STATE OF MICHIGAN.

MINERAL RESOURCES

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BY AUTHORITY

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INTRODUCTORY NOTE

I was pleased to learn from the secretary of the Executive that the Report of the Commissioner of Mineral Statistics was in active demand; not only do applications come to him from all parts of our own country, but hundreds of volumes have recently been sent abroad in answer to requests emanating from every quarter of the globe. The magnitude of the products of our mines, the wide-reaching influence which they exert in the markets of the country, have naturally awakened among those who are interested in mining matters a desire for full and reliable information regarding the mines and mineral deposits of our State. In preparing this volume I have endeavored to relate the facts pertaining to our great mineral resources in such a manner as should meet the demand of the public for definite information and as should best promote the important industries represented. While adhering strictly to facts, as I have understood them, I have borne in mind that the interests dealt with are largely of a private character and that these individual and corporate rights should be properly regarded, and I have thus sought to convey all needful information, while careful to avoid making any unmerited criticisms or statements regarding mines or mineral properties which would result in injury to private interests.

Under the law as amended in 1883, increasing the appropriation to $2,500 a year, the commissioner is required to furnish the report at his own expense; or, in other words, that the appropriation must cover all expenditures of the office, including the preparation and cost of publication of his report. Obviously, if viewed only in the light of economy and indulgence from labor, it would seemingly be for the interest of the commissioner to make the volume as brief as possible. However, aside from the fact that the purposes of the law could not

thus be met, I too fully appreciate the magnitude of our mining interests and am too strongly impressed with the desire to serve them, to be willing to subscribe to a report in the preparation of which every reasonable effort has not been exerted to make it fitly represent the important interest which the office was designed to promote.

No doubt the report contains many shortcomings and mistakes; but I have earnestly endeavored to avoid them. When it is remembered that there is so much to be done, so many different mines to be examined and described in so short a time, it is but natural that some errors should occur, however familiar one may deem himself with the subject considered.

I have deviated very little from the plan of previous reports, but have mainly sought to present as many new facts as possible and to avoid repeating what has heretofore been written in former reports. There are some subjects treated more fully than has been done heretofore,, among which the chapters on blast furnaces, soils, and Upper Peninsula railroad extensions will be found to possess interest.

The chapter in which the mines of the Agogebic Range are described was written by Hon. Chas. E. Wright, State geologist; as Mr. Wright has spent much time in that district and has made a special study of the geology of the region and become familiar with the details of the explorations and mining work thus far accomplished, he is thus unquestionably more competent to impart information regarding them than anyone else. His report upon the mines of this range herein contained will be likely to meet the approbation of the mining men interested, and be also received with confidence by the public.

I wish also to express my obligation to those who have charge of the mines and to mining men generally for the uniform kindness shown me and for the facilities afforded for examining the mines and acquiring information regarding them.

COMMISSIONER.

STATE OF MICHIGAN,
OFFICE OF THE COMMISSIONER OF MINERAL STATISTICS.
Lawton, Michigan, June 15, 1886.

RUSSELL A. ALGER,
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.

THE IRON INDUSTRY.

When Crœsus, the Lydian king, displayed his heaps of treasure to Solon, the philosopher told him that whoever had more iron than he would soon be master of his gold. Thus wisely intimating to the vain and pretentious monarch that his gold was but the semblance of power, the tinsel, pomp and display of royalty, while the real forces, which constitute the strength of a nation, which form the basis for permanent prosperity and durability, find their representative and instrument in the rude and more common metal.

A careful study of the history of past and of current events verifies the underlying truth expressed in the law giver's words: gold is but the semblance; iron is the real representative of power; the essential material upon which, beyond all others, the prosperity of the world is based.

Without it the marvelous progress which has characterized the career of those nations that have availed themselves of its utility and abundance was seemingly impossible. It is the symbol of war and of peace; it equips the soldier and the husbandman—it forms the musket and the plowshare; the destroying cannon and the saving reaper; the bristling ironclad and the peaceful ocean steamer.

Over it is everywhere flashed the world's hourly happenings. It bridges our rivers, and, stronger than the bonds which diplomacy weaves, are the ironways of trains, binding states and nations together in the indissoluble bonds of friendship and interest. The neigh of the iron horse as it advances into the remote wilderness is the signal of the doom of barbarism and waste, for in the wake of the locomotive follow civilization and industry; and native savagery gives place to culture, intelligence and order.

The present age, the age of iron, is transcendant in its achievements. The multiplied and extended use of iron has carried the world forward with giant strides. The iron sinews of machinery do the work of millions of men. The thousands of miles of railways distribute with rapidity the products of different sections, stimulating variety of industry and promoting intercourse and peaceful rivalry among men.

It may almost be said that the use of iron is the index of national prosperity—the gauge of its progress. The amount of iron used measurably denotes the degree of national or sectional activity. A large consumption of iron indicates the rapid building of railroads, of the lighting of furnace fires, of expanding mills, of the clang of hammers and the hum of machinery. It indicates that there is activity in commerce and traffic—that there are grains and merchandise and machines and implements to be transported, and hence that the farmers are prosperous, with good crops and surplus to sell. And, reciprocally, that the manufacturing interests are healthy and active. For the farmer by sale of his surplus, is

afforded the means to purchase the tools and agricultural machinery, the better to pursue his avocation. A large consumption of iron denotes that the mines are actively working, that large numbers of men are busily employed at good wages in this calling. It denotes an increased demand for rails, and hence the employment of large numbers of men in the rolling mills and railroad construction. It denotes the necessity for pig iron and hence the employment of an increased number of furnacemen, charcoal burners, coal miners and coke makers.

It shows that the builders of stationary engines and locomotives, of mining and milling, agricultural and other kinds of machinery are all busily at work. And so it is, the iron industry has its ramifications reaching to every other business, every other calling, it draws upon and it depends upon all; and reciprocally it sustains and benefits all, making its invigorating influence felt in every industry in the land.

The iron industry is fundamental. It is at the basis of material progress. It is allied, in its usefulness and necessity to mankind, to the primitive occupation of agriculture. Where the art of iron making is undeveloped, the art of agriculture is equally crude and primitive.

And in any period, when the iron industry languishes, agriculture, manufactures, commerce, traffic, labor—in fact every kind of business, every department of labor, will share in the depression. In the great contest of mankind the iron workers have held the ascendant.

Philip the II of Spain possessed the wealth of the Indies. Into his treasury flowed the product of the mines of gold and silver of the new world.

The pomp and circumstance of royalty environed him. The borders of his empire stretched away until the earth in its revolutions never ceased to present to the light of the sun some portion of his dominions. And yet his coffers were empty. His gold was drawn out to supply his arsenals, his navy and his soldiery, to purchase armament for his troops, cannon for his ships and implements and tools for his husbandmen. Mines of gold and silver he had in abundance; but mines and workshops of iron he had none. The real elements of prosperity and power were wanting. The industrious miner and the thrifty artisan were demanded. Spain needed, to insure the retention of her gold and the permanence of her power, mines and furnaces actively at work within her own borders. She needed to make her own cannon and muskets, her own tools and machinery; to build her own ships, sustain her own industries, employ and compensate her own workmen, and thereby retain among her own citizens the gold which her proud galleons conveyed from the mines of Mexico and Peru. Spain was a purchaser. She engaged in great wars, employed great armies and bought her material of England and abroad. Gold and silver were her only symbols of wealth and power. To the haughty Spaniard the working of iron held no attraction or inducement. In her competition with the wage workers, the miners and artisans of Europe, she was driven to the wall. Her colossal empire crumbled to fragments, while England, a nation of miners and iron workers, of manufacturers and shippers, absorbed her wealth and attained to her greatness in power. Spain possessed her mines of silver and gold, England those of iron and of coal, and truly the words of the great law giver were verified, that "he who hath the more iron will be master of the gold." The iron mines of England and the ability of her people to utilize them reversed the status of the two nations; Spain from her position of power, opulence and pride became weak and impoverished. England, from her condition of comparative weakness and poverty, through the industry of her people with neither mines of gold nor silver, but with iron as a basis, and with the fuel and the skill to manipulate it, and the enterprise to distribute the products of her labor, she, anon, possessed herself of the gold and the power and the splendor of her former rival.

We of the present time observe the astonishing rapidity of the world's progress, and we note in connection with this marvelous development the importance of iron as the leading factor.

In iron, as in every other mineral, this country is not wanting. Deposits of the ores of iron are found in all sections of the Union, while they occur in some localities in great magnitude. Among those chiefly favored with the possession of this important mineral is our own State of Michigan. We can point with pride to the surpassing richness and extent of the iron deposits of our Northern Peninsula. Though comparatively recent in its development this district has assumed its place in the front rank of the iron mining regions of the world. The ores that are mined and marketed are distinguished before all others for their exceeding richness and purity. The extensive deposits of lean ores and high phosphorus ores, that are known here, remain practically untouched. The best only is used.

It is barely 30 years since the mining of ore was begun in a primitive way in this peninsula, but the days of its infancy were speedily passed and the simple methods of the early days have given way to the most improved and advanced systems of mining. The older mines are deep under the surface and the most ponderous and effective machinery is employed to accomplish the necessary work, great compressors for condensing the air which is conveyed down into the mine through iron pipes and thence as required, by rubber tubing to the small machines, which are employed to perforate the rock. The most powerful explosives are used to insert into these holes to rend the rocks asunder. Powerful engines operate the great winding drums that take up the wire rope to which are attached the skips that bring the ore to the surface. Pumps of power sufficient to raise hundreds of gallons per minute hundreds of feet upward free the mines of water. Every improvement or device which experience or ingenuity can, suggest, that

will insure the economical or effective working of the mines, is adopted.

Intelligence, energy and experience are the order of the day in our iron, mines. Inefficiency is at a discount and finds scant room. They have learned, in a great measure, to avoid the mistakes of an earlier period; the incompetents have been eliminated or have learned better. The diamond drill is everywhere at work in the mines and on the surface boring through the rocks in search of ore. The best scientific skill, large practical experience and intelligence are engaged in directing the mining work in all its departments. In this particular the Lake Superior region is especially fortunate. The mine agents or superintendents are usually men who have acquired a, thorough knowledge of the business, who are familiar with the country from long residence in it. They are men of education, with an aptitude for the duties in which they are engaged, full of zeal and enthusiasm for mining work and with unlimited confidence in the richness and extent of the mineral resources of the region of their choice. The same may measurably be said of those employed in the suborninate positions, the mining captains, etc. They are usually men of energy and force of character. The great majority of the mining captains are Cornishmen, who passed the early years of their lives in working in the mines of Cornwall, England, and have since been engaged in similar work in this country, chiefly in the iron and copper mines of Lake Superior. The Cornishmen are good miners, probably the best in the world; they are apt to be opinionated and dogmatic; to be possessed with a much better estimate of their own abilities as miners and their own methods, whatever they may be, of doing work, than they are of others; but they are good miners nevertheless. They have great capacity for work and possess more intelligence than any other class of miners. Like other Englishmen, the Cornishman is a natural grumbler but he is seldom a bad citizen; on the contrary he is frequently a man of the largest intelligence and most liberal spirit. As miners they are distinguished for their energy, resource in emergency and progressive views. The Cornish miners are generally the ones who make the highest wages; they get the most difficult contracts and the largest pay—at least they are able to perform their work so as, frequently, to make it pay them largely. If there is a difficult shaft to be sunk or a tunnel to be driven in hard or dangerous ground, as a general thing it is Cornish miners who are the men to do it. The greater number of the laborers in the mines of the iron regions are Scandinavians, Sweeds, Norwegians, Danes and Finlanders. There are also many Germans, some Irish, and, latterly, Italians. These are generally of the better class of workmen, industrious, sober people, who have worked in the mines in their native land and have immigrated here to secure better wages and the advantages of a free country. The Germans and Scandinavians have either become citizens or aim to be so, and usually seek in all ways to better their condition. They are all, of whatever nationality, industrious, peaceable, law-abiding people; they earn good wages in the mines and are generally contented. Socialistic and communistic doctrines have as yet taken no root among them, and it is sincerely to be hoped that these false and disturbing notions may never obtain a foothold here.

There has never existed, unless in a very limited degree, any antagonism between the directors of the mines in Lake Superior and the laborers; the latter have always received good wages, and there has seldom been any disposition on the part of the management of any of our mines that it should be otherwise. When ore has been in good demand and prices have ruled well, the wages received by the miners and other laborers have been remarkably high, and even now, when iron and copper are unprecedentedly low, when the most favored mines are making little profit, and some none at all, the men are still the recipients of good wages. The depreciation in the price of labor has been very little as compared to the lessening in the price of ore. The cost of production has been reduced, but it has been accomplished in other ways than by cutting, very largely, the wages of the miners. The average wages received by laborers in the iron mines is from $1.40 to $2.50 per day. Of course, in this as in other occupations, superior skill, industry and merit have their place and obtain greater reward; the common laborers receive $1.40 to $1.60 per day. But higher wages are earned by miners working on contract, and in some mines, where the work is mostly done on contract and where a pretty liberal policy is observed with the men, the more skillful and enterprising of them obtain large wages—frequently from $3.00 to $5.00 per day. It is generally the aim of the management in ordinary mining work to so rate the price of the work that is let on contract, that the miners will at least make average wages with ordinary industry; of course, if they work harder they make more. It sometimes happens, in emergencies, that there are especial reasons for increasing the price; but generally they are assured only of the average wages for the class of work in which they are employed.

As the matter now stands there is mutual confidence and good feeling between the employés and the employers; in no section of country where the laboring population so greatly preponderates, is there less discontent or complaint. Strikes are so rare that they may be said almost never to occur. The miners are in a position of independence, they are reasonably sure of lair treatment and of good wages; any requests which they are likely to make will be acceded to, and it would be in the highest degree disastrous to all concerned to subvert all this harmony by substituting for the existing state of things the condition of affairs that is found in mining regions elsewhere.

To replace for the common sense and independence which characterizes the relations between capital and labor in the Lake Superior mines the dangerous and servile doctrines of some of the so-called labor reform organizations would be exceedingly unfortunate. A man should certainly reserve to himself the privilege of disposing of his own labor; he should be able to say

whether the conditions are acceptable to himself or not. He certainly should not willingly put it out of his power to decide as to his own action in the matter of his own labor. He should not, voluntarily, subject to the arbitrary dictation of others the fact whether he shall or shall not accept the terms of his employers. He has the right to work at any specified terms if he sees fit to accept them, and he equally has the right to reject them. On this basis, the basis of mutual interest and good sense, the interests of both are subserved; no intermediary organization is required; the workmen .and the superintendents can talk over their differences face to face and adjust them personally; but introduce a third - party, a party that assumes to dictate all the terms, that assumes to establish immutably the relations between employer and employé, and discord is sure to arise, confidence and harmony give place to suspicion, irritation and frequent rupture. There is no compensation, the whole system of labor unions as applicable to our Lake Superior mines is unnecessary and injurious, it finds no just reason for its existence; it is baseless in theory and greatly damaging to the interests of the workingmen in practice. There are always blatant, reckless demagogues among workmen as among other classes, and they are always makers of mischief. In the occasion of a strike or other disturbance these men come to the front, and by their violent acts bring discredit and shame upon the whole body of laborers with whom they are associated.

All the strikes and disgraceful conflicts so common elsewhere, leading frequently to lawlessness and violence, are unknown in our mining region. No general strike has ever occurred and none has ever been of long duration. The miners are able to provide well for themselves and for their families, they are well fed, well housed and well clothed, their children enjoy the advantages of good schools, since a public school is maintained within convenient reach of every miner in the peninsula. There are many mining captains, superintendents, agents, mine owners, merchants, bankers, etc., men who are now in lucrative employments and possessed of large property, who began working in the Lake Superior mines as common laborers, but who, by their industry, thrift and intelligence have thus succeeded in greatly bettering their condition. There are many Scandinavians who work in the mines to lay up money with the purpose that when they have acquired a sufficient amount for the object in view, to go to Dakota, or Minnesota, etc., and acquire a homestead.

Certainly laborers in our Lake Superior mines are as well paid as are the workmen in any other class of employment. Nor are the risks greatly, if any, in excess of those necessarily incurred in many other occupations. Men sometimes meet with injury and even death in the mines, but the proportion of such accidents to the whole number of men employed is not startling. In the Chapin mine, for instance, one of the largest of our iron mines, working an average force of about eight hundred men, there were but four men killed in the past year—two by falling ground, one by falling into a sand chute, and one by falling down a shaft. At the Cambria mine, which employs a hundred men and upwards, there has not been a fatal accident during the past five years. Certainly, at some mines accidents to men are much more frequent, but as a general thing the victims themselves are directly responsible for their occurrence. The miners become careless and fail to observe the precautions necessary to insure their safety. Sometimes they are stupid or reckless in the matter of their blasts, and are injured or killed by a premature or unlocked for explosion. Sometimes they will not take the trouble to support the ground properly and are caught by the rock falling unexpectedly upon them. Sometimes men are injured by riding in the shafts in the skips or buckets contrary to orders, and sometimes they fall with the scaffolding, insecurely made, in high back stops. Sometimes they step into a shaft or into a winze—in fact there are many ways in which accidents occur, and not all of them are avoidable, but as a general fact, if the men were careful not to assume any unnecessary risks there would be much fewer accidents in our mines. A great deal can be done, and is done, by the officers of mining companies to protect the men in this matter; every precaution should be taken and their observance stringently insisted upon; no miner should be permitted to take any avoidable risks; the mining captains and pit bosses should watch constantly to prevent any act of carelessness on the part of the men, either regarding themselves or others. They should protect the ladder ways, shafts and other dangerous pitfalls so as to lessen the liability of anyone falling into them. The hanging wall should be carefully watched to see that there are no loose fragments to drop out unexpectedly, or a large mass of "soap rock" to give way to the possible destruction of unfortunate victims. The method of mining pursued should be such as, in the greatest possible manner, to insure the safety of the men. The protection of life and limb should be considered as important as the mining of the ore, and the matter of filling a contract, of enlarging the output by a few more tons, should not be accomplished at the risk of the lives of the men. Ambition to make a large product should not interfere with the exercise of all precautions for safety.

These remarks are intended to be both commendatory and suggestive. I have found that some of our agents take every measure of care; that they render their mines as safe as possible and enjoin upon the men the observance of the stringent orders for their safety, punishing by discharge such as fail to obey them. But equally there are other mines in which there is a manifest carelessness on the part of the management regarding the safety of the mine and of the men. There is no mine where security and safety are not regarded, but there are those in which there is a greater liability to accident than is necessary, and where the loss of life is of too frequent occurrence.

It has been recommended that our Legislature provide for the appointment of an inspector of mines; but it is not easy to see what power could be given to him that would be of any important value as applicable to the purpose

for which the creation of the office has been desired. Certainly such an officer could not compel mine owners to obey his mandates. He certainly could not declare the methods of mining to be pursued and enforce their observance. Every mine has its peculiarities, the method pursued is something that the companies themselves learn as a result of their experience in each particular case. An inspector could not interfere with their work, he could know comparatively little about it. Our mines differ very widely in the character of the deposits and there is room for great divergence of opinion as to the way to work them. Some of them are rich, affording a large and valuable product, and are worked on a large scale; others are poor, with poor ore or with small and uncertain deposits. The company is perhaps obliged to pursue a limited, economical course; and while everything is done in a comparatively cheap and primitive way, and some things are done or are allowed that would be dangerous in large mines or in other circumstances, are here essential because they could not afford to do otherwise, and through the observance of care and precaution there is no increase of danger. A place in a mine may be safe to-day and unsafe to-morrow, and *vice versa*; the conditions change. A method may be safe in one instance and not in another. You cannot have immutable rules in iron mining work, unless in particular instances, and made by an intelligent, experienced manager. The distribution of pillars, the place of stulls, the necessity for timbering, the course of the shafts, the drifts, the stopes, the place of the drill holes, the kind of explosives used and the manner of handling them, and the hundred and one things constantly doing and to be done in a mine, where, perhaps, hundreds of men are at work, are things to be looked to on the spot, they cannot be directed in advance and from afar off; the right man on the spot, familiar with every condition and circumstance, is the one to dictate, and none other is likely to be submitted to.

A stranger can know very little about a mine unless he is taken through it by some one entirely familiar with it and wishing to give him every opportunity to investigate and observe, while he himself must be competent to judge and to form correct conclusions if he is to decide anything of importance relating to the mine.

Supposing he were an inspector and was to require certain things of the mining companies which they saw fit to disregard, as they probably would; they might deem his requirements unnecessary, expensive and absurd, and refuse to obey them; how is he to compel them?

At any rate it is very doubtful if any such interference as that which has been recommended would be tolerated in the management of our iron and copper mines. It is not certain that any supervision is necessary or that it could be exercised so as not to occasion more hurt than good. It would be difficult to designate any one thing in which the public has any occasion to interfere. The men in charge of our mines are generally skillful and experienced in the work; if in any case there is a lack of care for the safety of the men it is apparent more from the fact that there are a greater number of accidents occurring than is consistent with the due exercise of proper oversight and care. The mining problems have to be worked out by experience.

In our soft ore mines, where pillars cannot be relied on to support the walls, systems of timbering have been adopted, filling to a greater or less degree the purpose intended; but there have been extensive "caves" in several of these mines lately, which have tended to establish the fact that the methods followed are scarcely adequate to insure the necessary safety, etc. The mining men are anxiously considering this matter, and the matter of soft hematite ore mining is sure to undergo considerable modification in the near future. The Agogebic range, in which extensive soft ore mines are likely to be operated, will doubtless profit by the mistakes of the older mines. Timbering, I think, will be less resorted to. In its stead the mine will be filled with rock, sand, etc., as the ore is removed. No doubt the method of filling, in some form, is the proper one both for economy and safety. The subject will be further discussed in describing those mines which have begun to fill.

To revert to the subject of inspector, I have but to remark, further, that the object desired could be attained, so far as it is possible, by increasing the duties of the Commissioner of Mineral Statistics, requiring him also, in addition to his present duties, to perform such as are esteemed as pertaining especially to an inspector of mines. It must be remembered that we have but few coal mines, and none in which explosive gases are formed; it is this source of danger, the occurrence of those terrible mine explosions, which happen frequently in some localities, and of which there is always a liability in coal mines in which gas is generated, that the authority of an inspecting officer may be indispensable. In such cases there are certain precautions that must be observed; any neglect to comply with them may prove fatal, not only to the careless person who commits the error, but in the same degree to endanger the lives of scores of others, of all who are employed in the mine, as also he exposes the mine itself to the liability of great damage. Under such conditions it is undoubtedly highly proper that there should be an officer whose duty it should be to see that all necessary care was taken to avoid catastrophe. In such case the duty of all concerned is plain. In the mines of Michigan there is no danger of that sort to be met; they are of the character incident to ordinary labor under special conditions. And while many of the accidents that happen to the men could be avoided, no doubt, it is generally a fact, as I previously stated, that the victim himself is the one most to blame. I am pretty familiar with the mines in this State, and I find in this matter of the care of the men very much to commend and very little to criticise. There are some things that it is not always possible to prevent men from doing. They know better than to attempt to drill out a blast in the manner they sometimes do; or to force, with blows, a stick of giant powder into a drill hole that is

too small to receive it; or to pinch the explosive caps with their teeth instead of using the nippers which should be employed for that purpose. These are among the most frequent causes of accidents that occur and they are due to the reckless carelessness of the miners themselves. It is not easy to imbue them with a sense of continued danger, to keep them up to the observance of every proper precaution. A skillful, energetic officer in a mine will do much by his method of mining, by the distribution of his men, by the exercise of good judgment, care and watchfulness to prevent accidents. The men in most mines, if not in all, are required by the management to take such precautions as are necessary for their safety, and in some mines disobedience to such regulations is punished by discharge. I have devoted considerable space to this subject, from the fact that it was brought to the attention of the Legislature and of the public by Ex-Gov. Begole in his retiring message, who recommended that the office of Inspector of Mines be substituted for that of Commissioner of Mineral Statistics, assigning as a reason therefor that the reports of the latter were not desired except by those interested in mines, etc. Well, the people who are interested in mines and minerals comprise, in the aggregate, a pretty large body of men. They represent intelligence and wealth and are among the chief moving forces of the world. They are not confined to Michigan, but are found everywhere in this and in other lands. They are more or less acquainted with Michigan mines, many of them have capital invested in these mines, or are wishing to invest and are asking for reliable information pertaining to them. Michigan is a great mining State. Its mineral deposits are among the most important and remarkable in the world. Its mines are widely known, they represent the investment of a vast amount of capital, and their annual product is extraordinary for its magnitude and value. Knowledge regarding them is not alone sought by those who hold pecuniary interests or who contemplate making such investment in them. Mining men everywhere, mining journals, scientific men, economists, publicists, etc., etc., desire this information of our mines and mineral interests, and are at least thankful to obtain it. Mainly, the facts are a matter of history, scientific and mining history, which should be recorded and the information disseminated for present and for future reference. Our mineral interests are scarcely secondary to any other in the State. It is probable that the loss of the agricultural and horticultural products of Michigan would result in less inconvenience to the world than would a similar deprivation by the loss of the output of its mines. Its iron and copper are natural products, as are its grains and fruits; they are taken from its soil, they are fundamental in their nature, meeting the simplest and most necessary as well as the most extraordinary wants of men. Mining is the chief interest in a large section of our State, a territory comprising more than one-fourth of its total area and occupied by more than 120,000 people Mining here is comparatively new; it is yearly developing; new discoveries are being made, new mines coming in and old ones going out. The mines themselves are constantly changing, there are new methods of working, new inventions and important changes in machinery. All these matters are of interest to mining men everywhere. There is no mining region that attracts more curiosity and interest than does that of Lake Superior. There is none that offers more inducement, in a permanent way, for the investment of capital and for legitimate mining enterprise. It would seem but proper, therefore, that the State, which is an organization to promote the interests of all sections, to assist in the development of all its natural resources, possessing such vast mineral wealth as does Michigan, must publish such information as will be desired by those who interest themselves in these matters. It is very likely that all do not read the mining reports, neither does every one read the reports of the Commissioner of Railroads, of Insurance, the agricultural reports, etc. Yet they all contain valuable information relating to important interests of the State, and as such are desired and sought for by large numbers of people. It is not probable that farmers interest themselves very much in mining matters, and *vice versa*; and yet, in view of the magnitude of our mineral resources, and the fact that they occur, mainly, in an isolated portion of the State where there is likely to remain comparatively little other interest; and also the fact that the Southern Peninsula greatly preponderates in size, and that the interests are widely different; and the fact that the legislation applicable to the mining region must be somewhat modified from that which is required in the farming districts—it follows that the farmers of Lower Michigan should inform themselves thoroughly of the needs and the resources of the northern portion of the State. They should have a just pride in our great mines, an intelligent appreciation of the extent and value of our vast mineral wealth, and be prepared, when occasion offers in the Legislature and elsewhere, to speak and to act understandingly.

That the people of the Southern Peninsula may have full and reliable information regarding the mines and minerals of the State, the reports of the Commissioner of Mineral Statistics should be especially necessary. A competent observer may here record the facts which others can read, and through the press and other channels the information is more widely disseminated. Members of our State Legislature from the Upper Peninsula used formerly to complain grievously of the ignorance and prejudice regarding their section which prevailed largely with members from Southern Michigan. Very much of that feeling has worn away; there is a great deal more harmony and reciprocity of sentiment between the sections now than heretofore. And when they come to thoroughly understand and appreciate each other, to comprehend the great resources and interests of each, and to be ready to concede to each the important and necessary relation which it bears to the other,—all will be ready in every way to promote the development of the material interests of each section. It has been thought in the mining region, by some persons, that the people of Lower Michigan were obliged to think twice to include the Upper Peninsula as a part of the State; that they looked upon it as a sort of foreign

possession, an outlying province that they came into possession of through a bad bargain which they were forced to accept. Of course this idea is all wrong; no such sentiment prevails, or has had any foothold in the Lower Peninsula for many years.

Yet it is true that the people have been slow in appreciating the value of the mineral resources of the Northern Peninsula. This is not to be wondered at, for it was a wilderness and inaccessible. But all this has changed, or is rapidly changing, and I am sure that the intelligent portion of the people of the Southern Peninsula realize very clearly the value of their northern mining interests and have every disposition to deal as justly with that section as with their own. It only needs that they should be well informed, that they understand what is desirable and necessary, and there will be little likelihood of any serious clashing of interests, and the feeling of alienation which has heretofore, to some extent, been entertained, will entirely disappear.

There is after all a mutual reciprocity of interests between the two sections of our State, notwithstanding that the one is almost wholly a mining region and the other, to an equal extent, an agricultural one. The Upper Peninsula has a population, largely of laborers who are foreign born. The labor element must always largely preponderate in that section; and if at any future period a contest were to arise between labor and capital, the force of numbers would be in the hands of the former.

The laboring population in Lake Superior, as before stated, is industrious and law abiding; there is little to apprehend regarding it. But circumstances may change; we cannot foresee what emergencies may arise; the labor problem is one of the momentous issues of the future. There is every manner of doctrine afloat, every degree of demagogery exercised. It is not easy to predict the manner of fruit that all the pernicious influences, to which the laboring men will be subjected, will produce. But if blatant agitators and secret manipulators shall in the future engender a dangerous antagonism between the mining companies and their employés, the farming population of Lower Michigan will constitute an important regulating influence, a valuable safeguard. Men who own their own farms, pay their own taxes, educate their children, make their own laws, etc., are not the class of men among whom communism and similar subversive doctrines meet with any favor. With such men, before all others, the rights of property are sacred. They can ever be relied upon to uphold law and order. The prosperity of the mines is a matter of great interest to the farmers, from the fact that the mining region is an important market for their produce; in proportion as the mines are worked, as our mineral deposits are developed, so will the population to be fed and supplied be increased. If our mines are flourishing and prosperous there will be a large population of consumers to be supplied with all the necessaries of life, thus furnishing within our borders one of the best outlets for our surplus produce.

Active mining in Lake Superior region means better demand for the husbandman's surplus; it means a better home market for whatever he has to sell. And the matter of a home market is one of the most important facts connected with farming. Michigan produces a large surplus of grain and fruit, and much of it finds a market in the Upper Peninsula.

The farmers will understand the close relation which their interests hold with the mines, and will be found ready to act in accordance with their understanding of what is best to promote those interests. It only requires that good feeling be inspired, and full information disseminated; prejudice and ignorance must be wholly obliterated, and the completest intelligence relating to the minerals of the State be afforded to all.

Perhaps no one thing has contributed more to help the iron mines the past season than the reduction of fifty cents per ton in the lake freights to Cleveland. It looked in the spring as if there would be very little ore sent out, but the drop in freight stimulated the industry greatly. Still, the past year has been one of great depression in the iron business; all the disagreeable features of the previous year have been repeated. The season opened with great uncertainty, and the trade has continued in a very unsatisfactory state throughout. In the spring, at the commencement of shipping, but very few mines had made contracts for their ore, and the sales of ore have been generally for limited quantities, made from time to time as the necessities of the consumers demanded.

Furnacemen have made few large purchases of ore; their policy has been to buy only as fast as consumed, and then at the lowest possible price. This course has, naturally, been an exceedingly unsatisfactory one to the mining men. It occasioned a continued anxiety and uncertainty in their business. They were unable to determine the quantity of ore that they would be able to sell, or the price that it would bring; and thus, in a measure, they have been "kept at sea," as it were, through the want of the necessary data to make up their reckonings. The mining companies have found it difficult to decide whether to go fast or slow in their mining work. They could not feel sure that the ore, if mined, could be sold at all, or if sold, that it would bring a price equal to the cost of production, so that in the end instead of realizing a profit there should not result an actual loss in the business of the year.

This "hand to mouth" policy in the matter of purchasing, in so important an industry as the ore trade, has a very depressing effect in the iron mining business; it unsettles values and begets anxiety and a want of confidence that extends to all branches of business in the iron region. The managers are afraid to push their work; they are frequently in doubt whether to go on or to stop altogether. If they mine ore and put it in stock, they incur the risk of tieing up capital, which may not be very speedily released. When they are sure of the market, sure that the ore will be in demand at fair prices, then the mining work goes on without interruption, summer and winter alike. During the latter season the ore which is

mined is placed in stock at the mine, where it remains until the opening of navigation in the spring, by which time it was, in former seasons, usually sold and the product of the mine for the remainder of the season also contracted for. But at the present time there is little disposition to mine ore faster than it is sold. There is, of course, a slight additional cost when the ore is stocked, due to the rehandling necessary in putting it into the cars. In the shipping season the ore is run directly from shafts, etc., to the cars or into the ore pockets, where it is run into the cars as required; there is no further shoveling after it is put into the tram car in the mine. At present, when there is so little profit on the ore to the mine, the cost of this reloading may represent the whole margin above cost that the business affords.

This tendency to caution is very manifest in the restriction of what is known as "dead " work in the mines, the exploring work that is usually done, in the drifts, crosscuts, shafts, winzes, diamond drill boring, etc., all of which is important and generally unavoidable work of a mine. It not unfrequently is the case that the prosperity of a mine is largely due to the intelligent and successful prosecution of this kind of work. At present, however, there is comparatively much less of it done, in nearly all mines, than formerly. There is a shrinkage in every possible way in the amount of work done, a tendency to economise labor, to do only what is seemingly unavoidable with view to the present, and thus to put off for the future, to relegate to more prosperous times, any work not immediately necessary to be done.

This restricted policy of work, which most of our mining men are constrained, by the condition of the ore market, to adopt to a greater or less degree, is generally the reverse of true economy. It is the true policy, the one pursued by all intelligent mining men, when circumstances do not prevent, to keep the mine well opened in advance of actual stoping, to keep it so developed and explored that there is a certainty of something ahead. This is desirable for many reasons; first, that the opening work can usually be done with greater economy during the winter season—the period when there is no shipping or immediate demand for the ore. There is then time to give attention to this work of opening and exploring the mine, which, if put off until summer when the ore is actually wanted to ship, the work must be hurried; the hoisting facilities may be sufficient only for handling the ore, there may be room only to break ore, and little space for sinking, driving or exploring. And then, in the active mining season, labor is more difficult to obtain and more expensive, so that such exploring and opening work which must be done in all mines, if not performed at the proper time, is sure to be more costly and less satisfactory. It is necessary in some mines, to a far greater extent than in others, to push forward this exploring work. In some mines it has to be done constantly to keep up the supply of ore, and in all mines, even the largest and richest, it becomes a necessity at times; for, however great the supply, it becomes exhausted and new deposits, lenses or pockets must be found. This involves the sinking of test pits, driving tunnels, boring with the diamond drill, etc., to determine the situation, extent or quality of the ore; to find new ore bodies, to know as far as possible the magnitude and the quality of the ore in order to decide with reference to the future mining work.

But even if there is no exploring necessary, there is always more or less opening work to be done, shafts and winzes to sink, drifts to make, pumps to extend, tramways, chutes, etc., to prepare, so that the stopes are ready to work and the labor of breaking ore may go on uninterruptedly when required.

Practical mining men speak of this work as that of having the mine well opened up in advance, so that the management may know within a reasonable certainty the quantity of ore that may be mined out within a given period.

It has been customary, until within the past two years, for the mine agents to make the contracts for ore in advance of the season of shipment. With the mine well opened, with the ore in stock and in sight in the stopes in the mine, it has been easy to estimate, in advance, the season's production. Of course the contracts cannot be made and fulfilled to a certainty, only in this way: They must have the ore and know how rapidly it may be mined; they must also know its quality, and this knowledge must be based upon a familiarity with the mine, the ore already mined and hoisted and the extent of the openings. Not unfrequently, in many of our small mines, or in opening a new mine, the owners of which are limited in means, the money is obtained by advances upon the ore from the agent who sells, or the purchasers; thus in some way the money necessary for further mining work is procured, frequently, by loans or advances based upon the probable output.

During the past season the product of but few mines was contracted early or in toto; it was sold from time to time to the furnace men or mill men in small lots, directly from the mines or from Cleveland, where it was in stock awaiting sale.

The ore has been sold at a lower price than has ever before prevailed in the history of our Lake Superior mines, being about one-half the price received four years ago, while the cost of production has not correspondingly decreased, nor could the mining cost be reduced very greatly, although materials have very much depreciated in value; but labor, the chief element of expense in the production of ore, has lessened about twenty per cent., and the royalty paid by these companies which mine on a lease remains, inmost cases, the same as heretofore. Altogether, it has been a discouraging year in iron mining.

The matter of royalty, so-called, is one that needs further modification to adjust itself to the requisites of all parties concerned. Very many of the mining companies do not own the fee of the land in which the ore is mined they simply hold under a lease for a given period, which provides for the payment of a certain sum to the owner of the land, by the company, for each ton of ore that is

mined. This payment is termed a royalty, and has usually heretofore, been fixed at fifty cents per ton; in some instances it has been seventy-five cents. Now, however, in the new leases that are made it is usually twenty-five to thirty-five cents per ton.

Fifty cents per ton royalty is too much, more than in most cases can be paid and leave any margin for the company. When soft ore sells, as it does now, at $1.60 to $2.50 per ton at the mine, the leasor has the best of it; he has none of the trouble, none of the risk, and is generally sure of his pay. These leases require that a certain minimum amount of ore shall be mined annually, that is, that the company holding the lease shall pay, at least a certain sum annually, whether any ore is mined or not. Of course, this is a burden which some idle mines have to bear, and which they do assume in preference to taking the risk of mining ore, in the present state of the market. When the mining cost and the royalty exceed the selling price of the ore the result must be suspension of work in the whole or in part of the mine until a better state of things exists.

The demand for ore is largely confined to that suitable for the manufacture of Bessemer steel. Bessemer ores, as they are termed, find a comparatively ready sale, but at low prices. Since the introduction of the Bessemer process, rapid progress has been made in the substitution of steel for iron for many of the purposes for which the latter material was formerly extensively employed. Steel rails have almost wholly displaced those of iron, and in the manufacture of every other branch of iron goods steel is more and more used in place of common iron; even nails are made of steel and sold as cheap as are those of common iron.

Steel rails are now sold at no higher price than pig iron brought a few years ago. This important fact, the rapid cheapening of the cost of steel to a degree to cause it to be substituted for iron in the manufacture of a great variety of articles, has had a corresponding influence on the iron ore business, making the demand largely for ores which are suitable for the manufacture of Bessemer pig metal.

The Bessemer process for the manufacture of steel, which has created so great a revolution in the iron business, and has become so important a factor in the railroad world, consists of simply converting cast iron into steel by burning away a portion of its carbon. This is effected by running several tons of melted pig iron, of a suitable quality, into a converter or large crucible, provided with tuyeres, through which a strong blast of air is blown. The intense heat generated by this operation burns up the carbon and the silicon, or at least a great portion of them, and leaves the mass comparatively pure. The hot air is driven through with great force for about twenty minutes, during which the flakes of slag are carried up by the flame streaming up from the surface, and are thrown off. The practiced eye of the foreman determines the moment when the blast shall cease; the metal is then in the condition of bar iron, and is changed into steel by immediately adding ferro-mangonese, spiegel-eisen, in sufficient quantity to furnish the requisite carbon and mangonese, when the metal is drawn off and cast into ingots.

Spiegel-eisen is a crystalline variety of white cast iron, made from manganiferous ore, and containing a large amount of combined carbon and from three to twelve per cent, of manganese. It is excessively hard, and derives its name from its lustre—Spiegel-eisen—German for looking-glass iron.

Bessemer steel, though inferior to the best cast steel in quality, is admirably adapted for rails used on railroads, and for many other purposes. It is homogeneous in structure, and when properly made, of the best of pig metal, with the requisite amount of ferro-manganese added, it possesses great strength and durability. The necessity of great care in the selection of the ore from which the metal is made, that is to be used in the manufacture of bessemer steel, arises from the fact that a small percentage of phosphorus destroys its value; even the presence of one five-thousandth of its weight in phosphorus renders the steel brittle.

It is a peculiarity regarding phosphorus that every particle of it which is contained in the ore will be found in the metal made from it; hence only such ores can be used for this purpose as are sufficiently free from phosphorus, and it is for this reason that ores are rated more with reference to the percentage of phosphorus which they contain than for their richness in iron. Though it so happens in the Lake Superior mines that the so-called non-phosphorus ores generally hold, also, a high percentage of iron. The ores that are highest in phosphorus are usually among the so-called low grade ores; ores that yield 50% to 58% in iron. But many of the ores that carry a large percentage of iron—63% to 68%—hold, also, a percentage of phosphorus too great for bessemer purposes.

The furnace men have learned to combine the ores; that is, to use enough of bessemer ore with some that contains too much phosphorus, so that the result shall be within the limits. Some of our ores are so very low in phosphorus, fortunately, as to allow the use with them of ores that otherwise would be valueless for this purpose.

The maximum of phosphorus which an ore may contain and be rated as bessemer is one ten-thousandth of its weight of iron; that is, for each one per cent of iron contained, the ore may have one-thousandth of one per cent, of phosphorus.

Very much of the ore of our Lake Superior mines is so near the limits that, although theoretically out, it is practically bessemer, and is probably used for this purpose by the purchasers. The anxiety of buyers to obtain ore that is low in phosphorus is due to the fact that with such ore they can use those that are cheaper, those that are too high in phosphorus.

The bessemer ore is mostly hematite. Some of the hard ores are bessemer, as the Champion, Republic and

Boston, but the great part of the hard ore is non-bessemer.

The same is true of the majority of the soft hematite deposits; they are mostly now bessemer, and some of them contain so large a percentage of phosphorus as to be entirely unsaleable at the present time. But some of the largest and most remarkable deposits of hematite ore are bessemer, and the list has been lengthened recently by the addition of the mines which have been opened in the Agogebic iron range. The ores found in this range are largely bessemer and exceedingly low in phosphorus, and are also high in metallic iron.

The Agogebic iron range is the most important mineral development that has been made in the State since the opening of the Menominee range, nearly a decade ago. The Milwaukee, Lake Shore & Western Railroad extends through the range, and has been opened from Milwaukee to Ashland, giving an outlet for the ore to the latter place, where an ore dock has been built, similar to those at Marquette and other points. The shipment of ore from this range began the present summer, as soon as the railroad was completed, and the work at a number of mines has been pushed forward, to be in readiness for mining and shipping ore another season. It is altogether probable that the aggregate of the ore shipped from this range the coming year will be large.

The ores in the Lake Superior iron mining region are spoken of as either hard or soft; the former includes the magnetic and specular; the latter comprises all varieties of what are understood as hematites.

The mines producing hard ore are all confined to what is known as the Marquette range, within a distance east and west of about forty miles—from Negaunee west. No workable deposits of hard ores have been found in the Menominee range or in the Agogebic. All the ores obtained in this district are classed as hematites, and are not magnetic.

Nearly all the hard ore mines yield both magnetic and specular. The former is sometimes exceedingly rich, yielding 66% to 71% in metallic iron, and also low in phosphorus. It is designated as black ore, is coarse, granular, and is occasionally found mixed with the specular. In the Republic mine the black ore and specular—slate ore it is called—occur side by side, the one lying against the other. In this mine the two are found in about equal quantity. It is not, however, generally bessemer and not always otherwise pure; there are extensive deposits of magnetic ore, too lean to be workable. More aid has been derived from the use of the magnetic needle in the discovery of ore than from any other source. It has been everywhere constantly employed, in this country, for this purpose, and while the deviations of the compass do not generally indicate the presence of ore in appreciable quantity, they are nevertheless sometimes due to this cause and have thus led to the discovery of many important deposits. But magnetite is widely disseminated in the Lake Superior rocks and thus affects the needle so that its deviations may be due, as they usually are, to the presence of magnetite in the rocks rather than to deposits of ore. Experience has shown, however, that in localities where the needle is strongly affected it is a good place to explore for ore, and the search, in such cases, has been rewarded with success with sufficient frequency to justify the popular faith, in this matter, that is placed in the magnetic needle.

Specular ore practically comprises, among Lake Superior mining men, all hard ore other than magnetic and the so called hard hematites. It is exceedingly variable in its appearance and texture, sometimes made up of bright-glistening-micaceous like particles, rendering the mass friable, and causing the shining scales to adhere to the hands, etc., when a piece is handled. This variety is sometimes designated as slate ore; it is beautiful in appearance and is found in great purity and quantity at the Champion and the Republic mines. The slate ore at these mines will average 66% and upwards in metallic iron and is low enough in phosphorus for bessemer pig.

Another valuable variety is a very fine grained compact ore, sometimes massive in occurrence and as frequently somewhat laminated, seamed or jointed, so that it may be broken up in slabs of the purest and most beautiful ore. Ore of this character is found at the Lake Superior, Boston and other hard ore mines. The term specular, from speculum, meaning mirror, is an old one, having been long in use to designate this species of ore, owing to its brightness. Sometimes it may be made to present the appearance of polished steel. Magnetic iron ore is a compound of oxide of iron and a sesquioxide. Specular ore is a sesquioxide composed of three parts of iron to three of oxygen; magnetic is chemically the same with oxide of iron added.

All the other workable deposits of ore are classed under the head of hematite. These are of every variety of appearance, color and texture—red, brown, yellow and every imaginable shade of color. It is sometimes exceedingly fine grained, firm and hard as flint, and sometimes as soft as clay, and there are ores of every degree of texture between these extremes. Not unfrequently there are several of them in the same mine.

Spathic, or carbonate of iron, does not occur in any considerable quantity in Lake Superior, though some of the hematite ores contain quite a percentage of lime, magnesia, and maganese.

Bisulphide, or iron pyrites, is not found except in a limited way, occasionally appearing in the rocks or in the ore.

Some of the hematite deposits are exceedingly valuable, are nearly as rich in iron as the best hard ores and as low in phosphorus. In fact by far the greater proportion of the bessemer ore obtained from the Lake Superior mines is soft hematite. The value of a hematite ore can only be determined by analysis or by using it in the furnace. Its appearance affords very little data even to the most experienced eye. Some of the most

unpromising ores, in appearance, are among the most valuable in the furnace.

