOSTON MINE

will be worked. No ore from the lake can be sold for a greater price than can this. It is the best of hard specular ore, as was fully explained in the last report. The mine is well equipped. The plant of machinery is excellent, and includes a new Norwalk compressor, power drills, diamond drill machine, etc. There are on the location a suitable number of good dwelling houses, and other necessary buildings. While it is possible that the Boston may not become a large mine, there is certainly ore enough in the portion of the deposit that has been opened to insure a fair product, and it should be mined at a good profit. The first class Boston ore would sell the coming year at \$7.00 per ton in Cleveland, or at about \$5.00 at the mine.

The ore averages about 68% in metallic iron, and 1 $\frac{1}{4}$ % in silica, and .018% phosphorus.

No ore has been raised at the mine since 1883. The aggregate product for the four years in which mining was done was 61,715 tons. The Boston Mine Company owns the fee of the land—80 acres S. E. $\frac{1}{4}$ S. W. $\frac{1}{4}$, and the S. W. $\frac{1}{4}$ of the S. E. $\frac{1}{4}$ of Sec. 32, T. 48 R. 28 W., being about two miles north of Clarksburg, a station on the M. H. & O. R. R.

Samuel Mather, President, Cleveland, Ohio; James Pickards, Secretary, Cleveland, Ohio.

Further west in this range the

PASCOE IRON CO.

continues to work each summer, raising and shipping a moderate amount of ore. The mine is north from Champion about a mile, being in the S. $\frac{1}{2}$ N. E. $\frac{1}{4}$ Sec. 29, T. 48, R. 29. The strike of the formation is east and west and the dip to the north. The situation is favorable for economical mining. If ore of this quality were in sharp demand so that it could be mined at a fair profit the work could be pushed to the extent to secure a larger product. It is a medium grade hematite, with certain qualities exactly the reverse of what is desired,

that is, it is high in phosphorus and low in iron, about .30% in the former and 55% to 58% in the latter. It is also low in silica.

The following table gives the yearly output:

Year.	Tons.	Year.	Tons.
1882.....	18,880	1886.....	18,244
1883.....	1886.....	10,072
1884.....	11,465		
Total.....			58,667

D. H. Merritt, President, Marquette, Mich.

Directly north of the Pascoe is

THE MATT. GIBSON MINE,

operated by Matt. Gibson and Joe. Mitchell, who hold a lease of the property, the N. $\frac{1}{2}$ S. E. $\frac{1}{4}$ Sec. 29, T. 48, R. 29 W. The ore is identical with that of the Pascoe and the other mines of this locality. It is worked in open pit, and 12,142 tons of ore were mined in 1886 and 1,515 tons in 1885, making a total of 13,657 tons. It is reported that the mine has been sold to Samuel Mitchell for \$50,000.

Matt. Gibson, Manager, etc., Republic, Mich.

Directly west of the Gibson is the

DALLIBA MINE.

The property comprises the S. $\frac{1}{2}$ N. W. $\frac{1}{4}$ and the N. $\frac{1}{2}$ of the S. W. $\frac{1}{4}$ of Sec. 29, T. 48, R. 29 W. That no ore has been raised in this mine since 1883 is not due to exhaustion of the mine, but to the condition of the iron market for the past few years, to the quality of the ore, and to the embarrassed financial condition of the affairs of the company. The ore is identical with that of the other mines working in this range in the vicinity of Michigamme Lake; almost the only objection to it being the high percentage of phosphorus which it contains, $\frac{1}{4}$ to $\frac{1}{2}$ of one per cent. The mine is provided with the requisite machinery for prosecuting mining work. The company has been under a load of debt for some years, which has resulted in the change of ownership of the property and the organization of a new company, which latter has assumed the name of the PHENIX IRON MINING CO., with Peter White, of Marquette, as Secretary, Treasurer and General Manager. The resumption of work at the mine was begun about the middle of April last, and at the time of my recent visit the mine was nearly free of water.

The superintendency is, temporarily, in charge of Mr. Ed. Joplin, of Marquette. It is expected that 20,000 tons and upwards of ore will be mined the coming season. The mine was operated from 1881 to 1883—for three years—during which time the following products were raised:

Year.	Tons.	Year.	Tons.
1881.....	10,986	1884.....
1882.....	44,836	1885.....
1883.....	1,687	1886.....
Total.....			57,509

On the neighboring properties which have been heretofore described as the MESNARD, NORTHAMPTON AND MARINE, no mining work has been done since 1882.

West from Lake Michigamme are several mines, which afford ores identical with the ore found in the mines just described. The most easterly of these mines is

THE WETMORE,

situated in the N. W. $\frac{1}{4}$ of Sec. 25, T. 48 N., R. 31 W., owned by the Michigan Land & Iron Co., and held on a lease by Mr. Ed. Wetmore, of Marquette, who has continued to mine a moderate amount of ore each year since 1882. Previously to commencing mining work Mr. Wetmore thoroughly explored the property by means of test pits and the result was such as to indicate the existence of ore in unusual quantity.