It has become customary now to have frequent analyses made of the ore in all our mines. The whole character of the iron business has changed in this respect in the past ten or twelve years; formerly there were no chemists in the iron country. If an analysis was occasionally made it was done by sending the samples to New York, New Haven or Philadelphia. Now they must know what an ore analyzes, not what selected specimens, but what an average of a great number of samples, taken so as to represent the entire cargo or stock pile, affords. This work is done at both ends of the line, it is analyzed by the shipper and by the purchaser. In fact it is frequently only bought upon a guarantee, or what is nearly equivalent to it, the assurance that a given analysis shows an average of the whole. When received, sampled and analyzed by the consumer, if the results do not agree, even though the non-coincidence is but slight, there is sometimes trouble.

In every mine there has been a large number of analyses of the ore made, and some of the companies employ a chemist at the mine or at Cleveland to constantly sample their ore. Mr. C. E. Wright, State Geologist, has for twelve years maintained a laboratory in Marquette and has made thousands of analyses of ore for the mining companies. He is esteemed by mining men as the best authority in this matter of ore determination.

Among the best soft ores is the dark blue ore found at various mines in the Menominee Range; it is beautiful in appearance and of superior quality, eagerly sought after by the steel makers. West of the blue ore of Iron Mountain, there are no mines yielding bessemer ore. Some afford an excellent ore for foundry purposes, but for this there is not a large demand.

The rocks associated with the ore in the Marquette iron range are jasper, quartzite and chloritic schist. In the Menominee and in the Felch Mountain districts, limestone is also to be included. In the latter the limestone is hard and crystalized and the belt is of great width. It underlies the ore and has cut it out in all the valuable deposits that have been worked. In fact the ore, the fine, dark blue ore, the finding of which awakened such great expectations regarding this region, seems to be but a wash, shallow fillings in the cavities of the limestone.

The limestone belt in the Menominee Range also underlies the ore in all mines east of Iron Mountain. At this point, however, it is in the hanging wall and the dip is to the north, further east the dip is southerly; between Quinnesec and Iron Mountain a change has taken place in the dip of the formation. Which is the true position of the ore, overlying or underlying the limestone, is a matter that has not been satisfactorily determined, but it is a question that will be of sufficient practical importance to require that it be settled at no distant day.

The schist that occurs with the ore is usually called soap stone or soap rock, from its steatitic character. It is sometimes a source of danger in the mine when it occurs in the hanging wall, from its readiness to fall; it requires to be held in its place by pillars or stulls. The quartzite usually overlies the ore and is considered a very desirable hanging, from its commonly firm and compact nature. The ore occurs in the rocks with which it is associated in every manner of form of deposit. In common phraseology it is spoken of as the ore vein. But the deposits partake very little of the characteristics of a vein proper. They are generally very irregular, pockets or lenses, and there is little certainty when or where they may occur or to what extent they may continue. Pockets are of all sizes, from those holding but a few pounds to those containing thousands of tons. Occasionally there is considerable regularity in the ore deposit, as at the Chapin mine, which has thus far shown no variance in the dip or magnitude of the ore lense.

To what depth the ore will continue is of course only a matter of conjecture. Some of them have already considerable depth, as the Champion, with no sensible lessening of the ore. The ore lenses pitch downwards and hold their size.

The opinion prevails that there is persistence in the occurrence of hard, or especially of hard specular, ore. This sentiment is doubtless due to the continued ability of the old mines to annually furnish their accustomed product, and from the fact that all predictions that were formerly made of their speedy extinction proved utterly fallacious, and the old standbys still hold their own.

At Ishpeming the ore occurs in a great synclinal of the irregular geological fold made by the pressure of the forces to which in some former period the earth's crust was in this region subjected. It constitutes a wide basin, in the minor folds of which the ore is found. To what depth the ore may be found to continue, time and further exploration will show; but years ago an upper fold, now plainly to be seen in the wall of one of the deep, open pits in the Lake Superior mine, was pronounced by good authority to indicate the limit of the ore in that mine. The sequel has proved the erroneous-ness of the hypothesis upon which the conclusion was based. There has not time enough elapsed since mining work began in the iron region to afford opportunity to comprehend the geological structure thoroughly. Such scientific knowledge is cumulative, and to gather the facts is a work of time; trained observers, who avail themselves of every opportunity to garner facts, must in time evolve important scientific and practical results. But practical work and scientific exploration must go hand in hand to educe results of certain value. There is little faith to be placed in generalizations and hypotheses regarding our iron deposits that are based upon surface examinations only. There are deeper questions to be determined; questions that are within the domain of pure science.

The Lake Superiar region is, geologically, of great antiquity. In times long past it has been the scene of great elemental catastrophe. The rocks have been

thrown up, depressed, metamorphosed—subjected to every manner and degree of pressure, contorted and twisted, imposed, superimposed, and then reversed; broken up, dissolved, and again formed and resubjected to the stupendous forces of the elements. So that, plainly, it requires all the skill of the trained observer, aided by every appliance of modern science, to unravel the skein.

The origin of our ore deposits is still a mystery; of hypotheses there have been plenty, but they are based upon half knowledge, conjecture, too little observation and too few facts. The great forces, which were at play in the formation of these ore beds—chemical, mechanical, igneous—have left their traces in the rocks and the record can be deciphered, the perseverance and the skill of the microscopist may master the problem. I would not say that very much that is important and valuable has not been accomplished in the geological study of the Lake Superior region, but the kind of work is required that Mr. Wright, the new State Geologist, has recently entered upon, the work of the micro-lithologist, to interpret the history which the rocks themselves have for ages held locked in their constituent crystals. It is the key which, in the hands of the properly skilled interpreter, in possession of all the facts, shall unlock the final secret of the rock formations of this most remarkable region.

It is surprising how much has been accomplished in the brief period that mines have been worked; more than twenty-five millions of tons of ore in less than twenty years have been mined and shipped from our Lake Superior iron mines. It is barely thirty years since the first test of the ore was made, and what a remarkable result! No other iron mining region can make such a showing; and yet its success is due to intrinsic merit alone. It possessed seemingly few of the advantages due to location that belong to other iron mining districts. It was isolated, a wilderness, severe of climate, far from the coal fields to which its ores must be taken for reduction. But solely through the surprising richness of its ores and the great extent of the deposits, the region has surpassed all its rivals. And to day there is no iron mining region that has so successful a record and none that has so promising a future.

In describing the mines, I shall try and avoid what I have heretofore stated in previous reports. All have been visited and examined that are working, and the endeavor is made to as briefly as may be, outline their condition as it appeared at the time of the visit. Until within the past twelve years the mines were all worked in open pits, and at all the older mines there is a succession of great cavities to be seen that cannot fail of an effect even upon those who are familiar with them. The stranger walking over the extensive location of one of our older mines is impressed with the magnitude and the rough and rocky aspect of the monster chasms which everywhere meet his eye. A sudden trembling of the rock beneath his feet, and the smothered reverberations ascending from its depths, remind him that all the labor with which the years have been filled is not comprehended by the eye. Investigation will reveal to him that down in the earth, far below the level of the yawning abyss into the depths of which he gazes, brawny men with toil-hardened sinews and blackened faces, have formed caverns into which the light of day never enters; caverns no less in magnitude than those which greet his gaze; and anon as he ponders, the rumbling of the ascending skip strikes his ear, and there is revealed to him in its contents, as it comes into view, the product of their toil.

I do not propose to take up the iron mines in their chronological order, but I shall commence with

THE JACKSON MINE,

for the reason that it is not only the oldest, but it may be said to have been the first to establish the superior value of our Lake Superior ores. And this record for excellence which it thus originated, it has ever remained among the first to maintain.

The Jackson is one of the anomalies, in a geological way, of this remarkable region. It presents as many peculiarities as can be found in any mine in the district. It is an epitome of the entire iron mining business in this district. The difficulties which are met with in other mines are encountered here, and the efforts which are made to surmount the discouragements meet their reward.

The Jackson has been worked for thirty years and it has been, a constant producer of ore of the best quality. The location presents numberless open pits, very wide and deep, with rugged jasper walls, but for years the mining has been mainly below the bottom of these. At no mine can more places be seen where ore has been taken out than here. The Jackson has been a large producer of ore and probably will continue to be so; but it has not recently, nor is it likely to be in the future, a large producer as compared with several others. The product has been kept up for years past by doing a good deal of what may be called "scramming," a few men working here and there at different points and in small stopes and abandoned places. These contributions to the product from the main stopes have very materially increased the aggregate, annually. The ore has been found mainly in pockets, some of them very large, in the jasper. In all directions in the several mines, drifts have been cut in search of these pockets of ore, and the labor has been generally rewarded with a greater or less measure of success.

The latest discovery of importance is what they call No. 8 pit, the most easterly working in the old mine, close to the main lines of the M., H. & O. and the M. & W. railroads, and also to Main street, in the city of Negaunee. No. 8 is really an extension, easterly, of No. 7, one of the old pits of the mine. The discovery of the ore body was made in much the same way as was that, a few years ago, in No. 7, which proved to be such a valuable one.

The first level in No. 8 is on the same plane with the bottom of No. 7 open pit. They had drifted easterly a long distance, and accidentally a party of scrammers, not long ago, struck into the ore which, upon further trial, proved to be a large body.

A skip road shaft has been made into it. This shaft is 200 feet east from No. 7 shaft, and goes down to the south at an angle of 66° from the horizon, and is 130 feet deep on the lay, or 110 feet vertical; its direction is due north and south. The first 60 feet the shaft goes through ground that has been previously worked, drifting through it from No. 7. These previous workings were limited on the south by a wall of jasper, which had been assumed to indicate the limit of the ore in that direction, but it was by working south through the jasper that led to the discovery of the ore. Along the south side of this jasper, and in contact with it, is a deposit of hard ore —very fine grained specular ore, of as good quality as any in the Jackson mine. Its width, where cut through in the lower level, is about eight feet; in the level above it, somewhat less.

South of the shaft, in the upper level, they have two drifts in the ore 75 feet; these are 66 feet apart, and are connected at the south ends by a drift, which is all the way through ore. To what distance the ore reaches south of this drift has not been determined, except at two points further west. It evidently makes wider as it goes east.

A peculiarity in the ore deposit in this, as also in No. 7 pit, is that it rises up as it goes south. The hanging wall of the ore seems to conform to the surface contour of the ground, which rises to the south. The ore has not been explored east of the shaft, the east drift being in the line of the shaft, north and south. It is about a thousand feet from the shaft to the company's east line, so that if the ore continues they have space enough for working for many years.

There is also a small drift extending southwesterly, through the ore, to intersect the drift that is 66 feet east from the shaft. About 120 feet east of the shaft is a third drift going south about 25 feet, through ore, to the jasper. It was in this drift the ore was first found. A winze is sinking in the end of this drift, to be met by a drift extending east from the second level in No. 8 shaft.

That the ore body widens as it goes east is shown by the fact that in this west drift it is about twenty-five feet wide; 60 feet east it is 75 feet wide, and 66 feet further east the south margin has not been reached in the same length of drift. Here, also, in the southwest angle of the exploration a winze is sinking to the level, 70 feet below. This lower level had not been opened at the time of my visit, but the shaft was down and a drift south fifty feet, through jasper, had been cut, and they were already some distance in the ore. The hard ore vein lying against this jasper, on the south side, shows a greater width than it is above.

This drift to the south from the bottom of No. 8 shaft costs $18 per foot; it is in hard jasper, and the drill work is by hand, the mine having no compressor. The ore in this pit is identical with that found in No. 7, hematite, varying from fine brown amber colored to yellow; and in texture, from soft, pliable to compact, hard hematite. It varies considerably in appearance; at one point in No. 7 is found a black, slaty ore that comes out in rough sheets of the thickness of stove plate, and resembling it in appearance.

The ore is all good, varying but little in its chemical qualities. Analyses show a percentage of metallic iron of 65% to 68%, and of phosphorus of .080%. There is also a varying percentage of manganese and of magnesia; the latter is visible all through the ore.

No. 8 is the best showing for ore in the Jackson mine, at the present time. It comes very opportunely, just as No. 7 is nearly exhausted, and if it pans out as well as did the latter, it will be a fortunate thing for the company.

No. 7 is an old pit; but, as will be remembered by those who have read the previous reports, it had become, apparently, depleted of ore. The workings had been in a large, open pit, and far underground to the north, beneath Main street and the city.

About four years ago the discovery of the ore to the south was made, and since that fortunate "find" was made several levels have been extensively opened below the bottom of this pit and to the south of it. From these new openings upwards of 100,000 tons of ore have been extracted since the discovery of its existence was made. The shaft is 250 feet to the bottom from the surface. The shaft is just north of the ore, and in the first, second and. third levels some immense chambers are left where the ore has been taken out, leaving great pillars which support the roof. This deposit near the shaft was 80 feet in length either way, north and south, or east and west, and from it radiate, in all directions, the drifts which have been made in the ore or in jasper. Some of them followed "leads" of ore, and terminated in pockets of greater or less magnitude; others, exploring drifts, are all in jasper.

The occurrence of these pockets of ore in this great body of loose jasper is singular enough. Nothing could be more uncertain; sometimes the pockets are wide and large, irregular in form, round, oblong, cylindrical, spindle-shaped, or standing in the rock like an immense carrot—in fact, of every conceivable shape, but always of pure ore. Sometimes the ore has formed about an elongated mass of jasper that is left standing like a tall column or spindle, the ore having been worked away from around it.

The most extensive workings are seen in the second level, which is about a hundred and fifty feet below the surface. All the ore above the first has been worked out and very little is left even in this, except in the pillars, which are large. From the chamber near the shaft, a chasm from five to thirty feet in width is left, opening across the formation to the south five hundred feet and extending vertically a hundred feet. The same fact is noticeable here that was spoken of in connection with

No. 8, that is, the ore rises up as the drift goes in south, conforming to the topography of the surface. This ore extended down to the level below, but has been taken out and the space filled with rock. At the south end it makes an abrupt bend and cornea around to the east like a hook, and in going south the hanging wall comes down and the ore is turned gradually downward until the rock meets the floor of the level, and the ore proceeded onward into the depths below. This long deposit of ore across the formation illustrates the singular position the ore assumes in this jasper; these pockets have the most fantastic forms. Sometimes there are natural cavities in the ore large enough to admit the body of a man.

Between the second and the third levels considerable ore remains to be taken out. In the third the ore held out nearly as large as in the second, and it holds well for half the distance down in the fourth level, but at the bottom the ore has disappeared. The shaft is down to the fourth level, and the drifting thus far done beneath the ore in the levels above, develops only rock. In fact, a rise of forty feet was found necessary under the main ore body in the fourth level in order to reach the ore. It is apparent that the bottom of the ore lenses that have been worked in this pit has been reached. If others are found at greater depth they must be independent of those above. Going east from the shaft in the second level forty-seven feet, a party is drifting towards No. 8 to meet the winze mentioned as sinking in the west end of that pit. The drift is a mixture of ore and soap rock.

There is also in No. 7 a hard ore vein, the ore is of the best quality, but the vein is not large enough to have proved of much value. The rock that has been broken has been used in the mine for filling. In fact, all through the Jackson mine a good deal of filling has been done; in No. 7 open cut and in No. 8 the old openings have been filled up solid for sixty feet.

To the north in these pits, are extensive old workings reaching far under ground; one drift, 700 feet in length, goes directly beneath Captain Merry's house, at which point a small vein of beautiful hard ore was encountered.

The engine house standing south of this mine has lately received a new plant of hoisting machinery,—Meritt's external friction gear, made at the Lake Superior Iron Works, Marquette, four winding drums and two engines each 14x20. They do the hoisting in Nos. 7 and 8 shafts. Captain Merry states that he never wishes to have anything work better than this machinery. He had made two changes previously to getting this, but neither proved satisfactory.

Capt. Merry has hit upon what he deems to be an effective method of keeping his boiler flues clean and free from incrustation, which is simply to conduct the discharge pipes into the water tank. The oil which the moisture holds serves to keep the pipes clean, relieving them from the necessity of stopping to clean the boilers.

A new ore pocket has been made for No. 8, close to the top of the shaft and over the railroad track. It has a capacity of 150 tons. This pocket has some novel and interesting arrangements for convenience in discharging its contents.

Next to No. 8 the best outlook for ore in the Jackson mine is in what is called south No. 5. Going down to the floor of the open pit 100 ft. below the surface, and going west, we pass into a chamber from which the ore has been removed, two hundred feet long, if we include the arched pillar which supports the roof, and thirty to fifty-five feet in width. This ore nearly reached to the surface and goes down and is now opening in a level below where it is shown, by the main drift and two winzes that have been sunk, to be as good as found to be above. This lense terminates to the east in a sharp wedge, coming suddenly to an edge. It is hard No. 1 specular ore, yielding, metallic iron, 65%, 66%, 67%; and in phosphorus an average of .045%.

No. 6 mine ore is the same in iron but up in phosphorus—about .080%.

North of this hard ore lense and parallel with it but separated from it by twenty feet of jasper, was a lense of soft ore—Jackson mine hematite. The chamber is fifty feet wide, seventy-five feet high, and two hundred feet long. A vertical section of the deposit would be styled a saddle bag in form, since it has a north and a south pocket partially separated by the upward protrusion of the jasper. The north deposit is smaller and comes abruptly to a termination. Going east through a short cut we come into a chimney that has been worked out upward seventy-five feet and thence north two hundred feet, into north No. 5 open cut. In south No. 5, in the level below the one just described, they have a stope of ore upwards of a hundred feet long and, perhaps, thirty feet wide; it being slightly narrower than the ore was above. The ore finds its way from this pit, as well as from all the others, in this, the old mine, out through the tunnel. It is hoisted up to the tunnel level at various points and dumped into pockets, some of which are of large capacity, and thence thrown into railroad cars that are hauled in and out by the company's pony locomotive. Near the shaft from which the ore in south No. 5 is taken up is a large chamber eight feet in diameter; its floor is a hundred and seventy-five feet below the surface, and while it has been worked out above, the bottom is ore and thus there is the prospect of good stopes below. Two winzes have been started down, but discontinued for the present.

West from the shaft they are driving towards No. 6, southwest, and have but a few feet more to bring them into a body of ore. Sixty feet below a similar work is in progress for the same purpose.

A drift is also extending southeast, between south No. 5 and old No. 2 pit, to explore the ground; the drift is two hundred feet below the surface and is in sixty feet.

Years ago, when the ore all lay above the tunnel level, it was easily handled, being run down and out to the pockets—now, of course, it has to be hoisted up to the level of the pockets. North No. 5 has now no large deposits of ore in sight; it has been a large producer and

there are large openings, both surface and underground, made by removing the ore. In one instance is an opening, cylindrical in form, twenty feet in diameter and a hundred feet long—it was a chimney of ore surrounded by jasper. In this mine there are men all the while scramming in the walls of the open pits— as in south wall of No. 6. It is a hundred feet high and holds in the jasper very much clean ore. The men work in this wall partially suspended by a rope about the body, which is fastened to the surface above. They break out the rock and allow it to roll down to the bottom, where it is sorted.

The south No. 5 shaft is down two hundred and eighty-five feet from surface; it faces east, and through it all the ore is hoisted in this part of the mine, and mainly dumped into the big pockets situated west side of shaft. All the rock taken from the drifts, etc., is left in the mine. It is used for filling at points where filling is necessary.

There is very little timber used in any part of the Jackson mine; occasionally a few stulls are necessary, as a drift running under a rock filling is timbered. The walls are good and pillars are relied upon, and when they cease to be required they are mined out and the walls kept apart by rock filling or left to cave in, as desired.

No. 6 shaft is west from No. 5, and away to the west, beyond main street and the lines of the railroads, is the Merry pit, which a few years ago was a very promising showing, apparently, a great body of ore. Its glory has departed and so has the ore, for there is little of it to be seen in the mine now. The Merry pit ore is hard specular, very tough and fine grained, with steely lustre. The pit was as complete an illustration of a "pocket" as can be seen in any soft ore mine. It is about three hundred feet long and was worked down for about fifty feet as an open pit, when it went under the hanging wall and continued down on the dip to a depth of a hundred and seventeen feet, when the hanging wall came suddenly around to the foot and cut off the ore entirely. They are stoping at the north end, where it is narrowing up, also doing a little at the south end, but there is nothing encouraging to be seen in the pit.

North of it is the old North mine, so called, that has been abandoned and is full of water.

Futher west and northwest a few hundred feet are the drill holes that were made a few years ago—three in number—in one of which thirty-three feet of ore were bored through, in another twenty feet, and the third twelve feet. It may be desirable to endeavor to strike this ore from the Merry pit. It would seem to be a good plan to put a diamond drill in the bottom of Merry pit and with it explore the ground between the pit and the former drill holes bored from the surface. If ore is found in this ground in any quantity, then it will be perfectly safe to drift in that direction and the ore obtained will help carry the cost of the work. It is a little surprising that more use is not made with the diamond drill in this mine; particularly it should be used in this instance.

Underneath the bottom of Merry pit is a drift that was made from No. 6 mine to explore the ground; it passes directly under the body of ore, but is all the way in rock and so did not discover the ore. Above this, in the main pit, they are opening a drift to the southwest which is in forty feet; it is for the purpose of exploration—searching for ore.

No. 6 has for years been the main stay of the Jackson mine; the product is the best of Jackson mine hard specular ore. The deposit has continued vertically down, with a width of from ten to fifty feet and a length of five hundred feet of ore, and frequently there have been, making off into the foot or hanging wall, pockets of ore, some of them of great size. But the days of this mine are apparently numbered. At the bottom of the mine, four hundred feet down, little ore is to be seen. So far as this lense is concerned the chapter is closed, the bottom is rock. What further exploration may discover remains to be ascertained; but so far as is now known there is but little ore left to mine.

No. 6 mine presents some very singular features, as for instance in the bottom level the ore made two immense pockets going west; that is, the regular vein widened out into a pocket of ore thirty feet wide and a hundred feet long, and then south of it, and separated from it by a narrow wall of rock, was another independent pocket, still greater than the former, a sort of an ellipsoid, fifty feet by one hundred in dimensions.

In this deposit there is still some ore, in the bottom and at the extreme ends, but in the north deposit it is all worked out; and at every point is only rock.

The other old pits in this portion of the Jackson mine, the No. 3, No. 4, etc., and the Pioneer mine are no longer worked, except in a limited way by scrammers. These have all been large producers of ore but rate among the things of the past, and now No. 6 must be added to the list and also the Merry pit. Just where the ore is to come from, if a large product is required, it is not plain to conjecture. It will be interesting to see what next shall "turn up" in the way of discovery in this portion of the old mine.

The only other mine of this company of which mention has not been made is the South Jackson, in the southeast corner of the section, about a hundred rods south from the mines thus far described.

South Jackson consists of a great number of hematite open pits and underground burrowings, made indiscriminately wherever ore could be found. And this is in nearly every point in this particular place. The only trouble is to find where the ore is sufficiently clean to mine. It is a mixture of jasper and ore, with occasional pockets in which the ore is free of rock. It is a bessemer ore and also holds a percentage of manganese, chromium, magnesia, etc., and although it is but moderately rich in iron it finds a ready market but at a low price, selling the past season at $2.25 per ton in the cars at the mine. The percentage of iron will average 55%. The ground at the South Jackson rises to the south, and the mine workings extend to the south line of the property at the east end, arid to the greenstone

further west. A tunnel has been cut through the hill for the admission of the railroad cars to the mine. The ore is brought to the pockets at this tunnel level, and thence run into the cars. The mine, in its deepest workings, is down a hundred and thirty feet below the tunnel level. Next to the McComber, the ore is a little higher in iron but also higher in phosphorus, being 61 per cent metallic iron and about .075% phosphorus. There is considerable of ore here, but as the ore is not very salable it is not worked. Also the McComber being idle and full of water it is desirable to avoid breaking through, and thus causing the necessity of pumping the water from the McComber mine also.

No mining was done in the South Jackson until in July, when the reduction in the ore freights of fifty cents per ton was an encouragement sufficient to induce the management to commence operations. It does not appear, that to a certainty, this mine will afford a large product. The ground has been pretty well worked over and they have no very large stopes now in sight; but further exploration will doubtless find other deposits, possibly equal to those that have been worked out. The Jackson mine has no compressor; all is hand drill work. The workings are at so many points, so scattered over a large location, that it would be inconvenient to convey the air to all the points.

The product of the different pits for the past year is about as follows:

No. 5—bessemer ore, hard specular, all first class, 18,000 gross tons.

No. 6—Non-bessemer ore, hard specular, all first class, 16,000 gross tons.

Nos. 7 and 8—Non-bessemer, hematite, first class, 16,000 gross tons.

Merry Pit—Part bessemer and part non-bessemer, hard specular, first class, 10,000 gross tons.

South Jackson—bessemer, hematite, 8,000 gross tons.

The following table, taken from the books of the Jackson Iron Company, shows the number of men employed, their nationality, and the distribution of the laborers of the mine, and also the average wages paid per day:

Men employed at Jackson Mine in the Month of November, 1885.

	Laborers.										Miners.							
	Finlanders.	English.	German.	Irish.	French.	Swedes.	Canadian.	Dane.	American.	Total.	Finlanders.	English.	Irish.	Swedes.	Danish.	American.	French.	Total.
No. 8	....	....	....	1	....	....	....	1	....	2	....	6	1	2	....	2	....	11
No. 7	....	2	....	1	....	....	....	2	....	5	....	20	2	....	....	2	....	24
No. 5	....	....	....	2	....	....	....	4	1	7	....	9	9	3	5	1	1	28
No. 6	5	....	1	....	....	....	....	2	....	8	1	24	....	....	3	....	....	28
Merry pit	....	....	2	1	....	....	....	3	....	6	....	15	....	....	1	....	....	16
Scrammers	....	....	....	....	....	....	....	....	....	....	....	6	....	....	....	....	....	6
Carpenters	....	1	2	....	....	....	1	2	....	6	....	....	....	....	....	....	....	....
B. B. shop	....	3	....	....	....	....	....	1	2	6	....	....	....	....	....	....	....	....
Machinists	....	3	....	2	....	....	2	2	5	14	....	....	....	....	....	....	....	....
Teamsters	....	....	....	3	2	....	....	1	3	9	....	....	....	....	....	....	....	....
Surface men	....	2	1	1	....	....	1	1	3	9	....	....	....	....	....	....	....	....
Totals	5	11	9	11	2	....	4	19	14	72	1	80	12	5	9	5	1	113

Average wages per day for laborers for the year 1885, to December 1, $1.65 4-10.

Average wages per day for miners for 11 months of year 1885, $1.85 2-10,

The above table does not include the men working at South Jackson. A party is mining the ore in that mine on contract, and at present writing ten men are working at the mine.

Much of the labor done at the Jackson is what is called day work. The wages are so much per diem. There is less contract labor here than is usual at mines. The drifting and sinking is done by contract, but much of the ore breaking is day work.

The impression prevails that the Jackson management is a little slow, a little old-fashioned, somewhat behind the times, etc. This opinion, which some people entertain, is supported by the fact that the company has no compressor nor power drills, and does but little diamond drill work. No doubt mining work in the hard ore veins could be more cheaply and rapidly done with the aid of power drills. But Capt. Merry has many good reasons to offer in favor of the course pursued by the company, and it must be allowed that his quarter of a century experience at the mine has given him a good opportunity to judge. His mining methods have brought good results.

The formation of the Jackson has many peculiarities, and it is plain to see that a course applicable at other locations would be less effective here.

The ore is largely used by the company at its furnaces at Fayette, so that only a portion of it goes into the general market.

The Negaunee Concentrating Works, erected a few years ago near the mine for the purpose of crushing the jasper and saving the ore which it contains, have proved a failure. They were operated a short time and closed down two years ago permanently, as is generally supposed. There were found to be many drawbacks; the rock held too small a percentage of ore; the ore and rock do not separate sufficiently; the shoes of the

mortars 'and grinding rollers wear out too rapidly; the percentage of iron in the product after the manipulation was completed was too small, and the market value of the ore too low to render the business self-supporting.

It appears to have been a pretty expensive experiment, but perhaps large expenditures with poor results are not infrequent in mining regions.

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

Year.	Gross Tons.	Year.	Gross Tons.
Previous to 1856	25,000	1871	132,297
1856	417	1872	114,910
1857	12,442	1873	130,131
1858	10,909	1874	94,708
1859	28,377	1875	87,283
1860	41,296	1876	98,480
1861	12,919	1877	80,360
1862	46,096	1878	81,120
1863	77,237	1879	112,921
1864	83,905	1880	120,622
1865	65,505	1881	118,939
1866	92,287	1882	93,679
1867	127,491	1883	71,278
1868	130,324	1884	76,626
1869	125,908	1885	67,037
1870	127,642		
Total tons			2,495,367

Capt. Henry Merry, Superintendent and local agent, Negaunee, Mich.

Major Fayette Brown, general manager Jackson Iron Co. Office, Cleveland, Ohio.

THE CLEVELAND MINE

lies next west of the Jackson; the lands of the two companies adjoin each other, but the Jackson mine is in the western limits of the city of Negaunee, while the Cleveland mines are mainly in the east part of the city of Ishpeming. They are not only contiguous in position but they are practically coequal in age, and the companies have been from the very earliest period of iron mining in the Lake Superior region colleagues in the work. There is nothing that may be said favorable in the history of the Jackson, that may not also be affirmed with equal force of the Cleveland. Still, there is very little similarity in the mines. The situation of the ore, the occurrence of the deposits, the peculiarities of the formation are quite different in the two mines. The Jackson ore is found in lenses and pockets embraced in a wide formation of broken jasper, and the hard ore and the soft ore found together in all parts of the mine; hard ore and soft ore deposits are worked in nearly every pit. Not so at the Cleveland. The ore is all hard specular, with a lesser amount of magnetite, occurring in the folds of massive quartzite and banded jasper. The hematite is a mile to the south. In previous reports we have described the explorations which were extensively made with the diamond drill on the Cleveland property; and the work has for several years been in the direction of developing some of the "finds" which were thus made. The result, in some instances, illustrates the fact that, however thoroughly explorations are made with a diamond drill, there is no absolute certainty regarding the ore until it is fairly opened with drift or shaft. One example of the truth of this statement is the company's experience in J shaft. Here a vertical boring had been made, which at a depth of 357 feet passed through fifty-two feet of No. 1 specular ore. This was one of the holes selected where to sink a shaft. The shaft has been made, a fine one, covered with a good shaft house and connected with the main engine house; also provided with wire rope connection with No. 1 pumping engine house. In fact the management expected a mine; they had every reason to suppose that they should open one; the other borings which had been made in the vicinity aided in establishing the belief. But alas for their hopes; no ore of any considerable amount was found. The drill had bored through a narrow lense of ore that simply went down and had no lateral extension. Cross cuts and drifts were of no avail and the shaft has had to be abandoned. Thus a large expenditure has been incurred, based upon a diamond drill exploration that has given only disappointment and cost. No company in the country has made more use of the diamond drill than the Cleveland; innumerable holes have been bored from the surface, in the vicinity of the mine, and at places on the property where exploration was desired. The drill has also been much used in the mine, underground, for exploring work. Of late years this machine has been the guide in all the advance mining work at the Cleveland. Where shafts are sunk they are preceded by a drill hole. The drifts in the mine are extended on the line of a previous drill hole. The intention is that before commencing they may know what is to be found when the work is consummated. It costs less to bore through the rock than to drift through it or to sink in it—and the boring may determine all that it is necessary to know.

Three hundred and fifty feet west from the shaft just described, which was sunk in the line of J drill hole, is K shaft, now called the Moro pit. The shaft is four hundred feet deep and is vertical until the ore is reached, when it inclines to the west, following the ore. At a depth of 300 feet from the surface they encountered a “cut-off" of rock; that is, the rock comes in on the west and cuts off the ore, which is here six feet from the shaft, but in the second level this limit of ore is fifty feet west of the same vertical line. Thus the ore makes rapidly west as the shaft goes down, so that at the bottom of the mine the rock is 120 feet West from the point where it first appeared above. In fact they are following a lense or chimney of ore that pitches down to the west and gives a length of stope that has been increasing, and is now, on the third level, 120 feet long.

South from the shaft is another lense, the discovery of which was made with the diamond drill, and which has been opened and worked. From this south lense is mainly derived the product of this shaft. It is reached in the second level by a cross-cut drift, through hard jasper, 270 feet long. The ore has been worked out, leaving a

chamber 200 feet long east and west, and 10 feet to 18 feet in width. Near the end of the drift a winze is sinking hi the ore to meet a similar tunnel also driving south in the third level, sixty feet below, to the same body of ore.

This lower drift follows a drill-hole, as did the upper one, and is now in a distance of a hundred feet. The drill showed that the ore was only a hundred and seventy-five feet at the third level, so that they have only seventy-five feet more to drive. Thus these lenses are apparently coming together, having gained a hundred feet in a distance downward of sixty feet. If they come together, as they thus appear to be doing, they will perhaps make into a large body of ore. They may be the upturned edges of a synclinal fold which deeper will come together under the hanging. The shaft is down to the fourth level, but the ground has not been opened around it.

The ore is hard specular, nearly all first-class, but non-bessemer. The drifts are about 7 x 9 feet and cost $12 to $14 per foot. The hope is entertained by the management that these lenses of ore will not only come together and greatly increase in magnitude, but that the ore will continue and be found to form the body of ore which was bored through in what is known as the Union drill hole, north of the old depot of the M. H. & O. R. R. Co. This hole was bored a number of years ago by the Cleveland and Lake Superior Companies, jointly, and in it was found, in the aggregate, a hundred feet of ore.

The shaft is operated by wire rope transmission from the main engine house, upwards of 1,200 feet to the northeast; pipes are also laid on the same elevated supports that carry the ropes, to carry the compressed air from the compressors to the shaft to operate the power drills. Wire ropes also extend from the main pumping engine house, nearly half a mile from the shaft, to work the plunger pump. The rope is two inches in diameter, and has parted in two several times.

The other pits that are worked in this location at present are No 3, No 4 and the Incline. The workings in these pits has reached a long distance west, but have not much increased in vertical depth. The underground excavations along the north line of the property, and going west and south are of immense extent; but at no place do they reach a greater depth than about 200 feet below surface. They lie under the great body of overlying quartzite which is sustained by the huge pillars of ore that are left, as seemingly required, as the main body of ore is mined out. As compared to other hard ore mines the ore body lays flat, and it has become a long haul from the extreme end of these pits up the gradually rising skip roads to the surface—1,600 feet of rope is wound up in this way in No. 1 engine house.

The mine shows a great deal of ore, but there is not as much first-class ore in sight as might be seen at some former periods. No. 3 is perhaps the main mine; it is likely to be the largest producing pit in the future. A large proportion of the ore in No. 3 is second-class, which just about pays for mining, and so long as it does that they do not cease to take it out partly for the reason that they wish to push through it to get to the body of first-class ore found some years ago in what is called B drill hole, in which an aggregate of 60 feet of first-class ore was passed through. The work in the direction of reaching this ore has been in progress for some years, and has now nearly reached a conclusion, since there are but about fifty feet more to sink until the desired ore is reached.

The ore body in No. 3 has a length of about 600 feet. It is quite regular, with an average width of thirty-five feet. The second-class ore found in this pit is of good quality, yielding about 63% in iron, and not high in phosphorous, but still high enough to be non-bessemer.

The Incline pit has for years been the main-stay of the mine, and though it is on the wane, it is still a large producer and remains about as it has been for a year or two past. Formerly this mine was all clear ore; there was scarcely any rock to be seen, immense stopes of ore everywhere; but its character has changed; the ore is broken up into seperate lenses lying back in the foot. It is not uniform; the ore is narrow in places, and then perhaps suddenly widening out into a wide stope, which splits up into separate parcels. The ore is largely first-class; the best hard specular, but slightly too high in phosphorus for bessemer steel, yielding 66% to 67% in iron, and 2 per cent in silica.

The skip roads in the Incline pit are operated from the main engine house. The location has greatly improved in the past few years. I do not think it is too much to say that it is the most roomy, has the best appearance of any mining location in the iron district. This is due to the fact that all of the old houses, shops, small engine houses, sheds, lumber piles, etc., have been removed, the tracks suitably arranged and the surface graded down nicely. The fine new shop, the pumping house, enlarged hoisting, etc., buildings, all of stone and of ample size, are a fine addition to this portion of the city. The old carts, boilers, and other unsightly materials, that are frequently left to offend the sight, are all hid away in a large yard enclosed with a high board fence that effctually screens exerything within from view.

The principal machinery comprises a duplex compressor, with air cylinders each 16x30; two hoisting engines, each 22x42, with adjustable cutoff; four winding drums, each 8 feet diameter (W., C. & L., Akron, O.); three boilers 16 feet long, 6 feet diameter. This is the new machinery that was added three years ago on the completion of the enlargement of the main hoisting engine, etc., house. It doubles the machinery previously in use, giving them now in this building eight drums. The old ones were made at Marquette, L. S. Foundry and Machine shop—six boilers, all of same size. The pumping machinery is all in the new stone pumping house. The engine is 20x30, condensing, and the water in all the shafts is raised by Cornish pumps.

THE CLEVELAND HEMATITE, situated a mile to the south of the preceding, has proved to be a valuable mine. It

affords a large product annually, of excellent ore, that is not expensive to mine; and it is still looking about as usual, fairly well, with no reason to apprehend any diminution of the output the coming year. The location is disfigured by several very large and deep open pits from which the ore was formerly mined; now, however, the mining is all underground. The system pursued is peculiar, and is well adapted to ground of this character. The ore is a very soft hematite; the walls have very little sustaining power, so that pillars would be useless and timbering would be expensive.

There are several downright shafts, but only one is used now. It is 435 feet in depth and is furnished with cross levels and bucket hoist. The levels are forty feet apart and they are working in the lower ones, the sixth and the seventh. The ore is found in separate pumpkin shaped lenses, and there is no regularity in the manner of their occurrence or in the formation.

They speak of the deposits as the north vein and the south vein. The former was the one earliest worked, and the old open pits are mostly in the so-called vein. The mine is one of a series of hematite mines comprised in an east and west range about two miles in length, extending from Teal lake, just south of Negaunee, west to the Ishpeming and Deer Lake road.

The main dependence of the mine is in the south vein; the two are divided by soft rock—chloritic schist— which has a width of from eight to ten feet. The trend of the ore is east and west, with a drift to the south and a pitch to the west. They are working underground, altogether, west of the shaft. There has been no work done east of the shaft below the fourth level, though it is the intention now to work east and explore the ground in that direction below the seventh level. In the fourth level, 175 feet east of the shaft, they are sinking a winze. It is 16 ft. deep and in ore; it will be continued and they will drift to it in lower levels if the ore holds. The ore extends 200 ft. west of the shaft and is twenty to one hundred feet in width.

The mine is filled with dirt and rock above the fourth level. The method of mining this ore is very simple; they hold up the ground just long enough to remove the ore and then allow it all to cave in from the surface.

In order to stope out the ore it is essential to keep open a winze to the level above and to the one below; the first to let down the timber and the second to mill down the ore through.

They sink a shaft 40 feet for a level, and drift through the ore to its limit, farthest from the shaft. They also sink a winze in the ore at point nearest the shaft through which to mill down the ore into the car in the level below. In stoping, they work downwards, taking oil about 8 ft. of ore at a time. They drift through to the limit of the ore from the shaft and then work backward, taking the ore 8 ft. high, to the filling, and tramming it towards the shaft to the winze, through which it is run down into the car below and drawn to the shaft. The timbers that are required come down from level above through a winze that is kept open for that purpose. The timbers are light and crush down, as they are expected to do, with the weight of the ground when the ore is removed. It is a cheap and simple way to mine this soft ore. The shaft and the drift between the shaft and the stopes is safe; the ruin is behind them, in the ground that they are through with. A little ore is lost, naturally, taken in with the filling.

The effectiveness of this method is shown in the fact that 53,671 tons have been mined the past season, and hoisted in this single shaft in one bucket, which is certainly pretty good work.

The force worked at the mine averages about 100 men and the mine will duplicate in 1886 its product of the present year. The whole number of men employed by the Cleveland company varies from 500 in winter to 800 in summer season.

Contracts favorable to the miners are let and they are allowed to make good wages. As the Cleveland mine is managed on a liberal, progressive scale, everything is thoroughly and well done and quite in advance with the times. It is the last place to find anything that is old fogyish or obsolete in mining. And the men, the reliable laborers of the mine, are not debarred from participating in whatever of prosperity and profit the business may afford.

There has been some change in the management within the past few years, Mr. Jay C. Morse, the former agent, having removed to Cleveland, Ohio, a more extended authority has devolved upon the former Superintendent, Capt. D. H. Bacon, who is now alone in authority at the mine. Whatever the responsibility, Capt. Bacon is not likely to be found wanting.

The following is a statement of the ore shipped from the different pits of the Cleveland Iron Mining Co., during the year 1885:

Name of Pit.	First-Class Ore, Tons.	Second-Class Ore, Tons.	Hematite Ore, Tons.	Total Tons.
Incline mine	66,530	25,450	.....	92,967
No. 3 mine	10,192	33,443	.....	43,635
Moro mine	12,500	6,331	.....	18,831
Saw Mill mine	.....	7,161	.....	7,161
No. 5 mine	546	1,831	.....	2,377
Cleveland Hematite mine	.....	.....	53,671	53,671
Total number of tons	89,758	74,206	53,671	217,636

The Saw Mill mine and No. 5, which appear as productive in the above table, are practically scrams. They afford no prospect of being immediately valuable.

The following table shows the annual product of Cleveland mine from its opening to the present time:

Year.	Tons.	Year.	Tons.
1854	3,000	1870	133,884
1855	1,444	1871	142,658
1856	6,383	1872	151,724
1857	13,201	1873	133,205
1858	7,900	1874	105,855
1859	15,787	1875	129,881
1860	40,041	1876	145,661
1861	11,795	1877	151,554
1862	40,364	1878	143,930
1863	46,842	1879	113,108
1864	49,054	1880	187,254
1865	33,355	1881	197,843
1866	42,680	1882	304,341
1867	75,804	1883	218,219
1868	102,112	1884	224,479
1869	106,133	1885	218,632
Total tons			3,191,642

The ore dock at Marquette, which was built by this company, and was the earliest one of the kind on the lakes, and which has ever since, until recently, been operated by the Cleveland, has been sold to the Marquette and Western R. R. Co., and subsequently transferred, with this company's other property, to the M., H. & O. R. R. Co.

The officers are S. L. Mather, President, Cleveland, Ohio; Jay C. Morse, General Manager, Cleveland, Ohio; D. H. Bacon, agent, Ishpeming, Mich.; L. D. Doty, book-keeper, Ishpeming, Mich.; James Williams, Mining Captain, Ishpeming, Mich.; Geo. Williams, Mining Captain Cleveland Hematite Mine, Ishpeming, Mich.

THE LAKE SUPERIOR MINE.

This mine is not as large a producer as it has been; but it has made the largest output of any mine in the country. Its product of 1882, of 296,504 tons of ore, has never been equaled by any of our companies. And it is not probable that the Lake Superior mine itself will very soon equal its own record. The great streams of ore poured forth, annually, from its shafts, have left their traces. So much cannot always be taken and the residuum forever remain, even in appearance, equal to the original quantity. The immense drafts that have been made on the mine's resources have had their natural effect, and the magnificent stores of ore which but a few years agone, were among the wonders of this marvelous region, have been greatly depleted. But still to one not given to comparisons, or, if a standard of comparison were taken other than the mine itself as it appeared a few years ago, to rate it by, there is enough of ore to be seen in the stopes in the Lake Superior to-day to excite admiration and confidence. It is not the first time that the appearance of the mine was a little on the wane; and it is not surprising that deposits, however large, may be finally exhausted. It is perfectly certain that enough ore will be found to keep the mine in the front rank of producers.

The company holds an immense estate, and there is ore at various points, some of them only slightly developed. The location at Ishpeming is surrounded by the largest producing mines in this country, all the ore deposits of which seem to be pitching towards an ultimate home within the lines of the Lake Superior property.

The Lake Superior mine, the pits which furnish all the ore that the company at present obtains, is situated within the limits of the city of Ishpeming, in the land consisting of a hundred and twenty acres that the company originally held and in which the first discoveries of ore were made and the first mining was done.

The geological complications in the stratigraphical structure at this mine rival the Jackson in their nearly undecypherable contortions. Primarily the formation was pressed into folds having an east and west trend and pitching slightly to the west. In the synclinals or troughs of these folds, apparently, the ore is contained, the dimensions of the deposit being limited by the magnitude of the troughs.

But other forces have operated. The curves which may have been formed, have not been left with a symmetrical regularity. There has been longitudinal pressure that has contorted the folds. There have been lateral forces to upheave one portion or to depress another. So that altogether there is enough to confuse the most experienced stratigraphist and to perplex the most skillful miner.

But without attempting a geological discussion of the formation I proceed to describe the mine. The rock which is encountered is a firm quartzite, an exceedingly hard jasper, and with seams or thin belts of chloritic schist.

The only pits that are at present worked are No. 2, No. 3, No. 7, "A" shaft, and the Hematite mine, which latter lies a short distance to the south. The datum is taken as the level of the floor of the new engine house, and all the levels are distinguished at the number of feet each is below this horizon. The principal hard ore mine is No. 3 shaft, which descends to the west, starting near the quarter post on the west line of the section. All above the 360 feet level is worked out, though there has been some work done in this level the past season, in the direction of the Barnum mine, in No. 3 mine, also in a southeast direction from the shaft. In the 400 feet level they are stoping west in the main vein, the underlay being to the south, thus taking the ore away from the Barnum. It will be remembered that the Lake Superior and the old Barnum mines adjoin, both working along the east and west line which separates the properties. In the 400 feet level, in the main vein, the ore body narrowed up for some distance west, but again widened out. The level is not as favorable as were those above in this vein.

In No. 2 shaft in this level, to the east, the ore is worked out, but they are stoping west of the shaft, and have still considerable ore. A diamond drill boring to the northeast towards No. 3, developed a body of fine ore, 12 feet in width, but having no great length. They have opened to it and are now working it.

In the 440 feet level in No. 2 they have five stopes east and west of the shaft. The opening in this level is 400 feet long and the ore formation has a width of 60 feet, but it is not clean ore; belts of jasper separate the stopes of ore, and to some extent the ore requires picking over to complete the separation. No mining has been done in No. 3 shaft in this 440 feet level. The shaft is to the level below—480 feet,—but the vein has narrowed up; they are opening a drift to No. 2, following a drill-hole. The purpose is to take the water from No. 3 mine through this drift, when completed, and to do away with the pumps in No. 3. It is also expected to find some stopes of ore, that the drift will open, as shown by the boring.

The opening in No. 2, in the 480 feet level, is 400 feet long east and west, and 40 to 80 feet wide. This represents the distance from wall to wall across the ore formation, and includes the slips of rock. Formerly, in the upper levels, it was clean ore of the best quality. Now it is ore and jasper; or rather, there is considerable rock. They encounter horses of jasper in the vein. These latter are of course left for pillars, and sometimes occur so as to be quite serviceable for that purpose. It would have been fortunate for the company if the situation at the bottom of the mine could have been foreseen, and the shaft so directed as to have avoided the ore, and utilized these horses of jasper for shaft pillars, etc. As it is, the shaft is in the widest and best portion of the deposit, thus necessitating the leaving a good deal of the ore for the pillars.

In the 520 feet level they have worked 200 feet west of the shaft. The appearance of the pit is about the same as in the level above. In the portion of the ore through which the shaft descends in this level it is, for a length of 100 feet, 80 feet wide. To the east the opening extends 150 feet, but the ore bed is narrow and badly mixed with jasper; it pinches out in this direction, and in the level below—560 feet—if is so poor as to discourage much work east of the shaft. The width holds all right, but the ore is less free of jasper.

In all the levels in both shafts, from the 360 in No. 3, and from 400 in No. 2, down, there are in each two stopes, one east of the shaft and one west of it. In all these stopes they are breaking ore.

In the 600 feet level they have opened out, making a chamber 60 feet long and 30 feet wide. There seems to be too much jasper where the ore would be preferable. Stoping is in progress here as above, but the level has not been fully opened, so that it can not yet be fully determined how it will turn out. The shaft is sinking below the 640 feet level. In this distance of 640 feet vertical, the length of the shaft is 1,030 feet hoisting distance. From the surface to 400 feet level, the shaft slopes 35° with the horizon; thence down it is 62°. It is provided with double skip road. The pit works 63 miners, only day shift.

No. 6 shaft is wholly idle, and it is not regarded as of much apparent value.

No. 7 is worked in a comparatively small way. It is 1,300 feet west from No. 2. The shaft dips to the north 58°, is single skip, and has a vertical drop of 480 feet. Above the 290 foot level the ore is all worked out. In the 250 foot level four drill holes were made to the north, from a point west of the shaft. In all these ore was found. The holes are all at the same angle down and the ore found is probably the same vein further down in the underlay of the ore.

In the 290 foot level they have a stope 300 feet east of the shaft. There is here twenty feet of ore, but it is separated into two parts by rock. The whole length of the opening east and west in this level is 600 feet, and the ore was thirty feet wide. The bottom of the level is ore, which is opened in the levels below.

No. 7 was once a good mine, but it is not what it used to be. It has scarcely paid for the work done in it the past season. There are now only four good stopes in the mine. The work there is largely in an exploratory way. In one of these exploring drifts, in the 330 foot level west of the shaft, they have reached a body of ore eighteen feet wide. There are a number of these drifts in various directions made to explore the ground. In each of the levels—330, 340, 440 and 480—is a body of ore, but the ore is specked similar to that found in "A" shaft, and it is shipped with that ore.

They have been trying to find better ore in west of the shaft. A dozen borings have been made in the 440 foot level, but in none was much ore found; though if the ore that had been obtained above to the east had continued down, these drill holes would have penetrated it. It is pretty well proven that there is no good ore east of the shaft in the lower levels. To the west ore is found, but it is of poor quality; an ore that, in the present state of the market, it does not pay to mine. A hard granular ore too high in phosphorus for bessemer, and not rich enough in iron to be first class. The shaft has been worked mainly with the hope of finding ore of better quality.

"A" shaft was abandoned for two years, owing to the state of the ore market; but recently work was resumed, mainly in the way of mining the ore left in the open pit. In addition they are sinking the inclined shaft towards the ore found in the drill hole on "the base ball ground," to the north of the pit.

The boring was made to a depth of 959 feet; at a depth of 200 feet fifty feet of ore was found, and it is to this body of ore that the shaft is aiming. The inclination of the shaft is 32° 35 min., and its length thus far from the bottom of the open pit is 300 feet. It is a curious fact that a horizontal drift from the lower end of the shaft, sixty-two feet long, is now within five feet of the drill hole, but encounters no ore.

The best stopes of hard ore that the company have are in No. 2 mine, from the 440 foot level down. In this level the west stope is 35 feet wide and 40 feet high; but below the ore narrows gradually and is less free from rock.

In No. 3 mine there are some good stopes west of shaft, but these approach the Barnum line. They are good for another season; probably will afford as large an output as they have this year. If two shifts—a night as well as a day shift—had been employed in these pits they would, possibly, have not looked so well now.

An interesting feature of No. 2 mine is the fact that the south foot wall assumes a vertical position from the 180 foot level down, turning gradually in the opposite direction to the south, until from the 320 down it has become the hanging wall, and the foot wall is on the north, the reverse of their positions above the 180. The foot has a greater inclination and tends to a widening of the ore deposit. A cross section of the mine shows a tongue of jasper extending from the surface down below the 480 foot level, which separates the ore deposit into two portions; the south deposit rests on schist and the north deposit on jasper.

This tongue of rock does not extend through the entire length of the mine, but it is an important feature in places and affords pillars of rock to support the mine, leaving twenty feet of ore on each side. At other places it changes into ore or is joined with the north wall. The two branches separate wider and wider apart to the east, with the south vein dipping north and the north vein dipping south. The No. 2 south vein and the hematite overlapped in the open pit, but they have separated as they went down. On the west the veins are separated by 300 feet of jasper. The hard ore is in a minor fold with an inclination west; the hematite is in a similar trough, lying south of the former and having a slight inclination to the east.

The hard ore of the Lake Superior mine is specular slate and granular specular; it was formerly among the best ores produced, but while equally as good as ever in other qualities, it has lately attained a higher percentage in phosphorus, and now ranks as non-bessemer, though it is so near the line that it probably is used for the manufacture of bessemer steel.

It is very carefully selected and no pains are spared in picking over the ore. An average of a large number of analyses made of samples of stock piles gave, in metallic iron, 67%; from No. 2 pit—phosporus, .086%; silica, 3.90%.

An average of analyses of samples of stock piles of No. 3 pit gave 66 to 67% in iron; .070% in phosphorus.

No. 7 pit ore averages the same in metallic iron but is higher in phosphorus. Formerly No. 7 ore was of the best. Average analyses made of this ore six years ago gave in metallic iron 66%; phosphorus .03%; silica, 3.90%.

It is with the hope of again finding this ore, or its equivalent, that work is persisted in in this shaft.

THE HEMATITE MINE is one of the largest and best soft ore deposits that has ever been opened in the Lake Superior region. While not above one-fourth of the ore has been removed they have opened to the bottom, 460 feet below datum.

The ore is in a long synclinal fold, which has been worked east and west a length of 1,100 or 1,200 feet. It lies nearly level, but pitches slightly to the east. A vertical section of the deposit appears in the form of a hook, the body of the hook being the ore, the long branch being on the south side and the short one on the north. The former starts from the surface and goes down with an inclination to the north, when on reaching a depth of about 400 feet it makes a gradual curve upward, continuing half way to the surface. The overlying rock conforms in its curvature with that upon which the ore rests. A horizontal section made anywhere between the surface and down to a depth of 200 feet shows two parallel bodies of ore partially connected at the east by a curve, giving the upper section the form of an ox-bow, each forty feet to fifty feet in average width, and dipping slightly—the south vein to the north, and the north vein to the south—and the two separated by 300 feet of jasper.

At the point where the overlying rock curves upward again the horizontal plane would be tangent to it, and all below is the ore deposit, extending from foot to foot, of great width and length, a most magnificent prospect for ore. But the last level has been sunk; underneath the ore in the bottom level, a brief distance, the rock is found. The only thing that, apparently, remains, is to be contented with what ore lies above and to mine it out as cheaply as may be.

The ore is reached through a double skip shaft, and there are five levels, called respectively, the 157, 220, 280, 340 and the 400.

Above the 220-foot level the ore has all been mined out and the space filled with sand, etc., run in from surface. In the 280 level the opening extends 300 feet west and 700 feet east from the shaft in the south vein. A good deal of ore has been mined in this level but there is very much left in the stopes, in pillars and for a floor for the level above. The width of the ore averaged forty feet, becoming 120 feet wide in one place near the shaft. Of course the ore is worked out in the two branches, which are mainly east from the shaft. Above the 220 there is but one vein, as the north branch does not come up to that level, and they are joined into one body just below the-340. In the 340, at 500 feet east of the shaft, a transverse fold is developed, which makes also an inclination in the ore basin to the east and to the west—the opposite sides of the small anticlinal which the apparent fold forms across the deposit. A large number of borings have been made, mainly to the east, which served to prove the great length of the ore. Subsequently by boring downward in the lowest level the depth of the ore was found—varying from a few feet to fifty, having, possibly, an average thickness of thirty feet. The ore comes from the east and passes up over this transverse fold, when it is cut out, making an island of jasper in the ore. It is through this jasper that a new shaft will be sunk from the surface 600 feet east from the

present shaft. Another shaft has been needed for some years, but the work of making one has been deferred until it could be determined where was the best place to sink it, it being desired to avoid making the shaft in the ore—to locate it in the rock as far as possible.

The work of sinking was begun at the time of my visit at the mine; the shaft will be between the tracks of the M., H. & O. railroad and near the county highway. In the 340-foot level the distance from foot to foot is 300 feet, north and south, one-third of which space, on the average, is probably ore. The north branch, in this level, holds the most ore; probably 75 per cent, of it is yet standing in the mine in this level. Very little has been removed, except in drifts along the foot wall and in rises between the levels. The maximum tram distance in this level is 1,100 feet. When the new shaft is completed it will not exceed 300 feet; the average length of the tramming now in the mine is about 500 feet. The ore in this level—340—has shortened to the west 300 feet, but has correspondingly lengthened east.

Below the 340 the ore is in one body. In the 400-foot level, extending 600 feet east from the shaft, for half this distance the ore body is 200 feet wide. In this level they have made nine rooms or headings across the ore from foot to foot. These are 50 feet apart. The new shaft will be east of these workings. A winze sunk at a short distance east of the shaft is 42 feet in ore to the rock; at another point the rock bottom was found at a distance of eight feet. Before this level was reached and the borings were made by which the depth of the ore was ascertained, the estimates of its amount that were then entertained are now found to have been greatly exaggerated.

They have now found the bottom and may commence to work up to the top, filling up as they rise. There is no mine where a better opportunity occurs for practicing this method of mining than is found here. They can commence the work on bed rock.

The ore in this mine is a soft, ocherous-looking hematite, that becomes plastic when wet, but is generally hard when dry. An average of 2212 samples from the stock pile gave, on analysis:

Metallic iron	63.84 %
Phosphorus	.068 %

Some of the analyses run lower in iron and higher in phosphorus, and others vice versa. The above seems to be a fair average.

The mine is working in the direction of Lake Angeline. The eastern terminus of the 340 foot level is 200 feet west of the lake.

The mine has a fine stock pile ground 450 ft. x 100 ft., with high trestles running over it from the shaft.

An ingenious arrangement is adopted—the invention of Mr. C. H. Hall—for economizing the cost of operating the car on this track. For a short distance from the shaft the track is level, and then for a little way it is given an upward incline of 8 feet to 100 feet, and thence to the end a slight decline of 1 foot to 100 feet. Just under the apex of the track are two rollers, near together, and revolving transversely to line of track. When the tram car stands at the shaft the rope that draws it forward passes up from the drum in the engine house, between the rollers, and then down the track between the wheels of the car, and is attached to its end nearest the shaft. When the car is filled the signal is given, and the rope is wound, which pulls the car to the top of the grade, then it starts down the incline by gravity, the rope drops over on to the second roller and follows the car. When the car empties, the rope is again wound up and the car thus drawn to the apex, when gravity takes it down to the shaft for another skip load, the rope dropping alternately from one roller to the other. There is a third pulley placed a little way below the other two, under which the rope passes before going up between the other two.

The water in this mine is raised by two 12lb. plunger pumps, each having a lift of 226 feet—420 feet in all. They are worked by one small engine, 10 in. by 22 in. The plungers are worked on opposite centers, so that one conies up as the other goes down, thus balancing each other, otherwise the engine would barely move one plunger, but as it is the engine does the work admirably. The pumping house is near the shaft.

All the shafts of the mine, including the hematite, are operated from the machinery in the new stone engine house, which stands upon the solid ledge near No. 3 shaft. The hoisting machinery is from the Akron works, Ohio, Camp, Webster & Lane, manufacturers. There are four drums, each 12 ft. diameter, and four others that are each 8 ft. diameter. There are two new engines for operating these drums; also air compressors, electric light engines, etc. This new machinery was put in four years ago, and at the time, it is claimed, it was the most powerful machinery found in any iron mine in the world.

Electric signals are used throughout the mine; this method is claimed as a great advantage over the wire pull signal.

The general arrangements, buildings, machinery, methods of mining, etc., were fully described in the Commissioner's report of 1881, and there is nothing new to add.

The following shows the season's shipments in the year 1885, mined between Nov. 15th, 1884, and Nov. 15th, 1885.

	Tons.
No. 1 hard ore, from shafts No. 2 and No. 3	83,000
" " " " No. 7 shaft	19,000
"A" shaft	12,000
	114,000
Hematite ore	97,000
Essex hard ore, second-class	11,000
Total tons	222,000

No mining has been done for the past two years at the LOWTHIAN MINE, owned and worked by this company.

The company employs an average force of 450 to 475 men, of which 65 to 70 are miners..

The officers at the mine remain as heretofore, except a change having been made in the mining engineer. Mr. H. B. Sturtervant, a very competent engineer, is now serving the company.

The following table shows the product of the Lake Superior mine for each year of its history:

Lake Superior Mine.

Year.	Tons.	Year.	Tons.
1858	4,658	1872	145,070
1859	24,668	1873	158,428
1860	33,015	1874	104,311
1861	25,145	1875	119,365
1862	37,704	1876	110,570
1863	78,976	1877	127,349
1864	86,773	1878	104,674
1865	50,391	1879	174,747
1866	68,022	1880	204,094
1867	114,935	1881	282,235
1868	105,745	1882	296,504
1869	125,560	1883	200,799
1870	166,582	1884	204,796
1871	158,074	1885	221,040
Total tons			3,569,053

A larger total product than any other company in the country has ever produced.

C. H. Hall, Esq., agent, Ishpeming.

Jos. Fay, Jr., Treasurer, 37 Franklin street, Boston.

THE NEW BARNUM.

The new Barnum, so-called, is one of the best equipped mines in the district. The extensive diamond drill explorations, which had been previously made, resulted, so favorably that the company felt assured of having an abundance of ore, and all the preparations were made for opening and working a large mine. A fine and substantial stone building was erected, in which were placed new machinery—drums, engines, compressors, boilers, etc. A machine shop, etc., of stone was also built; two shafts were sunk and well fitted up, one of them provided with an iron-covered shaft house, and all preparation made for prosecuting mining work in the most approved and effective manner.

But the mine has proved much less valuable than was hoped. The ore deposits are broken up where regularity was looked for; there is a great deal more of irregularity than it was expected to find.

There were really some very rose-colored theories entertained regarding this new mine, before it was opened sufficiently to verify or discredit the conjectures that were made. Indeed, sufficient evidence was developed, through the systematic and thorough diamond drill borings that were made, to afford substantial basis for the best that was hoped for.

The new mine is in the northwest part of the city of Ishpeming, the shafts and buildings being on the high ground north of the swamp. There are two shafts, each vertical, 10' x 14' in size and well timbered, the easterly one called A. shaft and the westerly one B. shaft. The former is 470 ft. deep to the main level and the latter 420 ft. from datum; they are 834 ft. 8½ inches apart and are now connected by drift at the bottom. The length of the opening in direction of B. shaft, from A., is 500 ft., and to the east of A., in the main level, the workings extend 400 ft. The slope of the level in direction of A shaft, northeast and southwest, is about 15° with the horizon. The levels to the north, above the main level and parallel with it, are designated as A., B., C., and those below, to the south, as the 1st, 2d, 3d, etc. The formation in the mine dips southerly and a little east, at an angle of about 45°. But, as before stated, the formation is very irregular. The lenses are broken up, the rock cuts out the ore; and the ore itself is frequently so mixed with the rock as to make it difficult to effect a complete separation. The levels below the main one are filled with water and the stoping, etc., is in the main level and in those above it, in which the work, thus far in the mine, has been principally done. The drifting, which has been done below, and also the boring have not developed satisfactorily. So far the shafts seem to be at the bottom of the ore. One boring made south from the main level 150 ft. shows a succession of rock and small lenses of ore. Forty feet directly above, a hole made parallel with it, gave quite different results; the rocks passed through, as shown by the cores, did not correspond.

The largest amount of stoping has been done in the A. level, above the shaft and north of it 90 feet. In B. level, above A., 75 feet, a drift to the north 200 ft., mainly in chlorite, intersects ore in a rise at the end of the drift; this ore comes up from the A. level and continues on up for some ways, when it pinches out, while the formation seems to descend beyond; the ore has apparently followed a roll in the underlay.

All along the main level it is amply secured with pillars. The intention is that, however far the mine may extend, the main level shall always be open and safe, so that whatever befall it can never give way or be obstructed—a place of refuge in case of accident. Frequent winzes between the levels afford ventilation.

The main drift west is in ore and is flanked by pillars, nearly continuous, which are 20 feet wide. The work now doing in both shafts is mainly to connect them. The total force of men employed is 120. The ore that was mined and put into stock last winter remains unsold and at the mine. Some of it is second class; about 60% in iron, non-bessemer and rather high in silica.

The ore is of course mainly derived from A shaft, which was completed about four years ago. B shaft, however, has only been down about a year, although begun at the same time as the former. Much difficulty was experienced in the work of sinking this shaft, owing to quicksand, which for a long time prevented getting to the ledge. Adequate efforts were finally made and the work pushed forward—or downward—to completion. In the main level in this shaft they have drifted 100 feet west and 200 feet east from the shaft. It is expected that the

shafts will be connected by the meeting of the ends of this drift pushing towards each other from the shafts. This accomplished, there will then be perfect safety and perfect ventilation. In driving west from B shaft they encountered a wall of jasper, which has served to terminate all work in that direction since. The dip in B shaft does not, thus far, conform to that in A, it being in the former very irregular, but on the whole to the north; probably it will change to the south, in fact it must, as the dip is in that direction in A.

East from the shaft—B—the drift is in good ground. The probability is that the new Barnum will encounter the difficulties and perplexities which have been experienced in the history of the other hard ore mines in the Ishpeming basin. The mine affords a good deal of water, estimated at 1,000 gallons per minute, 700 from A shaft and 300 from B. In the latter a 20" plunger is used, and in the former two 14" plunger pumps do the work.

The Pioneer furnaces at Negaunee, owned by this company, smelts this ore, using mainly the second class red specular; with it is mixed, at the furnace, the Foster mine ore, an ore also low in iron and high in silica, but the two make, it is claimed, an excellent foundry or car wheel iron.

The old Barnum yields first-class ore, but it is, as it has been, for the past three years, nearly exhausted. A new "find" was made in the old mine last June, which awakened no little hope in those interested; but it has not developed into anything of much importance.

All the east part of the mine is worked down to the Lake Superior Co.'s line and the shafts are abandoned; the only work is in the extreme west part of the mine, where they continue to find some ore along the line of the property. There is not much ore left in the old Barnum shaft, except in the pillars which they are taking out. This is simply enough said, but it is not so easy a matter to accomplish, owing to the treacherous nature of the hanging, which is soap rock, and will drop out at any time if not held in place by pillars or other support. The work can be best done in winter when the ground is well frozen. The situation is such that heavy freezing will be of much advantage, and the ground is accessible to the frost.

The main shaft in old Barnum is 350 feet west of No. 3 shaft; the ore has a length of about 80 feet and a width of 18 feet. It goes down pretty straight close to the line; but it is thought to be working south away from the line, which, if such prove to be the case, the company may have a stope here for some time to come.

The "new find" was further west; the ore lense was 14' wide, but it worked out. They are looking for it further down.

There is no trouble in selling old Barnum ore; it is first-class, although not Bessemer. The mine is 1,150 feet southwest from the new mine and pipes have been laid on elevated trestle to convey the compressed air to the old mine to operate the power drills in it.

The company is evidently "going slow" just now. The ore has not been sold, probably, for the reason that an offer could not be obtained that was satisfactory. It is doubtful if the mine could produce a large product—large as compared to that of the leading mines—of first-class ore.

The Iron Cliff Co., to which this mine belongs, owns a large estate and has several other mines, but the Barnum is the most important one. Everything in and about the mine indicates intelligent and economical management so far as the local authority extends.

The product of the two mines the past year has been: Old mine, 20,593 tons; new mine, 26,865 tons; 47,458 tons in all.

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

Year.	Tons.	Year.	Tons.
1868	14,386	1877	38,314
1869	37,503	1878	36,680
1870	44,793	1879	34,911
1871	45,939	1880	24,921
1872	38,381	1881	27,281
1873	44,308	1882	41,424
1874	40,255	1883	62,752
1875	40,914	1884	67,782
1876	37,750	1885	47,458
Total			706,667

The hematite deposit has not been worked the past two years. In fact, there has not been enough work done to ascertain whether they may not have a mine. The location of this working is about a mile northwest from Ishpeming.

The officers are A. Maitland, general manager, Negaunee, Mich.; Wm. Sedgwick, Superintendent Barnum mine.

THE NEW YORK.

The New York was once one of the important Ishpeming mines, but for several years past it has been approaching exhaustion, and is now regarded as practically finished. At least, no mining work has been done in the last two years.

The mine is close to the Cleveland Iron Company's mine, the ore dipping to the south, to the Cleveland. It has been followed and mined out as far as their rights would allow the company to go.

The underground workings are along the Cleveland mine on the south, and within 75 feet of the Iron Cliff line. The New York is in the southwest corner of the property, and it has afforded a remarkable amount of ore. considering how small the mine really is. It has also been a very profitable mine. The ore was very cheaply mined, and the largest product was obtained during the years when ore brought the greatest price.

There is still some ore, one stope 110 feet long, and having a maximum width of 60 feet; but it narrows up rapidly. This ore carries some mundic, and is not salable now. There is no first-class ore in the mine, except the pillars, and if it is concluded to wreck the mine the pillars will be attacked. Capt. Beering has been exploring with the diamond drill, but nothing of value has been found.

The New York mine has produced as follows:

Year.	Tons.	Year.	Tons.
1864	8,000	1875	70,106
1865	12,214	1876	58,863
1866	33,761	1877	55,581
1867	43,302	1878	21,903
1868	45,655	1879	57,367
1869	71,756	1880	58,503
1870	94,800	1881	49,342
1871	76,381	1882	56,970
1872	68,950	1883	1,517
1873	70,882	1884	1,677
1874	77,017	1885	
Total tons			1,034,112

THE LAKE ANGELINE.

This is a most remarkable mine. The mineral deposit is of great magnitude and its quality is not surpassed, if equaled, by any other body of hematite ore that has been found in the Lake Superior region. The recent history of this mine illustrates the uncertainty in mining—the transition from adversity to the greatest prosperity that may suddenly occur. Four years ago the old pits lying to the east were exhausted, and there was but little ore to be seen. The only thing of an encouraging nature that was known was the fact that a small exploring shaft had been sunk a few hundred feet to the west from the mine, and some drifting done at the bottom, which work had revealed the presence of ore at this point of good quality, though estimated as somewhat mixed with rock. Three years ago the work of enlarging this shaft was undertaken; it was sunk to a greater depth, and the subsequent work has developed one of the most marvellous deposits of ore that has ever been opened in this region. It is an immense body of soft hematite, exceedingly rich in iron and low in phosphorus. An analysis of an average of samples of a cargo gave:

Metallic iron	66.50 %
Phosphorus	.030%

An analysis of a soft brown ore found in this mine gave the extraordinary result of:

Metallic iron	69.80 %
Phosphorus	.017%

There are several varieties of ore in the mine—a soft, black, slaty ore, brown ore, blue ore, a reddish colored ore, and a variety that looks precisely like a bed of clay, and it may be manipulated in the same manner, in the hand—but all the ore in the mine is bessemer and none of it will go less than 65% in iron.

The location of the mine is at the southwest corner of Lake Angeline, in the city of Ishpeming. The mine is entered through two shafts, denoted A and B—the former of which is the one used for hoisting the ore; it is vertical and divided for double hoist, for pump and ladder ways. The latter shaft goes down on the foot wall at an angle to the north, in the eastern extremity of the mine, and is used for a timber shaft. The machinery for operating the mine is all new and placed in a fine stone building, recently built, standing a little way south of A shaft. This engine house is 73x44 feet, with slate roof. The machinery was made at the Iron Bay Foundry, Marquette, and is greatly liked by the management. It consists of six winding drums, each 6 ft. diameter, two hoisting engines each 18"x24", pumping engine 16"x24", working two ten-inch plungers. There is also a smaller pumping engine. From A shaft a well-constructed elevated trestle is built, on which to run out the ore to stock pile and pockets.

The mine exhibits several peculiarities: A shaft afforded a large product from north and east of the shaft in the first and second levels. The shaft is 40 ft. south of the main east and west thoroughfare of the mine. A crosscut south in each level connects the shaft with this drift. In the first level the limit of the ore is 120 feet north of the south end of the cross-cut, and extends east of the shaft 140 feet.

But in the second level, 60 feet further down, the limit of the ore north was found to be only 80 feet, thus showing a shortening in that direction of 40 feet, while in the third level the north boundary of the ore deposit is at the south end of the cross-cut, and in the fourth it is at a 100 feet still further south—thus showing that the hanging wall side has come in and that the ore has been rapidly set over into the foot. The shaft was at first in the great ore body, but it is now, at the lower depths, in rock; and the ore body, which was at first mainly north and east of the shaft, is now west of it and south of it. From above the second level there was very little ore south of the main drift, while now the positions are reversed. As it now appears the ore occupies the trough of a synclinal, with an inclination to the west of 45°, and leaving nearly upright walls on the south and the north. West of the shaft, in the the third level, for a distance of 220 feet east and west, the ore has an average width of 180 feet—clean ore—and a width or depth, at right angles to the pitch, of about 60 feet. The bottom and north wall appear to be the same character of rock.

Perhaps it would be better to designate the ore body as a lense with the vertical plane of its main axis east and west, and with a downward inclination of the axis to the west at an angle of 45°.

The fourth level has not been fully opened, but it shows the same peculiarities found in the third, and a continued pitch and lengthening to the west, with a width of ore equal to that found in the level above.

From this it would be reasonable to infer that if the conditions continue as now the limits of the ore body are substantially determined; for when the west line of the Lake Angeline property is reached the ore will go to the Lake Superior Co., which company owns the land adjoining on the west. Assuming this to be the case there is nothing alarming in the situation, for there is distance enough now before the line is reached, with what is left in the present openings, for several years' work, with a maximum output.

The ground below has not been proved. Vertical borings will soon be made for the purpose of determining if other ore lenses do not underlie this one. Some important developements have been made through recent diamond drill explorations in this mine, also by drifting. It has been thus ascertained that the mine holds several fine deposits of hard specular ore. In the second level the main drift extends west to a distance of 520 feet from the shaft; from the end of this drift a horizontal boring to the west cut, at a distance of a 140 feet, a body of hard specular ore, 40 feet wide; thence the drill passed through a succession of jasper and of smaller ore deposits, all equally good. One of these small lenses was 15 feet wide. An average sample of this ore, analyzed by Mr. Wright, gave

Metallic iron	69.00 %
Phosphorus	.015 %
Silica	0.31 %

which certainly shows it to be a very remarkable ore.

Another body of this ore has been drifted through in two places at points 300 ft. west of A shaft in second level. The drift forks at this point, or near it, one branch going southwest and the other turning with a bend to the north. The drifts are 120 feet apart at the point where they leave the ore, and the south branch is 142 feet in the ore.

This ore body overlies the soft ore and is practically in contact with it. There is enough of it, at any rate, here in sight to become an important factor in estimating the value of the mine. It is possible that this one continues southerly, bending to the west; for further on in the drift, 450 ft. west of the shaft, a boring was made to the south 600 ft. long, which struck ore at 200 feet, passing through 80 feet of it, No. 1 hard specular identical with that already described. All this, makes not only a valuable acquisition for the Lake Angeline Company, but holds out a pleasing prospect for the Lake Superior Iron Company. It is a valuable exploration for that company.

The walls of this mine, as well as the ore, have little sustaining power, so that, as the ore is removed, the mine must be held up either by filling with sand and rock or by a complete system of timbering. The hanging wall is a rock that disintegrates readily and improves every opportunity to run. The method pursued is to sink 50 feet, cut south to the ore and then drift west through the ore; thence to open, to the north and south, each way from the main shaft, rooms or headings in the ore, each 18 feet wide, leaving pillars of ore between 20 feet wide. These rooms are worked out to a height of 40 feet, leaving ten feet of ore for the floor of the level above. These rooms are filled with a framework of timbering in "sets," each set 10 feet high and 9 feet wide, framed on the Nevada system, that has now become well understood by miners. The main drift is timbered but the ore above it is not taken out, also each side of it a large thickness of ore is left. In fact a heavy longtitudinal pillar of ore is left, through which the main drift and the lateral drifts, to the headings, are cut.

In the third and in the fourth level there are in each three of these east and west pillars, which are tunneled with drifts, lengthwise and crosswise; so that it will be seen that there is left in each level, when it is completed, the three longitudinal pillars, and at each 18 feet, cross pillars 20 feet wide, also an unbroken roof or floor in each level, 10 feet thick; in addition, the openings are all completely timbered. The greater portion of the ore is left in this way to hold up the mine, and yet the timbers show, in places, the effects of immense pressure. One cannot escape the conviction of the utter inadequacy of any system of timbering to support a mine of this character. The cost of the timbering, partial as it is, is 30 cents per ton of ore mined.

The plan is to commence soon to mine out the ore left in pillars and floors, by commencing at the top and working down, taking each level in succession, from the upper one, and allowing the surface to run in and fill up as the ore is removed. Mr. Kidder calculates that the pillars and the heavy floors will hold up all the run from the surface.

Several rooms in the first level have been already filled south of the engine house, there being a little apprehension that the ground was liable to be weakened, to the possible detriment of the building and machinery.

I see no reason why this system of "wrecking" may not be carried out successfully if not too long delayed; but I incline to the opinion that the easier, safer and cheaper way would be to either fill up the mine as fast as the ore is taken out, by milling in dirt and rock, or to wreck as you go down, taking out all the ore, let the earth and rock come in from the surface, and thus escape the cost of timbering, except for a limited amount, for just enough to hold up in advancing the stope under the filling.

It is the intention to sink a new shaft at the west end of the mine. To mine the hard ore veins—the one west and the one south—will perhaps require a shaft for each. It would hardly do to, otherwise, make the long rock drifts from each level to reach the present shaft.

The fee of the land is held by the company, which owns quite an estate. It is an old company, and began the work of mining and shipping ore at its location south of Lake Angeline, under the shadow of the elevated diorite bluff, that rises steeply on the south and a little way east of the present underground mine, in 1864. The mine has been under the present management almost since it was first opened. Certainly it could, not have been, better supervised.

Years ago the mine sent out hard specular ore; of late the product has been only soft ore; now again it is to become a producer of both hard and soft ores, and both of the very best quality that the market affords.

The corporate name of the company is the Pittsburgh and Lake Angeline Iron Co.; Secretary's office, Cleveland, Ohio.

The company's general manager is Alfred Kidder, of Marquette; mining Superintendent, Harvey Diamond, Ishpeming.

The following table shows the annual product of the mine in past years:

Year.	Tons.	Year.	Tons.
1864	19,500	1875	30,282
1865	20,151	1876	22,539
1866	24,070	1877	19,113
1867	46,807	1878	28,161
1868	26,651	1879	25,420
1869	39,644	1880	14,794
1870	53,467	1881	18,000
1871	33,645	1882	14,518
1872	35,221	1883	27,359
1873	43,933	1884	87,018
1874	30,499	1885	111,051
Total number of tons			771,656

A new Rand compressor and power drills are to be added to the mining plant the coming winter.

THE WINTHROP.

The Winthrop is an excellent mine of soft hematite ore that has had many vicissitudes, but is now in excellent shape to afford a large product of ore the coming year at a low cost. Several years ago it was the practice to have annually, or oftener, at the Winthrop a great caving in of the ground, burying the ore deeply beneath the fallen earth and rock, thus occasioning much expense and delay. For the past year or two the company has met none of these setbacks, and their work has been pretty plain sailing, barring a lawsuit that is pending in the United States courts, which regards the rights and authority of the present management.

The general run of the ore is about east and west, with a dip to the north of about 60°. Standing upon the edge of the pit on the north side we may look down into a chasm, artificially formed, 150 feet in depth and a surface area of opening of 300 feet in length and 200 feet in breadth. Up the foot-wall on the south side and at the east end, ascend the skip roads, on which one may observe from time to time the loaded car emerging from the depth below the bottom of the open pit; or descending, it finally disappears into the same mysterious region.

Looking down into the pit one may trace the ore along the bottom around to the west end, where it makes a steep curve to the south and is swallowed up in the foot wall. From the West end along the bottom of the pit 100 feet the ore extends arid then rises abruptly to a height of 60 feet. This stope of ore at the east end of the pit they are preparing to mine by rolling down the rock from above it into the bottom of the pit and milling it down a rock shaft for filling below. The ore body is upwards of a hundred feet wide, but not all ore; it is separated by seams of jasper, which intervene, dividing it into lenses. At the west end of the pit the ore is exposed to a height of 80 feet, and they are stripping from above, rolling the rock and dirt down into the pit, whence it is milled down into the mine for filling. All this is doing preparatory to stoping it underhand.

The underground openings are 570 feet long east and west. No. 4 shaft is in about the middle. To the west of this shaft the ore is separated into two veins, each of a good width, varying from 20 feet to 50 feet. The method of mining is to drift under the ore to the end and then stope towards the shaft, so that between the stope and the shaft is safe ground and open drift. The shaft is sunk two levels, so that there may be four stopes coming in from the east, from the Mitchell line, a length of 300 feet.

No. 5 shaft comes down in the west end where the ore bends back upon itself, coming around south and turning east. Here it is very wide, but narrows rapidly.

The mine is well opened, with an abundance of ore in sight, and the stoping can be carried forward with great facility. I should say that the product for the ensuing year would be large, and cheaply mined.

The mine may be called a wet one, but ample provision seems to be made for excluding the water. The water is raised by Cornish pumps which suffice for the work, but there are also two large Cameron pumps in the mine, ready to be started at a moment's notice in case of accident to the plungers. This provision, having steam pumps in the mine, is a teaching from experience.

Mr. St. Clair estimates the product for next year at 12,000 tons per month for this and the Mitchell. The company works 100 men as an average force. The ore yields:

Metallic iron (first-class)	64.00 %.
Phosphorus	.060 %.

About 75% of the product is shipped as first-class. E. G. St. Clair, Secretary and Treasurer, Ishpeming, Mich.; Geo. A. St. Clair, Superintendent, Ishpeming, Mich.

The following shows the annual product of the mine to date:

Year.	Tons.	Year.	Tons.
1870	2,469	1878	23,740
1871	7,314	1879	27,050
1872	14,239	1880	45,247
1873	31,150	1881	43,900
1874	8,248	1882	23,259
1875	8,642	1883	50,143
1876	27,236	1884	53,077
1877	12,549	1885	63,915
Total number of tons			443,183

THE MITCHELL MINE.

This mine adjoins the Winthrop on the east; the two mines open into each other underground and they are operated by the same parties, the St. Clair brothers, Messrs. E. G., G. A., J. O. St. Clair. The lease of the mine was purchased by these gentlemen three years ago and has since been worked by them in connection with the Winthrop, which it greatly resembles.

The mine is wholly underground and has been for six or eight years. There are four shafts, all vertical; commencing with the easterly one, they are designated as A, B, C, D. A shaft takes all the ore to the Winthrop line and goes down in the open pit and below its bottom. The distance from the shaft to the Winthrop line is 278 feet. Recently the company has built a steam pumping engine house, standing on the solid ledge northwest of the Winthrop mine. The new engine, which is 24" x 56", in this building, works the Cornish pumps in both mines. The length of rope to work the Mitchell pumps is 2,000 feet long, 2¼" wire rope.

A-shaft is 285 feet in depth, B has been abandoned, C is 236 feet deep and D 156 feet. The latter is a new one and has been sunk by the present company. Its dimensions—which are unusual, 6½ feet x 24 feet—were among the stipulations in the lease, required by the Pittsburgh and Lake Angelina Co., the owners of the fee. All the other shafts have been sunk only one lift, in the past two years, below the workings of the former company.

The mine is a long one and had been opened to a great length, comparatively. The openings had been timbered and much ore left in pillars to hold up the ground in the several levels. The present company adopted a system of wrecking that has been since pursued. They have been simply robbing the old levels of the ore left in floors and pillars and letting the ground come in as the ore was gotten out. In doing this work a small drift was secured, or drifts, as necessary, and all around them was left to crush. Sometimes they have timbers and ore mixed together, the timbers sticking every which way in this ore; but they manage to get it, even then, without much trouble.

It is a long, rambling mine, the ore lying in two or more lenses of medium width, sometimes expanding into considerable amplitude. The minimum amount of timber is used, and no attention whatever is paid to appearances, the aim being to get out the ore as cheaply as possible. The expenditures are only in the way of meeting the bare necessities. The timbers are only designed to hold up long enough to get out the ore, and it is, expected that they will give way.

The Mitchell is not a pleasant mine to go through; it is wet and nasty, the drifts are sometimes low and small, so that you must assume a stooping posture. Ends of the fallen lagging timbers frequently protrude through the roof or the sides of the drift, against which one's head or limbs come into sudden and forcible contact, with no agreeable sensation. The ladder ways are sometimes too nearly filled with hot steam pipes. These minor matters might be helped, the offensive ends of timbers sticking down through the tops of the drifts could be cut off, the drifts could be made a trifle higher, so that one could walk upright, and the ladder ways might be made passable with small cost. But after all their method is not a bad way to mine this ore. The object of mining is to get out the ore as cheaply as possible, and other ends being kept in view and properly provided for, the method that accomplishes this result is the best one to pursue. After the ore is out a mine has no value whatever except to enter to look for or to take out more ore. This trying to hold up a soft ore mine is worse than nonsense. It necessitates leaving, frequently, half the ore in the mine, together with a costly system of timbering, and then there is seldom any absolute security, at least for any considerable period of time; a mine held up in this way—by timbers and soft ore pillars—is sure to come in sooner or later. It is also sure to be more expense and trouble to attempt to remove the pillars, etc., subsequently, after a mine has been opened to some depth.

To take out the pillars in an old mine, particularly a soft ore mine, is generally a precarious undertaking—a task that few care to assume. The timbering is a dead loss. The true way is to fill up, or to run in from the surface—to work up and fill in behind, or work down and let in the overlying burden. And this latter is the way they are doing at the Mitchell. Thus far they have opened no new ground. They have sunk the shafts, two of them, one level, but have not worked new stopes. The lower level is opened ready to be stoped. For three years the product has come from the old levels and now they are pretty well exhausted; but the mine is really in better shape and more valuable now than it would be if the old levels had been left and the same amount of ore taken out by sinking and opening new levels from which to remove the ore. So far as they have gone the ground is solid; they have done with it, they have no further use for it and no further danger to apprehend from it. The ore below is all intact. The shafts are in the foot wall, in firm ground, and the ore is reached by short cross-cuts through rock from the shafts, in each level.

I see no reason why the mine should not continue to afford its usual product, as much ore the ensuing year as in the last one.

They make two grades of the ore: One, the blue Mitchell, goes about 65% in iron on the average, if well selected, and .15% to .18% in phosphorus. The other grade is nearly bessemer. A large number of analyses show quite a wide discrepancy in the matter of phosphorus. All the ore is well up in iron.

The mine was first worked in 1872, under the name of the Shenango. It has produced as follows:

Year.	Tons.	Year.	Tons.
1872	197	1879	11,450
1873	8,552	1880	12,750
1874	7,699	1881	20,904
1875	.....	1882	33,396
1876	5,596	1883	.....
1877	3,897	1884	29,883
1878	4,250	1885	7,415
Total number of tons			146,012

The mine is worked under the corporate name of the Winthrop Iron Co. E. G. St. Clair, President; Geo. A. St. Clair, Superintendent, Ishpeming, Mich.

THE NATIONAL

mine, situated about a mile north of the Winthrop, has been abandoned by the lessees, and the machinery all removed. The mine was opened in 1878, and was extensively worked down to and including a part of 1884. During this period it produced a total number of tons of ore of 150,273. The product was a very peculiar looking ore—a hard blue hematite—but of excellent quality, averaging 65% and upwards in iron, and about .070 in phosphorus. The company has not relinquished its hold without having made every reasonable effort to find more ore; diamond drill borings have been made everywhere on the property where it was deemed probable that ore could be found, but without sufficient success to encourage a continuance of mining effort. The machinery has been taken to the company's new find on the Mitchell farm, east of Negaunee.

THE FOSTER MINE

is the oldest hematite mine in the State. Work was begun here in 1868, and that year 6,000 tons of ore were mined and shipped. It has ever since, and still continues to be, a moderate producer. The mine has done in times past, excellent service in helping to bring our soft ores into repute. The Foster ore is only of medium quality, never high in iron, averaging rather low as compared to other hematite ores in the vicinity, but it was found to work well in the furnace with hard ores, and those furnacemen who had become accustomed to use it, came to like it very much, and to regard it as a kind of necessity. It makes a first-class foundry iron—too high in phosphorus for steel.

The mine is mainly underground, beneath the bottom of the highest of the three open pits from which the ore was for a long time obtained. Some mining, "scramming," is done in all the open pits yet, but the main part of the product comes from the upper workings underground. Ore has never been found in great quantity. It has never been possible, so far as appeared, for the mine to furnish a large product, but a moderate supply exists now, as heretofore, and probably will be found for an indefinite period.

The mine is owned and worked by the Iron Cliff Co., and the ore is smelted in the Pioneer furnace at Negaunee, used with the Barnum ore. The aggregate product of the mine to date is 148,796 tons. Alex. Maitland, general agent, Negaunee, Mich.

THE SAGINAW MINE.

This is also an abandoned mine. All work has ceased and the mine has permanently closed down from want of ore.

The Saginaw is one of the mines that has scarcely equaled the expectations that were entertained regarding it during the first few years of its history. The mine was opened in 1872, and was worked for two years, during which time it produced an aggregate of 439,328 tons of ore.

The location is a fine one, the scene of considerable expenditure in the way of surface improvements and mining plant. The pleasant village of Stoneville has grown up in the vicinity of the mine; but with the stoppage of all work at this and other mines in the vicinity, the village itself must soon become deserted and silent.

Some future explorer may doubtless unearth treasuries of ore in this locality, now hidden and unknown; possibly too late to help out the present sojourners.

THE GOODRICH MINE.

The Goodrich mine, which adjoins the Saginaw, is also idle, but not from the same cause. There is iron ore at the Goodrich, possibly a good deal of it. The mine was never worked in a very effective way, and never explored to much extent. It certainly appears to be a good property to explore thoroughly, and when the iron business revives sufficiently this section of country will, probably, be gone over in a way that may lead to excellent results. The aggregate production of the mine is 51,479 tons. The ore is scarcely first-class, and could not be mined at a profit in the present state of the market.

The location is the w. ½ of the n. w. ¼, sec. 19, T 47, R 27.

THE CAMBRIA MINE.

This mine, situated northeast from Ishpeming, west from Teal Lake, has remained one of the most valuable of the recent hematite mines. The ore has continued from the first of the most excellent quality, of the best produced, a rich bessemer ore, for which there is a sharp demand.

Metallic iron	66.40%
Silica	2.20%
Phosphorous	.045%

So great has been the call for this class of ore that the management have been induced to push the mine to its utmost limit of production during the past year—50,000

tons in a single season is a large yield for so small a mine, wholly underground and requiring constant timbering. But the effect is apparent in the mine; one cannot always check out largely and still have his deposit hold good, and so with the Cambria Company, they are in the position to want more ore and to want it very badly. They have got to the bottom of the mine and the ore is all gone, or pretty nearly so, and the work now is in the direction of a new opening and further exploration. Some diamond drill work has been done and is still doing. The drill is working in the bottom of the mine, boring to the south; the core is jasper and lean ore—about 50% ore. If nothing better is found the drill will be turned north. Some borings were made heretofore, which passed through a large body of ore, as it was believed, and a shaft has been sunk to attack this ore. The shaft is 260 feet, vertically down; they have drifted from it for the ore, but thus far have not found it, as was anticipated. Still they express every confidence that the ore will be found in this shaft, and I see no reason for doubting that their hopes will be verified. The ore has all occurred in separate pockets or lenses which have been worked out, in whole or in part; new ones have been found as the old ones were exhausted, and no doubt similar good fortune will be met with. It is just at the close of the shipping season when it is expected that a mine, if ever, will look depleted. At such a time it is safe to assume that the shafts will be exhausted. I have no doubt but in the spring the mine will look very differently, showing, as usual at that season, plenty of ore.