There is a brook with a rapid current that runs southerly along near the west boundary of the property, and then cuts across southeasterly, the southwest corner of the land. The general slope of the surface for some distance to the east is in the direction of the creek. The test pit work is a succession of pits mainly along the east and west center line, and dug in lines north and south. The foot wall, proper, found about 80 rods north of the center line, is an actinolite schist and dips to the south at a variable angle of 30° to 50°. The hanging wall is a micaceous quartzite. Mr. Wetmore states that he found this quartzite in three or four of the pits. Pieces of the actinolite schist and of the plumbagenous slate which underlies it are to be seen in the drift overlying the formation. The strike is east and west. Not far east of the center of the west boundary and 12 feet above the creek is No. 1 pit, and east of it, about 150 feet, are Nos. 2, 3 and 4 pits. These I saw in 1882 and in 1883 soon after they were sunk, and from the facts obtained, by observation and from Mr. Wetmore, the following results may be chronicled. No. 1 was a shallow pit owing to the water, but loose ore was found, the others mentioned were dug

north and south across the formation. No. 2 was 20 feet deep and good limonite ore was found in the bottom. No 3 pit is 30 feet south of the former and probably did not reach the ledge, though ore is found in the debris surrounding the pit. No. 4 is about 35 feet south of No. 2, and shows good hard limonite ore. It is probable that the ore extends all the distance between Nos. 2 and 4 pits, the extreme ones, and perhaps to a much greater thickness.

From these pits it is about 250 feet east to the west end of the open cut which leads to the stope from which all the ore has been mined. The bottom of this cut is on a level with the ore dock along the R. R. track, and about 25 feet above the creek. The cut is about 350 feet long east and west, the breast of ore becoming higher as the work progresses eastward, being now 25 feet high. It is not possible with the present knowledge to give with certainty the width of the ore. In the pit neither the foot nor hanging wall has been reached, but the ore, measured at right angles to the strike, is 55 feet wide. About 270 feet easterly and a little south of the open cut is another series of test pits. In No. 6, the most northerly one, there is nothing in the refuse to indicate that the ledge was reached. The contents removed show nothing but gravel. It is but 12 feet deep. No. 7 is 50 feet south of the former, and was dug 21 feet deep, having for the bottom hard limonite ore. The other two pits of this series, Nos. 8 and 9, reached what was supposed to be the hanging wall of the ore, being quartzite. This is probably near the east end of the lense of ore of the open pit, or possibly the west end of a lense of ore to the east. About 80 feet easterly from No. 8 pit is No. 10, in which hard limonite ore was found at a depth of ten feet. Still further east 180 feet is another series of test pits, of which the most southerly one has a depth of 40 feet. In this, after passing through the drift and succeeding rock, clean ore was reached. In the bottom a drift was made to the north 35 feet in length, all of it cut in clean limonite ore. From this pit, No. 11, to 19, all were ended in ore. These extend across the formation a distance of 215 feet. Apparently they indicate a width of ore equal to at least the distance between the two extreme pits.

No 12, 15 feet deep, afforded yellow ore. No. 13, 15 feet deep, yellow and red ores. No. 14, 15 feet deep, hard yellow ore. No. 15, 10 feet deep, hard brown ore. No. 16, 10 feet deep, yellow ore. No. 17, 12 feet deep, brown and red ores. No. 18, 10 feet deep, the brown and red ores. No. 19, 10 feet deep, brown and yellow ores. No. 20, 10 feet deep, mixed ore and rock, supposed to be in the foot wall.

Mr. Chas. E. Wright collected from each of these pits samples of the ore in order to obtain an average of the shipping ore across the formation. These samples, after being crushed and ground in the mortar and the powder thoroughly mixed, gave by analysis:

Metallic iron.....	59.49%
Phosphorus.....	.139%
Silica.....	5.52%

Considering how the samples were taken, the above is certainly a very good result.

No. 21 pit is 160 feet east of No. 11, and shows hard brown ore; and Nos. 22 to 25 inclusive, extending in a line north and south, were not sunk deep enough to reach the ledge. In the last one mentioned was found a boulder of magnetic ore weighing, by estimate, not less than 20 tons. Again, easterly about 200 feet, are pits 25 and 27, neither of which reached the ledge.

South 64° east from No. 11, and 600 feet distant, are pits Nos. 28 and 29, in both of which good brown ore was found, also siderite, or carbonate of iron in 29. This brings the explorations to within 450 feet of the east line of the property, or about 2,000 feet east from No. 1 pit.

It is not necessary to assume that there is a continuous run of ore for the entire distance. As fair an inference would be to expect the occurrence of several lenses that may lap, the one upon the other, but are separated by intervening rock. Furthermore, in going eastward, should the end of a lense be reached, the next one will be found to the right.

The ground lies favorably for cheap mining, and it is safe to estimate a product of 300,000 tons above water drainage.

The ore, with the present price of labor, can be mined for 60 cents per ton, provided that 20,000 tons or more are taken out annually. The ore requires little or no sorting, it is practically clean ore, holding among its impurities a considerable percentage of lime, that should render it easy to smelt.

Mr. Wetmore is preparing to operate the mine with machinery; a hoisting plant consisting of two boilers, engine and two winding drums, with space for two more when required, will soon be completed at the mine.

A track from the main line of the M. H. & O. R. R. comes in on the foot wall side of the ore. The grade is 4 feet in 100, and on an 8° curve, not a favorable track, but the grade is down from the mine.

The following table shows the annual product:

Year.	Tons.	Year.	Tons.
1882.....	1,706	1885.....	5,887
1883.....	2,766	1886.....	10,756
1884.....	4,585		
Total.....			25,771

Ed. A. Wetmore, Manager, etc., Marquette, Mich.