The ore has been pitching east. The west pits were exhausted some time ago, and of late the working has been to the east.

The east pit furnishes the product now, mainly. The pitch of the formation is to the south, but the ore has made deeper as they worked east. In the east pit the ore widened out, but the foot wall flattened and has cut out the ore entirely in the bottom. The pit is 280 feet deep. The new shaft, which is south and east, is in lower ground and is thus fully as low below datum as any part of the mine. The mine is now all underground, and has been for the past three years; previously it was worked in open pit. Going down No. 2 shaft, which is in the hanging wall of this ore, we find the workings extend mostly under the open pit above, and that they have been removing the pillars, letting the mine come in. In fact a large portion of the product the past season has come from the pillars in the west part of the mine. No. 3 is to the east of it, and we may pass from No. 2 to No. 3, which latter has been a fine mine, is now, only from lack of ore. The maximum width is 100 feet, and this for considerable distance, and for a depth of 100 feet or more the space is filled with timbers erected on the Nevada system. It is the best work of the kind to be seen in Marquette County, and there is none other in the State as good except that in the East Vulcan mine, which, is identical with it and in as perfect shape; the sets are apart 6½' one way and 7' the other and 7½ feet high; no timbers are used that are less than 24" diameter, and some as great as 48". The uprights are under each other in exact vertical line and the caps are also in perfect horizontal line.

In placing these timbers they have evidently been governed by the principle which guided the parson in building "the wonderful one hoss shay."

> "It should be so built that it *couldn't* break down,"
> "For," said the deacon, "'t's mighty plain
> That the weakest place must stand the strain;
> And the way to fix it, as I maintain,
> Is only jest
> To make *that place* as strong as the rest."

Now I do not know whether the directors of the work at the Cambria have made as perfect a mechanical success of this undertaking as did the deacon in his; but it is certain the timbers in this part of the mine show no signs of weakness yet. There is no evidence of liability of giving way. That the timbering is well done is evident; the "weakest place" has been guarded against effectually, and the timbers are all in original position. They are mining out the pillars of ore in No. 3, placing timbers in the space as the ore is removed, and thus far this work has progressed without disturbance of the mine.

Where the ore deposit lies very flat, or where the walls are vertical or nearly so, this system of timbering can no doubt be frequently depended on to hold up the mine. But where the angle of dip is a bad one, not much underlay for a floor, it cannot be depended on. There is too much of a, tendency to slip, which cannot be guarded against. Even if the bed pieces are cut into the foot, the rock itself may give; it may be a schist or other non-stable rock that will give way, as it is known to do sometimes.

A defection at one point will be fatal. The weakest point must stand the strain, and if it gives way at one point the whole must collapse. Capt. Murry gives his personal attention to putting in the timbers. He understands the matter thoroughly and he sees that the work is done as it should be. The timbers are framed on the surface and let down the timber shaft, being held by a grip iron similar to that used by ice men in handling blocks of ice. When down the proper distance the logs are easily swung from the shaft into the level.

The mine was opened in 1876. All the old pits have been worked out, old Nos. 1, &, 5, 6; from the former the pumps have just been removed. The new shaft, upon which the hopes for the mine are at present hanging, is designated as new No. 1.

Capt. Murry has been in charge at the mine for five years, and the care and safety of his management is shown from the fact that in all that time not a man has been killed.

The hoisting machinery is of the Iron Bay manufacture, Merritt drums, etc. The plant has been in use five years and is pronounced by the officers of the company as perfect in its operation as it was the day it started. They like it very much.

The force at the mine is 100 men—120 on the roll. If no more ore should be found next year's product will make a poor showing; but the officers are not at all alarmed, seemingly; the mine has been in the same situation before and pulled through all right. They expect to find ore west in new No. 1 shaft in a few days, and, knowing the previous history of the mine .and fully acquainting myself with the situation, I cannot but share their confidence.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1876	6,324	1881	18,837
1877	10,082	1882	47,545
1878	3,754	1883	47,508
1879	6,860	1884	59,740
1880	7,252	1885	60,796
Total number of tons			258,742

The mine is the most easterly of the Teal Lake range mines. Alex. Maitland, General Manager; Gordon Murry, Mining Captain.

The fee of the land is held by the Teal Lake Iron Co.

Just east of the Cambria line some Negaunee parties are sinking a shaft. They were working in it at the time of my visit, but had as yet no evidence of ore. They stated it as their plan to sink a suitable depth and then to drift across the formation. They have an engine for pumping out the water and for hoisting bucket.

THE LILLIE MINE,

formerly known as the Bessemer, lies northwest of the Cambria. The open pit workings of the two mines are contiguous. The mine was formerly worked by Mr. C. M. Wheeler of Marquette, with very profitable results. Much of the ore was obtained at a very small cost. But the pits were worked down to a considerable depth and the sides caved in, in the spring when the frost went out of the ground, burying the bottom beneath a great depth of sand and rock. This happened in February, 1882.

The work of sinking a shaft to open under the bottom of these pits was begun, and in the meantime a small amount of ore was secured from the sides of some of the pits, mainly adjacent to the Cambria, where the best deposits of ore had been found.

Nothing much has been done for two years past. Recently the interests of the former owners were purchased by Mr. Wm. H. Barnum of Connecticut, and a company formed under the corporate name of the Lillie Mining Company.

There is not much to be said about it: the mine has heretofore been described with sufficient fullness, and little has since then been done. The present managers seem to be disappointed in the result of their explorations so far. They were led to believe, or believed from some basis of evidence, that the bottom of the pits were ore. This assumption has not been verified by the work that has been done. They do not find the ore as anticipated; but they are still at work sinking and drifting to greater depth, looking for ore that does not seem to materialize abundantly. I can see no reason why ore may not be found. The indications are favorable. The ore is of excellent quality.

Metallic iron	63%
Silica	3.50%
Phosphorous	.080%

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		
Total tons			118,550

The land is owned by the Teal Lake Iron Company: Alex. Maitland, general manager, Neganuee, Mich.

East from the Lillie some exploring for ore was done by Ishpeming parties a few years ago with diamond drill, but with no important result. East of this is the

FOREST CITY MINE,

which was worked for a couple of years, in an open pit close to the line of the Cleveland Iron Company. The deposit appeared to have been shallow and the ore was of rather poor quality, that is, it was too difficult to pick it sufficiently clean to make it salable, and the mine was abandoned.

The mine produced 1,895 tons in 1881 of 57% ore. The estate comprises 60 acres in sees. 35-48, R. 27. F. A. Bates, Secretary and Treasurer, Cleveland, Ohio.

The Cleveland Hematite mine, which adjoins this, has already been described with the other mines of the Cleveland Iron Co. Next west of the Cleveland Hematite is the

DETROIT MINE,

which is directly south from Ishpeming 1¼ miles. It was first opened in 1881 as the Norwich mine, but was soon after sold out to the parties who now hold the lease and operate the mine under the corporate name of the Detroit Iron Mining Co. The estate is 40 acres, described as the N. E. ¼ of S. E. ¼, Sec. 2, T. 47, R. 27. The mine was at first worked in open pit, but is now wholly underground and east of the earlier workings.

It is situated in low ground—frequently a cedar swamp—at the foot of the high round knob of land that rises up on the south. The underground mine is reached by a single

shaft 375 feet deep to the bottom. The main workings comprise a long drift in the ore vein, which runs east and west, dipping to the south at an angle of 45°. The shaft is vertical to the ore, then follows the underlay on the foot wall. The openings extend 300 feet east of the shaft, the ore averaging about 14 feet wide, with a stope at the end, and to the west 500 feet.

The distance down to the main level is 320 feet. Below this another level has been started. It is a pretty good little mine now. The ore is got out cheaply. The walls are kept in place by stull timbers mainly, so that there is not much expense in the way of timbering. Besides the ore that they are-working in, there are other bodies of it both north and south of the mine, as has been proven by diamond drill borings. There were three of these holes south of the mine, which gave important results; the ore is probably in the underlay of the same vein, and the holes assure of its continuance further down without diminution in volume.

In 1884 little ore was mined. The old workings had become exhausted and they were engaged in sinking the present shaft to open the new mine. The shaft is 200 feet from the old workings.

The ore deposit so far is pretty regular east and west; it is free of rock and has an average width of 12 to 14 feet.

The machinery comprises two hoisting drums (W. C. & L.), etc., and Knowl's pumps. A branch from the Ch. & N. W. R. R. comes to the mine, also the Marquette and Western road extends to all the mines in this range. The owners are Detroit men. J. S. Newbury, President, Detroit; John McMillan, Treasurer, Detroit; W. J. Officer, Superintendent, Ishpeming. The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1882	5,402	1884	3,038
1883	12,314	1885	19,755
Total tons			40,509

The ore is non-bessemer, yielding below 60% in iron, but found to be excellent for car wheel iron, etc. It is largely used at the Vulcan furnace. The company employ an average of 70 men.

THE BOSTON MINE.

Situated north of Clarksburg, is in a vein of remarkably rich, hard specular ore that is not surpassed in quality by any found in the Lake Superior region. The ore has every advantage in quality; it is high in iron and low in phosphorus, making one of the best ores for bessemer steel that is found.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Metallic iron	67.12	67.70	67.75	67.357	69.02
Phosphorus	.037	.017	.015	.016	.018
Silica	1.40	1.35	1.19	.....	1.15
Insoluble	.....	.....	.....	3.785	.....

The above table, though it has been previously published, is here reproduced for the reason that it is a valuable record of the quality of this ore. They are all analyses of average samples taken by competent parties at different times and made by reputable chemists. Numerous other analyses have been subsequently made, which show equally favorable results.

The ore occurs between a quartzite on south and jasper on north, and the geological character of these rocks is conceded to be identical with those at the leading hard ore mines of the district. The strike of the formation is N. 75° W., and it dips 80° to the south. The walls go down with much regularity.

The ore, when not cut out by the rock, has a width of from nine to fourteen feet. The mine is opened up to the west line of the property, where the mine workings exist.

The extreme length of the underground workings is about 400 feet, and .are reached by two shafts, No. 3 and jasper shaft; the former is the main hoisting shaft and is about 220 feet in depth. Borings were made with the diamond drill across the formation beneath the mine and to the east, some of which have been described in previous reports, and others have since been made with results corresponding with those heretofore given. The ore vein has been thus explored in this practical way for a distance of 1,140 feet from the west line east.

In working the mine, headings of jasper are encountered both east and west of jasper shaft, giving but a short length of ore in this shaft. It has been expected that the ore would make under this jasper and then the mine would have a continued run of ore the whole length of the openings. This expectation is still entertained and it is nearly certain to be verified. The evidence is based on the fact that a diamond drill boring across the formation from the south, made below this horse of jasper, cut ten feet of ore, and for this reason they have been looking for the jasper to give way.

At none of our mines are the rocks more favorable for a large body of ore than here; and at all those where a fine quality of hard specular ore occurs in place, as here, it has been found to be persistent and to continue in depth and to increase in magnitude. And while there has been no increase in the magnitude of the ore at the Boston so far as developed, it must be admitted that the mine has yet reached no great depth nor extent of workings.

The mine shut down at the end of 1883, so that for two years no ore has been raised. The reason for closing down was the low price of ore. It could not be mined at a sufficient profit to make it any object to continue work,

and so it was decided to stop until there should be better prices.

The mine is excellently well equipped with machinery, engine, hoisting plant, and a new Norwalk compressor and power drills—the latter put in. the last year of work. Also, there was added an automatic hydraulic elevator, which raises all the water from the mine. This new machine, lately introduced by Mr. F. A. Wright into the mining region, and manufactured at the Iron Bay foundry, Marquette, is a decided acquisition to our mine machinery. It can be used in all mines which have a compressor, and within the limits of its capacity, it is the simplest and most economical method of raising water from a mine that has ever been devised. There are three of them in use at the Lake Superior mine, two at the Cleveland, etc., and all pronounce very emphatically in their favor. "Sea Lions," the miners call them, from the peculiar intermittent sound which they make. On the location are a number of good frame buildings, among which are included a large boarding house, half a dozen dwelling houses, etc., etc. The mine will probably start up again in the spring. The company owns the fee simple of the land, S. ½, S. W. ¼, Sec. 32, T. 48, R. 28. Samuel Mather, General Agent, Cleveland, Ohio.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1880	6,478	1883	20,199
1881	14,824	1884	2,148
1882	18,077	1885	
Total tons			61,715

THE STERLING MINE

joins the Boston on the west. The two are opened in an isolated rise of hard land surrounded by swamp or low land. This swamp to the west on the Sterling is quite soft and wet, to the east on the Boston it is drained by the lake and the creek, which runs to the south with a rapid current.

The Sterling has not much mining equipment and no great extent of opening. It has but one shaft, and that a small one close to the Boston line, and somewhat deeper than the Boston pit. The depth is about 250 feet, with an equal maximum length. Next to the Boston the ore has a. width of 12 feet, but to the west it narrows up and is mixed with rock. Further to the west some diamond drill borings were made. No. 1 hole, 490 feet west of line, angle to north 66° with horizon, 57 feet soil, 14 feet quartzite, 59" No. 1 ore, 18' jasper, 16' 10" hard ore, 15' hematite ore.

No. 2 hole, 990 feet west of line, to angle 58°—88 feet soil, 15 feet quartzite, 5¾ feet No. 1 ore, 30 feet jasper, 8¼ feet ore, No. 1. Thus the mine has ore at a considerable distance west in greater quantity than where worked; but it would be troublesome to get to, owing to the water and quicksand.

The ore is identical with the Boston. The company hold on a lease 50 cents per ton royalty, from T. B. Brooks and R. Pumpelly, owners of the fee. There are rumors of a consolidation of the two companies being effected; which would seem to be a very natural arrangement.

The Sterling has produced as follows:

Year.	Tons.	Year.	Tons.
1880	1,187	1882	6,135
1881	4,702	1883	3,618
Total			15,642

The mine has been closed down since 1883. J. H. Outhwait, Secretary and Treasurer, Cleveland, Ohio.

THE DEXTER MINE.

This mine is situated about two miles east from the Boston. The ore is a hard hematite of medium quality, for which there is not a ready sale at the present time. The mine has been idle since 1884. A small amount of ore that was held over in stock has been shipped away the past season. The mine is adjacent to the Dey, which it joins on the west. The Dey did not prove of much value and the work was abandoned. The ore deposit extends. east and west, dipping to the north. The shafts are sunk from the north slope of the hill, which rises above the level to the north about 40 feet; from the shafts the ore is reached by cross cuts. The ore body has a width of about 16 feet and is free from rock. The mine was opened in 1883 and worked two years.

The product has been as follows:

Year.	Tons.	Year.	Tons.
1883	4,878	1882	750
1884	16,532		
Total			22,160

Joseph Sellwood, Superintendent, Ishpeming, Mich.

THE ST. LAWRENCE MINE,

in the same range with the above, and producing ore similar in appearance, is situated about three miles west from Ishpeming, in Sec. 5, T. 47, R. 27, comprising 80 acres in the northwest quarter section. A railroad track was built to the mine in 1882 from the main line of the C. & N. W., and during that year the mine shipped a product of 9,992 tons of ore; in 1883, 11,961 tons, and with that year work at the mine ended. It is an ore for which there is practically no sale. What was mined was probably used by Mr. Cornell in his furnaces at Youngstown, Ohio. It yields in metallic iron 53% to 57%, and in phosphorus .086 to .104%.

Some litigation has recently been had between the company and the owners of the fee, in the Marquette County Circuit Court, regarding the time of payment of

royalty, which was decided in favor of the company. The ore is not likely to come into market in the present condition of the iron business, neither is there a large amount of it; at least there is not so far as the developments enable one to judge.

A. B. Cornell, President, Youngstown, O.

Following this range west to Champion, we reach, at a mile or two north of that village, a succession of hematite mines which a few years ago, at the time of their discovery, made considerable stir in the mining region.

Some or these have an abundance of ore, but it is of a poor quuality, that is comparatively low in iron and high in phosphorus, containing over 50% in metallic iron and from .25% to .50% in phosphorus; it is low in silica, and contains a good deal of lime and 10% of water. When carefully selected it is 57% in iron and .25% to .27% in phosphorus. The ore works well in the furnace and smelted with hard ore is said to correct red short in iron.

The most easterly of this series of mines is the

MESNARD.

This mine never amounted to anything more than an exploration made during the summer of 1883. A short distance west of this is

THE JIM PASCOE MINE.

This mine is one of the most important in the list. At the time of its discovery it attracted a good deal of attention, and the shares of the company's stock were readily taken at figures which, from our present standpoint of experience, seem exceedingly high.

It illustrates what a rapid educator experience may be. People now know that ore of this kind, in the present condition of the market, is very nearly valueless, for the reason that it cannot be sold; but four years ago there were those who predicted that the Jim Pascoe would be the largest producing mine on the lake. The only fact considered was that there was, apparently, a great amount of ore; that the mine was likely to be able to produce a great deal. The quality, however, was not greatly regarded, except among those better informed and more observant. There were those who read the .signs of the times more accurately, and with such persons this new range had few charms. The demand has been all for steel ores—ores suitable for steel making—and in such a contest the Jim Pascoe must stand, imperatively, out of the list.

The mine has an abundance of ore, possibly all, in this particular, that the most sanguine ever claimed. Still the mine has been very little worked, not enough to develop the deposit fully. The mine is in the S. ½, N. E. ¼, Sec. 29, T. 48, R. 29. The strike is east and west and the dip to the north. A little way to the south end the ground descends in the same direction down into the valley, through which runs the M., H. & O. R. R. On the opposite side the ground rises again to an equal elevation, where is the Champion mine.

The mine has been moderately worked the past season, having shipped 18,249 tons.

Year.	Tons.	Year.	Tons.
1882	18,880	1884	11,465
1883		1885	18,244
Total tons			48,595

A. Kidder, General Agent, Marquette, Mich. The mine closed down in November last, for the winter.

THE DALLIBA MINE.

The Dalliba lies next west of Jim Pascoe. The lease covers 160 acres, being the S ½, N. W. ¼, and N. ½ S. W. ¼, Sec. 29, T. 48, R. 29. No work has been done at this mine for three years past, the idleness being due to the want of any demand for the ore, possibly; also to some financial embarrassment, into which condition it is reported that the officers of the company are involved. The quality of the ore in these mines does not much vary; what is found to be true of one is true of all. Sometimes specimens of the ore show better qualities than the average, but altogether it evens lip about the same, medium quality in iron, high in phosphorus and low in silica, with considerable lime. No doubt, if treated understandingly, it will flux easily and make a good quality of car wheel iron. I should judge that the Dalliba has plenty of ore and could, if worked properly, make a large output.

The mine has produced as follows:

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

James H. Dalliba, President, Cleveland, O.

THE NORTHAMPTON MINE.

This mine is near the Dalliba, joining it on the west and opened in the same range; but the owners of the Northampton do not seem to possess the fortune of holding an ore body equal of its neighbor; at least the work that was done did not lead to results that would warrant the assumption that a mine would be found on the location. S. E. ¼, Sec. 30, R. 29, T. 48; opened in 1880, by Champion Iron Company.

A. Kidder, Agent.

Still west from the Northampton is the location of

THE MARINE,

on which some buildings were erected and mining work done in 1881. No ore, however, was found. The digging showed only soft graphite. Some parties were very sanguine regarding this enterprise; not a few mistook the graphite for ore.

The organization was under the corporate name of the Marine Iron Mining Company. This is the last of the mines in this range until we reach the west end of Lake Michigamme. West of the lake there is a continuation of this range of ore, and a number of mines have been opened in it, the most easterly of which is

THE WETMORE.

This mine is situated about one and a half miles west of the lake, in the N. W. ¼, Sec. 25, T. 48, R. 31. Explorations by test pits have been made east and west nearly across the quarter section, and ore found along the whole line of search for a width of 200 feet or more.

If mining work were to be extensively and systematically undertaken here it is probable that a large amount of ore could be obtained easily and cheaply. The topography of the ground is admirably adapted to economical mine work. Along the south the ground slopes down to the valley of the river, affording excellent drainage for a considerable depth. A railroad track has been built in, running along the side of the bluff, and they are working with about 15 men, mining ore and hauling it out to the track in carts and dumping it into the cars. The ore is stripped of the overlying dirt and attacked endways from the west. The stripping is very difficult, for the reason that it is almost a complete mass of boulders nearly connected together by a hard, compact soil of clay and earth, which has to be shaken with powder blasts; it is 10 feet to 20 feet thick, and the cost of removing it is considerable. They are working on what appears to be a top lense, and make the rock which divides them the foot wall, along which they advance. The dip is very flat to the south, with a slight pitch to the east. The breast of the stope is about 50 feet wide and 25 feet high. They shake up the ore with powder blasts and then pry it with picks and bars and load the lumps into the carts. The ore comes out mainly in large blocks, which require further breaking before they can be readily handled.

The ore is very clean; there is no rock in it. It is peculiar in appearance, certainly not fascinating in this particular, but there is a small proportion of hard blue ore that is of better quality. The ore is sold on a guarantee that it will yield 57% metallic iron. It is sold to the Vulcan Furnace Co. at $1.50 per ton on the cars at the mine. The royalty is 30 cents per ton, so that there is probably a small margin of profit. They are mining 60 to 80 tons per day and will continue to work until January. The work is directed by Mr. Ed. A. Wetmore, of Marquette, who nominally holds the property, no corporate company having been formed to operate the mine.

Product:

Year.	Tons.	Year.	Tons.
1882	1,706	1884	4,585
1883	2,766	1885	5,887
Total			15,015

THE WEBSTER MINE.

This mine is situated across the river west from the Wetmore, and here considerable expenditure has been made for mining and surface improvements, for dwelling houses and other buildings and for machinery.

The mine has been idle since 1883, though in shape to start up at any time. The pits are full of water, but it is said by those who are familiar with the situation that there is plenty of ore; that the mine is as favorable in this respect as it has been at any time. I have visited the mine frequently and have found no just reason to infer to the contrary, though during the last season that the mine was working some horses of rock were encountered that gave trouble and uneasiness to the management.

The mine has an engine, house, engine, hoisting plant, skip roads and elevated tramways for running out the ore and stocking it. The location is a pleasant one, being in the forest of fine, hardwood timber which remains standing uninjured. It is said that the mine will be worked next season. The ore is identical with that of the other mines in this range.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1882	4,413	1884	934
1883			
Total tons			5,347

THE BEAUFORT MINE.

The Beaufort mine is the next location, situated about two miles west from the Webster. This and the Titan are contiguous mines, and are the ones that have been worked the most largely of the mines of this range since they were opened. The location is reached by the county road, which has been extended from Spurr mine westerly to this point; also by railroad branch from the main line of the M., H. & O. The mines are in high, dry ground, and are thus far troubled but little with water.

From the surface down for a depth of about 75 feet the walls of the ore dipped at a sharp angle about 60° south, to which distance the ore was mined out in open pit workings. At the Beaufort the pit is about 300 feet long east and west, and from the bottom the walls flatten out, so the ore goes in under the hanging, dipping to the south 15° or 20° from the horizon. The ore is hoisted from the pit in a skip, the track for which descends from the north side of the pit. The whole length is about 260 feet. Two hundred and fifty feet east from this is a downright shaft that was sunk 38 feet through sand and

gravel, etc., and 30 feet in ore. The shaft has not been used any further. Underground they have worked out large chambers 40 to 50 feet across, leaving pillars of ore to support the roof, which shows no tendency to fall. They are sinking for new stopes. The ore body has a width of about 25 feet, perhaps 20 feet to 40 feet. In the working season the company employed about 60 men, 45 men in the mine, and were raising about 140 tons of ore daily. The miners were paid on the average $1.65, and the company account men $1.40 per day. The ore is mined on contract, the company paying 40 cents per ton for breaking and 12½-cents per ton for loading the ore, the company doing the hoisting, furnishing tools, etc., and the men furnishing their own powder and lights, etc. The total mining cost of the ore is about 90 cents per ton in the cars. This does not include stripping, construction account and royalty, which are to be added. The royalty is 30 cents per ton, and the ore sells for $1.40 to $1.50, thus leaving but small margin to cover risks, losses and profit. In fact it is doubtful if there is any profit now in mining this ore; there is too much of it to be had and too little of it wanted. The outlook for the immediate future is no more encouraging than the past has been. The Agogebic mines are coming to the front with their high grade ores, so that unless the consumption of ores increases immensely, ores of the class furnished by the Beaufort are not likely to be wanted to such an extent as to render active all the mines which produce this kind of ore. It is the same ore, in appearance, quality, etc., of the Dalliba, Jim Pascoe, and the others of this range. At the present time (November), they are working 12 miners and a few surface men; are sinking for new stopes, etc. The mine could be opened so as to furnish a large amount of ore.

S. S. Curry, General Agent, Ishpeming, Mich.; M. E. Williams, Mining Captain, Beaufort, Mich.

The product for each year is as follows:

Year.	Tons.	Year.	Tons.
1882	5,532	1884	
1883	18,976	1885	17,167
Total tons			41,675

THE TITAN MINE

is only separated from the Beaufort by the line which divides the properties; the same open pit is in both mines. Each mine has about an equivalent surface and mining plant, and each is opened in the same manner and to about the same extent. In the Titan mine, however, the dip of the ore to the south continues from the bottom of the pit at the same angle Instead of flattening out as in the Beaufort. The length of the skip road is 180 feet, going down on the foot wall from the west side. The length of the underground opening in the ore is about 200 feet east and west. The depth of the ore is about 20 to 25 feet. The hanging wall is jasper and the foot wall a friable slate—plumbago—where it is in contact with the ore.

The mine is apparently in two lenses. The west lense makes to the north as it goes east. They designate the pits as No. 1 and No. 2, the latter being the west pit. They hoisted from this pit in the summer about 100 tons >each 24 hours—night and day shift. The east pit is separated from the former by intervening rock. In July there were 20 men employed in this pit, working two shifts, stoping ore against the hanging and sinking shaft to meet the drift coming east from No. 2, were hoisting about 50 tons per day.

At this time (November) the mine works, all told, 16 men. The ore nearly all comes up on the skip road and is dumped into the pockets situated on the north side of railroad track. An elevated trestle runs out beyond for use in stocking ore and dumping rock. The mine has a sufficient hoisting plant for present purpose.

The agent and mining captain are the same as at the Beaufort. The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1882	1,778	1884	
1883	13,128	1885	23,340
Total tons			38,236

About two miles to the northeast from the Beaufort is the

SPURR MINE,

which has had an unfortunate history. It was opened in 1873 in a fine outcrop of rich magnetic ore and the most confident hopes were entertained regarding the future of the mine. The location was put in admirable shape for operating a large mine; a great number of good dwelling houses and other buildings were erected. A complete plant of machinery, which subsequently included a compressor, was obtained, and thus everything adequate to working a large mine was procured, and is still in readiness for use at the mine. The mine, however, did not develop according to expectations. The ore, which appeared so promising on the surface, did not hold out. The company became heavily involved, the mine yielded only a small product, and was finally closed down to be taken possession of by the bondholders, who organized a new company, and in 1880 again began to mine ore in a small way. The new company provided but very little working capital; they operated on the plan that the mine must pay its own way, that ore enough must be raised and sold to furnish all the funds that should be needed. This theory is all very well when they have the ore, but when the ore itself is the uncertain factor, or becomes an unknown quantity in the problem, it puts a different phase on the matter. This was really the position during the last undertaking. There was too little ore to make it worth while to bother with it, or to try to keep up the struggle to make their ends meet.

Two years ago the mine closed down for the second time and there seems to be no immediate prospect of a resumption of work. It would be useless to attempt to operate this mine without thoroughly exploring it with a diamond drill. It is one of those locations where the drill can be used to the best advantage, and, strange to say, this effective machine has never been used at this mine. It is the first machine that should be set at work. The ore is magnetic, averaging well in metallic iron, but adapted only to foundry purposes.

The ore trends east and west, dipping west at an angle of about 45° to 50°. The hanging wall proper is a massive gray quartzite, but usually intervening between it and the ore is a layer of chloritic schist. Underlying the ore is a, belt of jasper and schist, impregnated with iron, that rises to some height at the rear of the mine and out-crops for a long distance east and west. Still further to the north is the high range of greenstone, which becomes the important feature in the topography.

The company owns in fee simple a quarter section in which the mine is. located—N. ½ S. W. ¼, and S. ½ N. W. ¼, S. 24, T. 48, R. 30.

The mine has four shafts, but the entire work, recently, was confined to one of them, No. 1, which is at a depth of 400 feet. The ore lenses are short, narrow and shallow as far as the mine has been worked, but the company has plenty of ground, apparently favorable, to explore on.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1873	31,033	1880	
1874	41,765	1881	2,746
1875	21,095	1882	8,872
1876	20,276	1883	9,067
1877	22,801	1884	
1878	2,225	1885	
1879	1,409		
Total tons			164,189

W. D. Wisson, Secretary and Treasurer, Detroit, Mich.

About one and a half miles east from Spurr is the far more important

MICHIGAMME MINE,

which has also had a somewhat chequered career. The Michigamme was started at the same time as the Spurr, and has been continuously worked since. The mine has proved moderately productive, though scarcely equaling the expectations of its owners. The diamond drill has been used in this mine to much advantage; in fact if it were not for the discoveries which have been made with this machine the mine would probably have been worked out and shut down long ago. The mine has been fully described in previous reports. Since the last description was given, two years ago, the new shaft has been completed and has become the main working shaft in the mine. Its depth is about 400 feet on the lay 61½° to the south. In the main level in this pit—now No. 5—the opening extends 200 feet east and 165 feet west of the shaft; the ore is 10 feet to 17 feet wide. If the ore were clean it would be a good mine, but some rock is found mixed with it—a very small amount —but enough to hurt the sale of the ore. The ore is carefully sorted and made into three grades. The 1st is a fine magnetic ore yielding 66% to 69% in metallic iron. The 2d class stock pile gave on recent analysis of average sample about 64%. The 3d class affords 59% in iron, 5% in silica. All the ore is too high in phosphorus for bessemer steel. The best ore gives only 1% to 1½% silica, and in phosphorus is not above .070%, running from .035% to .095%.

In the north mine they are working in four levels; the fourth is just opening out. The pit is north of No. 4 about 125 feet, and the two are connected by several cross-cuts through the foot wall of No. 4. This rock is a compact, gray quartzite and becomes the hanging of this north mine. It is expected that the workings west will soon be opened into old No. 5, which was worked out and abandoned years ago. No. 4 shaft is the deepest in the mine, about 550 feet in depth. It varies in dip at nearly each level, owing to the fact that the ore has been followed in sinking the shaft—the ore making sometimes to the north and sometimes to the south. An illustration of this is seen now in the bottom. The ore is found to be 44 feet in the hanging, that is, they find in the hanging wall 44 feet south of the shaft a lense of fine ore 14 feet wide. They have opened into it by cross-cut and drifted in it 70 feet east and west, and also have bored down 140 feet, all in ore. To reach this deposit they will begin upon the line of the shaft, where it bends down, and cut out the hanging wall so as to carry the shaft directly to it. No. 4 has been a valuable mine, but the ore deposit has been narrowing and shortening for some years past, until now it is of comparatively small dimensions.

Possibly the new lense will help out materially.

No. 3 has a good deal of the "Spersburg" ore, so called from its supposed resemblance to the ore of the celebrated Spersburg mine in Sweden; it is an ore which does not sell now.

No. 2 shaft has some very fine ore. The shaft is 200 feet deep, and the pit is, on the whole, looking better than it did two years ago, for the reason that they have the soap stone hanging, which is possibly important since the experience in this mine has led to the belief that under the soap stone ore will be found: when the formation was regular the ore has always occurred in that position. Owing to the accumulation of ore at the mine, and the fact that no sales had been made, together with the dubious outlook of the iron market for the coming season, the mine was shut down the 9th of June last and no mining was done until November 1, the mine in the meantime being kept free of water and a suitable force kept employed on the stock pile picking over the ore and loading cars.

The company now have about 40 miners at work day shift only, and are raising 80 tons of ore per day.

The company has an ingenious and effective arrangement for running the ore out from the shaft to the stock pile. It utilizes a part of the hoisting power to pull back to the shaft the car which is employed for this purpose—to run to the stock pile or to the rock dump. Its essential features are a friction wheel, placed upon the shafting, which carries the shive over which the wire rope runs that draws the skip. Below this is a wooden drum and friction wheel fixed in a frame, so that by means of a lever the friction wheels are brought together and the revolution of the axis of the shive revolves the drum, thus winding up the rope that passes down and around a small pulley fixed at a level with the track and then to the end of the car, where the rope is finally attached. The track is given a slight downward grade, and thus, when the car standing under the shute at the shaft has received its load from the skip, the brake is thrown off and the car runs out on the track by force of gravity; if necessary a man rides with it to attend to the dumping. When the skip comes up the man at the shaft who attends to the signals, etc., puts his hand to the lever and by pressing down brings the friction wheels in contact, thus causing the drum to revolve and the rope to which the car is attached to wind up, drawing the car back to the shaft. It may be arranged so as to require only the person at the shaft to do all that is necessary. It could also be made to draw back the car by the descent of the skip, thus utilizing a power that is wholly wasted. If the material is run to different points a man may be necessary to attend to the switches. It is certainly a very economical arrangement, and adapted to all mines in which the ore, etc., is hoisted in the usual manner. The power is only what is necessary to draw back the empty car. At this new No. 5 shaft the run is 780 feet, and the run back is made while the skip is coming up 150 feet. Of course the track can have any number of branches—simply use switches.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1872	141	1879	56,935
1873	28,906	1880	52,944
1874	45,218	1881	57,115
1875	44,756	1882	43,712
1876	20,074	1883	42,583
1877	28,238	1884	28,757
1878	58,622	1885	12,372
Total number of tons			507,063

The local officers are J. C. Fowle, Superintendent; J. P. Christopher, Mining Captain; James Rood, Secretary and Treasurer, Chicago, Ill.

THE CHAMPION MINE

is situated near the east end of Michigamme lake, and is one of the best and most successful mines in the State. It is among the largest producers and its ore is of the best. The Champion has another element of distinction; it is the deepest of our iron mines. It is a very interesting mine as well as a very valuable one, and is altogether regarded with much pride by the people of the iron region.

In speaking of the mine it may be necessary to recapitulate some of the essential features. The ore occurs in separate lenses, designated as the north lense and the south lense. The shafts are in the former, dipping to the north at an angle of about 80° with the horizon. The ore lenses incline downward to the west at an angle of about 45°. Thus the mine is all the time making deeper to the west, and with each successive level the ore shortens to the east and lengthens to the west. The south lense is reached by cross-cuts through the rock separating the lenses. The hanging wall is massive gray quartzite, and the foot wall a jaspery, magnetic schist. The length of the mine east and west is about 1,900 feet.

Owing to the pitch of the ore to the west, causing it to lengthen west and to shorten east, the tendency is that the ore will be found, ultimately, wholly west of each shaft in succession, and thus one after the other of the shafts from the east will become useless. In this way No. 1, No. 2, and No. 3 shafts are all now east of the ore. The latter has reached the rock in the north deposit, at a little below the tenth level, at a depth of 616 feet. The shaft is to the twelfth level. Shafts Nos. 3 and 4 have furnished the most of the ore, for they take the ore from the main north and south deposits. No. 5 takes the ore from two small deposits lying further west. All are connected by cross-cuts in the seventh level. The main north deposit in the seventh level was 500 feet long and from 18 feet to 40 feet wide. The south deposit was nearly as long but somewhat narrower. The dimensions in the eighth level were about the same. In all the levels there are two cross-cuts—one at each shaft. The length of each lense was about 500 feet in the 9th, and the width in each was about the same—averaging 25 or 30 feet, ranging from 20 feet to 50 feet.

In the tenth level each lense was 400 feet long, and averaged 22 feet wide. The eleventh is now the main level, and is equally as large as the tenth. This level is 700 feet below the surface.

To enter into a more particular description of the underground appearance of the mine: all the ore above the seventh level is worked out, except that left in pillars. Most of the ore at the present time is taken from the eleventh level, from the south deposit, and finds its way up No. 3 shaft. There are two stopes in the south deposit in this level, one east and one west of the shaft, and one west of the shaft in north deposit. The stopes are 30 feet wide and 45 feet high. The levels are 60 feet apart, and thus in taking a 45 feet stope there are 15 feet left for floor for level above. In the north deposit in this level, the stope is 153 feet west of the shaft, and the length of ore yet standing is 47 feet, 35 feet wide, besides leaving 20 feet of it for shaft pillar to No. 4.

No. 2 shaft goes down to the fifth level, where it struck the rock, and the ore went to No. 3, which is now to the eleventh, having been for the last 40 feet in rock, but having ore in the south deposit and west of the shaft in north deposit. Thence forward the north deposit ore will go to No. 4 shaft. No. 3, south deposit, is sunk to the twelfth level, and drifted, each way from the shaft, 35 feet; the ore is 30 feet wide. In No. 4, north deposit, the ore is 30 feet wide west of the shaft, and east the stope is 35 feet wide, in the eleventh level.

The winze is sunk to the twelfth, and all is in readiness to open there, 760 feet below the surface.

One of the best stopes is in No. 5, between the eighth and ninth levels. The ore at 70 feet west of shaft is 36 feet wide, a great improvement over what it was above. The shaft is sunk to the tenth level and they are opening out.

In the eighth level, on a rise east of the shaft, they are boring with a diamond drill, nearly vertically down, and were in ore; had already 40 feet of it, and still in ore. This is something new, probably a new lense, as it is east of any ore heretofore found in this shaft. They will go down into the ninth level and bore in horizontally to further prove this new find, which seems likely to be of importance. The mine has always been prolific in lenses, chimneys or pockets of ore. They are likely to be found at any time. The ore lengthens west in No. 5. In the eighth level it reached 150 feet west of the shaft, and was 20 feet wide. In the ninth they are now in 70 feet and the ore is 36 feet wide, and they are confident it will extend west a greater distance than it did above; and so on keep increasing in length in the tenth, etc., owing to the westerly pitch of the lense. Some further testimony is had to verify this conclusion from diamond drill borings.

The work of sinking a new shaft has just been undertaken, located 450 feet west of No. 5, being half way between it and No. 7. They are also sinking No. 7, which was 160 feet deep. The purpose is to strike a deposit of ore, which was found by diamond drill some years ago by two borings.

No. 6 will strike ore at 200 feet down; there are 15 feet of it as found by drill; also at a greater depth will be found the lense of ore that lies under No. 7, which is estimated as a body at least 20 feet wide.

Two-thirds of the ore taken from the mine is first-class—100,000 tons. They make three grades. The third grade is a 63% ore; the second a 65% ore, and the first is 68% to 70%. In phosphorus .040%, and silica 1.50%. In quality of ore it is the leading mine in the State—hard ore mine. The ore is about one-half magnetic and half specular slate; it is all bessemer. The walls are good and being so steep require less support than if they were flatter. It is an easy mine to work; dangerous places, passage ways into which there is a liability of the men falling, are provided with railing, and, apparently, the safety of the men is carefully looked after.

The company employs about 500 men, and it is stated that the miners earn $2.00 to $2.50 per day on their contracts. The management is esteemed as being liberal with the men it employs. Mr. A. Kidder has been agent of the mine for many years, he has made himself familiar with the geological features of the mine, as well as with all other matters that concern it. The other local officers are John Simpson, Mining Captain; W. Field, Assistant, Superintendent, Champion, Mich.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1868	6,225	1877	70,883
1869	21,535	1878	73,764
1870	73,161	1879	96,208
1871	67,588	1880	112,410
1872	68,404	1881	144,025
1873	72,782	1882	157,516
1874	47,097	1883	104,960
1875	56,877	1884	208,156
1876	66,002	1885	173,914
Total number of tons			1,618,242

THE EAST CHAMPION MINE,

which is situated a little way east of the former, is opened in the same formation, but the ore deposits have proved small and irregular. The mine was started in 1872, but never proved profitable.

Under the first organization it was called the Keystone. About four years ago it was re-incorporated under its present title. The mine has been shut down for the past two years. They were working in two shafts, No. 2 and No. 3, the first of which is about 300 feet deep. In the bottom of this they did a considerable diamond drill work, and, found small lenses or pockets of ore. All the deposits that have been found at this mine were small. The lense in No. 2 is about 150 feet long and 5 to 8 feet wide; the shaft is about 200 feet deep. No. 3 has a lense of ore 6 feet wide. The ore is scarcely first-class—magnetic and hard specular.

The record of the product of the mine for each year is as follows:

Year.	Tons.	Year.	Tons.
1873	12,701	1880	10,221
1874	4,880	1881	3,408
1875	3,348	1882	3,713
1876	7,715	1883	5,039
1877	14,496	1884	.....
1878	5,401	1885	.....
1879	4,029		
Total number of tons			74,951

F. B. Spear, President, Marquette, Mich.

The mine is near the village of Champion, on the line of the M., H. & O. R. R.; description, S. E. ¼ S. W. ¼, S. 32, T. 48, R. 29.

THE HUMBOLDT MINE

has not improved any in the past few years, on the contrary the line of its fortunes tends in the opposite direction. The Humboldt property has a pretty long stretch of ore formation, and a good many openings have been made at different points, but none of these have been in large deposits of ore. The best deposit is the one which the company is still working, which is reached by two shafts, Nos. 2 and 3.

At the time of my previous visit to the mine—two years ago—this pit was about 300 feet long. The shafts were at the bottom 280 feet deep, dipping northwest. Now the shafts are 350 feet down and the ore between them is practically exhausted. North of No. 3, 90 feet, a crossing cuts off the ore; this bar has been recently bored through and a body of black magnetic ore found beyond. They have opened into it and are hoisting it to the surface. Analysis shows it to be good in iron but high in phosphorus. The body is 14 feet wide. They are sinking a winze in it. This is the most encouraging thing in the mine now, as it may prove of considerable value.

The main ore lense lay in a bend, possibly the good ore will dip to the northwest, under the conglomerate.

At present they have only one stope of ore in the mine, which is southwest of No. 2, and is 14 feet wide. They have cut through a narrow part of the vein to reach it, and thus get rock mixed with the ore, but when hoisted the ore is carefully sorted; all poor ore and rock is picked out.

Thus they will have this new body to the north of No. 3 and the stope southwest of No. 2 for the future product. To reach this ore they are preparing to sink No. 1, and will fit it up and so abandon No. 2. The new deposit, if it turns out to be of sufficient value, will be reached by No. 3 shaft; they will change its direction so as to take it down into this ore. The length of the ore to the south and southwest of No. 2 is 190 feet, with an average width of 12 feet. No. 1 shaft will come down in the middle of this lense. The ore is more free of rock; it all has to be picked over carefully. There are now (Nov.) at the mine in stock about 14,000 tons of ore; it is very good second class, averaging about 60% in iron. No. 3 pit having become exhausted of ore the mine has reached pretty contracted dimensions. Unless there is an improvement the mine is not likely to be worked very long; it cannot be profitable as it is. There should be an improvement both in the mine and in the market. The ore is mainly, after being ready for market, first-class non bessemer, hard specular slate, with a mixture of magnetic. The second class is designated as Franklin—martite and slate.

The ore should dip to the northwest under the conglomerate.

It would seem that the ore formation should lie between the ridge on the east and south side and the conglomerate, which forms the opposite ridges on the northwest, and under which the formation dips. There is a valley between the mine and the conglomerate that has not yet been explored. The local management remains unchanged. J. B. Maas, Agent; Ed. Maas, Superintendent, Humboldt, Mich.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1865	4,782	1876	8,338
1866	15,150	1877	16,546
1867	25,440	1878	23,921
1868	35,757	1879	18,204
1869	58,032	1880	14,727
1870	79,712	1881	26,922
1871	42,725	1882	42,636
1872	38,841	1883	31,866
1873	38,014	1884	23,763
1874	27,890	1885	11,776
1875	9,042		
Total number of tons			600,338

THE ARGYLE MINE

is adjacent to the Humboldt; both of them are on the Republic branch of the M., H. & O. R. R. The Argyle is an old mine. It was the first of our mines to be worked wholly underground. It originally belonged to Judge Edwards of Marquette, now deceased, and was known as the Edwards mine. The shafts dip to the west, with the formation, and have attained considerable depth, No. 3 being 600 feet in length, and No. 2,500 feet. The ore is magnetic and specular slate, and so mixed with rock as to require careful picking. It was never a profitable mine. The lenses of ore are too small and too much dead work is necessary. It is a good property to explore to the north in the level land. Some diamond drill borings should be made to test the property. The mine has been idle since 1883.

It has produced in past years as follows:

Year.	Tons.	Year.	Tons.
1866	2,863	1876	19,420
1867	4,928	1877	10,591
1868	17,360	1878	10,303
1869	21,450	1879	5,455
1870	24,232	1880	.....
1871	26,437	1881	4,584
1872	26,026	1882	12,461
1873	20,281	1883	15,700
1874	2,842	1884	.....
1875	12,804	1885	.....
Total number of tons			256,774

Don M. Dickinson, President, Detroit, Mich.

THE REPUBLIC,

taken all in all, is probably the best hard ore mine in the State; there is more ore to be seen in the mine now than there is any other, and then it is of better quality than

that of any other, except the Champion. I might except the Boston ore, but that is a small mine and is not working. The Republic has also taken its place with the other great mines in the improvement of its mining plant. Its new hoisting machinery is probably not excelled in power or perfection of working by that possessed by any other iron mine in the world. In many respects the mine is improved, and thus altogether the visitor is greatly impressed with its magnitude and importance.

The ore deposits in this mine outcrop along the westerly slope of the high bluff that descends to the shore of Smith's Bay. The high jasper formation curves around conforming to the contour of the water, being at the south end of the bay nearly east and west, and on the east side of bay, running north and south.

The bay, which is a bayou from the Michigamme river, that lies on a basin formed by the converging dip of the high jasper bluff which nearly surrounds it, is an exceedingly interesting location—scientifically, practically and æsthetically. Scientifically, from the excellent opportunity which this immense and varied outcrop affords for geological study; practically, from its great importance derived through the magnitude and richness of the ore, and æsthetically from the remarkable beauty of the scenery itself. It is one of the most romantic mining locations in the whole upper peninsula.

Many of the ore deposits in this mine, especially the slopes at the south end, are really chimneys of ore or lenses set up partially on end inclining towards the lake, and the shafts go down, following through the long way of these deposits.

These chimneys of ore also approach each other in their descent, and thus have the appearance of radiating from one body like the fingers from the body of the hand. This fact has led to a belief that is quite freely entertained that all these now separate deposits come together finally, forming one great body of ore underneath the bay. The theory is not an improbable one; there are many facts that tend to verify it and lead to the inference that this fine hypothesis may ultimately be found to be a pleasing reality.

Commencing with the Perkins shaft, the most southerly and westerly one, the ore is a red specular, not as much in favor as the best ores of the mine, and the shaft has been abandoned. Next east of it is the Morgan. The dip of this shaft is 38° to the north, and it is 800 feet long. The levels are 50 feet apart; they are working the three lower ones. The lowest is the twelfth. It may be well to state that the lower levels in all the shafts are not yet very near the bay; assuming a continuity of the present dip and rate of advance, the bay will not be reached under ten or twelve years.

In the Morgan shaft and Ely, etc., the levels are shaped like the section of a lense, with the long axis north and south, or in the direction of the line of the shaft. The Morgan gave more ore last year than ever before. There are bunches of jasper in the vein, but the rock is left in pillars. The pit is about 120 feet long—that is the levels are—and 20 to 30 feet wide. The ore is magnetic and specular slate, and is all first-class. The slate ore generally overlies the magnetic. The former is friable, made up of glistening scales. The product is about equally divided between the magnetic and slate. They are sinking below the twelfth and apparently the pit is likely to afford as much ore the coming season as it did the last one.

The collar of the shaft is 75 feet above the bay, as is also that of the Pascoe shaft which is the next one east, and which is also of the same depth. There are three lenses of ore in this pit, two of them slate ore and one magnetic. They are parallel and are placed edgewise in the same manner. The shaft is sunk to the thirteenth level, which is just opening out, though there is a half year's stoping in the upper levels yet. The policy of course is to keep the mine well opened ahead of the stoping. The average angle of the shaft is 38° to the north, being very much flattened, since at the top it is 50°.

The shaft is in the middle lense; they are separated by banded jasper. These lenses furnish a small amount of second class ore against the walls. The body of the ore is first-class. The levels in the east vein are 50'x12', in the middle one 10'x30', and the west one about the same. It don't look very promising, and is thought not to be improving, at least. There are ore pockets for each shaft. Each pit is worked on separate contracts. The ore is mined by the ton, put into the tram car. Usually the contract includes 8 men. The men take the contract to do the sinking and drifting, break the ore, etc., for the year; leaving the pit in same condition at end of year as it was at beginning. It is so much per ton for breaking the ore; so much per foot for shaft; so much per foot for winze, etc. The contractors pay the fillers and the company hoists the ore and charges the men with the supplies.

The Morgan and Pascoe shafts are single skip. The latter used to be double; but the skips now are larger than were formerly used and one answers the purpose. They carry one and a half tons. This is one of the results of the new machinery.

The next pit is the Ely, which used to approach the Pascoe, but at a depth of 600 feet its direction was changed to run parallel with it. The Ely shaft is also 800 feet long and sunk to the thirteenth level and opened out for another year's work. In the eleventh level the Ely and Pascoe are connected by drift. In the Ely pit is one large lense, in which the shaft goes down the same as in the preceding, except that its direction was changed as above stated to keep it in the ore, the lense having turned a little to the east. The pit produced more last year than in any year before, and it is considered to be looking as well now as it ever did; pillars are left for the shaft in this and in the others also.

A new plant of hoisting machinery has been lately procured for the pits, placed in a large brick building—

iron roof—erected for the purpose. This plant comprises 4 drums, each 12 feet diameter, 7 feet face, Merritt's external friction gear; it runs as smoothly and perfectly as the works of a chronometer. The Ely pit ore is all first-class slate ore, except about 3,000 tons on the side next to the Pascoe. All the ore from this west end pit is sold for bessemer. The ore is about 15 feet wide—average—and 100 feet long north and south. The water is taken to the Morgan by a Cameron pump, thence to the surface by a 12" plunger. There are two Cameron pumps in each pit, and occasionally a small one is used for some especial purpose, as in sinking a winze, etc.

The Republic has had, considering the state of the market, one of the most successful years in its history, which is probably due to this new contract system. The men work harder, because working for their own interest, and, it is stated, have made better wages than ever before, but there have been more men killed by accident than in any previous year. The men will, under the incentive of greater profit to themselves, take more chances than they will when working on company account. They require constant watching. It is also stated that the ore has cost the company less per ton than ever before.

The next pit, the Gibson, is a small one, 5 or 6 feet wide and 50feet long; it approaches the Ely and will, in time, make another opening for the Ely. The ore is first-class slate ore. Six men are employed in it on contract. The length from surface down is 650 feet. The plant is the one formerly used at old No. 5. The Ely and the Gibson are 100 feet nearer together at the bottom than at the top.

From the Gibson north the pits were numbered from 1 to 10, but they are no longer all of them worked as separate pits. The ore from Nos. 1 and 2 is taken now out to No. 9 shaft. It will be remembered that No. 5 and No. 6 pits are upon either side of a double cage shaft. To reach No. 1 a skip road has been made going down to the eighth level, where it turns east, going on an incline of 24° for 200 feet, to No. 1 vein, where it bends to the right, making a horizontal angle of 50°, going thence down in the ore. They are preparing to make still another bend in the skip road, to the left, to comply with the conditions of working at the greater depth. I rode up in the skip around these curves and found it went very smoothly. No. 1 shaft is still lowered for a pump shaft and also used for timber. The ore in No. 1 is 8' to 10' feet wide; I found them stoping in the ninth level and sinking for a new lift. Coming up the curving slope to the eighth level and passing through No. 6 pit, we pass through a chamber 60 feet wide coming, to No. 7. The ore body is 400 feet long. There is both black ore and slate ore; the lenses are parallel and have continued so from the surface down. The black ore lense runs out before reaching No. 7, leaving only slate. In No. 7 the black ore of No. 6 continues, and there is both slate ore and black ore on towards No. 8.

The water is taken up No. 1 by plungers, 200 and 250 feet lifts; large, well supported cisterns receive the water at each lift.

The ore from Nos. 3, 4 and 5 goes to No. 6, which makes No. 6 the largest producing pit in the mine. No. 5 is now called the inclined shaft. No. 7 pit is 270 feet long, 12' feet wide, the shaft dips 80° west. It is down to the tenth level, 700 feet deep. No. 6 shaft is 820 feet long. There are several minor pits working to the north of No. 7, which are similar to the Gibson, in which they hoist with bucket, one a small lense 7'x50', slate ore. It is trammed to No. 7.

No. 8, independent pit, is 200 feet long, mostly north of shaft, average width of ore 10 feet, slate ore, best quality, down to eighth level. No. 9, another independent pit, 6'x55'.

No. 8 is pitching towards No. 9, and they will probably come together. A small hoisting plant on top of the bluff is used with these shafts, working two drums, which operate No. 9 and a scram; No. 5 engine operates the No. 7 scram.

Three years ago the rock engine house was built, of stone, iron roof, 78'x89' inside. In it are four 12' drums, Merritt external friction gear, also electric light engine, and 3 boilers operate Nos. 5, 6, 7 and 8 shafts.

The new brick engine house, further south, is 58'x78'; also 4 12' drums, 7½' face, same make, carry 2,400 feet 1" rope, 2 engines each 20"x30". The machinery at the Republic, the Lake Superior, and a few others, is not surpassed, and probably not equalled by that found in any other iron mines in the world. The mining plant at our Lake Superior iron mines is said, on the authority of the best experts, to be the most effective and powerful possessed by any iron mining region on the globe; and of these there is none better than that at the Republic.

The Kingston pit away to the north of the river has been abandoned. The ore is not salable now.

The product of the several pits from Dec., 1884, to Nov. 1, 1885, was as follows; the average force employed being 700 men:

Mine.	Tons.	Mine.	Tons.
Morgan	37,117	Nos. 5 and 6	50,807
Pascoe	30,529	No. 7	28,942
Ely	31,719	No. 8	19,614
Gibson	2,535	No. 9	2,010
Nos. 1 and 2	25,113		
Total tons			226,385

The product for each year is as follows:

Year.	Tons.	Year.	Tons.
1872	11,625	1879	135,131
1873	105,435	1880	235,387
1874	122,639	1881	223,651
1875	114,736	1882	235,108
1876	120,045	1883	152,565
1877	165,836	1884	227,739
1878	176,221	1885	249,070
Total tons			2,339,666

David Morgan, General Manager, Republic, Mich.; Peter Pascoe, Superintendent, Republic, Mich.; W. D. Rees, Secretary, Cleveland, Ohio.

THE WEST REPUBLIC

mine is situated on the opposite side of the bay, and joins its important neighbor on the west. The workings thus far have only developed a small mine instead of the large one that was hoped for. Some borings have been made with diamond drill to prove the property; the best results were obtained in a hole made near the east line, south of the bay, next to the Republic. The drill penetrated to a depth of 800 feet and passed through 60 feet of ore. Mr. St. Clair, the Superintendent, is anxious to sink here for this ore, feeling assured that the expense would, in the end, be amply compensated for.

The mine is all underground, reached by a shaft from the east side of the river, which is sunk in rock a little way from the ore. There were formerly two lenses of ore, an east one and a west one, the one running parallel with the river, and the other extending under it. The east lense has been abandoned. They have under the river and west of it a length of ore of about 80 feet, with a width of 12 feet. In the 181 foot level they have worked 30 feet west of the river. In the 225 foot level have not quite reached the river, and in the 385 foot level they have been driving west and have just reached the ore. The ore extends under the river and beyond it. The river runs south. It is contemplated to sink a shaft on the west side of the river, as the lense which they are now confined to is mainly on that side, and from the present shaft there is too much dead ground to go through to reach it. At the present time, November, the company employs 15 men in and about the mine. J. O. St. Clair, Superintendent, Republic, Mich. The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1881	7,378	1884	19,623
1882	27,865	1885	12,674
1883	30,734		
Total tons			98,284

THE COLUMBIA MINE

is situated north of the Republic, about a mile from the river, which, where it crosses the line from the Republic to the Columbia, runs west, but immediately bends around to the south, which is the direction that it pursues where it crosses through the West Republic. The Columbia has been idle since 1882, and there is nothing to add to the descriptions which have heretofore been given of the mine. The mine has been quite largely worked, and is provided with suitable machinery, also dwelling houses and other buildings; but the lenses of ore are narrow; they have never developed into deposits of any great magnitude, and they have never afforded for shipment any amount of strictly first-class ore. It is a slate ore similar in appearance to the Republic, or rather to the Republic's Kingston pit ore, specked with birdsige quartz, and is too high in phosphorus for bessemer. In the summer of 1882 a good deal of work was done with the diamond drill, but nothing encouraging was found.

Yearly product of the Columbia mine:

Year.	Tons.	Year.	Tons.
1873	21,271	1880	6,636
1874	34,348	1881	11,158
1875	8,050	1882	12,066
1876		1883	714
1877		1884	
1878		1885	
1879			
Total tons			94,249

All along the south and east side of the river from the Republic to Lake Michigamme are the evidences of former explorations—test pits, exploring shafts, abandoned houses, etc. A number of companies were organized to mine at selected places in the line of this ore formation. Lenses of slate ore were found, but none of magnitude sufficient to make a mine of any commercial value, though a few rose to a sufficient temporary importance to cause the shares of this stock to sell at pretty high figures. Starting from the Republic and naming these locations in their order, we have, after passing the Kingston pit and the Columbia, the Metropolis, Windsor, Standard, Cannon, Erie, Magnetic, Northwest Republic, etc. the magnetic is an old location where the company that owns the property has explored off and on, with no very good results.

THE NORTH WEST REPUBLIC is a new development, and they have opened up a small body of ore, and have altogether favorable indications in the way of future mining.

The Erie is in the hands of gentlemen who have great faith in the mineral value of the property, and who have persisted in their endeavors to develop a paying mine, under great discouragements.

Two years ago the Messrs. Wright, who operated the Erie, succeeded in getting a branch railroad built from the Republic to the mine, a distance of six miles.

Recently the company has been re-organized under the corporate name of

THE FREMONT IRON CO.

The mine is about 6 miles from Republic, with which it is connected by a good highway, also a branch railroad track.

The shaft is 200 feet deep; from the bottom to the northwest, 60 feet, the ore had been worked out and from the end three borings were made, after shutting down two years ago. These holes are to the west, northwest and west. The second hole was 94 feet long at an angle of 30° down. The ore shows a succession of seams of schist and martite ore in about even quantities. They have drifted out on this hole 35 feet, and sunk a winze to strike a deposit of clean ore 4 feet wide, which they propose to develop and mine. The ore was found at 14 feet and the winze has been continued down and is now 33 feet, the last 18 feet in ore, in which it is still sinking. From the end of the drift they also went in west 21 feet, but found nothing. The plan is to continue the sinking to a sufficient depth and then to drift under the drill hole and cut the succession of lenses. The hole to the west was made 80 feet long, with a result very similar to the preceding—ore and soap rock alternating. The ore is slate and magnetic. The underlay is now in the north drift, dipping northwesterly; the first hole, apparently, cuts across the formation. Another hole cutting under, a little north of shaft, starting from off to the east, went down at an angle of 60°, 394 feet long, seeming to prove that the hanging is a little to the east and north. The formation bends around from the east side to the west as it goes north. West of the No. 1, 60 feet, another shaft was sunk some years ago 60 feet deep.

In the bottom of No. 1 shaft the ore has been mined out to the south 30 feet, leaving a breast of ore at the end 8 feet wide. A little south of this stope a drill hole from the surface at an angle of 54° passed through as follows:

Quartzite	43′	6″
Martite ore and soap stone	10′	0″
Slate ore and quartz	11′	5″
Slate ore, clean	27′	--
Soap stone	8′	0″
Slate ore, clean	3′	0″
Slate ore and quartz	18′	6″
Coarse grained slate ore	55′	2″
Slate ore, clean	8′	0″
Bl. ore, clean	6′	9″
Bl. ore and quartz	18′	3″
Soap rock	3′	6″
Bl. ore and quartz	24′	10″
Soap rock	7′	10″
Quartz	20′	--

It will be seen from the above table that there seems to be a body of black and slate ore 15 feet wide, and this they are also pushing to get into and are now within a few feet of it with the drift.

The whole length of the underground opening which was formerly mined is 100 feet, and about 5 feet wide. This is the lense which has furnished the ore that has heretofore been shipped from the mine. The bottom is still ore, and they have sunk for another stope. No pillars have been left, but as the mine is continued down they will be necessary.

The mine has very little machinery, a small engine and hoisting drum. Mr. Wright is negotiating to supply this want without delay. Analysis of the drill cores have been made, and the best show a percentage of 67% to 69% in iron; .015 to .119 in phosphorus; silica, 1.63% to 6.90%. Ore of this grade is certainly first-class. In making a sale of the ore the company guarantees that it shall not exceed .045 in phosphorus. The stock of the company is divided into 20,000 shares, par value $25. One-half of this has been sold to secure a working capital.

E. H. Wright, President, Republic, Mich.; W. A. Wright, Secretary and Treasurer, Republic, Mich.

Shipments from the mine:

Year.	Tons.	Year.	Tons.
1882	2,730	1883	5,405
Total tons			8,135

THE MILWAUKEE MINE

is one of the so-called Negaunee hematites. In the south of this city there has been opened in the aggregate a good many small mines; some of them have had excellent ore and have proved profitable for a time, until they were, seemingly, exhausted; others have never shown much value, and were abandoned with loss, and still others are yet esteemed valuable, only awaiting the advent of better times to render them, again active.

At present the most important of these south side mines is the Milwaukee, which is now working and under very favorable indications of prosperity. The Carmichael Bros., who are practical miners and were previously familiar with this mine, took the contract of mining the ore for the company, guaranteeing a certain amount, and finding themselves and paying all costs, receiving in compensation a certain price per ton for the ore. They began in April last to pump the water out of the mine, and were raising ore early in May. During the season they have worked 3 pits, Nos. 7, 8 and 9. The latter is a new shaft 60½ feet northwest of No. 8. No. 8 shaft dips southeast. No. 9, 52° southwest. The vein runs east and west. The shaft is 120 feet down. The ore body is 10' to 40 feet wide, and has been worked west 200 feet, where it is cut off by a bar of rock, though there is a leader of ore in the west side which they will drive on.

The shaft is mainly sunk in rock, though it started in ore; it is now, at the bottom, in ore, and the ore continues 50 feet east of the shaft. In the level above the shaft was just at the east end of the ore, thus showing that the ore is lengthening east.

No. 9 is the best showing they have in the mine, and it seems likely to be the main source of supply for the

product for the coming year. No. 9 is wholly underground. The hanging wall is a jasper paint rock. The pits, Nos. 8 and 9, are connected by drift for air.

No. 8. shaft goes down to the south; the depth to the first level is 41 feet. This level runs off to the west with slight bend to the north, for a distance of 240 feet from the shaft, when it goes west 50 feet, bringing the end of the working near to No. 9. There are two levels below the first, which conform in direction with the first, except that they do not extend so much north. The shaft is sunk to the fourth level, and on its way to the fifth. The plan is to sink to the sixth to be ready for next season's stoping. The ore to the east of No. 6 has been mined and taken to No. 7, but how No. 7 will go to No. 8, drifting east and west at each level to the end of the ore, and then stope towards the shaft.

The ore body varies in width from narrow to wide; it makes out into pockets, and from these the most of the ore is obtained.

The plan for the winter is to open in each pit three levels in advance, for next season's stoping, and to mine and put into stock about 5,000 tons of ore ready for early spring shipment.

No. 8 shaft is in the body of the ore, thus necessitating the leaving of a good deal of ore for shaft pillars, which may be removed when they are ready to abandon the shaft, as may also the floor of the levels.

No. 7 was thought to be the best part of the mine in the spring, but contrary to their anticipations the ore pinched out, and had it not been for No. 9 they would have been short in their estimated product. They will drift under No. 7 pit from No. 8, working east, and thus prove the ground. The depth of No. 8 is about 300 feet, all underground. The ore occurs in loose jasper, in pockets and lenses, etc., in a similar manner as it is found in all this south side range. During the summer the openings had to be carried forward at the same time with the stoping and hoisting of the ore; as the men could not, with safety, work in the bottom of the shaft, sinking it, while the work of dumping ore into the skip and hoisting it, etc., was going on above them, it led to the adoption of a neat arrangement for accomplishing this work. They drifted out the requisite distance and sank a winze so that the bottom should be in the line of the shaft, and in the next level, then they rose up in the shaft, hoisting the dirt up through the winze, thus continuing the shaft by rising instead of sinking. The shaft, the drift, and the winze form the three sides of a right angled triangle, of which the former is the hypothenuse. Of course this made the work of sinking the shaft doubly expensive, but under the circumstances was an excellent plan.

Between May and November they have mined and shipped 38,000 tons, all taken from the 3 pits, ⅛ of it coming from No. 8, ⅓ from No. 9, remainder from No. 7. No. 9 looks very favorable, in fact it improves as it is developed; the ore body is lengthening, as before indicated, by extending further east. But No. 8 is not looking as well as it did, rock is showing in bottom level.

In drifting west in the fourth level they encountered rock at 60 feet from the shaft; instead of attempting to push through it they are sinking a, winze from the third level, further to the west, to see if this rock continues, or if it is only a temporary bar and ore will be found beyond. The Milwaukee mine ore is a very fine quality of hematite, not exactly bessemer, but very near it.

All the ore averages above 60% in metallic iron—is about 2 to 3% silica, and .065 to .070 phosphorus, and brings $2.20 to $2.25 at the mine.

The average force employed was 100 men, but during the winter 25 will suffice. The men work on contract altogether, in departments of the work.

Mr. Alfred Kidder, Agent, Marquette, Mich.

Annual products:

Year.	Tons.	Year.	Tons.
1879	941	1883	805
1880	13,142	1884	35,000
1881	31,254	1885	38,466
1882	41,200		
Total tons			150,808

THE WHEELING MINE

joins the Milwaukee on the west. The workings are contiguous, so that each company has claims against the other for mining over the line.

The Wheeling mine shaft is 150 feet deep. They have a good body of ore, though somewhat broken up, and interspersed with rock. The hoisting plant is the same that was formerly at the Chicago mine. They have taken out, all told, 10,000 tons of ore.

The product for 1885 was 6,383 tons. Captain Foley says there is no profit in the work, paying 50 cents per ton royalty, and selling the ore for $2.00 per ton. The mine will probably be pumped out and work resumed in the spring.

J. C. Foley, Agent, Negaunee, Mich.

THE McCOMBER MINE

has remained idle since 1883; in fact no ore has been mined in it since 1882. Everything remains about the location in readiness to start up. It is understood that the lease by which the property was held by the company has been cancelled, and the mine is now in the hands of owners of the fee—the Pendill estate. The mine has been fully described in previous reports and there is nothing to add or to modify. It is somewhat doubtful if the mine could be made to yield as large a product as it has done, and also it is a fact that the ore does not give as good satisfaction as it did at first. It was fair in iron, sufficiently low in phosphorus for bessemer, and had

also from 1% to 10% of maganese. It is now non-bessemer, which greatly lessens its value.

It is stated that the mine will be worked the coming season.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1870	4,866	1878	30,180
1871	15,442	1879	28,962
1872	25,600	1880	31,028
1873	38,332	1881	28,230
1874	2,642	1882	40,390
1875	10,357	1883	14,676
1876	17,282	1884	
1877	19,691		
Total tons			307,008

The McComber company met with serious losses which greatly crippled its resources, and probably were the occasion of its suspension of mining work. The losses were through the failure of the Union Iron and Steel Co., of Chicago, to whom it had sold its ore, and which was indebted to the McComber Co. to a large amount.

THE MANGANESE MINE,

operated by Messrs. Shadt and Breitung, has furnished 3,112 tons of ore the past season, taken from a pit east from the McComber. But nothing has been done during the past two years of any note at the ETNA, ROLLING MILL, NEW YORK, CHICAGO, and other locations situated in this south side range of mines.

BAY STATE.

They propose to do some work at the Bay State location the coming winter to test the ground a little further. A few years ago on the north side of the bluff where they had test pitted a good deal, they found indications which they deemed it best to develop further, and to this end they put a party at work the past summer to sink a shaft in a loose ore; but after getting down about 20 feet they concluded to wait until the ground should be well frozen. They claim to have got into good ore, and will open it up this winter and find out about it.

East from Negaunee, about a mile, on the Mitchell farm, the

SAGINAW MINING CO.

is engaged in opening a mine which promises to be an important one. They are now sinking two shafts which are 400 feet apart, one of which, at, the time of my visit in November was down 18 feet. The total depth of drift to be gone through to strike the ledge is 115 feet. They were using a Ney pump to sink the shaft. The pump being suspended in the shaft throws out the sand and gravel with the water. The shaft is strongly built with square timbers and heavily weighted; size of shaft 12'x12' inside of timbers. From the surface to the ore is 385 feet, as determined by diamond drill; at each point a 100 feet of ore was gone through. A great many of these vertical borings were made at different points in the fields, but those points were chosen for sinking as there was less drift covering the ledge. The shafts are sinking in the side of the hill bordering on the swamp and sloping to the south, at other places, upon the hill, in the meadow, south of the railroad, the ledge was found to be covered with 200 feet of soil, etc. At the other shaft—the west one—they were just to the ledge, 40 feet below surface; they had experienced considerable difficulty in accomplishing the task, but it was anticipated that the experience acquired would be of practical value in the work of sinking the other one.

An engine house has been built, and the machinery formerly at the National mine placed in it, and it is now in working order. Captain Samuel Mitchell, who directs the work, states that ore was found in most of the holes bored, and that it is bessemer. Analysis of all the ores show 60% and upwards in iron, and within the bessemer limits in phosphorus.

They expect to be ready to ship ore in the spring. They are laying a side track to the mine from the main line of the M., H. & O. The land is owned by Mitchell, Maas and Longstorf, who lease it to the Saginaw Mining Co., at 25 cents per ton royalty for the ore. The fact of the existence of the ore here was made known years ago, but the work of development was not undertaken because the owners wanted too high a royalty—50 cents per ton. Samuel Mitchell, Agent, Negaunee, Mich.

THE SALISBURY MINE

is the property of the Iron Cliff Co., and is justly esteemed as a valuable mine. It was opened in 1872, and after 14 years' working is looking as well now as it has at any time in its history. Formerly the ore was mined by stripping the surface, and a very long, deep cut has resulted, from which the ore has been taken. More recently the workings have been mainly underground, and the greater portion of the ore has been raised through a single shaft situated at the southeast point of the open pit. This shaft extended down into what was called, the south vein, a fine body of ore lying south of the lense that had been previously worked in the open pit; connection was also made by drift extending from the underground pit to the south beneath the ore in the open pit. The strike of the formation is east and west, and the dip of the ore bodies to the south.

The railroad track and ore pockets are south of the workings and hence the open air descent of the skip road from the ore pocket and elevated track running to the stock pile is to the north down to the collar of the shaft; thence downward from the surface it is vertical for a considerable distance, but finally bends to the *south*, going thenceforward at a sharp inclination in that direction.

This change in the direction in the movement of the skip is very readily effected by means of a fixed pulley, with

grooved contour for receiving the rope, placed at the angle of the road; the wheels of the skip will of course follow the rails in their inclination to the south.

The change in the direction of the skip road was rendered necessary in order to follow the ore which was found to dip to the south more rapidly than was anticipated through another important fact due to the recent discovery of a valuable deposit of ore situated south of their former workings.

Captain Buzzo started a drift in the fifth level to explore the ground to the south, and at a distance of 90 feet from the shaft the drift came into ore which, on further investigation, proves to be a valuable "find." This discovery was made in May last, and in the fifth level the new deposit has been opened for a length of 200 feet east and west, and is found to have a width of 50 feet. They have also "cross-cutted" to it in the fourth level, and find the deposit to be, apparently, equally good as it is in the fifth. Drifts to this new deposit are also in progress from the levels above those mentioned, and it is thought to be certain that the ore reaches to the surface drift.

At the sixth level, which is the bottom of the mine, the newly found deposit and the old. south vein come nearly together, due to the greater southerly dip of the latter. In fact I should judge that the foot Wall was cutting out the old deposit, arid that they have found about its limit. Still the old openings hold yet a good deal of ore, but it contains a higher percentage of phosphorus than analyses show the south vein ore to possess. The latter is equally high in iron and sufficiently low in phosphorus to be rated as bessemer. The plan for the coming year is to mine only in the south deposit, as this is an ore for which there is a market, and also from the fact that as much ore can be mined in the new opening as can be hoisted in the shaft.

The ore deposit is very clean, entirely free of rock; it is a soft hematite, yielding 60% and upwards metallic iron, and .05% in phosphorus.

Heretofore the ore has been the same in iron and higher in phosphorus. The openings are timbered after the Nevada system, and the mine being short and not very wide the supports suffice. The vertical depth is about 300 feet, to the bottom of the sixth level. The shaft descends 100 feet vertically, and thence inclines to the south.

The estimated product is 60,000 tons for 1886, which is not in excess of the capacity of the mine. The drawbacks are the lack of suitable hoisting machinery, the fact of being limited to a single shaft and that a crooked one, and also the expense of the cross-cuts to the ore and the necessity of tramming through them to the shaft.

The mine requires better pumping, as the present plunger pump is scarcely equal to the task of raising the water. Steps are to be taken to supply the want in this direction without delay.

The ore deposits lie in a broken jasper formation imbedded between the bluff situated to the north and to the south of the mine, and it is altogether probable that further discoveries of ore will be made to the south of the present openings, as there is no change in the character of the formation. No doubt a few more exploring drifts would result as have those previously made and will enable the mine to afford its annual product for many years to come.

The mine is about one mile south from Ishpeming, and under the immediate supervision of Captain Thomas Buzzo, but under the more general management of Mr. A. Maitland, the Agent of the Iron Cliff Co.

Product of the Salisbury mine for each year is as follows:

Year.	Tons.	Year.	Tons.
1872	545	1879	30,770
1873	11,023	1880	32,387
1874	6,730	1881	41,888
1875	4,571	1882	42,019
1876	20,510	1883	17,028
1877	37,868	1884	23,171
1878	52,155	1885	29,503
Total tons			352,626

THE PITTSBURGH AND LAKE SUPERIOR IRON CO.

has done considerable exploring in the past few years with the diamond drill, on its property, with very good results. The cores show a sufficient thickness of No. 1 specular ore at several places for profitable mining. The ore also in the old mine has greatly improved in quality, so that on the whole the mining prospects of the company are much better.

They are not working any of the old stopes, but have drifted northeast from the old pit and are now stoping in a lense of ore that has a width, or length east and west, of 70 feet. They are mining—February, 1886—60 tons per day, all No. 1 ore. The mining is done on contract, by the skip load—1¾ tons—pay $1.75 per skip for the first-class ore, the second class the company pays nothing for. The men furnish themselves with hand drills, powder, lights, etc. The company furnishes the air, steam power, etc., does the hoisting. The wages paid are $1.50 to $2.00 per day. The average in October last was $1.68.

The following table shows the wages of the different classes of workmen at the mine:

Classes of Workmen.	Wages.	Classes of Workmen.	Wages.
Carpenters, per day	$1 50 to $1 75	Engineers, per day	$1 75
Pit Boss, per month	60 00	Firemen, per day	1 60
Blacksmith, per day	2 00	Trammers, per day	1 60
Assistant, per day	75	Sorters, per day	1 50
Pump men, per day	1 87		

The average wages of the contract men in January, 1886, was $2.02 per day.

The company has contracted. 17,000 tons of ore to furnaces at Sharon, Pa., $5.75 per ton. Lake freight estimated at $1.00 and R. R. freight at 80 cents per ton. The parties who take the ore tried it the past season and express themselves as greatly pleased with it, as the following communication from one of the officers of the furnace company indicates:

SPEARMAN IRON CO., SHARON, PA.

Jas. Kirkpatrick, Agent L. & L. S. Iron Co.:

Dear Sir—We used the Palmer mine ore in the Spearman furnace from the 28th of November till December 5 with the following result:

Pounds of Palmer mine ore used	2,864,000
Pounds of coke used	1,655,750
Gross tons of pig iron made	521 tons No. 1 iron
	214 tons No. 2 iron
	53 tons No. 3 iron
Total gross tons	788

The above shows 2,000 pounds of coke to a gross ton of pig iron
3,634 " " ore " " " " " " "

being 61 64-100% of iron from the ore. There were used 1,135 pounds of limestone to a gross ton of iron made.

We have never made a ton of iron from the most favorable mixture of soft ores, on as little coke as this, nor as large a product as 788 gross tons of iron in a week's run.

The iron is so low in phosphorus and sulphur that we shall be able to sell it to the steel makers. The ore works finely in the furnace and it received no favor, but had to stand the test of its merits.

Yours truly,
B. H. HENDERSON.

The following analyses of the ore, made within the past two months, by Mr. C. E. Wright of Marquette, show the quality of the ore in:

	No. 1.	No. 2.	No. 3.	No. 4.
Metallic Iron	65.47	66.10	63.40	63.10
Phosphorus	.063	.067	.065	.063
Silica	2.81	1.83	2.78	4.35

No. 4 is the analysis of a diamond drill core. It will be seen that this ore is bessemer, a quality it has not heretofore possessed.

The mine is in poor shape to work. There are four skip roads going down to the east into the pit. but only the north one is used, and they are working a considerable distance north of this. The skip road is 375 feet long on an angle of 45°. It would be better to abandon them all and sink from the surface a vertical shaft, from which all the ore in the mine could be reached. In fact not much can be accomplished until this is done.

The company is sinking two new shafts 1,100 feet distant northeast from the old mine. The shafts are 385 feet apart. The east shaft will be 224, feet to the ore, and the west one 206'. The former is now 86' down, and the latter is 165 feet. They pay $31 per foot for the sinking, the company finding the steam power and the timber. They are following diamond drill borings in the sinking. The east boring disclosed 21½ feet of ore, and the west 17½. Five other borings have been made, and the drill is now working, the boring being, at the time of my visit—February 28—565 feet deep. The purpose of the present boring is to catch the ore on its underlay from the high ground where the shafts are sinking. The entire cost of the boring is but $1.80 per foot. Two years ago it cost $5.00 per foot to do the same work.

The company has a large estate, but the trouble has been to obtain ore in quantity of a quality sufficiently good to be merchantable. The following table shows the product of the mine to date:

Year.	Tons.	Year.	Tons.
1871	4,171	1879	24,141
1872	34,695	1880	38,597
1873	41,204	1881	34,273
1874	16,100	1882	40,590
1875	4,070	1883	19,414
1876	15,324	1884	11,747
1877	20,211	1885	5,679
1878	4,704		
Total tons			324,727

Joseph Kirkpatrick, Agent, Palmer, Mich.

The mine is usually known as the Palmer, and is in what has long been known as the Cascade Range. There have been a great number of mines opened in this range, but none have recently been operated except

THE WHEAT MINE,

which is still worked with good results. They are only mining a brown, soft ore, working the hematite deposit that was first opened in 1881.

No hard ore has lately been mined. The hematite ore is mined from an open pit situated on the opposite side of the valley, south of the hard ore mine. It is a medium quality of soft hematite ore.

The out-put of the mine has been as follows:

Year.	Tons.	Year.	Tons.
1879	850	1883	6,625
1880	3,324	1884	6,824
1881	9,040	1885	9,200
1882	9,554		
Total tons			48,638

Thos. Prout, Superintendent; Daniel McGarry, President, Cleveland, Ohio.

THE TAYLOR MINE,

situated in section 9, N. E. ¼ N. W. ¼, T. 49, R. 33, was fully described in the report for 1881. Since that time no attempt has been made to work, the mine. The aggregate product of the mine is 31,784 tons.

THE SWANZY MINE

has also been idle for two years past. The location is the S. W. ¼ N. E. ¼, S. 18, T. 45, R. 25, and is reached by a branch from the C. & N. W. R. R. at Cheshire Junction. It is said, on good authority, that the mine will be operated during the ensuing season. The ore is hematite of fair quality, and there has been mined since 1872 an aggregate amount of 143,372 tons.

J. J. Pierce, President, etc., Sharpsville, Pa.

THE MENOMINEE RANGE MINES.

The first one of these mines that is met with—the most easterly one—is

EAST VULCAN,

one of the Penn Iron Company's mines. The mine has been greatly changed since it came into the hands of its present owners. Four years ago the shafts were simply lagged up with poles and only large enough for bucket hoist; now they are all finely made, large, double cage shafts. The underground workings are all systematically timbered, in the most substantial and effectual manner, on the Nevada system. In none of our mines is there such a good opportunity of studying this method of timbering as is here afforded; and in none would one be so likely to be impressed in its favor. From top to bottom, throughout the mine, it is the one system without modification, and it accomplishes all that is intended.

There are three separate shafts, the middle one of which, No. 1, is the only one which is at present worked.

No. 2 is the easterly one, 1,700 feet east of No. 1, and No. 3, high up on the hill is 1,500 feet west of No. 1. The mines are upon the hill-side, north of the Pulley below, through which runs the railroad. No. 2 shaft is 255 feet vertically down, and has at the bottom a good body of ore 12 feet and upwards in width, and 160 feet long. The pit has not been worked for two years: it is proposed to start it again in the spring. John E. Wood sunk a shaft south of it 200 feet deep, in lower ground, and broke through into No. 2, taking the water out of it. The timbers all stood perfectly.

The shaft is double cage, each compartment 4½ feet by 7 feet. The ore in the bottom dips west and pitches to the north.

No. 3 mine is 284 feet deep. There is a surface rise from the shaft at No. 1 to No. 3 of about 100 feet. This shaft also is vertical, with double cage, and complete. The bottom has not been opened out, but, it is claimed, it is in ore, and also that there are stopes of ore in levels above the bottom. This ore is high in phosphorus, and for that reason the shaft has been idle for two years past. During this period the work has been contracted in No. 1, which, like the others, is reached by a downright shaft, double cage, 500 feet in depth; from the surface, for the first 168 feet, it inclines slightly, thence down it is vertical. All the rock broken in the mine is left on the timbers, lagged in between the posts. The ore and rock are all taken up clean. There are no scattered heaps to be seen. Much of the roof has given way also in places and rests upon the timbers, so that there is immense weight of rock which the timbers support, without any apparent tendency to give way; tens of thousands of tons are thus upheld, but the most careful scrutiny fails to find the least evidence of danger. Nowhere are the uprights out of plumb or the caps broken or pressed beyond their capacity to amply sustain their load. The timbering that was put in 4 years ago is as perfectly in place as is that just completed.

From the fourth level to the top, 425 feet vertically, there is a complete connection of the timbers, in some places of considerable width and length of opening; in the fourth level 100 feet wide and 190 feet long.

The uprights are cut exactly in vertical line and come up the one under the other with entire precision. A plumb line along one of these columns of posts shows entire exactness in vertical alignment.

All the timbering is on this system. The old ones which were in the mine when Captain Curnow took charge have been taken out and the present system substituted. This system I have previously described in the Commissioner's report for 1881, and need not here repeat the method; its application in this mine shows that it accomplishes completely the purpose required. The timbers are the only support; the ore is all taken out, every scrap of it, no ore pillars are left. I have scarcely ever seen a mine which is internally kept so clean. There is certainly no ore wasted.

Going down into the mine on the ladder, level by level, and coming up in the cage, affords an excellent chance of seeing the mine and having an easy exit from it. Taking up the levels in detail, in No. 1 they have started a cross-cut south in soap rock to reach what is called the new vein, which was found two years ago and has proved a bonanza for the mine. They expect to reach the ore in 100 feet. This estimate is based on the fact of its being cut in the second level and on the pitch of the ore. No other work is in progress in the first level; the ore has been all mined out.

Descending to the second level, 227 feet below the surface, we find the ore in the old mine has all been taken, leaving a chamber 165 feet by 55'.

A drift across the formation 260 feet west, with a cross-cut south 95 feet, cuts the new vein; this has been opened 125' in length, and of a maximum width of 55 feet. In the second level some stoping is still done east and west of the shaft; 102 feet up from the bottom of this level they opened a cross-cut south 118 feet, and struck

No. 2 vein and worked it out 60 feet long and 12 feet wide, leaving a bottom of ore. Also a cross-cut starts from the shaft and goes south 128 feet, which cuts the ore formation at 100 feet, and thence for 20 feet lies in good ore. They are now raising here to intersect the cross-cut that is extending south in the first level. It is expected to intercept the ore in this rise and in the cross-cut, arid that it will extend up to surface stoping. To the east an exploring drift was run 337 feet, and at the end of it a cross-cut south 26 feet and north 86 feet.

I should think it wise to continue this south cross-cut, as the ore, if found at all, probably lies in this direction. This long drift, made at considerable cost, has resulted in no appreciable benefit; on the contrary it opened at the extreme end a large stream of water whose constant flow added somewhat to the labor of the pumps.

At 200 feet in on this drift some ore was mined, leaving an open space 40'x37'. The ore is low grade and not at present valuable.

Going down to the third level, 350 feet below surface, we find the opening in the old blue ore vein reaches from the bottom of the level to the surface; only timbering and the rock filling occupy the space. A drift 260 feet long going west is all in rock, but a cross-cut north shows some ore.

There are two lenses of this ore which Captain Curnow calls the north vein and the south vein. Finding nothing further to inspect in the third level we descend to the fourth, which is 425 feet down. From the shaft they drove 50 feet south to strike the old blue ore vein, which was found to be 100 feet wide and 190 feet long. There is a little show of ore in the west end that may lead to something larger, otherwise the ore is all gone. Going down to the fifth level 502 feet, the shaft is 10 feet lower, we find a drift to north 86 feet; also one west 300 feet, and from the end of this latter a crosscut has been made north 60 feet, and thence west again 83 feet, and thence a raise 78 feet high connects with the west end of the fourth level. This raise is all in ore. Another similar raise at 200 feet west of shaft, 78 feet up, is only in ore for the last 20 feet. Thus it appears, so far as developed, that the ore in the 500 foot level is of equal magnitude with the one above.

The East Vulcan is, perhaps, the deepest mine on the Range, and affords as good ore as any mine on the Range. The product the past season has been 27,000 tons, fine blue bessemer ore. This has probably been obtained at reasonable cost. But in the past this mine has been a source of more expense than profit to the Penn Co.

It was all out of repair. The former company had got to the end of their rope with this mine and it had to be made over new. Shafts, machinery, and timbering were all immediately required, and have cost a good deal. The mine is in admirable shape now; it is a small mine but admirably worked. Captain Curnow and A. C. Davis, the former agent, who introduced this system of timbering and persevered in its use against no little opposition, deserve much credit. It is the solving of a practical mining problem, and has afforded an illustration and result that are of much value. The maximum force is 100 men divided into four shifts—two day and two night. The same gangs who do the mining put in the timbers. It will be seen from the above description of the mine that a good deal of the work is in the way of exploration—cutting drifts. There are now 36 men engaged in this work.

Some new machinery will be added, a new engine, now on the ground, 12"x24", two new drums 5' diameter. Also pump, Frazer & Chalmer's. Use Cornish plunger—12"x12"—at 350 foot level, 150 feet down to bottom.

I should not recommend this method of timbering, nor indeed of any system of timbering, for all soft ore mines. But looking at it here, in this short mine, in which the walls are fairly good, it certainly answers admirably and there is nothing to be said against it. It is a system that requires perfection in its construction; all weak places must be guarded against, as has been discussed in the description of the Cambria mine. It is not always that so careful men can be found to do this work as Captain Curnow has proved himself to be. The ore is the soft, beautiful blue ore, peculiar to some of the Range mines, and which is so greatly esteemed by the furnace men. It is used by the Cambria Iron Co. at their works at Johnstown, Pa. Since my visit to the mine they have started work at No. 2, and are building a shaft house 75 feet high, and also an engine house, which will be furnished with new plant of machinery—hoisting and pumping—12" Cornish plunger pump.

Wm. R. Babcock, General Manager; John U. Curnow, Superintendent, Vulcan, Mich.

Going west about a mile, or a little upwards, we come to the

WEST VULCAN,

also one of the mines of the Penn Co., and situated in the hillside which slopes to the south. The West Vulcan has been from the beginning of its history, as it still remains, a valuable mine. It is a large producer of the best of ore. There is no prospect of abatement in its annual product. There is considerable improvement, made and in progress, apparent upon the surface, and underground the ore holds out. The mine, as will be recollected, is in two lenses, called the north vein and the south vein, both dipping south. They are about 530 feet apart on the surface, but only 350 feet apart at the bottom. This is due to the fact that the south vein goes down nearly vertically, especially for the last 300 feet, while the north vein preserves its inclination to the south. The lower levels are each 100 feet apart vertically. For the first 200 feet the ore dipped to the south at an angle of 45°, when it took a roll and has since gone down vertically. In the south mine the ore has a width of about 25', on an average, for a length of 600 feet. This shows that the mine is holding its own pretty well.

The west vein is higher up on the hill, so that the sixth level in the south vein corresponds with the eighth in the north vein. The mines are connected by cross-cuts running from No. 2 shaft in the south mine to No. 4 shaft north. The ore in the south mine is free of rock, a little redder in color than it was nearer the surface, but still passes for soft blue ore. The vein in the north mine is more split up and has been from the fourth level down a distance of about 300 feet; horses of rock occur, the ore is clean, but the rock cuts it out. The dip is pretty uniform, about 60°, southerly. The limestone is to the north, underlying the ore, while at Iron Mountain the ore dips north, and the limestone is in the overlay. The south mine furnishes four-fifths of the product, coming out, mainly, from No. 2 shaft. Descending No. 4 pump shaft, which is near the west end of the north vein, we find it pretty uniform down to the fourth level. The vein was short, but of good width. It is unfortunate that the shaft goes down in the vein, as too much of the ore is taken up in pillars. Between the fourth and fifth levels, 200 feet below the surface, a horse of rock comes in from the foot wall and splits up the vein. In the sixth and seventh levels were good deposits 50 feet long. This north mine is short and pockety, affording excellent ore, wide in places, but cuts out from the foot wall.

Going through a long cross-cut in the fifth level we come to No. 2 shaft in south mine, to which the cave reached; the mine is to the seventh level. They are engaged in stoping the ore in the floors and pillars and filling with sand and rock. The floors above the sixth level have been taken out. In this work they fill up the rooms, leaving a "mill" at each 50 feet for running down filling. They have filled in up to the fifth level. In removing the pillars they will rise up through the center for a mill for running down the ore and then cut away the pillar, drawing in the filling from the rooms to replace the ore that is taken away. These pillars are about 30 feet wide. Much of the timbering is excellent, built, in late years, on the Nevada system. But it is apparent that this timbering will not suffice to hold up the West Vulcan, now. The immense pressure is, in places, crushing the timbers. The hanging is slate, sometimes jasper lies between the slate and the ore. In October, 1884, a large space in the mine caved in, from surface to bottom, due to the pressure of the hanging and the insufficiency of the timbers to support it. At that time the bottom was at the fifth level, now it is 200 feet lower. No floor had been left in No. 4 level, so there was a stretch of 200 feet with nothing but timbers to hold up the mine, and they proved inadequate.

The company has begun the work of some important changes that will, when completed, be of great advantage. At present the machinery is all upon the hill, above the mine, while the mine is under the level ground at the foot of the hill; thus the ore and water must be elevated through the extra height; a matter that is no longer necessary. To avoid this the company is sinking a downright shaft in the hanging wall, south of the mine; it is now down to the fifth level, 380 feet from surface, and connected with the mine by cross-cut. The shaft is 10'x16' inside the timbers; will have double cage, also ladder way, timber and pump space. A new building for machinery has been constructed in which will be placed the hoisting plant lately at the Quinnesec mine. The yare laying the foundation for the new pump bobs, 16" plunger pump, 10 foot stroke, first lift to sixth level. This shaft will soon do the main work of the mine. No. 2 will still be used for a time as now. The new engine house is 72'x44', is placed near the shaft.

When the mine is adjusted to the new shaft the old ones will be gradually abandoned, and the ore in the mine left in the pillars will be taken out and the mine left to come together.

The work of filling this mine—wrecking it—can be easily carried out by reason of the nature of the hanging wall, which is a “demoralized" slate, that will, in places, almost run like quicksand; it will crush up in the sand and may be thus manipulated into mud. Left to run it will fill the mine. Under the circumstances it is doubtless the economical way to mine the ore. Do away with the timbering. Let the mine fill up above and work down under the filling; as fast as the ore is taken out, let the hanging wall run in and fill up. This hanging wall is kept in place now only by the timbers and lagging; it crowds and squeezes the timbers out of place as it is.

The working force is 380 men, 120 of whom are miners, and 40 timber-men, 225 men work underground; 200 of the men are Italians. The company has had them for several years and likes them; they are industrious, frugal and peaceable. The average wages paid is $1.65 per day. Contract men make more, usually; day laborers receive $1.40 to $1.50 per day, timber-men by the day get $1.55. The mining cost of the ore is about $2.90 per ton, about what it would sell for, especially if royalty be added, which is 25 cents per ton on this ore.

They will have a fine ground for stock pile at this new shaft. The Vulcan mines have produced as follows:

Year.	Tons.	Year.	Tons.
1877	4,543	1882	94,042
1878	31,239	1883	79,874
1879	67,350	1884	101,782
1880	72,405	1885	124,120
1881	85,071		
Total number of tons			650,906

Wm. E. Babcock, General Manager; E. S. Roberts, Mining Captain, Vulcan, Mich.

THE CURRY

is a small mine a short distance west of the Vulcan. It is worked in a limited deposit of soft blue ore, which pitches pretty rapidly to the west, while the shaft is at the east end, and goes down to the south. The mine is thus in very inconvenient shape to work. The Briar Hill mine lies west of it and the underground workings of the Curry are not very far from the line. There is some talk of a

consolidation, which would seem to be a good plan, and then sink a shaft near the line to reach this deposit.

The Curry has produced as follows:

Year.	Tons.	Year.	Tons.
1879	13,010	1883	3,676
1880	21,741	1884	10,079
1881	17,504	1885	4,897
1882	13,374		
Total tons			84,281

The mine is now idle. N. E. ¼ N. E. ¼, S. 9, T. 34, R. 29.

J. H. Outhwaite, Agent, Cleveland, Ohio.

THE BRIAR HILL MINE

adjoins the Curry on the west. The mine is held by the celebrated coal company, of the same name of Youngstown, Ohio. The company has explored a good deal with the diamond drill, hoping to find ore in quantity that would pay to work. They have spent considerable money in this way, but without success; the mine has not paid its way. There is a small lense of ore in which the shaft is sunk, but it costs as much to get the ore, at present prices, as it is worth. The company shut down two years ago and no work has been done since. In 1882 and in 1883 the mine yielded the aggregate product of 14,982 tons.

Analyses of the ore give

Metallic iron	61% to 67%
Silica	3.60%
Phosphorus	.05%

THE PERKINS MINE

is the next one west of the Briar Hill, situated on the outskirts of the village of Norway. The Perkins has been a good mine, though a small one. It had a fine body of excellent ore, close to the east line of the Norway mine. The ore was dipping south with the formation and pitching west. The underlay is limestone, and it has run flat and cut out the ore. For two years all the ore obtained at the Perkins has been from the pillars. They have been mining them out and letting the walls fall in, so that now the mine is a wreck. The machinery has been taken away, removed to Negaunee. There is said to be a little ore somewhere down under the debris, which Captain Perkins says he is going to try and mine, but it looks like a dubious undertaking.

The mine has been worked since 1879, and has produced 329,936 tons of ore.

In close proximity to the Perkins on the west is

THE NORWAY MINE,

which of late has met with some misfortunes, and has been somewhat under a cloud. The east end of the mine has collapsed, caved in from the surface down to the fourth level, leaving the bottom, level, which was well sustained by pillars and timbers, intact, as is supposed, though there has not been much investigation in the bottom, there being a wholesome apprehension entertained regarding its safety. The mine has been filled with water for a long time to the fifth level and no work has been done below the third. No. 3 shaft is open down to this level. Nos. 1 and 2 to the west are in the crushed part of the mine. The fall of the mine only extended as far west as No. 3, on the surface, leaving the shaft intact down 200 feet to the third level. Men are now engaged cleaning about the shaft in this level preparatory to pushing through the collapsed ground to No. 1. This work has been delayed, waiting until the new pump should be working and the mine freed of water so that it can be inspected below and ascertain if all is secure. It is not certain now but the floor may be "swinging," and liable to give way at any time. There are 300 feet of the mine from the Perkins line west that are included in the "cave."

All the east part of the Norway is underground and has been worked out pretty extensively, leaving very large chambers; the roof being wholly sustained by the pillars of ore or rock. Very little timbering has been employed. The ore occurs in the broken jasper formation, in pockets, some of them of great size, and when the ore is taken out the walls stand extremely well.

The foot wall of the ore formation is hard, crystalized limestone, which lies very irregularly, sometimes dipping at a sharp angle to the south, and again lying flat or pitching to the west, or making a roll, forming troughs in the ore formation, wherein, if the ore occurs, the limestone forms two foot walls or is both foot and hanging. This condition exists at the west end of the mine in No. 8 pit.

The present company has owned the Norway four years, and has not extended the openings at all. All the east part of the mine, the underground portion, is no deeper now than it was then. A large amount of ore has been mined annually, but all taken from the old stopes. It seldom occurs when a mine of the size of the Norway is so fully opened as it was at the time of the purchase. I went through the mine carefully in the spring of 1881, and was impressed with the amount of ore in sight; since that time they have been working at the same stopes, and have done no exploring, sinking or drifting. The mine has kept up its annual product from what was already developed. But the result is nearly ultimate depletion. This process cannot be carried any further. There are no more stopes to exhaust. The ore, the good ore is practically gone; 200,000 tons of ore is a good deal for a comparatively small mine like the Norway to furnish from openings previously made. They have reached a point where the mine must be further opened to secure a product.

There is plenty of ore in the mine now but not of a quality to be merchantable; it is mixed with rock, rather high in phosphorus and not high in iron. The ore formation is

peculiar; it is broken jasper and ore, sometimes all ore, but never quite all jasper. Some of it, if picked, will give good ore, but that work makes an additional cost, which the price will not bear.

There are two veins, so called,—the old blue ore vein and the B. B. vein. All the non bessemer ore is sold as B. B. grade, that is its trade mark. The south vein is bessemer, and the bessemer ore is what the company wants. They have plenty of B. B. ore that could be easily mined, but there is little or no sale for it. The rock is all left in the mine, none is hoisted, or if it is it is dumped back to fill some other place. They do not seem to regard the cost of hoisting very much, as it takes only nine cords of wood per week, it is claimed, to do all the hoisting of the mine.

The inadequacy of timbers to support a mine is plainly to be seen here in the timbered drifts that were crushed in. Sound, stull timbers two feet and upwards in diameter are snapped in two like a pipe stem. Uprights are crushed down completely in direction of the fiber. No doubt the falling in of the Perkins had much to do, as they claim it did, with the disaster at the Norway.

In order to reach the underground workings with more facility, and to extend the openings in future with greater safety and economy of working, the company has undertaken the sinking of a downright shaft, which is already to the depth of 380 feet, or 100 feet below the present bottom of the mine. The collar of the shaft is 100 feet lower than the surface of the mine, on the hill above, so that if the shaft were started from the same horizon it would be just at bottom. The shaft is started in the lower ground. It will be sunk still another 100 feet. The main value of the shaft now is to furnish an avenue to get the water from the mine; ultimately it will be furnished with double cage. They will raise the water with two 16" plungers to the mouth of a tunnel, which will intersect the shaft 100 feet below the collar. They are driving up this tunnel now from the swamp, starting 1,200 feet south, and are already 600 feet on the way, giving fall sufficient to secure discharge.

They have a new pumping plant at the Norway which was nearly ready to work at the time of my visit. They claim it to be the best in the mining region, and I see no reason to dispute the claim, for I admire it very much. The pump is similar to the one at the Barnum mine, 10 feet stroke. Two bobs and two plungers with discharge pipe between them, one plunger rises as the other descends, and the flow of the water is constant, instead of being intermittent, as is the case with only one plunger. This doubles the amount of water raised in a given time without any increased expenditure of power. The capacity is stated as being 116 gallons per stroke, with four strokes per minute. The best of stone foundations have been laid for the bobs and rods: and the new engine house of stone, which is 100'x40'. It will be seen that; the rods are so fastened, on opposite sides of the wheel, that one pulls in as the other pushes out, thus balancing and saving the use of the weighted bob so commonly employed.

The big gear wheel to which the rods are attached is 34' 4" diameter, made at Riverside works, Detroit, as was the rest of the new machinery, except boilers. The engines are low pressure, each 28'x38', built in 1884, and were ready to work October 27 last. When I saw them they were running on 27 pounds of steam and running one plunger, the other not being ready. The machinery was designed by James B. Lyon of Marquette. There are two new boilers, each 72"x18', built at Johnstown, Pa. These boilers seem to require but little fuel. Captain Oliver has designed a grate which works admirably. The ones that were in soon twisted out of shape so as to be worthless. Oliver's design meets with no such difficulty. The boiler front is also unusually convenient, being arranged so as readily to get at the flues, revolving doors to supply fuel, etc. There is space for two more boilers to be put in when required. This machinery will suffice for the mine for many years.

Up on the hill, at the west part of the mine, are the large open pits in which the men are still at work. They are down pretty deep, but in places there is still ore in the bottom; in others the roll in the limestone cuts off everything. There are a good many geological peculiarities at the Norway, which require time to study and unravel. In fact the whole range through to Iron Mountain is little understood. The limestone, the ore formation, and the sandstone are in different relative positions at different points, and it is not perfectly certain what are their true positions. Sometimes the limestone has been so folded as to give the impression that it overlaid the ore, but its position here is under the ore and no ore has been found north of it; though I think it by no means improbable that there will be, basing the impression on the character of the rocks.

What has helped out the Norway the past year is the new pit, which is divided between it and the Cyclops, each mine taking about half of it. This pit is at the foot of the bluff, is about 300 feet long, 100 feet wide on top, and 50 feet deep. The ore is the best soft blue ore that is not surpassed by any found on the range. The width of the ore is about 30 feet and dips to the south. Test pits have been sunk south which bottomed in this ore, showing that it continues under the surface. It was a very valuable find for the Penn Co.

The Norway mine employs about 250 men, and the annual product is shown in the following table:

Year.	Tons.	Year.	Tons.
1878	7,533	1882	165,084
1879	73,540	1883	114,838
1880	108,765	1884	71,515
1881	137,558	1885	67,741
Total tons			835,742

Wm. R. Babcock, General Manager; John Oliver, Superintendent, Norway, Mich.

THE CYCLOPS MINE

has proved the most profitable, comparatively, of any of the Penn company's mines. It was not rated very high at the time the purchase was made four years ago, but it has annually given a good product of the best blue ore, and has cost less than any other that the company has mined. Nothing could be more fortunate than the discovery of the new pit on the line between it and the Norway. It has already given at least 50,000 tons of valuable ore, obtained at the least possible price. There is but little to be said of the mine; there is little of it except a great irregular excavation made by mining out the pockets of ore, which were found in the sandstone and beneath it. There is still ore in the old workings, as good likelihood of finding it as there was two years ago. But of course the best deposit is the new find to the east. I should estimate the product at 50,000 tons for the ensuing year. The mine has given each year as follows:

Year.	Tons.	Year.	Tons.
1878	6,275	1882	18,287
1879	46,442	1883	22,675
1880	14,368	1884	24,000
1881	12,214	1885	49,897
Total tons			194,287

William R. Babcock, General Manager; John Oliver, Superintendent.

THE STEPHENSON MINE

lies north of the Perkins, that is the property does, but the mine comprises a narrow lense of ore lying in the foot wall of the Perkins. It did not extend down very far. The ore was near the surface, between the Perkins ore and the limestone. They worked it out and when it fell in it took down part of the Perkins also.

The company continues to explore in a small way and it is rumored that .some mining work will be done next year. It worked three years and produced a total product of 34,995 tons. The property comprises 320 acres of land owned by Lumberman's Mining Co.

Going west from Norway we reach in a few miles the

INDIANA MINE,

of which there is not very much to be said in addition to what has been stated in previous reports. The mine is somewhat deeper but the ore deposit has not increased in size, and there is no more promise of a good mine now than there was several years ago. The company has added a new hoisting plant recently and also new pumping machinery, Cornish 17" plunger put in in October last, which will insure them the mastery of the water. The location is a wet one, and the water has been a serious obstacle to development. The mine has reached a depth of 175 feet, and remains, in the shaft, as heretofore, a small lense of blue ore; but quite lately another small deposit has been found, also blue ore, 5 feet wide, a short distance east of the mine. They have opened into it and it is increasing in size and bids fair to be of value. The maximum force is 60 men, and they raise about 80 tons of ore per day. The ore is not rich, medium in iron, but low enough in phosphorus for bessemer, so that it is in demand. A branch railroad reaches the mine.

R. P. Travers, Agent, Chicago, Ill.

Product:

Year.	Tons.	Year.	Tons.
1882	4,280	1884	636
1883	4,312	1885	2,738
Total tons			12,116

N. E. ¼ S. 27, T. 40, R. 30.

No ore was found at the Illinois adjacent to the Indiana; but there are other explorations in that vicinity which promise better results. On Sec. 22, west of the Indiana, the Cuff Bros, are exploring, and have several good "shows" of ore. Further work may develop enough for a mine.

THE QUINNESEC MINE

was considered exhausted 18 months ago. Captain Morcom, the Superintendent, so reported, it is said, to the company; the machinery was removed, the pumps taken out, and the mine was suffered to fill with water up to the point of surface drainage. Subsequently Captain Oliver, of the Norway, went in and examined it and found indications of ore that was left in the mine in sufficient quantity to pay for further mining, so that effort was made to pump out the water; the lower part of the mine caved in so as to preclude any work being done at the bottom. However, 14,110 tons of ore have been taken from the upper levels in the past year. It was found behind the lagging, where it had been covered up, and in the pillars.

They were obliged to sink in the foot wall to reach the ore, as the shafts had become useless. The company is still at this work of scramming ore. They have a Rochester engine and hoisting drum. The old machinery has gone to Vulcan. The mine employs about 50 men. The Quinnesec is one of the mines owned by the Penn Iron Co. The company is also exploring for other deposits of ore, but as yet with no marked success.

Major Harry Pickands, of Chicago, is sinking a shaft in the east part of the village, where it is claimed a good body of ore exists. It is sincerely to be hoped that such may prove to be the case; Quinnesec is too pretty and substantial a village to be left wholly without the support of active mining interests.

continues to be one of the mining wonders of this remarkable country. The ore deposit still holds its phenomenal magnitude and excellence without diminution in quantity or purity, as greater depth and extent of working are attained. But some of the difficulties that have long been apprehended as liable to occur from the system of mining pursued are seriously realized.

The deposit is of immense extent, reaching a maximum width of 128 feet, and averaging 90' for a distance of 400 feet in length, from the west end of the mine, and continues with variable but diminishing width for a further distance of 1,800 feet. It is a magnificent deposit of mineral—soft blue specular ore, that is easily mined, but has little value as a support in pillars.

The mine is wholly underground; contrary to the custom that formerly prevailed, no open cut work was ever pursued. Ten shafts have been sunk in the ore on or near the foot wall, and the method of extracting the ore has been in accordance with a system that has been followed from the beginning. It consists, essentially, of opening a drift for passage way along the foot wall, or from shaft to shaft in each level, thus connecting them. This is done in advance of and preparatory to stoping. At each 18 feet along the main passage way and at right angles to it, cross drifts are cut through the ore to the hanging wall. These openings, rooms, or headings are 20 feet wide and are thus separated by pillars of ore 18 feet wide left standing for the support of the mine; but as the ore is soft and friable, it would readily disintegrate and crush down if it were not itself sustained by lateral supports, this is sought to be accomplished by timbers, which are framed and placed in the rooms between the pillars in accordance with a uniform system.

A mud sill is laid on the floor of the level against each pillar, and kept in place by cross sills laid on the bottom and extending across the rooms, 7 feet apart. The uprights are 7 feet long, and are set in mortices 7 feet apart along the main sills and at equal distances apart on the cross sills; on these uprights caps are placed, lengthwise and crosswise of the rooms. The cross caps thus rest on four posts.

This "set" forms the foundation for a similar one that in time is made above it and so on to the end.

These successive bents continue to the hanging wall and are placed as fast as the ore is taken out to the height of the post. When one "set" is completed a covering is made with plank, or poles split in half, thus making a floor on which the miners can stand to stope the ore from the back of the room, causing it to fall upon the floor, whence it is run down through apertures into tram cars below and thence out to the main drift and to the shaft. The ore having been stoped out to the height of 7 feet, or as fast as it is done, a "set" of timbers is carried forward as the stoping advances; and so on in succession one "set" above another, the uprights carried up in vertical line until the level above is reached and the final timbers connect with those in the bottom of the preceding level.

Openings are made through the pillars for longitudinal drifts, and these openings are timbered in the same manner. Thus the pillars of ore stand between the openings 20 feet wide, filled with these timber sets. To prevent any danger of kuckling, as far as may be, and also to guard against the disintegrating tendency of the pillars, and of the friable, slaty hanging wall, lagging or sheathing is firmly placed between the uprights and the ore and rock. The timbers are fitted in the company's mill, and are lowered into the mine through the timber shafts.

When completed there is nothing left in the rooms but the timbers. The hanging wall and the overlying burden are sustained by these pillars of ore reaching from wall to wall, and from the bottom to the top of the mine—sections of ore 100 feet in length and 400 feet in height and that are kept in position by the timbers which are placed between them.

It will be seen that a large percentage of the ore is left in the mine; chat great expense in timbering is incurred, and that, after all, by reason of the great width of the ore deposit, the slaty, friable nature of the including walls, the want of stability in the pillars, due to their great height and tendency to disintegrate, the weakness and uncertainty inherent in any system of timbering however well devised and carried out, render this method of extracting ore unsatisfactory. There is more than the usual element of danger in the long run, that cannot be eliminated from this system of mining. However apparently secure there is ever the liability through, possibly, unforeseen weakness, of collapse in some point of the mine. The fact that there are serious grounds for apprehension of danger is verified by the several catastrophes that have occurred when portions of the mine have caved in, a matter not confined to the Chapin alone, but a disaster that has been experienced at other mines on the range. The most serious caving in that has happened at the Chapin occurred a few days since, on October 23, last, which reached from No. 8 to No. 10 shaft, a length of about 400 feet; but while the mine caved in on both sides of No. 9, the shaft itself is left intact, and will hereafter be used as a rock shaft. The shaft pillars kept it from injury. All the mine between 'No. 9 and No. 10—between the shaft pillars— went in, down to the bottom, to the fifth level. The shafts are to the sixth level but the ground is not opened between. East of No. 9 shaft pillars two rooms went in to the fifth level, and above the third level to the pillars of No. 8 shaft. Another caving in between Nos. 5 and 6 happened the year previously and reached down to the third level. There was also a minor one at a previous period. The inherent weakness, which must inevitably lead to such results, and which must, in time, include the whole mine, has not been unforeseen by the management. For some years the officers have held under consideration plans for extracting the ore which should obviate the objections of the present method. It

had been decided not to pursue the old plan to any greater depth, but to endeavor to fill up the rooms and to mine out the pillars above the bottom and below to begin a system of stoping and filling.

It has been found necessary to remove some of the buildings, elevated trestles, ore pockets, stock piles, etc., from the surface over the mine. The late collapse extended to near the office, taking down an ore pocket and a long stretch of railroad track.

The shafts are sunk to the sixth level, and from No. 6 shaft to No. 9 they are connected by drift, and also some stoping has been done between No. 6 and No. 7. The levels above the fourth have been opened into rooms and also including the west end of the fifth level. Between shafts 6 and 7 in the fifth and sixth levels they are mining out all the ore and filling the space with sand and rock, run down from the surface. In the fifth they are mining the pillars, having selected this part of the mine because it is the safest and the best to acquire experience in this kind of work. In this space of 250 feet they have the pillars nearly all mined out up to the fourth level, and filled with sand and rock. In cutting away the pillars they rise up in the pillar, filling in as they go, and keeping a chute open through which to mill down the ore as they proceed upwards. Naturally there is settling of the ground. Some ominous cracks appear in the pillars of ore above where the men are cutting away.

Just how much of this work can be done is uncertain, but it does not appear that it can be carried out very extensively. The judicious plan will be to strip the dirt resting on the ore and run it down into the mine for filling, and, possibly, to underhand stope the pillars as far down as practicable, and also rise up in them from below and cut them away, when, if it gives way, it can go no further than the filling and the debris will be only ore and timbers, so that the ore will be clean, unmixed with dirt and can be mined and saved; the timbers mixed with it will be an obstacle in mining it, but not an insuperable one. But mixed with the sand and ground much of it would be rendered worthless. They are engaged in this work of stripping the ore and milling down the dirt into the mine to fill the rooms where they are now mining out the pillars.

In the sixth level, between Nos. 6 and 7 shafts, they are stoping all the ore, carrying the stopes lengthwise with the vein. They rise up in the back about 8 feet and back-stope the ore with the vein, letting the ore fall on the floor, whence it is loaded into the cars and trammed away to the shaft. The level is filled with rock up to near the back, and then another back-stope taken and so on.

In accordance with their new plans for mining, three new downright shafts are sinking in the hanging wall north of the mine, from which cross-cuts to the south will reach the ore. These shafts are designated as B., C. and D. The former is the one to the east, and is already 282 feet deep (November 1); it is 9'x12' inside the timbers. It is just to the fifth level, and the cross-cut to the ore is 30 feet. C. shaft is 755 feet west from B., and 287 feet deep.

D. is only a stand-pipe as yet, 1,100 feet west from B. It is 100 feet through quicksand, etc., to the ledge, and they apprehend considerable difficulty in sinking to the rock.

The management talk of sending to Europe to get the service of parties who sink shafts, etc., through soft ground by freezing it. These foreign parties have the machinery designed for the work, and by thrusting pipes down into the ground surrounding the shaft the influence is brought to bear to freeze the earth so that it will stand up while the space within for the shaft is excavated.

From the new shaft cross-cuts will be made to the ore in each level, and the south ends of these cross-cuts will be connected with drifts made in the hanging a little way north of the ore. These main drifts will be 8 feet wide in the clear, and will be laid with double track, T. rail, for the tram cars, which will be run to and from the shafts by endless rope. To this endless chain the cars going out will be attached; on the north track those coming toward the shaft will be on the track next to the ore. It will be simply an endless chain running all the while, and the cars may be attached or otherwise as desired. At each 60 feet of space along the main drift cross-cuts will be made through the ore to the foot wall and extended into the foot wall a short distance to secure rooms for safety in case of accident. The ore will be mined in stopes 6 feet wide through the vein to the level above and filled with rock as fast as the ore is removed. Several adjacent stopes can be carried forward at the same time, in advance of one another, and the ore body can be attacked at different points. The stoping will of course be carried up to the filling above, no floors will be left, in fact no ore will be left anywhere. The method of mining for the future contemplates removing all the ore. Of course in advancing under the filling timbers must be employed after the manner well understood by miners engaged in this work. Uprights are set up at each few feet of advance, with heavy cap across on which the lagging of poles is thrust in ahead. In order to do this the lagging is pushed forward at an angle upward, so that while it rests on the front timber the farther ends are held up on a “false" cap, a cross timber that is placed above the true cap and free from it, leaving space between the two sufficient to insert the lagging poles for the next advance. In this way they can advance under the filling as well as under the ore. The settling that must ensue will be only gradual, and cannot be great in amount.

The ore will be run down in chutes into the cars standing on the track, which, as fast as filled, may be attached to the moving chain and sent to the shaft. The rock, for filling, will be run down in separate mills from the level above.

The shafts will be double cage, and the rock filling material will come down in cars to the level above the bottom and be run out to the mills to be dumped through and distributed over the filling. It is designed to build

three rock mills of short round poles laid horizontally, radiating from the aperture as from the hub of a wheel; thus the rock, when chuted down, will impinge against the ends of the timbers.

The diameter of the chutes will be 2½', the lower end being made bell shaped, opening downwards to prevent choking up.

Of course all this is somewhat in the future; there are many details in the contemplated work into which it is not worth while at present to enter. Changes and modifications are liable to be made before the new work of opening is consummated. The rock for the filling will come from the sandstone bluff on the company's land situated a short distance northeast from the mine. It is very accessible, easily mined and admirably adapted to the purpose, and it is down grade to the shaft.

The mine at the west end is of variable width, but, as previously stated, the ore, for a distance of 400 feet, is on the average 80 feet to 90 feet wide, thence it narrows until it pinches out. At No. 7 it is about 30 feet wide. The dip to the north at the west end is 85°, and at the east end it is 60°. The ore pitches to the west at an angle of about 35°, but the mine has not shortened by reason of this westerly pitch of the main ore body, by reason of the coming in of the north deposit at the east and of its constant lengthening. It is about 40 feet north of the main deposit and has lengthened to the west in each level until now, in the fifth, it is 400 feet long, with an average width of 40 feet, being at one point 110 feet wide.

In planning the new mine it is designed to locate the ore chutes along the main drifts at 50 feet apart, each one to be provided with a ladder way for the convenience of the miners. The rock winzes will be further south in the ore body as they discharge on the filling.

The company in this work of opening a new mine is incurring a great expense. The labor and cost of sinking these three new shafts through the hard limestone is considerable. The driving of the cross-cuts and connecting tunnels in each level will be costly dead work. The railroad tracks are to be changed, new ore pockets built. In fact the work to be done is nearly fully equal to opening a new mine.

It may be objected that the shafts are in the hanging wall, and that the inevitable settling of the ground will in time seriously disturb them; but it is probable that the company was constrained to sink in the hanging for the reason that it has very little land on the foot wall side, and also that the surface of the foot wall is on the high ground and is rough and broken, while below the hill the land is level and they have plenty of room.

One of the palpable mistakes made was in the location of the new stone pumping engine house, which is at the east end of the mine, 128 feet above the surface level of the west end; through this additional height the water must be raised, as the pump shaft is just north of the building, and takes nearly all the water from the mine.

The pumps are two 12" and two 17" plunger; each lift 200 feet. For the first 200 feet down there are a 12" and a 17" plunger placed side by side. In the second lift below this the positions are reversed. The pumps make 7 strokes per minute, 10 foot stroke, and raise 1,300 gallons per minute. There are also No. 12 Cameron and Wells pumps in the mine.

The extreme length of opening from east to west is 2,700', while the total length of the property in the same direction is f of a mile; doubtless the mine will be opened the whole distance, to the Ludington line, as the ore is pitching that way and unquestionably reaches all the way.

The ore averages above 60% in metallic iron, probably 65%, and averages .070% in phosphorus; it is made all one grade. The company has a laboratory and employs a chemist at the mine, so that the ore at all points of the mine is being constantly analyzed.

Five million feet of lumber is annually used in the mine for timber, and nearly one-half of the underground force is engaged in the work of putting in the timbers. The new mine, when opened and at work, will save this expense, will save all the ore and will without any manner of doubt be found to be a far more economical method of extracting the ore, to say nothing of the saving of the ore which, in the present plan, is left in pillars, and which is in a fair way to be lost. If the mine had been filled from the first, it would now, with the same aggregate product, have been only a little more than half as deep as it is, it would be perfectly safe and all expensive changes would have been avoided.

The total number of men employed is 800.

The prices vary somewhat for the work done, but in November last they ranged as follows: For drifting, $3.50 to $7.50 per foot. For sinking winzes, $6 per foot. For sinking shafts, $25 to $70 per foot, including timbering. For B. and C. shafts they have paid about $30 per foot; for A. (an abandoned shaft) $60 to $70. For the small sand-shafts to the rooms they pay $1.50 to $2.00 per foot.

In the filling stopes, between No. 6 and No. 7, the company pays for breaking and filling 45 cents per ton, the ore to be divided in the chutes and the rock to be taken from the rock winzes.

For the first-class stopes west of No. 7, in the sixth level, they pay 35 cents to 40 cents for breaking ore only.

Mr. Per. Larsson, the company's accomplished mining engineer, visited some of the mining regions in Europe the past season, having been sent there by the company to inspect the methods of mining, especially of filling mines, in vogue, with the view to their application to the Chapin. The Chapin is held on a lease by the Menomineee Mining Co., the company paying 50 cents per ton royalty for the ore. All the power for hoisting, pumping, etc., is furnished by compressed air, brought in pipes from Quinnesec Falls.

The Chapin was only opened in 1880, in which year the first ore was shipped. It has furnished annually as follows:

Year.	Tons.	Year.	Tons.
1880	34,556	1883	265,830
1881	134,717	1884	290,865
1882	247,505	1885	177,978
Total tons			1,151,451

G. D. VanDyke, Secretary and Treasurer, Milwaukee, Wis.; C. H. Cady, Superintendent, Iron Mountain, Mich.; Wm. Oliver, Mining Captain.

It shows the great care taken of the men when, in so large a force and in so large a mine, but four men have been killed in the past year, two by falling ground, two by stepping into shafts.

Since writing the foregoing the managers at the Chapin have found it necessary to modify the plan of stoping the pillars, and have for a brief period discontinued this work between No. 6 and No. 7 shafts. They are at this date (January) cutting a drift in the hanging wall, about 25 feet below the fourth level of the mine arid about 15 feet north of the ore. This drift is in the same horizon with the points where the pillar work was discontinued.

Cross-cuts, south, will be made from this main shaft to each of the pillars, and when they have mined the ore out in the pillars from above down to about the second level the remainder of the pillars will be attacked from this new hanging drift. The cross-cuts will extend through the pillars to the foot wall and be timbered, and as the ore is taken off in slices longitudinally and the space filled with rock, the ore will be run down in cribbed chutes to this timbered level and trammed to the shafts.

THE HEWITT MINE,

situated south of the east end of the Chapin, still continues to work in a limited way. The mine has one or two small lenses of ore from which an annual product of a few thousand tons is obtained. The prospects of the mine have not varied for the better or the worse for the past three years. The ore is the same as the Chapin, soft blue ore.

The mine has produced as follows:

Hewitt Mine.

Year.	Tons.	Year.	Tons.
1881	4,352	1884	7,927
1882	9,667	1885	4,037
1883	7,516		
Total tons			34,099

W. P. Bice, Superintendent, Iron Mountain, Mich.

THE EMMETT MINING CO.

is still engaged in the work of sinking a shaft in the southwest corner of Sec. 30, T. 40, R. 30, close to the Chapin and Ludington lines. The shaft is vertical, and is now 820 feet deep, and is in ore, recently cut in the bottom; how extensive it will prove is not known. The purpose of the shaft is to find the Chapin and Ludington ore in the underlay in the Emmett land; but unless the ore flattens a good deal they are not likely to get into it largely very soon.

They have a fine shaft covered with a shaft house of great height.

E. P. Foster, Agent, Iron Mountain, Mich.

THE LUDINGTON MINE

increases greatly in importance; it is rapidly becoming a leading mine, both in the matter of its increased out-put of ore and in its plant of machinery; from its primitive condition of four years ago the Ludington has developed into a great mine. Inferior to few of the Range mines in the magnitude of its ore deposits, it is second to none in the quality of its ore. The ore is of the finest quality of soft blue specular, analyzing 66⅔% in metallic iron and .050% in phosphorus, and 2.00 in silica. The above was the analysis of an average sample of a shipment of 15,000 tons sold to the Joliet Steel Works Co. The Union Steel Co. spoke to me very highly of the ore. About half of the product is bessemer.

The encouraging feature of the mine is in the fact that the ore deposit is found to increase in magnitude as it is opened westward. The ore body pitches in that direction and there is every present indication of its indefinite continuance.

The total length of the mine is about 800 feet, and its depth 500 feet. There are three shafts from which they are hoisting. A. shaft is in the hanging wall 150 or 200 feet north of the ore, and is sunk 500 feet deep, 10½'x11½' inside of the timbers, and will at no distant period be used for the main part of the work in this portion of the mine.

The ore body has an average width of 60 feet for a length nearly equal to the extent to which the mine is opened; at one point the ore is 90 feet in width.

The method of mining is similar to that practiced at the Chapin, with the exception that the rooms are larger and that floors of ore are left in each level 12 feet thick. The ore is mined out in rooms, across the vein, 22 feet wide, leaving pillars 15 feet to 18 feet wide, and on these latter rest the arches which form the floors. The timbers are left in the rough and are framed by hand instead of by machinery, as is done at the Chapin.

These heavy floors in each level constitute an important difference in favor of stability of the Ludington, and must greatly facilitate the ultimate removal of the residue of the ore when that matter is undertaken, as it eventually will be. The intention is to continue the present system

of mining another year and observe the developments at the Chapin, with the view to profiting by the experience of that company. However, they have begun to do some rock filling in the Ludington; all the rock that is necessarily broken is kept in the mine and judiciously used in filling rooms. Another matter that tends to strengthen the mine is the fact of the existence of a great horse of rock that holds through the ore and aids materially in supporting the walls.

Some necessary changes have been made by the erection of ore pockets, ore dock trestles, etc., but by far the most important improvement that the company has instituted is in the new mine machinery.

A building has just been completed, built of sandstone with slate roof, in which a new hoisting plant has been placed, consisting of four drums, each 12 feet diameter, (W., C. & L. manufacture, Akron, Ohio,) three engines, two hoisting and one pumping engine, 24"x48".

This hoisting machinery is the most powerful to be found anywhere on the Range. It was not fully in place at the time of my visit (November), but it was the intention to use it to hoist from the old shafts next season and ultimately to abandon them and use only the A. shaft. They have also the machinery and are preparing to light the buildings and surface with electric lights.

The company employs about 450 men and mines and hoists 16,000 tons per month. The Ludington has been especially unfortunate in the matter of fatal accidents to men in the past year. It is stated that the number of men killed at the mine is considerably in excess of that at any other mine on the Range.

The Ludington is owned by the Lumberman's Mining Company.

A. A. Carpenter, President; Geo. E. Stockbridge, General Manager; A. D. Moore, Superintendent.

The mine joins the Chapin on the west and the mine is very near the east line of the property. Iron Mountain, the most flourishing village on the Menominee Range, has grown up and is maintained from the business of these mines.

All the power for operating this mine as well as the Chapin, is the compressed air brought in pipes from the compressor works at Quinnesec Falls on the Menominee River, a distance of about two miles. The air is brought in 24" pipe. The capacity of the water power is in excess of the present requirements, as there is a great volume of water and 40 feet head.

It is stated by the officers of the mine that the use of compressed air to operate the machinery has resulted in great advantage to the companies in the matter of mining cost, the compressed air furnished by the water power being much cheaper than steam power.

Similar works have for years been in use at the Republic with a like result; but at the Republic the water power is only sufficient to partially supply the necessary force for compressing all the air required.

The present Ludington mine was opened in 1881; previously the company worked further west.

The annual production has been as follows:

Year.	Tons.	Year.	Tons.
1880	8,876	1883	102,632
1881	3,365	1884	101,165
1882	52,519	1885	124,194
Total tons			392,751

Not far from Iron Mountain, near the margin of a beautiful lake, is the pleasant location of the once promising, but until recently abandoned

CORNELL MINE.

This mine was opened in 1879 and worked for a year or two, when the lense of ore in which they had been working became apparently exhausted, and the mine has since been idle. It is one of the most pleasant situations in the whole mining country, the picturesqueness being due in a great measure to the presence of a fine sheet of water, Lake Antoine, above which, about 90 feet, is the surface of the mine.

There is a good wagon road to Quinnesec and to Iron Mountain, and also the railroad makes a detour to take in the mine and the beauties of the lake, by branching from the main line west of Iron Mountain and connecting with it again beyond Quinnesec.

The old company worked out a pit 300 feet long, easterly and westerly, with a surface width of 75 feet, and a variable depth of 50 feet at east end, and 100 at the west. The strike of the formation is about south 55° east, and the average dip about 70° southerly. Overlying the ledge is a surface stripping of 20 feet of sand, gravel and boulders. The bottom of the pit, and apparently the whole formation, pitches in the direction of the northwesterly end of the pit, at an angle of 25 or 30°.

Last summer John Friedricks, of Iron Mountain, commenced to explore the old pit. He cut two drifts into the south from near the northwest end of the pit, which ran all the way in ore; in fact the ledge on the south side appears to be ore; not exactly clean ore, but a greater percentage of ore than rock. In the northwest corner of the pit is a body of ore 12 feet wide, apparently pretty good ore, and in the bottom pitching under the hanging in the northwest corner, is the ore, the same that is found in the cross-cuts higher up and further southeast.

Upon the north side of the pit they have explored the ore by removing a narrow covering of soap rock, and across the bottom are lenses of ore, separated by seams of jasper and schist, and pitching to the northwest. Also, the ore appears at the southwest end of the pit in considerable body. In fact, there appears to be the same lenses of ore now that were originally worked. The ore has become, perhaps, more mixed with rock, or the ore body split up and separated.

But Mr. Friedricks and his party have found indications enough to insure the existence of ore in sufficient quantity for commencing systematic mining work.

The analyses of the ore that have recently been made show well in iron, but high in phosphorus; it is not likely to prove a bessemer ore. There are a number of dwellings, engine house, store building, office, etc., already at the mine, and a new plant of machinery is to be speedily supplied. A company is to be organized to operate the mine, the lease of the mine having been relinquished by the old company, and one secured by the parties now in charge.

They already have a few hundred tons of ore ready to hoist, and working about a dozen men. There are a number of gentlemen at Iron Mountain interested in the matter, but the work is in charge of John Friedricks.

The description of the property is the E. ½ of N. W. ¼, Sec. 20, T. 40, R. 30, and the mine was worked two years, 1880 and 1881, producing 42,672 tons of ore.

THE KEEL RIDGE MINE.

The Keel Ridge mine, which was the scene of the fatal catastrophe a few years ago, whereby eight men were buried in the mine, and in which their bodies still remain, is lately being explored by parties who claim to have found ore in apparently sufficient quantity to insure the opening of a new mine. Analysis shows the ore to be of the best quality.

Going westerly from Iron Mountain the railroad crosses the Menominee into Wisconsin, and brings us to the

COMMONWEALTH MINE,

a mine which has greatly improved in the last year or two; showing as much ore now as it has at any time since the mine has been worked, But it is an "off ore," medium in iron and high in phosphorus; an ore for which there is no great demand; still the company has shipped the past season 41,472 tons, and its shipments since 1880 amount to 300,000 tons. They are preparing to work the mine wholly underground in the future.

W. E. Dickenson, Superintendent, Commonwealth, Wisconsin.

Two miles further west, in the outskirts of the pleasant city of Florence, the capital of the county of the same name, is

THE FLORENCE MINE,

one of the properties of the Menominee Mining Co. The mine holds a great deal of ore, but it is low grade. A full description of the mine is given in the Commissioner's report for 1882, during which year the mine shut down, and has ever since remained idle. There is also a blast furnace at Florence, which, too, is idle. The Florence Iron Works, however, are in active operation, and turn out excellent work.

Beyond Florence about two miles, the railroad forks, one branch continuing west along the west side of the Brule to Iron River, and the other, turning north, extends to Crystal Falls. This latter branch was completed in the spring of 1881, at which time there was a great deal of activity throughout that section. At the terminus of the railroad, near the falls in the Paint River, the village of Crystal Falls was built up; lots sold readily, and houses and stores, etc., were erected with great rapidity. The Paint River is a stream of considerable volume, and from the beautiful falls, not far away, the village takes its name. These falls, or rapids, constitute a fine water-power; the fall is 17 feet, in a distance of 600 or 800 feet, extending along a narrow island, which divides the stream, having a main channel on the west and a minor one on the east. Through this smaller channel as much of the water could be drawn as desired, and a bulkhead at the lower end would give the full head of the fall, affording a great power, and one cheaply to be utilized. It is admirably adapted to operate a compressor plant, similar to the one at Iron Mountain.

In the vicinity of the falls are several mines. The Younstown, Paint River, Fairbanks and the Star, etc., all of which could be operated by the power running to waste over these rocks.

But as the mines are practically idle, and as there is no prospect of their being very largely worked in the future, it is probable that if the utilization of this water rests exclusively upon its application to the compressing of air for the use of these mines, it is likely to remain untrammeled, and to continue forever to foam over the rocks in all its primitive freedom.

The C. & N. W. R. R. Co. built branches to all the mines in this section; in the branch extending to the Paint River and Star mines, the river at the falls is spanned by a bridge, altogether making a monetary outlay for which the railroad company has failed to receive, as yet, an adequate return.

The commendable enterprise and liberality shown by the railroad company, have seemed to develop this section and to open the mines. If the demand for the ore had continued, a different outcome would have resulted.

The Crystal Falls district is a region of very fine timber. There are no better hard wood lands in the State than are to be seen here. The sugar maple, birch, basswood, elm, etc. trees are tall and large, affording a great abundance of the finest material for charcoal, for the manufacture of pig iron. The soil is excellent, and yields potatoes and other root crops, oats, grass, etc., in ample fold. Capt. Waters, at the Youngstown mine, raised rutabagas of enormous size, one specimen, symmetrical and perfect, weighed sixteen pounds.

Just now the lumbering business is the chief source of activity. There are lumber camps on the upper waters of the Paint River and its tributaries, and large numbers of men are employed in cutting pine logs and in hauling them to the streams.

Crystal Falls is the chief depot of supplies for this lumber interest. From here they are hauled with teams to the camps as required. There are several saw mills in the district, which manufacture lumber for local consumption and to ship away.

One of these is the Mastodon mill, four miles from the Falls, on the line of the railroad, where a branch runs off to the Delphic and Mastodon mines. It is contemplated that either Crystal Falls or Iron River—as the voters may determine—will be the seat of the new county of Iron.

Numerous deposits of ore have been discovered in this district, but generally it is low grade hematite, medium to a low percentage in iron, and high in phosphorus; kinds of ore for which there is but little demand, and if sold at all, it must be at a price which leaves little or no profit in mining it.

Nearly all the mining companies hold their lands under leases, paying a royalty for the ore. Until recently this royalty was 50 cents per ton; now it is generally modified to half that sum.

The largest and best equipped mine in the Crystal Falls district is

THE YOUNGSTOWN,

situated in the E. ½ S. E. ¼, Sec. 19, T. 43, R. 32, being about a mile from the village of Crystal Falls. The mine was opened in 1881, and is admirably equipped with everything necessary for operating a large mine. The ore deposit extends east and west across the property to the low, level land at the foot of the hillside which rises steeply to the south. The engine house is near the west line, and the hoisting ropes, etc., run east on "pulley stands" to the shafts and mine openings. A nearly continuous ore dock has been made in the hillside to the south, on a level with the top of the ore cars, where these are placed, ready for loading, on the track in front of the dock. Short elevated trestles extend from the shafts to the ore dock and also to ore pockets, to load directly from the mine in season of shipment.

But a limited amount of ore has been shipped from the mine. The work has been in the way of opening, getting ready to mine, after which it was found necessary to shut down, because no ore could be sold.

At the east end the magnitude of the ore deposit is evidently great. Here they have sunk two shafts 150 feet apart, and in the east one, known as the Nelson shaft, they have cross-cutted in clean ore 163 feet, only finding one wall, and have drifted east and west 300 feet, all in ore. The bottom of the shaft is in ore, and ore all the way up to the stripping; 100 analyses of this ore have been made, largely from this shaft. A typical analysis of the ore from Nelson shaft I have taken as follows:

Metallic iron	54.5 %
Phosphorus	.57%
Silica	3.00%
Manganese	4.50%
Lime	2.50%
Alumina	1.30%
Water	6.00%

The phosphorus varies from .35% to .80%, and some analyses show a percentage of manganese of from 20% to 36%.

On top of the hill above the mine are a number of good dwellings, large boarding house, etc.

For a year past no work has been done. John Stombaugh, President, Youngstown, Ohio.

Product of Youngstown mine:

Youngstown Mine.

Year.	Tons.	Year.	Tons.
1882	6,198	1884	8,343
1883	15,292		
Total tons			29,833

QUINCY MINE.

At the Quincy mine, so called, lying west of the Youngstown, no work has been done in the past two years. It is probable that the location has been abandoned by the parties who were working. The efforts were confined to getting a shaft down to the ledge through the quicksand, and it is doubtful if even this was fully accomplished.

At a short distance east of the falls in the river, previously described, is the

PAINT RIVER MINE,

where a small amount of work has been done in the past two years. In No. 1 shaft, 55 feet down, they run a cross-cut south 60 feet to the south vein; and in No. 2 shaft, 165 feet down, a cross-cut struck the same ore at 20 feet, showing that the two lenses are coming together at greater depth.

The ore is about 45% to 50% iron, and non-bessemer. They have just made a new discovery (Oct.) at a point 400 feet north and 600 feet west of old mine, and near the west line of the property; they sunk some test pits, and at 6 feet below the surface found a body of ore into which they have sunk 15 feet and drifted 40 feet, all in ore,—a light, friable ore, in appearance like rotton stone, and holding a large percentage of lime.

An analysis of samples gave:

Metallic iron	61 %
Phosphorus	.932%

Joseph Austrian, Secretary and Treasurer, Chicago; C. T. Roberts, Superintendent, Crystal Falls, Mich.

Product:

Year.	Tons.	Year.	Tons.
1882	4,615	1884	11,546
1883	5,971	1885	2,374
Total tons			34,506

OF THE FAIRBANKS MINE,

situated close to the former on the east, there is nothing new to record. No work has been done of any kind on the location during the past two years, neither is there any body of ore, so far as known, of any magnitude on the property. The deposits next to the Paint River was worked out, and the shaft next to the Great Western failed to develop any ore. Mr. S. D. Hollister has charge of the property. Product, 1882, 8,131 tons.

Adjoining the Fairbanks on the west is the

IRON STAR MINE,

formerly the Great Western. The only work done during the past year has been with the diamond drill, with which they are still boring and are obtaining good results. This work with the drill is to the east of the mine and not far away. Four holes in all have been made, and in all ore has been found. In one of them, a vertical hole, 90 feet of ore was found, and when still in ore an accident to the drill compelled them to abandon the hole.

The ore from this mine is better than that from other mines in this vicinity. If proper care is taken in selecting it, it is a very good quality of hematite, fairly high in iron, and only .25% to .30% in phosphorus. It is claimed that it is much lower than this in phosphorus, and possibly it may be. The reputation of the ore was injured during the first year or two that the mine was worked through shipping nearly worthless mineral; more care is taken now, and an effort is making to establish a good reputation for the mine. Sample cargoes of the ore were sent to the De Pere, Leland, Elk Rapids, Florence, and other furnaces, but the result was not such as to make a demand for the ore, so that it would pay to mine. The price is too low. It costs more to mine it than it will sell for.

The mine is in a swamp, and is thus a wet mine, and there is no surface drainage. The ground all about is higher than where the mine openings are.

The mine is wholly underground, with timbered openings; undoubtedly the better way would be to fill, for which there is abundant material to the east in the sand hill. The greatest depth is 145 feet. There are three shafts: the middle one for timber and the other two for hoisting ore. No. 1 is 170 feet east from the west line of the property, and is about 85 feet deep. No. 2 is 100 feet east from No. 1, and No. 3 120 feet east of No. 2.

Product:

Year.	Tons.	Year.	Tons.
1882	567	1884	20,732
1883	22,825	1885	
Total tons			44,134

The company has secured the services of Captain Wm. Hooper, formerly in the employ of the Champion Iron Co., who is residing at the mine and devoting his time to the exploratory work.

J. S. Newbury, Treasurer, Detroit; D. K. Moore, Secretary.

About two miles from the village of Crystal Falls is the

SHELDON AND SCHAFER MINE,

the estate comprising the N. W. ¼, S. 31, and S. W. ¼, S. 30, T. 43, R. 32, and held in fee by Messrs. Sheldon and Schafer, who are at present operating the mine, or rather preparing to. The mine was formerly held by the Union Iron and Steel Co., of Chicago, under a lease from the owners; but through the failure of that company the lease has been cancelled.

No mining work has been done for two years past and recently the partners owning the property have undertaken to pump out the mine with the intention, as they stated, of mining ore. The mine is simply a narrow, open pit 200 feet long, 80 feet deep, 30 feet wide on top and 10 feet at bottom, running east and west with the formation.

No great amount of exploration has ever been made at this mine, some large test pits have been sunk on the line of the ore, but no cross-cutting has been done in the mine. The ore is of much better quality than is generally found in the mines in this district; it is lower in phosphorus; some analyses place the ore within the bessemer limits. The mine is certainly worth working thoroughly, and it may develop into a profitable mine. There is ore in the bottom of the pit and at the ends, and they have no true foot wall. The soap-rock, which was taken as the foot, should, of course, be gone through. They are also stripping the ground at the east of the pit, and it looks as if the ore would extend under the hanging, that is, as if the so-called hanging was only a slip of rock, and that the ore continues beyond it. There are a number of dwelling houses on the property.

The mine was opened in 1881, and has shipped:

Year.	Tons.	Year.	Tons.
1882	15,947	1884	6,774
1883	4,234	1885	
Total tons			2,055

Mr. C. Sheldon superintends the work.

Following the wagon road south from the last described mine, we pass several mining properties which have at least a name and location, in the woods, and at all of which work has been done and buildings erected, and some of which, if the times were more auspicious, would be actively working. Among these is the

ALPHA,

situated about two miles south from the S. and S. mine, in Sec. 12, S. W. ¼, 42-33. It is about one mile from the Mastodon mine, and an extension of the branch railroad from the latter mine will probably be made. No ore has ever been shipped from the mine, but some has been taken out and very much more could be if required.

Capt. J. B. Swartz has charge of the property.

A mile further south, to Sec. 13—42—33, and we reach

THE MASTODON,

where we find a mine that has been considerably worked, though it is now idle and filled with water. The mine is a large, open pit, from which the workings extended to the west and north under the hanging wall 100 feet. The ore seems to strike north and south, dipping to the west, and is overlaid by a coarse, granulated sandstone. The skip road runs down on the east side of the pit, and further to the east is the engine-house.

Capt. Roberts states that the bottom of the pit, underground, is all ore, and the stopes are good for 8,000 tons. In fact he says the ore is 100 feet east and west,—clean ore,—and 180 feet in length. It is hard hematite, yielding about 60% in metallic iron, but high in phosphorus. The company had a quantity on hand last spring, and as the times appeared so unfavorable, they resolved not to work the mine. However, it is stated that they could have sold a good deal more ore if they had had it out or had been in shape to produce it. The work now doing at the mine is exploring with the diamond drill to the north of the mine: one hole to the east, at an angle down of 60°, is 276 feet; found rock and mixed ore and rock; are now boring to the west at an angle of 65° from same place; are down 256 feet, but have not found ore. The description is the S. ½, N. E. ¼, Sec. 13, T. 42, R. 33 W. There are a number of dwellings on the location; also good school-house, and a public school is maintained. Ed. Breitung, Prest.; Jos. Austin, Sec. and Treas.; C. T. Roberts, Agt.

Product:

Year.	Tons.	Year.	Tons.
1882	5,477	1884	18,020
1883	18,537	1885	11,737
Total tons			51,811

THE MANHATTAN

is an abandoned location adjacent to the last described mine, adjoining it on the south. A shaft was sunk in the same trend of ore, but the work did not develop anything of value.

Continuing south to Sec. 24, N. E. ¼, S. W. ¼, T. 42, R. 33, we reach

THE DELPHIC MINE,

which is held by the parties now working it on a lease from the Delphic Iron Co. The mine is on a level table land covered with fine, hardwood timber, and scattered about among the trees are the miners' houses and the other necessary buildings. The mine is wholly underground, reached by three shafts, two of which are virtually down and are used for hoisting ore with small buckets worked with drums and wire ropes. The ore trend is west and south. In the west shaft the ore deposit is 54 feet wide, but narrows down rapidly to 6 feet in the south shaft, which latter is only used as a ladder way; but further exploration is contemplated with the view of using this shaft also for hoisting. The whole length of the underground workings is 400 feet, and depth 100 feet below surface. The mine is two miles south from Mastodon.

The ore is clean,—a hard blue hematite,—averages 58% in metallic iron. The mine has two stopes from which they are getting a maximum of 60 tons of ore per day; work about 20 men, and pay 40 cents per ton for mining the ore; the company hoisting it. A branch two miles long, from the C. & N. W. Ry. leads to the mine. W. W. Whittlesey, Supt., Florence, Wis.

The mine has produced:

Year.	Tons.	Year.	Tons.
1883	3,410	1885	9,843
1884	508		
Total tons			13,761

THE CALADONIA IRON MINING COMPANY

is an organization recently effected to operate a mine in Secs. 17 and 20, T. 43, R. 31, about five miles east of north from Crystal Falls. Here a deposit of ore has been found which seems to promise well, judging from the development of ore made, and from its quality as shown by analysis. According to analysis of the specimens taken, the ore averages above 60% in iron and is within the bessemer limits in phosphorus. It is a brownish red, soft hematite.

The work done comprises two shafts, one of which was sunk on the line between sections 17 and 20, 18 feet through earth to the ledge and 65 feet in the latter. The rock sinking was mostly in ore, it is claimed, and from bottom of shaft they cross-cutted 25 feet in ore. The property extends over one-half mile along the west bank

of the Michigamme River. Along the river is the slate out-crop dipping west at an angle of about 80°; this forms the foot wall of the ore, the hanging is greenstone. From this shaft they went north 200 feet and west 100 feet and sunk a shaft 8'x16', 90 feet deep through mixed quartz and schist, and then drifted east 13 feet and struck clean ore in which they continued for 30 feet without finding any wall. This work was done two years ago. An extension of the Great Western mine branch railroad could, probably, be made to the property.

The land is owned by Geo. Wilson, of the Republic, and is held on a lease by the company. Dr. D. M. Bond, Prest., Iron River; W. V. Northern, Sec. and Treas., Marinette, Wis.

On Sec. 14, S. E. ¼, T. 43, R. 32, seven miles west from the above is

TOBIN'S MINE,

where some good hematite ore has been found, also at the

BLANY IRON CO.'S

location, comprising 80 acres, one and a half miles southeast from Crystal Falls, some work has been done which resulted in finding ore. The company sunk 65 feet, and have a body of ore 12 feet wide.

Analysis of sample furnished gives 62% to 64% and low enough for bessemer, so Mr. McDonald tells me. John McDonald, Prest., Iron River; Joseph McKnight, Sec. and Treas., Milwaukee, Wis.

THE IRON RIVER MINE

was opened and the work of mining and shipping ore begun in the spring of 1883, and the result of the first season's operations was that 102,000 tons of ore were mined and sold. The average cost of mining was about 50 cents per ton, the situation having been very favorable for cheap ruining. The main outcrop was along the side of a bluff that only necessitated the stripping off of the overlying dirt, when the ore could be directly attacked, dug out and loaded into tram cars and carts and run out to the railroad cars placed on the track in front of the mine. The whole cost of mining, which included loading into the cars, was at first but 20 cents per ton. No steam power was required the first season. In the meantime, however, while this comparatively inexpensive mining work was in progress, preparations were making for the future, when another order of circumstances should govern. In this preparatory work considerable difficulty was experienced and large expenditure incurred, as must be the case in all mines. The Iron River Mine is somewhat elongated, that is, the points of attack are at quite a distance apart. The ore is found along in the foot of the bluff that extends north and south on the east side of the Iron River, in Sec. 36, T. 43, R. 35, close to the west line of the section. The company also holds the land adjoining in section 35, in which ore has been found at several points and a limited quantity mined.

The principal mine workings are at the extreme north and south limits of the property, the main one being at the north end; or from a point 1,600 feet south from the northwest corner of the section, thence north 1,200 feet. An ore dock with a rise of one foot to the 100 runs the whole length of this part of the mine.

The fee of the mine is in several different hands. The lines of division crossing the ore, thus making it necessary to keep up the lines in the stopes, as separate accounts of the ore have to be kept to adjust the royalty with the several owners. The several pits at the north end are called the Cyr, the Stegmiller and the Selden. The south mine is known as the Isabella.

The mining now is largely underground at the north end. In the large pit the horizontal section shows the ore body as an arc of a circle open to the west and dipping to the west. The whole length of this bow is 1,200 or 1,400 feet, and the extent to which it has been worked underground is about 760 feet. The lowest level is 200 feet below the surface and extends about 350 feet north of the shaft; a drift to the south has been opened 300 feet long. This underground mine is reached by a single shaft near the foot wall, starting in the S. W. ¼ N. W. ¼, but dipping to the northeast, so that its foot is now near the north line of this 40. Ventilation to the north of the shaft is secured by means of an opening to the surface, through which the rock is milled down to fill up the mine as the ore is extracted.

To the south but little has been done except drifting; a blower is used to force in air. In the bottom level exploring drifts have been made to the east and to the west with good results, one of 40 feet in length is all in ore, and on the same line to the south 15 feet the drift that is made is also in ore. The general width of the ore deposit at the bottom as mined out is from 20 to 30 feet; it is far from regular; as in most hematite deposits, slips of rock intervene, but the aggregate of the ore holds out very well. The ore at both ends seems to be reaching out under the river. The west end pointing to the Nanaimo mine and the south also is making easterly and does not seem to belong to the Selden pit further south on the section line.

There is a large amount of ore in sight, just south from the west line of the property. The open cut level has only been mined down to the level of the dock. This is here an ore bottom of a continuous length of 700 feet, and varying in width from 10' to 50'. This should afford 20,000 tons and upwards of ore that can be cheaply mined. The ore is uniform and clean, free from rock and needs no sorting; it is excellent ore for foundry purposes. Analyses are somewhat varied, but an average of a great many give as a result:

Metallic iron	60.39%
Phosphorus	.17% to .40%
Silica	2% to 5%
Manganese	.53%
Lime	1.20%
Water	2% to 5%
Magnesia	.18%
Alumina	1.05%

In the north mine the ore taken out has been mostly from north of the .shaft, but a drift has been made in what is called the first level, 96 feet below the surface, which at 80 feet from the shaft encountered ore. They drifted in this ore 130 feet. At 48 feet from the point where the ore was met with, a cross-cut was made at right angles with the drift, 60 feet, which is in clean ore, as good as any found in the mine. In the bottom level, 200 feet below the surface, a drift was extended in the same direction and the ore is found in portions corresponding with that indicated above. A cross-cut shows it to be of equal magnitude, so that it would appear that there is here a large body of ore, found to a depth of 200 feet, a length of 130 feet, and a width of 50 feet as yet untouched.

It has been uncovered at one point on the surface and probably could be mined by open cut as cheaply as any way.

The method of underground mining that has been adopted consists in filling the mine as the ore is removed. The main drift through the ore is well timbered by placing bed pieces close together in the bottom; they are shouldered or cut down at the end to relieve the uprights. A cap made in the same manner is placed on top of the posts, leaving the bent 7 feet high 6 feet wide in the clear. Upon this a floor is laid to receive the ore, which is taken there from above and sides until space enough is made to require filling up. The planks are removed and rock is run down from the surface and the drift filled up. A floor is again made and the ore back-stoped away and "milled" down into the drift into the tram cars, and drawn to the shaft. These ore shutes—"mills"—are timbered and carried up as the level is filled. In this way the ore can be all taken out to the surface. They will again sink another level and rise up with the stoping and filling to the level previously filled and so on proceeding downward.

During the past year but little dead work has been done; there have been only men enough employed to mine the ore that has been shipped.

At the Isabella pit much improvement in the character of the deposit is apparent; heretofore the ore has been somewhat mixed with rock, giving considerable second class ore, for which there has been no demand. The overlapping mixed ore and rock has disappeared and they are down in clean ore of which there is a very satisfactory show.

The workings at this mine are in three open pits, about 100 feet apart, the main ore being to the south of the others. This is about 50 feet in depth and 40 feet in diameter. The bottom is ore, and on the sides are 3 stopes, there being no foot wall; yet on the east the ore dips to the west and there appears to be a further surface extension to the west; the ore will probably be found to continue to the south line of the property. Some pits sunk below the line in Sec. 1, a few years ago, were favorable to this supposition. A few hundred feet north of Isabella pit a line of test pits was made recently east and west across the formation, which discovered ore on the line of the continuation of the Isabella pit.

Isabella mine will furnish 25,000 tons next year, if so much is required, and this without much, if any, additional cost for stripping or other preparatory work. In the two north pits the ore can be run out in carts for some time yet, and in the south pit the bucket-hoist can be continued indefinitely or a skip road made down into the pit. A substantial ore dock has been built, and a side track from the main line of the railroad runs in front of it, the track having a down grade of 2 ft. to the 100 to run away the loaded cars and run down the empty ones. The same is true at the north mine, where the dock is upwards of 1,000 ft. in length.

Between the Isabella and the north mine there are several small pits where ore has been mined, but the work was undertaken simply for exploration.

Much expenditure has no doubt been incurred that doubtless would not have been, if the state of the ore market could have been foreseen. Above the hill, east of the mine, a village was platted—Stambaugh—and some fine, costly buildings were erected by the company: of these are the Superintendent's residence, and a hotel, both of which are among the best of the kind to be seen on the Range.

If the mine could be worked to its full capacity, and at a reasonable profit, this would be a prosperous village and the expenditure incurred would not be seriously felt, but as matters stand the village and its buildings are of no value to the company, especially since Iron River is growing rapidly and is sure to be an important village and it is nearly as convenient to the mine as is Stambaugh.

If the company had wished to build a village it should have been laid out just west from the depot where it is level land, near the depot and near the mine and near to Iron River. Stambaugh is off the thoroughfare, it is to one side and is doomed to failure. It is a pleasant spot, however, in one respect, it overlooks a wide range of country.

The mine is well equipped for thorough and economical working; a substantial engine house has been built and supplied with a fine plant of machinery, capable of much more work than is required of it. It is situated in the line of the vein, south of the mine, and contains three hoisting drums made at the Iron Bay Foundry, Marquette. They are used to hoist the ore and to run it to the cars. The other buildings are, a fine office, barn, dry and the new building which is a store house, machine and blacksmith shop, carpenter shop, etc. It is made up of four portions built together, two of these are 80'x30', and two each 50'x30' to which is also attached

an oil house. They are all so arranged as to be a model of convenience for the purpose intended.

The whole location has been thoroughly mapped out, so that everything may be systematically arranged for operating a large mine. Originally, four years ago, it was a wild looking place, now it is one of the pleasantest, most convenient locations to be seen. The cedar swamp that existed between the mine and the river has been cleared and filled up and on this ground the mine buildings have been erected.

Among others is a small laboratory supplied with apparatus for analyzing ores, etc.

It is expected that but a small force will be employed during the winter. The ore market is too much depressed to make it worth while for the company to put ore in stock. If sales are made in the spring, enough ore can be mined during the season of shipment to make a good season's output. Mr. F. P. Mills, the former Agent, recently severed his connection with the company to accept a position with the Union Steel Co., of Chicago. Mr. J. N. Porter retains his position, and now directs the affairs at the mine.

The mine has produced annually as follows:

Year.	Tons.	Year.	Tons.
1882	29,115	1884	32,583
1883	100,969	1885	55,693
Total tons			217,760

Robert McCurdy, Sec. and Treas., Youngstown, O.

A very little to the northwest from the Iron River mine and a mile and a half distant is the

NANAIMO MINE,

which is a small hematite mine, the ore being of about the same quality as the Iron River ore.

The pit which they were working in 1883, at the time I last described the mine, has since been suffered to fill with water and the mining work was transferred to a new "find" further up the hill from the river, to the south. No mining has been done the past year, both pits have been filled with water and were wholly idle until recently. In September last the north pit was pumped dry and the sinking of a shaft begun in the bottom preparatory to stoping ore. The old pit is about 140 ft. to the bottom and Capt. Luxmore states that the ore in the bottom remains as favorable as at any time previously. The new "find" was opened in 1884, and is about 500 ft. to the north of the former. The deposits are very similar—simply large, irregular pockets of hematite, lying directly in contact with the overlying drift. Each pit, has a skip road running down into the bottom, and they have a good plant of hoisting machinery, also ore pockets by the railroad track, etc. The mine is on the south side of the Iron River and near the north line of the property, so that it is fortunate that the ore is found in the south.

The ore, a soft hematite, averages 58% to 60% in metallic iron, 2 to 3% in silica, and, 20% to, 40% in phosphorus; it also holds 5% of water.

The estate comprises 40 acres, which is held on a lease from the McKinnon Bros., and is held on a lease by the company. Mr. J. S. McDonald and other gentlemen, who control the mine, have also organized another important enterprise, to be operated in connection with the mine, which is

THE IRON RIVER FURNACE CO.

J. S. McDonald, President; J. T. Jones, Superintendent.

The purpose is to smelt the ore on the ground, and with this view they have built a charcoal furnace 1,700 feet north of the mine. The ore will be run over on an elevated tramway, extending from the mine across the river valley to the top of the furnace. The cars will be operated with an endless rope, worked from the engine-house near the furnace. The ore will dump from the tram-car to the crusher, passing over an inclined screen, which will admit of the passing through of the fine "dirt" into the ore bin below, upon the top of which the crusher rests, as does also, a small engine to operate it.

The ore will be drawn from the bottom of the rock bin into the car standing on the scales, when the weight will be taken, and then it will be run up to the top of the calcining kiln, and its contents dumped into the kiln.

When roasted, the ore will be drawn out at the bottom in a condition heated to redness, the weight again taken, and then it will be again immediately elevated to the top of the furnace, and dumped into the stack to be smelted. The arrangement is known as Fayette Brown's calcining attachment to furnaces. The plan is said to be in use in a number of furnaces, and to give satisfactory results. The patentee charges $1000 per furnace for the right to use it. The skip roads for elevating the ore will be operated by wire ropes from the engine-house, running up over the stack, on the top of which the pulleys are fixed. The arrangement is such as to make the pressure as nearly vertical as possible, thus to prevent a horizontal thrust at the top of the stack. The rope runs from the engine-house to the bottom of the stack, thence up over the pulley at the top and down the skip road to the opposite side, thus in a measure making the resistance of the ascending car on one side counteract the pull of the rope on the other.

The height of the the stack is 56 feet, with 11 feet bosh. In the calcining kiln it is expected to use slabs for fuel, largely, to be brought from the Mastodon mill, together with the charcoal braze.

The furnace and other buildings essential to its working are at the foot of the hill that rises sharply on the north. Along the top of the hill a railroad track is laid on a level with the top of the kiln. To secure foundations, piles

were driven in the soft ground, so that sufficient stability, it is thought, has been secured. Four boilers are in place to furnish steam, as also the blowing, hoisting and pumping engines.

The work is supervised by Mr. J. T. Jones, who has had charge from the beginning, and is an experienced furnace worker. Mr. Jones expresses great confidence in the success of the undertaking, and states that he shall be greatly disappointed if the furnace does not turn out, at a profit, 70 tons of pig metal per day. It will probably be in operation about February or March next.

This furnace is in a fine hard-wood region, affording in abundance the timber for any amount of charcoal. But unfortunately the region is in the limits of one of the contested railroad grants—a grant long since forfeited, though still claimed by railroad organizations—a claim that is liable to receive the sanction of Congress. Much of this land—the even sections—has been purchased by the government, and the same lands have been preempted by others under the pre-emption laws, or settled on by "homesteaders" under the homestead law, the last claiming a sort of "squatter sovereignty," hoping that finally the government would concede their right to the lands in preference to all other claims. Of the "homesteaders," there are several hundred in the vicinity of Iron River, and it was largely from these men that the company expected to obtain its coal. If the settlers were secured in their title, they would, in clearing their lands, turn the wood into charcoal, under contracts with the company, at such a price as would pay them for their labor in clearing their lands.

The company would thus secure its charcoal cheaply, and be relieved of much of the labor and of the investment of capital that would be otherwise required in operating the furnace. If the "cash entry" titles are confirmed, which includes very many of the even sections, and the railroad should secure the odd sections, the homesteaders would be thrown out and the furnace company will fail to realize their supply of charcoal from this source.

They will be compelled to buy lands or to buy the timber and manufacture their own charcoal. All this will necessitate the building of roads and houses, the keeping of a force of charcoal-burners, wood-choppers, teamsters, etc., etc. All these men will have to be brought on the ground and be supplied with work. They will mostly have no interest in the country except to get employment at wages; whereas, if there is a population of farmers—homesteaders—they are interested in clearing up a farm, in breaking roads, in improving the country. They raise products from the soil—potatoes, grass, oats, etc.—and the furnace and the mines afford a market for their surplus, while in clearing their lands and getting them in condition to produce, the furnace company gives them support, that is, buys their wood or charcoal, and they make their living in doing the work, and in the end have their lands cleared. It is a region of not only good timber, but of excellent soil also, and would make a good farming country. Of course, it's cold in winter, and the summers are short, but they can raise good crops nevertheless.

The company has about 150,000 bushels of charcoal on hand, and has also a row of kilns on the bank above the furnace, where they are adding to the stock. All the arrangements seem to be excellently well made for economical working. The estimated capacity of this kiln is 150 tons of ore per day, which amount will suffice for the furnace.

I should judge the hot blast oven would scarcely suffice; it is one of the old ox bow pipe ovens that are too much out of date. The furnace was brought from Munising, where it once stood but was burned; it has been repaired and much new material and machinery added, but will certainly require an additional hot blast.

The working will be watched with a good deal of interest. The roasting kiln for the ore is a new thing in charcoal iron making and theoretically is an advantage. Not only will the ore go into the furnace in a heated condition, but with the moisture and oxygen driven off. So the ore thus prepared should contain only its silica and metallic iron—say 58% of iron and 3% of silica—thus its weight will be reduced, and the burden which would otherwise be a 100 lbs. would be reduced to 61 lbs. It should effect a great saving in coal and should also cause the iron to smelt more rapidly.

The fuel for roasting the ore will be slabs and charcoal braise, which possess but a nominal value.

On the north side of the river (the river runs east at this point) just opposite the Nanimo mine, Mr. John Schipkin has explored on his land with a churn drill and claims to have drilled in 20 feet in ore.

The McKinnons have also done some exploring on the south side of the village and state that they have discovered ore.

Nothing has been done at the

CHICAGON LAKE MINE

since the previous report on the iron mines was written.

A first class turnpike road has been made from Iron River to the mine a length of six miles east. However, there is no work doing at the mine and no one living there. There is hardly enough of the deposit, considering the quality of the ore, which is poor, to warrant the building of a railroad to the lake.

There is a small pile of ore in stock at the mine, and they have uncovered ore for a length of 100 feet, 10 to 15 feet wide, and even more in places. It is a low grade brown hematite, high in phosphorus.

THE FELCH MOUNTAIN IRON DISTRICT

has perhaps been the greatest disappointment of any mining section that has been opened in our State for a number of years. The early explorations there led to

such promising results that public interest was greatly awakened.

The ore found was of excellent quality, soft blue hematite, like the Ludington ore, and judging only from surface indications there seemed to be plenty of it. A number of companies were organized and all claimed to have an abundance of ore. The C. & N. W. R. W. Co. built a branch railroad from Narenta, a point in the main line, to the new iron district, a length of 35 miles.

This road has had and seems very likely to have very little to do. The mines are all idle; no mining has been done in the region for the past year, and to all intents and purposes, as a mining section, it is practically abandoned. A good deal of expensive exploring was done during the season of activity but all to no avail, no ore was found. The ore deposits that looked so well when first uncovered proved shallow and evanescent. It was all on the surface and wanting in depth. The deposits are all a "wash of ore," mainly laying on the limestone, and were soon exhausted. In fact some mining companies were organized, having, it was claimed, a fine "show of ore," and the stock of which sold at a high figure, but which did no mining at all. In the summer of 1883,

THE CALUMET MINE

had as fine a showing of ore as would be necessary in other localities to insure the existence for a long time to come, but the ore had very little depth and was all worked out in one season. A few tons were scraped together in the following year, but nothing further has been attempted.

The total shipments from the mine in the three years that shipments were made amount to 38,709 tons. A. B. Cornell, Pres., Youngstown, O.

THE METROPOLITAN MINE

has some non-merchantable ore, especially of the yellow ocher variety, spread out over the limestone bottom, and lying near the surface. Two years and a half ago, when I examined the mine, I concluded that it would soon be worked out, as the limits of the ore deposit were clearly to be seen. I am not aware of anything more favorable having been found on the location and no ore has been shipped in the last year. The description is N. E. ¼, S. 32, T. 42, R. 28.

Product:

Year.	Tons.	Year.	Tons.
1882	33,854	1884	27,377
1883	30,643		
Total tons			88,074

Joining the latter mine on the west is the

NORTHWESTERN MINE.

There is quite a body of ore sufficiently opened up to be mined. The shaft is 188 feet deep and they have cross-cutted from the bottom through the ore. Diamond drill borings have been made at three points west of shaft, so that it is claimed that the ground has been pretty well proved for a length west of 900 feet. The ore body has a width of 10 to 18 feet, improves from the east towards the west. The walls are good and single timbers would suffice in mining the ore. The deposit is probably a deep, narrow basin, like the one worked out at the Metropolitan—the ore analyzes below 58% in iron and is non-bessemer. With facilities for getting rid of the water the ore could be mined cheaply.

The mine has produced as follows:

Year.	Tons.	Year.	Tons.
1883	7,202	1884	10,004
Total tons			17,206

At the time the railroad was built, and in anticipation of great mining activity in this section, several villages were plotted and the lots extensively advertised and sold. These towns, however, did not make a very large growth, and now there is little doing in that country except lumbering, there being a saw-mill at Metropolitan.

Contracts for the shipping season of 1886 have been made to some extent already, as also have contracts with some of the leading mines for the ore at prices somewhat in advance of those which prevailed last year.

Contracts for shipping from Escanaba to Cleveland	$1 10
Contracts for shipping from Ashland to Cleveland	1 35
Contracts for shipping from Marquette to Cleveland	1 25

Gentlemen well informed in such matters predict that the above rates will be very soon advanced to $1.50, $1.75 and $1.65, respectively, and even to higher figures if the ore business should become very active.

THE AGOGEBIC IRON RANGE.

How little do those journeying north to-day in one of the palace drawing room cars of the Milwaukee, Lake Shore & Western Railway, through a hundred miles or more of primitive forests and dense swamps, that may now be complacently viewed from the car window, and stopping at sumptuous eating houses along the route where the cravings of the inner man may be fully satisfied, appreciate the hardships and privations endured by the early explorers of this range. When there were no roads or even passable trails; when the simplest necessities of life had to be carried in on the explorers' backs; when, too, many of them were men of limited means, and in some instances risked nearly everything they possessed on the result of the trip or season's work as the case might be. The courage and faith of such men in the future of this region cannot be overestimated. The credit due the capitalist who may have risked a few thousands of his abundant wealth is small in comparison.

Attention was attracted to this region by the report of the Geological Survey of Michigan, published in 1872. In that report is a brief description of a geological reconnaissance of this range by Professor Pumpelly and Major T. B. Brooks, and on the map of the Upper Peninsula accompanying the report the Huronian belt is, in a general way, laid down.

In 1879 F. H. Brotherton, Esq., and party located, for the Canal Co., very closely, the Huronian belt across ranges 44, 45, 46 and 47, Town 47, and the ore vein within this belt; in fact all the discoveries of iron ore made in the above towns are within a hundred feet or so of the line determined by Mr. Brotherton.

From section 10, town 47, range 45, Mich., just east of Sunday Lake, to the East Branch of the Montreal River, a distance of fourteen miles, the range bears nearly west-southwest, and the rocks vary in their dip from 40° to 80° to the north. All the workable discoveries of iron ore thus far developed on the Agogebic range in Michigan are within this section of the iron belt. East of section 10, town 47, range 45, the iron ore range bears to the east-southeast. Considerable exploring has been done on this eastern extension, but the drift appears to be deep and more springy than to the west. The exploring was done early in 1883, before there was a railway into this region; when facilities for doing such work were very limited, so much so that it was practically impossible to reach the ledge in the majority of the test pits. This statement applies more particularly to the first seven or eight miles east-southeast from the Sunday Lake mines, and is based on a personal knowledge of the same.

Since the railway reached this district from the south, a little more than a year ago, the villages of Bessemer, Ironwood and Hurley have sprung into existence and are still making rapid strides in their efforts to excel each other. The strife is now mainly between Bessemer and Hurley.

Bessemer is located on the south half of the southwest quarter of section 10, Town 47, Range 46, Mich. In some respects it has the advantage of Ironwood or Hurley. The Colby mine joins it on the south, and to the west, within two miles, and therefore tributary to Bessemer, are some very promising explorations. To the east are the Sunday Lake mines and some explorations that are at present dependent upon Bessemer for their supplies. The village of Bessemer now contains about 900 inhabitants. It has a fine, large hotel, the best on the range. There are also six grocery stores, two clothing stores, one hardware store, two drug stores, three hotels, and a full complement of saloons. The railway company has a round house here for several of its locomotives.

Ironwood is situated on the north half of the southwest quarter of section 22, Town 47, Range 47, Mich., and Hurley about half a mile southwesterly therefrom across the river into Wisconsin. On the Michigan side of the river, and therefore tributary to Ironwood, are several working mines. In regular order, easterly from the river, are the Ashland, Norrie, Aurora, Vaughn and Pabst iron mines that will employ the coming season not less than 700 men. Add to this number those that are exploring to the east, of the Pabst mine and the number actually engaged will not fall short 1,000 men. Ironwood is at present about one-fourth as large as Bessemer, but if it is not compelled to share too largely with Hurley of what naturally belongs to it, it will yet rival either of them. Bessemer will make more rapid progress in the beginning because of the present natural advantages that the Colby mine possesses. Hurley has the Germania mine and there are said to be some fine veins of ore to the west of there. The Germania promises to be a fine mine, but upon the magnitude of these tributary western "finds" will greatly depend the future of Hurley.

There is another source of prosperity to Ironwood and Hurley, and that is the water power of the Montreal River that will eventually be utilized for mining and other purposes.

There is still another resource that would be well for the towns of the Agogebic range to look into, and that is the abundance of heavy hard-work timber all along the range, that could be made available for the manufacture of charcoal pig iron. With a constantly increasing demand for iron of greater strength the day is near at hand when the superiority of iron made from charcoal will again be more appreciated than it has been in the last decade and its comparative market value correspondingly enhanced.

The rapid development of the Agogebic district during the past season has been in part due to the prompt and efficient management of the Milwaukee, Lake Shore & Western Railway. This company, though unacquainted with the mining business or the ore carrying trade, has in many instances anticipated the requirements of the mines, and as far as can be learned has given thus far little cause for complaint from the mining companies. It has introduced to the mines of this State the large form of the ore car, first adopted, it is claimed, in the Vermillion Lake district, which gives good satisfaction, though at first the mining men were skeptical as to its practicability. The road bed, for a new one, is in exceptionally fine condition, and is laid nearly its entire length with steel rails. Twenty-five to thirty car loads of ore, of twenty gross tons each, can be hauled from Bessemer to Ashland. At Ashland the company has fine ore docks for handling the ore. The number of ore cars was rather limited this past season, but this will be remedied the coming winter.

The early history of the explorations and development of the mines will be given in connection with the following detailed description of them, and .as the greatest development of the north and south veins has been made at the Colby mine we will begin our description of the Agogebic district with that mine.

COLBY MINE.

The "Mecca" toward which all mining men instinctively gravitate when visiting the Agogebic district, is the Colby iron mine. It is at present to this new iron field what the Calumet is to the copper district, or the Chapin mine is to the Menominee range. It seems as if nature, foreseeing the pres-:sent and wishing to make amends for compelling the other mines of this new iron district, thus far opened, to delve in darkness underground, had gone to the other extreme and produced a mine of soft hematite ore in two veins of ample width for economic mining, and of good quality; of comparative light earth covering; from 100 to 200 feet above inexpensive drainage; easily attacked at one end, permitting of carrying forward at the same time stopes at different levels, thereby affording, under the most primitive mode of mining, a maximum amount of ore at a minimum cost.

It is not intended in the foregoing to convey the impression that the Colby is a larger mine, or even equals, the Chapin, the Lake Superior, the Republic, the Champion, or the Cleveland iron mines, for those mines have been mining for years and have given fair proof of their permanency. A comparison as to the greatness of the Colby, or any other mine of the Agogebic range, and those mentioned above can more consistently be made five or ten years hence.

The Colby mines embrace the N. E. ¼ of section 16 and the N. ½ of section 15, T. 47, R. 46, Michigan. The former was leased January 15, 1883, by Jas. McDonald, John McKay, and Helen Moore to C. L. Colby, who assigned his lease to the “Penokee and Agogebic Development Co.," and by it was sub-let this season to Mather, Morse & Co. The latter described N. ½ of section 15, was leased by the Canal Co. to Wm. Sedge wick, Alexander Maitland and others, and by the them transferred to C. L. Colby, and by him assigned and sub-let as above.

Ore in place and in quantity, it is said, was first discovered during the season of 1880, on section 15, by Capt. N. D. Moore; in fact it is claimed that this was the first ore found *in situ* on the Agogebic range. On section 16 Capt. C. P. Pease began exploring in June, 1881, for the Cambria Iron and Steel Co., and partially developed the ore veins of the present Colby mine.

At the time of a visit to these explorations, in June, 1883, I found a large number of test pits and trenches sunk on these properties. Those examined on section 15 were on the present site of mining operations. A shaft was sunk 43 feet to the foot wall quartzite, and a cross-cut at the bottom driven north showed 18 feet of ore; west of this 40 feet, was an open trench 115 feet in length that shows 36 feet of ore,—south end mixed ore. On west side of trench the ore was cut off by quartzite; east side was heavy surface. East of the shaft about 100 feet was a test pit 20 feet deep, with ore in the bottom. South of the trench for 400 feet were a dozen or more test pits sunk to the ledge, showing lean ore and iron slates.

On section 16 considerable more exploring had been done that had resulted in developing 600 feet in length of the south vein, varying in width from 30 to 40 feet. To the north of this, 450 feet on the north vein, a shaft had been sunk 50 feet; the last ten feet of it in clean ore. About 350 feet east of this a series of test pits were sunk with a view of cross-cutting the formation to the north and south of the "two veins,” also the ground between them; but no first closs ore was found. This, however, is not surprising, as some of the test pits were 50 feet apart.

With this brief description of the early operations of this now promising mine it will be in order to describe the more recent developments.

Actual mining was begun on the N. E. ¼ of section 16 early in October, 1884, by Capt. N. D. Moore, and the first shipment of ore was made on six flat cars over the Milwaukee, Lake Shore and Western Railway, that had just extended its line from the south to Bessemer. A test cargo of the ore of nearly 1,000 gross tons was shipped, via. Milwaukee, to Erie, Pa.

The railway company, with commendable energy, completed, in July of this year, a branch into the mine.

The main line of the road passes through the northerly portion of the south half of section 10, T. 47, R. 46, on a course a very little north of west, but at the west line of section 10 it curves to the southwest, and within 200 feet southwest of that point a switch leads off S. S. W. to the mine workings, obliquely ascending the north slope of the range on a grade of two feet to the hundred. About a mile from the switch, on the branch to the mine, is another switch connected to a "Y" that leads northeasterly on a still ascending grade to the mine workings of the south and north veins of section 16; also curving around to the right to those on section 15. The "Y" branch crosses the south vein about 1,425 feet west of the east line of section 16 and 100 feet north of the south boundary of the N. E. ¼ and the north vein at 1,125 feet west of the east line, and 580 feet north of the south boundary of the N. E. ¼. The veins now worked on section 16, as far as known, are nearly parallel and have a trend of N. 80° E., and a dip to the north of about 70°. The veins are about 400 feet apart and are separated by a gray quartzite that is intersected by veinlets of iron ore and vein quartz; also small pockets of ore and bunches of jaspery looking quartzite.

The railway branch, where it crosses the south vein, is about 155 feet above the main line at Bessemer, or 75 feet above the center of section 16, near which point; the south vein is supposed to cross the west boundary of the east half of the section. As the ground is wet and springy at this place, it will probably determine the natural drainage level in the mine workings, though local springs and permeable rocks or impervious material may raise or lower that level.

Abreast of the mine is a long ore dock for running over the tram-cars in loading ore into the railway cars; also for stocking ore during the close of navigation. Within 75

feet of the outer edge of the ore dock, and easterly therefrom, begins the open cut of the south vein into the westerly end slope of the hill, formed by a depression in the range. The bottom of the cut descends as the hill is entered, and is drained of its water by a drift driven in from under the railroad track to beneath the pit. Two hundred feet from the outer edge of the dock the line of the foot wall bends outwardly into the foot wall, and opposite this point the hanging wall is said to-do the same, thereby affording a maximum width of vein. I measured the vein at this point, and made it 75 feet. This measurement, however, does not include the depression into the hanging wall, that had been determined by a cross-cut that was covered over at the time with loose ore. The existence of the cross-cut was made known to me after leaving the mine.

The stopes of ore across this line were 25 feet high. Fifty feet farther east is the west end of a "horse of rock." The ore makes around the south side of it, and is from 10 to 12 feet wide; the main body of the ore, however, is on the north side of the rock. The extent of the "horse" has not been determined. The ore has been mined out on the south side of it for 30 feet to the east; the stope at this point was 30 feet high, and above this, or on top of the stope, another one was going east. The ore from this upper stope is trammed to an ore pocket, alongside of the railroad track, over a trestle erected on the north side of the pit. The foot of the upper stope was about 60 feet east of the top of the lower stope. East of the upper stope about 35 feet is the shaft of the south vein. The collar of the shaft is about 64 feet above the railroad track, where it crosses the vein. The shaft is 35 feet deep, and from the bottom of it is a cross-cut to the south of 18 feet in ore, and to the north a short drift of five feet, and then a chamber of 24 feet in diameter by 10 feet high, that was mined out last fall by Capt. Moore. This chamber was all in ore, with no hanging wall in sight, which gives at least 47 feet of ore. If the "horse" of rock noted to the west in the open cut extends east, it probably pitches down to the east and passes somewhere beneath the bottom of the shaft or cross-cuts therefrom. This is as far as any mining has been done to the east on the south vein. The total length of the workings of the south vein is about 400 feet. The ore contains a variable amount of manganese, ranging from 2 to 15 per cent. The percentage of iron fluctuates, averaging about 60. In phosphorus some of the cargos have come within the bessemer limit.

To the east of the shaft the ground gradually ascends, and at the section line it is 60 feet higher than the collar of the shaft; just east of the section line is another shaft in ore.

The plan of working the north vein is nearly the same as that of the south vein. A tram-road leads from the ore dock into the open cut driven easterly in the vein, and at 370 feet meets the foot of the main stope. This stope is about 35 feet high, and is very free from rock. There is a fine chance here of mining ore very cheaply; after greater depth is attained, the walls will have to be sloped back and supported, or underground mining resorted to, when the cost of taking out the ore will be materially increased. About on the same level as the bottom of the open cut is a large tunnel driven 80 feet easterly in the ore to what is known as the No. 1 shaft of the north vein. This shaft is one of those sunk by Capt. Pease over three years ago. The collar of this shaft is 63 feet above the railroad track, and the floor of the tunnel is 49 feet below the collar of the shaft. Easterly of the shaft the tunnel has been driven 230 feet. Immediately south of the shaft a branch from the tunnel has been driven easterly along the foot wall side of the vein. The branch tunnel was in about 100 feet, and at intervals of 40 feet crosscuts to the north connected with the main tunnel to test the vein and provide better ventilation. The ore in these underground workings is very dry, and appears to "stand" well in the roof and on the sides. The ore from the underground workings is "raised" through the shaft, and thence trammed over a trestle to the ore pockets.

It may be seen from the foregoing that the open cut and underground workings afford a total length of vein of 680 feet, with an undetermined extension to the east and west, and a width varying from 40 to 70 feet.

The Colby attained a product of 1,000 gross tons per day very soon after it began shipping and could have increased it to 2,000 tons, with ample shipping facilities, had it been desired, a record that the management may well feel proud of after giving the mine credit for the natural advantages it possesses.

The mine workings on section 15 are located about 300 feet east of the center of the N. W. ¼. The railroad siding passes about 140 feet north of the mine opening. The vein of ore, before noted in the long open trench, was very soon cut out by converging walls of quartzite. The vein has the appearance of a fissure vein or leader from a main vein. It may prove more regular as greater depth is reached. It looks no worse than did the Germania at one time during the present season.

It is not the intention of the management to make a business of mining ore the coming winter or during the close of navigation, but to devote their entire attention to the "opening out" of the mine for a large product the coming season. I can see no reason now why Capt. D. H. Bacon's estimate “that 1,000,000 tons could be mined within the next three years, provided the present size of the veins be maintained." This statement, though made after a careful examination by Capt. Bacon, who has had a large experience as Superintendent of the Cleveland Iron Mining Co's. mines, to Mather, Morse & Co. before actual mining at the Colby was begun this season, seemed hardly credible; in fact Capt. Bacon's report to Mather, Morse & Co. was seriously questioned by them, but the results of this season's work seconded by the present able management bids fair to confirm it.

The product of the mine for the season will be given in the table at the end of this report.

Capt. Joseph Sellwood is General Superintendent and Agent at the mine. His long experience in mining

matters bespeaks for the mine good management. Capt. Sellwood is ably assisted in his work by Capt. Samuel Harvey, another of Lake Superior's able mining men.

SUNDAY LAKE MINES.

Sunday Lake is a very pretty inland sheet of water, one and a half miles east and west by half a mile wide. The land immediately to the south of it is flat, but the ground along the north shore gradually ascends to the north and within half a mile attains an elevation of three hundred feet above the lake, or about 1,230 feet above Lake Superior. The slope is heavily timbered with hardwood and the land bordering the south shore is covered with spruce, tamarack, some pine and hemlock, the greater portion of which is suitable for mining purposes. A reef of rocks crosses the lake in a north and south direction about midway east and west. To the east of the reef the water is quite shallow, but to the west the bottom of the lake drops suddenly away into deep water.

The inlet of the lake conies in from the south about half a mile from the west end; the outlet is at the west end.

The quarter post between sections 9 and 10 is on the trap range. To the south of the quarter post for 100 rods or more is a broad descending ridge, along the crest of which are a large number of test pits. The formation has nearly an east and west trend across section 9, but to the east, through section 10, it bends a little to the south of east. The trap extends south of the quarter post for 270 feet, and south of the trap for 300 feet is a banded jasper and lean ore, with occasional narrow veins of iron ore; then comes the so-called north vein, and underlying it the foot wall quartzite that is intersected, as noted elsewhere, by narrow seams and veinlets and pockets of soft hematite ore. The south vein, if it exists here, has not been found.

The first exploring for iron ore near Sunday Lake was done by Geo. S. Fay, Esq., in 1881 and 1882, for D. H. Merritt, Esq., and others of Marquette, Mich.

The ore belt extends through the south half of sections 10, 9 and 8; and as noted above, its course across section 9 is nearly east and west, but westward through section 8 it turns to the southwesterly.

In section 10 the vein dips to the north from 70 to 80 degrees, but westward through section 9 the dip is as low in some instances as 50Q to the north.

Early in 1883 Messrs. Vaughn & Moore, of Ashland, began exploring on the west half of the southwest quarter of section 10, under an option from George M. Wakefield and others, of Oskosh, Wis.; and about the same time P. H. Brotherton began on the north half of the southeast quarter of section 9 under an option from the Canal Co. Their explorations soon proved that the work of their predecessors had, in many instances, been too superficial.

BROTHERTON MINE.

In the first shaft put down by Mr. Brotherton, located 175 feet west of the east line of section 9, he sank through 30 feet of loose ledge before meeting with anything "in place," when the ore vein was found dipping regularly to the north at an angle of 70°. The shaft was sunk 51 feet, the last two feet in a lean, soft ore. A 36 feet down a cross-cut was driven south 13 feet, the first 10 feet of which was in good soft ore; the remaining 3 feet was a lean soft ore similar to that found in the bottom of the shaft. Opposite this cross-cut is another drift driven to the north 11 feet. The first nine feet of it is through the lean, soft ore, and then is cut about two feet of good soft ore; the end of the drift is in banded jasper. The past season the shaft was sunk to 59 feet. The lean, soft ore in the bottom of the shaft proved to be only five feet thick, as first-class soft ore was found beneath it; but after sinking in this for four feet the water came in too fast for the bucket.

Samples taken from the upper vein and bottom of shaft afforded, on partial analyses, respectively as follows:

	No. 1. (Upper Vein)	No. 2. (Lower Vein.)
Metallic iron	64.15	63.21
Alumina	-----	.76
Lime	-----	1.66
Magnesia	-----	.41
Manganese oxide	-----	.68
Silica	-----	5.76
Phosphorus	.026	.027

Mr. Brotherton sank two other shafts, one 900 feet west and the other 1,100 feet west. First-class soft ore was struck in the first one at 21 feet below the surface that continued down for 5 feet, then followed 10 feet of quartzite and below that good soft ore to the bottom of the shaft, 44 feet from the surface; at that point they were compelled to stop sinking on account of water coming in too freely for the bucket and windlass. The present season the shaft was sunk 8 feet more in the ore, when the water again proved too much for the bucket. The west shaft struck good soft ore at 27 feet from the surface; at 39 feet cross-cuts were driven to the north and south each, 12 feet in length, and in good soft ore, with the exception of an occasional boulder of quartzite. The cross-cuts with the shaft give a thickness of vein, measured horizontally, of 30 feet.

Analyses of the ores of these two shafts afforded respectively as follows:

	No. 1.	No. 2.	No. 3.
Metallic iron	66.62	63.96	64.68
Silica	2.54	3.47	2.74
Phosphorus	.006	.039	.024

No. 1 is from top vein of shaft 900 feet west, and No. 2 from lower vein of same shaft. No. 3 is from west shaft.

The parties holding the lease of this property are Messrs. Pickands Mather & Co., F. H. Brotherton and Chas. E. Wright. These parties have on the ground a steam boiler, pumps, and one of Merritt's small external friction hoisting machines that gives the very best of satisfaction.

A shaft is now being sunk at 60 feet west of Brotherton's west shaft in the foot wall quartzite. It is the intention of the above parties to open the property this winter for active mining.

SMITH MINE.

This property is immediately east of the Brotherton Mine and embraces the west half of the southwest quarter of section 10. It was leased by Geo M. Wakefield, Esq., March 3, 1883, to Messrs N. D. Moore & S. S. Vaughn, of Ashland. About the first of June of the same year they began exploring on this property. Their first shaft was located 175 feet east of the west line of the section, or 350 feet east of the Brotherton's east shaft. A fine quality of soft hematite ore was struck it the shaft at 30 feet from the surface, and at 42 feet a cross-cut was driven south, showing in all 11 feet of ore that dipped at a high angle to the north; the north side of the shaft was rock. One hundred and twenty-five feet east of this another test pit was sunk 25 feet and then bottomed on the foot wall quartzite. One hundred and fifteen feet still further east another test pit was sunk 40 feet, and then cross-cutted to the north, cutting a narrow vein of ore. Other test pits were put down to the south of this that bottomed on the foot wall quartzite.

In October, 1883, the Sunday Lake Iron Co. was organized; capital stock $500,000 in 20,000 shares. N. D. Moore, President; C. T. Bowen, Vice President; Angus McKinnon, Secretary; S. S. Vaughn, Treasurer.

Mr. Vaughn sold out his interest, and H. D. Smith, Esq., Appleton, Wis., now owns an 8-15th interest in the lease.

Early the present season J. Wells Smith, Esq., resumed work in No. 1 shaft; at 72 feet down Mr. Smith drifted east 30 feet, all in a fine quality of soft hematite ore, but the water flowed in so freely that they came up in the shaft 12 feet, or 62 feet below the collar of the shaft, and then drifted east 90 feet. Forty-two feet east of the shaft, at that level, the vein was cross-cutted and showed a width of 13 feet, though it is questionable if the true hanging wall was struck in the north drift, for only 23 feet farther east a cross-cut shows 23 feet of ore on the north side of east and west drift, and five feet on the south side. Twenty-four feet farther east, or 86 feet from the shaft, the vein was cross-cutted again, showing a width of 22 feet. After this nothing more was done until this fall when Mr. Smith began mining operations. He built a regular mining camp, large enough to accommodate from 25 to 30 men; erected a long, high trestle from the shaft to the railroad track; also a building over his engine and boiler; and has nearly completed a test cargo of the ore of 1,400 to 1,500 tons. The ore is an excellent quality of hematite very low in phosphorus and above 60 per centum in metallic iron. It is the intention of the company to thoroughly open the mine the coming winter and be prepared for next season's work; also to do some exploring to the south in order to test the south vein.

ASCHERMAN MINE

embraces the east half of the southwest quarter of the same section as the Smith mine. Considerable exploring has been done on this property. Carnagie Bros. & Co., of Pittsburgh, Pa., held an option on the property the latter part of this season. They continued one shaft to 105 feet below the surface, besides doing considerable other work, but were not altogether satisfied with the prospects and surrendered their option.

The deep shaft is located about a hundred rods south of the east and west center line of the section and ninety rods east of the west line of the section. In this shaft, at 60 feet down, a vein of soft hematite ore was cut.

After the abandonment of the property by Messrs. Carnagie Bros., Capt. James Tobin began exploring the upper vein of the shaft for Geo. W. Wakefield, Esq., the owner of the lease; and at the time of a recent visit—Oct. 25—they were cross-cutting south into the vein; the ore is a fine looking soft hematite, though mixed with an occasional boulder of quartzite. Mr. Wakefield writes Nov. 17, that they had then drifted “65 feet west in clean ore and 97 feet east,” and the following is an analysis of the ore contained in the same letter:

Metallic iron	65.075
Silica	4.230
Phosphorus	.031

This analysis, Mr. Wakefield claims, is an average of the vein.

Mr. Wakefield purposes to keep at work this winter from 35 to 40 men; he intends also to thoroughly explore the southeast quarter of the above section that is now included in the same lease; he will also explore for the south vein, though the earth covering is from 40 to 50 feet in that part of the section. Mr. Wakefield now considers the prospects very flattering for developing a good mine on this property, and his statements certainly warrant the belief.

To the west of the Brotherton mine, on the southwest quarter of Section 8, J. H. Alward, Esq., is exploring. He has found some very fine ore, but not in sufficient quantity to pay for mining.

Farther west on Sections 7, 18, T. 47, R. 45, and Sections 13 and 14, T. 47, R. 46, considerable exploring has been clone during the past three years.

In Sections 7, 18 and a part of 13, deep drift and water has heretofore seriously interfered with the work; but now, with transportation facilities at hand, when it is comparatively an easy matter to make use of steam pumps, the question as to whether large deposits of iron ore exist on these sections cannot long remain in doubt.

On the northeast quarter of Section 14, known as the "Hart & Shores mine" I understand is looking very favorable. The ore is an excellent quality of bessemer, very low in phosphorus and rich in metallic iron, but was formerly somewhat mixed with rock. In next year's

report there will no doubt be some shipments of ore to report from these sections.

LONGYEAR MINING CO.

The explorations of this company are located a short distance west of the mine workings of the Colby mine, and are in the northwest part of the N. W. ¼ of the S. E. ¼ of Section 16. About 130 feet southeasterly from the northwest corner of this forty are two test pits in the ore; the surface here is about 22 feet deep. From the bottom of one test pit, 33 feet down, a cross-cut is driven south that cut ten feet of ore. The strike of the formation is N. 70° E. and the dip is to the north. This, it will be seen, gives but a short run of that vein on this forty.

On the southwest quarter of Section 16, same town as above, Alexander Maitland, Esq., and Captain N. D. Moore had just started a small party of men to explore. The men had one test pit down on quartzite and were about starting another farther north. The property is considered a good one.

Farther west on the west ½ of the S. E. ¼ of Section 17, T. 47, R. 46, are the explorations of the

IRONTON MINE.

In 1882 Messrs. Vaughn, Moore & Co. had a lease of this property from the Canal Co. and did considerable exploring.

At the time of my first visit, June, 1883, there were two shafts down into the ore. No. 1, located near the west line of the eighty and about 70 feet south of a point midway between the center of the section and its north quarter post. No. 1 shaft was down 70 feet, 60 feet in dirt and loose ore and then 10 feet in the ore. From the bottom was a cross-cut north of 28 feet in ore and then 7 feet in quartzite and mixed ore. These shafts are in the south vein. Nothing more was done here until October of this year, when Messrs. Carnagie Bros, took an option on the property. They had just begun working under the direction of Captain William Ross. It is their intention to "show up" the south vein and to explore for the north vein. The ground gradually ascends from near the east side of the property to the west, and at No. 1 shaft attains an elevation of about 150 feet above the ore low land.

Adjoining the Ironton on the west are some explorations made by Geo. S. Fay, Esq., in 1882, for Messrs. Merritt & Co., who held a lease from the Canal Co. Mr. Fay proved the vein for 650 feet in length.

The present season J. H. Alward, Esq., continued the explorations and tested the south vein from No. 1 shaft of the Ironton mine westward for 1,600 feet; the vein varied in width from 5 to 35 feet. The earth covering in most of the test pits and trenches was very light. The ground ascends slightly to the west and lies well for mining purposes.

This fall the above parties sold their lease to Hon. J. H. Chandler and others of Houghton, who will soon begin operations. They purpose to explore the north vein and will "open out" on the south vein this winter. Section 17 is a very promising one for iron ore, and it will greatly surprise me if a good mine or so is not developed on it.

Farther west on the S. ½ of Section — and the N. ½ of Section 19, T. 47, R. 46, considerable exploring has been done, and it is claimed with encouraging results. None of the properties were being worked at the time of my visit, except the N. ½ of the N. W. ¼ of Section 19, therefore but little can be said regarding them. On the above described eighty J. H. Alward, Esq., has just "started in" three men who had struck hematite ore in a trench.

On the N. ½ of section 24, T. 47, R. 47, N. D. Moore and others had just finished a regular mining camp and were beginning to sink some test pits on the eastern and western portions of the property, but at that time had not "bottomed" any of the eastern pits, and only one of the western ones had struck the vein. Since then I learn that they have partially developed a promising vein of ore.

ASHLAND IRON MINING CO.

This company filed articles of association October 9, 1884; capital stock, ,000,000, divided into 40,000 shares of $25 each; cash paid in, $10,000.

The officers of the company are: J. O. Hayes, President; E. A. Hayes, Secretary and Treasurer; Hugh Richard, Vice President.

The property embraces the N. ½ of the N. W. ¼ Section 27, and the S. ½ of the S. W. ¼, Section 22, Town 47, Range 47, Mich. The first described eighty is leased from the Canal Co. and the latter from the J. C. Ayer estate.

There are two working shafts 245 feet apart; No. 1 is the westerly one and is S. 70° W. of No. 2 shaft. It is 102 feet to the bottom of the "sumpf" and 87 feet to the first level. A cross-cut leads to the north 18 feet, through soapstone, and meets a hard, steely specular ore. This ore is exceedingly hard to drill and therefore expensive to drift in. From where the cross-cut intersects the ore are wide drifts or chambers leading to the east and west. To the east for 50 feet the drift is 15 feet or more wide. It is in specular ore, with here and there bunches of reddish quartzite. The soapstone lies on the foot wall or south side. At 50 feet east from the cross-cut a decomposed felsitic vein of light pearly gray to pinkish white kaolinite obliquely crosses the opening on a northeast and southwest course. To the east of this fissure vein is a purplish brown to bluish soft hematite ore. The chamber here widens to 38 feet, cutting away to the foot and hanging wall sides of the soft ore vein, with no hanging wall yet in sight.

The quartzite on the foot wall side is in places more like a hard-pressed sand bank, caused apparently from the decomposition of the matrix or cementing material of the

quartzite. This is not to be wondered at, as the water forcing its way downwards naturally follows the junction of the strata, fissures and joints, dissolving a portion of the mineral ingredients of the rocks it traverses and again replacing it with others. It is highly probable that the purity of some of the soft hematites is due to this very process, as has been noted in previous numbers of this report. Many of the soft ore veins were originally, no doubt, very siliceous, but "alkaline" water filtering through them under pressure, especially if by any means they had become broken or shattered, would in time carry away the silica in solution and leave the iron oxide and other bases behind.

The foot wall, as noted above, drops away to the south about 15 feet, but at 50 feet to the east it turns sharply to the north for 15 feet and again takes its regular course to the easterly. No true hanging wall was seen, but within 20 feet or more of No. 2 shaft is a large mass of rock in the ore vein. It is probably only a "horse," as the ore appears to be making around on the north side of it, and then, about the same distance easterly from the shaft, the ore is cutting it out to the north. They were "breast stoping" some 35 feet high by 35 feet wide, and were in 54 feet easterly from No. 2 shaft. The vein on this side of the shaft was 38 feet wide, with no hanging wall in sight.

One interesting feature is the presence of occasional rounded boulders of quartzite in the ore. Whether these boulders will disappear in depth is a problem that may throw some light on the origin of these hematite veins.

The Nevada system of timbering has been adopted here, but it will probably prove too expensive for the present price of ore to be long continued.

The plan now being adopted by some of the older hematite mines of the Marquette and Menominee districts for supporting the walls of the underground workings is to sink the shafts a number of levels below where the ore is mined out and then drive longitudinal drifts along the foot wall to either side of the shafts, thereby drying the "ground" above that will enable it to stand better during the course of mining; then to begin and back-stope the ore towards the shaft, the width and height of the stopes depending on the character of the ore and width of the vein; then to mill in dirt or other material to replace the ore. The cost of putting in loose material, such as sand or gravel, with proper appliances, where it is convenient to the mine, should not cost more than 30 cents per cubic yard. A cubic yard of hematite ore will weigh in the ledge about 2½ tons, or say 12½ cents per ton; now if 2½ cents be added for the sinking and maintenance of the dirt shafts, we have a total cost of 15 cents per ton of ore mined. By this method all or nearly all of the ore is taken out, and there is no danger of caving in from defective timbering and the mine is always practically safe. This system is no experiment, as it has been in operation for several years in Europe. An occasional stoll is needed to support temporarily any loose ground,

To the west of the cross-cut from No. 1 shaft is a drift leading westerly, from five to seven feet wide. The first few feet of it is in hard ore, but the most of it is driven in soapstone. At 70 feet from the shaft is a cross-cut branching a little to the right for 35 feet. The branch follows a narrow lense of ore. From the branching off point another drift leads to the south, and at 18 feet intersects another lense of soft ore 18 feet across. The lense has been mined out for 50 feet along its length. It appears to have a pitch of about 25° to the east. Its extension east would then pass somewhere beneath the shaft. Should the larger lense between the two shafts have a similar pitch, as is highly probable, No. 2 shaft will eventually become the main working shaft. The ground in the heading of the drifts is quite wet, but it very soon drains out as the work advances.

The plan is to sink two or three levels the coming winter and to drive drifts to the east and west that will obviate the "wet headings" in the levels above.

On the surface, 150 feet westerly from No. — shaft, is a test pit 57 feet deep, the last ten feet of which is in ore; a cross-cut at the bottom of it, said to be 21 feet deep, all in ore and no walls. This is probably the same lense of ore described in the main workings below, as a pitch of 20° or 25° would adjust the two nicely. Another test pit was sunk 200 feet to the west in the low ground that bottomed on ore, but it was too wet to cross-cut. It is the intention of the company to put down a working-shaft this winter and develop this westerly lense of ore. They will also add to their mining machinery.

The officers at the mine are: E. A. Hayes, Manager; J. A. Wetmore, Assistant Manager; J. H. Taylor, Mining Captain; Daniel Sullivan, Second Mining Captain.

The ore is a fine quality of bessemer, and I understand has given excellent satisfaction.

For the shipments of ore see table at the end of the report.

About half a mile easterly from the Ashland is the

NORRIE MINE.

This mine is located in the S. ½ of the S. E. ¼ of Section 22, T. 47, R. 47, Mich. The first exploration for iron ore was made on this property by Capt. Jas. A. Wood for A. L. Norrie, Esq., about the middle of July, 1882. Mr. Norrie holds a lease of the same from the J. C. Ayer estate. Ore was found very soon after they began work, and within two months Capt. Wood reported "a length of vein of first-class hematite ore of 660 feet and a width of 24 feet." An analysis of the ore taken at that time afforded: Metallic iron, 63.65; phosphorus, .040; silica, 2.59.

The exploratory work was continued until late in the fall of that year, and resulted in showing an apparent length of 1,200 feet and width varying from 6 to 60 feet.

Early this season Mr. Norrie entered into an agreement with the Metropolitan Iron and Land Co., whereby it

mines the ore and gives Mr. Norrie a certain share of the net profits. The officers of this company are S. S. Curry, President; H. S. Hazelton, Secretary; K. H. Hanna, Treasurer; J. D. Day, Superintendent; Wm. Treblecock, Mining Captain.

The present mine consists of three shafts and an open trench. No. 1 shaft, the middle one of the three, is located in the center of the property. It is sunk 90 feet; the first 25 feet is through surface, and the remaining 65 feet in ore. The shaft was sunk vertically for 60 feet to the foot wall and then to the bottom on the foot wall. The foot wall dips to the north about 50° and has a strike of N. 70° E. No. 2 shaft, the easterly one, is 190 feet from No. 1, and is sunk 120 feet. The first 90 feet of it is vertical, and from there down on the foot wall. The underground workings of Nos. 1 and 2 shafts are connected, and may be briefly described as follows:

From the bottom of the middle shaft is a large drift driven westerly along the foot wall for 210 feet to what is apparently the west end of the lense of ore, the ore in the west end of the lense becoming much harder; in fact much of it is quite steely and hard like that of the west end of the Ashland mine. To the east of the shaft a large drift extends along the foot wall to No. 2 shaft. At 25 feet east of No. 1 shaft is a cross-cut ten feet wide by eight or ten feet high, driven north 110 feet, through soft hematite ore, to the hanging wall of lean ore and soapstone. At 55 feet east is a 75 foot cross-cut to the north, all in ore; at 95 feet is a 75 foot cross-cut to the north; at 105 feet is a 45 foot cross-cut to the north; at 135 feet is a 35 foot cross-cut to the north; all of the cross-cuts are 10 feet wide and 10 feet high, and arching at the top. The object of opening the mine in this manner was to get ore for this season's shipments. To the west of the middle shaft a similar plan was adopted. Twenty-five feet west of the shaft is a cross-cut driven 78 feet north, with quartzite in the breast of the drift. This is probably a "horse of rock," as the 110 foot cross-cut, only 50 feet east of this point, met with nothing but first-class hematite ore, and again from the north end of the long cross-cut is a drift leading to the west that is nearly opposite and north of the 78 foot cross-cut. As at the Ashland mine, there are large rounded boulders of quartzite in the ore, and the quartzite next to the ore is frequently disintegrated into common sand.

The ore is apparently in a lense form, the horizontal section of which appears to be 400 feet long by 110 feet wide, north and south. The ore is a soft hematite and works well and free in the furnace. It averages about 62 per cent, in metallic iron and .047 in phosphorus.

The plan of working the mine has not been fully determined upon, though the "filling in plan" is seriously talked of. It is the present purpose to sink the shafts two or three levels and open out below, then can a system of taking out the ore be more intelligently devised.

The company intend to mine not less than 100,000 tons of ore next year, which can be easily done, provided the quantity of ore is what it promises to be and the mine be properly opened out this winter.

The west shaft is 350 feet westerly from the middle shaft. It is down 75 feet, the first 35 feet through surface and the remaining 40 feet in ore. From the bottom of the shaft is a cross-cut to the north of 68 feet in a steely, hard ore; the breast of the drift is in a lean, hydrated ore. West of the shaft, 30 feet, another cross-cut has been started north in ore. The longitudinal drift westward is driven along the foot wall and is now 90 feet from the shaft.

East of No. — shaft, about 600 feet, a shaft is being sunk and is down 19 feet, 14 feet of which is surface and 5 feet ore, foot wall on south side of shaft, and thickness of vein not determined. The plan is to sink the shaft to 100 feet and then cross-cut the vein; also to open out to the east and west from the shaft. East of this shaft and near the east end of the property is an open trench, from which some ore was mined this summer. The vein varied from 3 to 20 feet in thickness, but in the present bottom of the trench it has narrowed to 7 feet. It is possible that this narrowing of the vein may be only of a local character.

The local management of the mine cannot be otherwise than first-class, as Superintendent Day and Captain Treblecock are both able and experienced mining men.

The total shipment of ore from the mine for the season is 15,591 gross tons.

To the easterly about half a mile are the Aurora and Vaughn mines that are now consolidated under the title of the

AURORA IRON MINING COMPANY.

The original lease of the Aurora embraced the E. ½ of the S. W. ¼ of Section 23, T. 47, R. 47, Michigan, but since the consolidation with the Vaughn it includes the N. ½ of the S. E. ¼ of the above section.

The first described eighty was known in 1883 as the J. H. James option. Early in 1883 the Vaughn Iron Co. was organized on this eighty. Very little work had been done July, 1883, on the Aurora, but on the Vaughn the following notes were taken by myself at that date:

"No. 1 test pit, 325
"feet S. S. E. from the northwest corner of the eighty, is 26 feet deep, 11
"feet of which is surface and the remaining 15 feet ore, vein said to be 17
"feet wide; ore a soft hematite mixed with limonite and hard, steely blue ore.
"One hundred feet east are four test pits, 35 feet deep in clean ore and
"mixed ore, but improving in depth. One hundred feet easterly again is a
"test pit down in good ore; others not down on account of water. Easterly
"again 150 feet is a test pit down 30 feet, 10 feet surface

and 20 feet in good
"ore; struck a grayish white foot wall of quartzite in the bottom; drifted
"north 17 feet, all in clean ore. One hundred feet again easterly is another
"test pit down to the ore. The trend of the ore vein is north 70° east."

It will be seen that even at that early stage of development there was a fair prospect for iron ore on this property.

Early the present season a syndicate of capitalists became interested in the above properties, with general office at Milwaukee, and have worked them vigorously ever since.

No. 1 shaft of the Aurora mine is located about 800 feet east from the west line of the property. It is 65 feet deep on the foot wall. At 60 feet is a cross-cut each of 85 feet; also drifts to the east and west, along the foot wall, of 65 feet each, all in ore. In the west drift, 40 feet from the shaft, they were cross-cutting north; were in 30 feet, all ore. The cross-cuts and drifts are all ten feet wide and high. This was done to get out this fall a few test cargoes of the ore. A No. 7 Knowles pump takes care of the water easily.

No. 2 shaft is N. 70 E., 150 feet from No. 1 shaft. It is sunk through surface and ore 30 feet to the foot wall, and then for 10 feet more in ore along the foot wall and still going down.

About 500 feet easterly from No. 2 shaft is No. 3 shaft. It is on the Vaughn eighty, and was down 28 feet with ore in the southeast corner. On the same course as above and 300 feet easterly from No. 3 is No. 4 shaft. This shaft is sunk 64 feet, with drifts-east and west, each 20 feet.

The strike of the formation, as will be conjectured from the trend of the ore vein, is N. 70° E., and the dip about 60° to the northerly.

Nos. 1 and 2 shafts are located on the north side of a branch track that leads out of Ironwood past the Norrie mine, and Nos. 2 and 3 shafts are on the south side of the track. The ore a soft hematite; analyzes high in metallic iron and low in phosphorus.

The sinking of the shafts and driving of the drifts, getting out two or three test cargoes of the ore, erecting several buildings for the accommodation of the miners and many other improvements have all been accomplished since the middle of July of this year, a little more than three months; surely a good record and one that the management can refer to with pardonable pride.

The consolidation of the properties gives a length of vein of about 3,000 feet, with good workable mines to either side.

There were employed on the location, all told, about fifty men, and were shipping a hundred tons per day. Many of the men, however, were employed at "dead work." The officers of the company are as follows: N. D. Moore, President; M. J. Luther, Vice President; John E. Burton, Secretary; Alvin E. Tyler, Treasurer; George Brewer, Superintendent.

Adjoining the Vaughn mine to the east is the property of the

PABST IRON MINING CO.

This mine was known as the Albany mine until early this season, when the present owners came into possession, and named it the Pabst mine.

The property embraces the S. ½ of the N. E. ¼ of section 23, T. 47, R. 47, Mich. The workings consists of three shafts. No. 1 shaft, the middle one, is located 430 feet west of the east line of the section and 100 feet north of the south boundary of the property. It is sunk in the foot wall on an angle of 70° to the north for 35 feet and then 35 feet more at 60° to the bottom of the shaft. At 65 feet down is a large cross-cut, driven 68 feet to the north; the first 12 feet was in the foot wall and the remaining distance all in ore.

A short distance to the northwest is No. 3 shaft, located in the hanging wall. It is sunk through 27 feet of sand and 10 feet in the hanging wall of quartzite and mixed ore.

No. 2 shaft is located about 150 feet northeasterly from No. 1 shaft; it is down 23 feet in the foot wall; will sink it deeper and then cross-cut north.

The vein has been tested northeasterly from No. 1 shaft for 525 feet to-the east line of the section.

This winter it is purposed to sink No. 1 shaft to a depth of 150 feet, and then drive drifts along the foot wall to either side of the shaft; also to cross-cut the vein at different points.

The ore averages well in metallic iron, some of the car loads of the ore weighing 22 gross tons each.

The mine has a plant of machinery that will meet all requirements for the coming season, especially the boiler portion of it—a desideratum of great-advantage in the opening of a new mine.

Quite a change has been wrought in the appearance of this location within the past three months. A little berg has sprung up here in the wilderness and presents a cozy, comfortable outlook.

Captain Geo. Berringer, one of the pioneers from among the mining men of the Marquette mining district, is the superintendent and part owner of the mining lease. He is ably seconded by Richards James, Esq., the mining captain.

The mine has shipped a test cargo of 1,224 gross tons.

The officers of the company are as follows: Philip Best, President; Chas. Best, Secretary and Treasurer; Geo. Berringer, Superintendent.

This comprises, as far as I know, all of the mines and more prominent-explorations of the Agogebic range in Michigan, except those in section 21, T. 47, R. 43, and sections 12 and 13, T. 46, R. 42, Mich., that were described in the commissioner's report for 1883. As nothing has been done on these properties for some time I did not visit them this season.

GERMANIA IRON MINING CO.

Westwards, just across the Montreal River into the State of Wisconsin, and therefore not properly within the limits of this report, is the Germania mine, operated by the same parties as the Ashland mine.

This company was organized in 1884; capital stock, $1,000,000, divided into 40,000 shares of $25 each. It embraces the S. ½ of the S. W. ¼ of Section 24, T. 46, R. 2 E., Wis., and is leased from the Northern Chief Iron Mining Co.

The mine consists of three working shafts, Nos. 1, 2 and 3. No. 3 shaft is located near the centre of the “eighty.” It is down 65 feet, and was just into the ore. No. 2 shaft is about 300 feet westerly from No. 3 shaft.

The first ore mined from this property was taken out of an open pit, from the bottom of which the shaft is sunk. In July of this year they had reached in this open pit, at 25 feet down, what appeared to be the lower side of the lense of ore; that is, the foot and hanging walls were in contact. This was caused by what seemed to be a longitudinal fault or slip. The formation dips to the north, and the plane of the fault apparently to the south, while the direction of the throw or slip is that the north portion or side of it moved downwards. I didn't have time to examine into this as thoroughly as I would liked to or hope to the coming season, but this hypothesis of structure best accounts for the above conditions.

At the bottom of No. 2 shaft is a cross-cut to the north; the first few feet of the drift was through quartzite, then comes 22 feet of hematite ore; the hanging wall is a lean limonitic ore. Along the foot-wall side of the vein a drift was driven east 85 feet and west 40 feet, all in ore of a superior quality of soft and hard hematites. As no cross-cuts have been driven to either side of the shaft it is impossible to give the thickness of the vein. No. 1 shaft, 295 feet westerly from No. 2 shaft, is sunk 50 feet to the ore. From the-bottom of the shaft is a cross-cut 13 feet in ore, but the water coming in too freely compelled them to stop work for the time being. The coming winter they will sink all of the shafts two or three levels, and if the ore proves continuous will connect them by drifts.

They purpose also to continue exploring on the north vein of the property. They have already tested the north vein for 600 to 700 feet in length, and at one point have an apparent thickness of 70 feet of a hard, steely hematite, that is very rich in metallic iron and low in phosphorus.

The officers of the company are: E. A. Hayes, President and Manager; Hugh Richard, Vice-president; Louis Cheynoweth, Secretary; J. O. Hayes, Treasurer; J. A. Wetmore, Assistant Manager, and J. H. Taylor, Captain.

To the west of the Germania are several very promising explorations, some of which will probably be shipping ore early next season.

In regular order, westward from the Germania, and in town 46, range 2 east, Wisconsin, are the Nimekon, of the N. ½ of the N. E., section 26; the Kaukagon, E. ½ of the N. W. ¼ of section 26; the Wood, the W. ½ of the N. W., of section 26; the Superior, the S. E. ¼ of the N. E. ¼ and the N. E, ¼ of the S. E. ¼ of section 27; the Kennan, the N. W. ¼ of the S. E. ¼ of section 27; the Ryan, the N. E. ¼ of section 33; the Section 33 Co., the E. ½ of the N. W. ¼ of section 33; and the Montreal, the S. W. ¼ of the N. W. ¼ of section 33.

FURNACES.

L'ANSE AS A FURNACE SITE.

It seems to me to be one of the best points imaginable for the manufacture of charcoal pig iron. In nearly all directions there is a world of the best hardwood timber, and it has become accessible. The lands bordering upon the bays—Keweenaw and Huron—are heavily wooded, and cord-wood cut along the margins can be taken to L'Anse by water. From Michigamme to L'Anse, 26 miles, the railroad passes through nearly unbroken forest. Along the railroad, kilns could be built and the charcoal or the wood taken to the furnace by rail. West from L'Anse the new State road through to Ontonagon, 30 miles, is through the finest hardwood lands, good hardwood timber and good soil. Swedes are beginning to settle along this road and to clear up farms. A charcoal furnace at L'Anse would be of great advantage to them, as it would give them a market for their wood and help them to clear their lands. The immense area of accessible hardwood lands, the adaptability of the soil to general farming insure to a company its charcoal for an indefinite period and to any required amount. L'Anse has one of the best .harbors on the lake and is also connected with the iron mines by rail; it has an extensive ore dock, and is a shipping point for iron ore. There is an abundance of room for dock for holding ore, for stacking iron, coal, wood, etc. It affords the best possible building sites for a furnace on the level ground adjacent to the water and against the high clay bank which rises abruptly in the rear. The kilns and charcoal sheds can be on the high ground on a level with the top of the furnace, as can also the crusher, etc., thus saving the hoisting of the stock. Hot blasts, boilers, etc., can also be on a level with the top of the stack if deemed advisable.

I have previously spoken of other points in connection with this subject of charcoal pig iron making. Particular mention has been made of the Iron River district and the Crystal Falls district; of the advantages which they possess for the manufacture of charcoal pig iron. The new furnace enterprise at Iron River has been described, and I might as well complete the subject by mentioning those Michigan furnaces which are in actual operation.

In citing these it is proper to begin with the

PIONEER,

built at Negaunee, since it is the oldest furnace operated in the State. The Pioneer furnace went into blast in February, 1858, and has been continuously operated since, saving only such stoppages as necessarily occur. It was originally the property of the Pioneer Iron Co., which company was subsequently, in 1866, absorbed by the Iron Cliff Co., that now owns and operates the furnace. There are now two stacks, each 45 feet in height, with 9½ feet bosh, and have an average capacity of 45 tons of pig iron per day, using 100 bushels of charcoal to the ton. No. 2 stack is the only one that has been operated the past year. It has turned out 15,718 tons of pig iron during year ending December 31, 1885.

THE DEER LAKE IRON CO.

operates a furnace situated 2 miles north of Ishpeming. This furnace has been in operation since 1868, and was originally a very small one, 7½ bosh and 33 feet high, driven by water, using an 18" turbine under 35 feet head of water. Subsequently, in 1874, a larger furnace was built in proximity to the former, with shell stack 9½ feet bosh.

The furnace produced during the year ending Dec. 31, 1885, 9,245½ tons.

W. H. Rood, President, Ishpeming, Mich.

THE FAYETTE FURNACES,

situated at Fayette, in Delta county, are owned and operated by the Jackson Iron Company. The company owns a large body of hardwood lands—16,000 acres—and the furnaces were put into operation in 1867, and in 1873 were making on an average of 25 or 26 tons of iron, each, per day, using 94 to 100 bushels of charcoal to the ton of iron made. This was at that time extraordinary good work, and was not exceeded, nor even equaled by any charcoal furnace in the State. The furnaces have always been well managed and have run on the best of Jackson mine ores.

In 1883 the furnaces were burned, but were soon again rebuilt and put into operation. A large amount of pig iron has accumulated at the furnaces, so they have run but a small portion of the past year, only from January to July, during which time 8,456 tons of iron were made in No 1 stack.

No. 1 stock, in blast from July 1 to July 3, 1885, tons of iron made	8,456
No. 2 stock (idle)	----------
No. tons limestone quarried, etc	1,319
Average No. of tons of iron made per day	45½
No. of bushels of charcoal used per ton of iron	123 56 lbs.
Average yield of ore in furnace	61%
Height of furnaces	54 ft.
Diameter of bosh	9½ ft.
Kind of ore used, soft hematite. Quality of charcoal, 50% soft, 50% hardwood	----------

H. G. Merry, Superintendent.

THE VULCAN FURNACE,

Lee Burt, manager, is situated at Newbury, on the line of the D., M. & M. R. R., is a new furnace, in the midst of a fine hardwood region of excellent soil and excellent timber. The company holds a great body of these farming lands, which are for sale at moderate prices to settlers, who in turn, in clearing their lands, will supply the company with charcoal for its furnace.

All the buildings connected with the furnace are substantial structures. The same company owns also the Martel furnace, situated at St. Ignace, the eastern

terminus of the D., M. & M. R. R., in which line the owners of these furnaces are greatly interested. These furnaces are among the best built furnaces in the State.

Vulcan furnace was in blast during 242 days in 1885, and turned out 11,426 gross tons of pig metal. Number of bushels of charcoal used was 1,118,258, reckoning 20 pounds to the bushel. Height of stack, 53 feet; diameter of bosh, 10 feet 6 inches. Number of pounds of iron obtained from each 100 pounds of ore smelted, was 59; using a mixture of specular, magnetic and hematite ores.

Number of pounds of limestone used per ton of iron	101
Pressure of hot blast, (lbs)	3½
Temperature of hot blast, degrees	1,000°

THE EUREKA IRON AND STEEL WORKS CO.

has operated its furnace during nine months of the past year, to-wit: From April, 1885, to December 31, producing in that time an aggregate of 10,904 tons of pig iron.

Height of furnace stack	56 feet.
Diameter of bosh	11 feet.
No. bushels charcoal used per ton of iron made	96,097
Ore used, Lake Superior hematite and hard specular, yielding in furnace	60.25%

Office Wyandotte, Mich.

THE DETROIT IRON FURNACE,

situated at Hamtramck, was in operation 282 3-4 days during the year 1885, in which time it turned out:

Of pig iron	13,614.820 tons.
No. of bushels of charcoal used per ton of iron made	94
Average furnace yield of the ore used (using magnetic, specular and hematite ores from Lake Superior mines)	59½%
Height of stack	50 feet.
Diameter of bosh	10 feet.

E. C. Wetmore, Agt., Detroit, Mich.

THE UNION IRON CO'S.

furnace in Detroit has turned out during 1885, a total of 3,343 tons of pig iron. I am unable to give any further particulars. Lee Burt, Manager.

THE BANGOR FURNACE,

situated at Bangor, Mich., W. H. Nelson, Supt., after having been idle for several years, went into blast again on the 9th of July last, and up to the close of the year produced

Gross tons of iron	6,891½
Average bushels charcoal used, per ton (2,748 cubic inches)	90
" Yield of iron from the ore used	60%
" No. of tons of iron made per day	44

The Company uses Lake Superior ores brought from Escanaba to St. Joseph, thence 27 miles by rail. The furnace is in a fine farming country, which is largely under cultivation and the charcoal and wood are largely obtained from the farmers. The daily product is about 44 tons of iron average. Stack 51 ft. high, 10½ ft. bosh.

The furnace was built in 1871 and for the first few years made 15 to 20 tons of iron per day. A few changes subsequently made, run the product up to 40 tons per day, and 106 bushels charcoal per ton. The improvement was due to increasing the blast and using a "Bell-hopper."

THE ELK RAPIDS IRON CO

operates a charcoal blast furnace at Elk Rapids, Mich., which is one of the largest producing furnaces of its kind in the country. During the past summer the company filled a large order for pig iron from England. Elk Rapids is near the east shore of Lake Michigan,—in the northern part of the lower peninsula—and the company possesses important advantages for obtaining an abundance of hardwood and charcoal, through the fact that the furnace site is accessible to a chain of inland lakes opening into Lake Michigan. The furnace was built about 1870 and of late years, at least, has been very successfully run. Fifty-three tons of iron per day, as an average for a whole year, is pretty good work for a moderately sized furnace; 60 tons and upwards per day is not an unusual product, and is three times as great as was turned out 12 or 14 years ago in this same furnace. The greatly increased product of this furnace, in the Pioneer, Bangor, Fayette and other charcoal furnaces, illustrates the progress that has been made in iron making in the past decade.

In 1873, 25 or 26 tons per day was extraordinary work, and not exceeded by any furnace in the State; now twice that amount as an average daily yield is not unusual work in the same furnaces. And in accomplishing this result there has been no increase in the average consumption of charcoal, on the contrary, really less is used. Iron is now made with a less number of bushels per ton than heretofore. In the Bangor furnace, the first year it run, they used 140 bushels of charcoal per ton of iron, and in 1875, when the average number of bushels was reduced to 106 per ton of iron, it was counted extra good work.

And the Elk Rapids Co., in raising the product of the furnace to an average yield of 53 tons per day, has also reduced the number of bushels of charcoal per ton to 93. Certainly the cost of iron making has been greatly lessened, as well it should be, when the market price in Chicago is below $20 per ton. The following shows the year's work of the Elk Rapids furnace, for year closing Dec. 31, 1885:

No. of days run	304
No. of bushels charcoal used (hardwood—beech and sugar)	1,512,5000
No of tons of pig iron made	16,077½
Average No. of tons of pig iron made per day run	52 tons, 1982 lbs.
Height of furnace stack	47 feet.
Diameter of bosh	11½ feet.

Edwin S. Noble, Sec., Elk Rapids, Mich.

THE SPRING LAKE IRON CO.

has a furnace at Fruitport, in Muskegon county, on the east shore of Lake Michigan, which has been from the time it first went into blast extremely successful. It probably has the best record of any furnace in Michigan, and I do not think that the record of the furnace for the past year can be equaled by any other furnace of its size in the country for the same length of time. If the record was ever equaled in a charcoal furnace the fact has not come to my knowledge.

It will be seen that the ore used did not give an extra yield in the furnace, it having been largely soft hematite, Milwaukee mine and Lake Superior mine ores.

The wood used for coaling was not what would be termed extra, but certainly good, 30% hemlock and 70% mixed elm, birch and sugar maple. The stack is 46 feet high, and the diameter of the bosh is 10' 8", not by any means a large furnace. The limestone was from Kelly Island, used for fluxing.

Statement of the working of the Fruitport furnace for year ending December 31, 1885:

No. of days run	321
No. of tons of charcoal used	1,444,675
No. of tons of ore used	28,684 tons, 1870 lbs.
No. of tons of limestone used for flue	386 tons, 1220 lbs.
No. of furnace charges run	57,787
No. of tons of pig iron made in 321 days' run	17,217
No. of bushels of charcoal per ton of iron	84
No. of pounds of limestone per ton of iron	50
No. of pounds of ore smelted per ton of iron made	3,732
Average No. of gross tons of pig iron made per day	53½
Per cent. of yield of ore, i. e., No. of lbs. of iron from each 100 lbs. of ore smelted	60¼
Per cent. of soft hematite ore used	70%
Per cent of hard specular ore used	30%
Size of steam cylinders	20" diameter, 4' stroke
Size of wind cylinders	60" diameter, 4' stroke
Average No. of revolutions per minute	27
Average pressure of blast	3½ lbs

There are two ovens, one on Player plan, having 24 upright pipes each 12 feet high, giving 850° to 900° temperature of blast.

The other oven is small, old style of horse-shoe or "U" pipes 3¼"x6½" diameter and 8 feet high. These give a temperature of same as the other. The average hot blast temperature is 875°.

The charcoal is measured, 2,748 cubic inches making a bushel; when made from dry wood a bushel weighs 20 pounds as an average. The furnace is advantageously situated on Spring Lake, so that the ore vessels unload expeditiously in stock house of the furnace. The freight of the ore from Escanaba, put in the stock house, is but 75 cents per ton. Kelly Island limestone, cost, laid down at the furnace, $1.25 per ton. Freight to Chicago on the iron is 75 cents per ton. Same to Cleveland.

The company has 45 coal kilns, 20 rectangular and 25 round ones. The former holds 80 or 90 cords of wood, and the latter 60 cords. The wood costs $1.25 to $1.75 per cord. Wages paid, $1.25, $1.40, $1.50 and $2.00 per day.

The ore used in 1885 was ¼ Lake Superior mine No. 1 specular, ½ L. S. mine hematite, and ¼ Milwaukee mine ore. The ores bought for 1886 are Colby, Lake Angeline and Cleveland No. 1 hard ore.

From January 1, 1885, to July 1, 141 days, the furnace made 55 tons of iron per day, average, using an average of 80½ bushels of charcoal per ton. For the week ending April 4, 1885, 7 days, the total product was 441 tons, using an average of 68½ bushels of charcoal per ton. The ore yielding 60⅔% in iron. The product runs up to 68 and even to 73 tons of iron in a day. These statistics I have taken from the books of the company myself, which were submitted to my inspection.

Mr. J. C. Ford, the manager, and Robert Lameraux, the foundryman, it need not be said are skilled in their work.

THE DETROIT AND LAKE SUPERIOR IRON MANUFACTURING CO'S

furnace at Detroit has been in operation eight months of the past year. It was out of blast from August 15 to December 23.

No. of tons of pig iron made in year 1885	4,803
Height of stack is	40 ft.
Height of stack from bottom stones to cover of bell and hopper	44 ft.
Diameter of bosh	9½ ft.
No. of bushels of charcoal used per ton of iron made	99¾
The charcoal is weighed and 20 pounds taken as a bushel.	
Average yield of ore in the furnace	58 6-10 %

W. M. Gaylord, Treasurer, Flint.

THE PENINSULA IRON COMPANY

manufactured the past year 7,439 tons of pig iron.

Office, Detroit, Mich.

The following table shows the product of Michigan furnaces for the year 1885, and of the five furnaces situated in Wayne county, for 1884 also:

By C. D. Lawton, Commissioner of Mineral Statistics.	1884.	1885.
	No. Gross Tons.	No. Gross Tons, Lbs.
Eureka Iron Co., Wyandotte	6,000	10,104
Detroit and Lake Superior Iron Manufacturing Co., Detroit	7,200	4,803
Detroit Iron Furnace Co., Detroit	6,205	13,619-820
Union Iron Co., Detroit	8,000	3,333
Peninsular Iron Co., Detroit	7,200	7,439
Bangor Furnace Co., Bangor	.....	6,891-1,120
Elk Rapids Iron Co., Elk Rapids	.....	16,077-1,368
Spring Lake Iron Co., Fruitport	.....	17,217
Jackson Iron Co., Fayette	.....	8,456
Vulcan Iron Co., Newberry	.....	11,429
Deer Lake Iron Co., Ishpeming	.....	9,245-1,120
Iron Cliff Co., Negaunee	.....	15,718
Total No. of gross tons manufactured		125,190

The present tariff on English and Scotch pig iron is $6.72 per ton.

The foregoing are all the blast furnaces in the State which have been active within the year past.

There is talk of putting the Grace furnace at Marquette into blast. It is an Anthracite furnace, built in 1873, and was only worked a short time. There are a number of idle furnaces in the State, a few of which will never be started again in their present location.

It may be noticed that the furnace yield of ore is less than might be expected, judging from analysis of the ores of many of the important mines, but this result is due to the fact that a large percentage of the ores now used in the furnaces are the soft hematites. In the Michigan furnaces enough of the low grade varieties were used to bring down the per cent, in the furnace. Many of the hematites average below 60% in iron, and then the furnace yield of the ore is always 3 to 5% less in iron than what the ore yields by analysis.