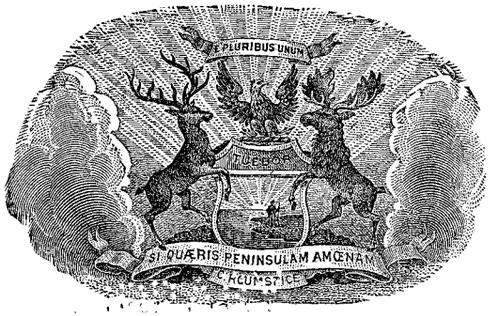
STATE OF MICHIGAN.

MINERAL RESOURCES

BY

CHARLES D. LAWTON, A. M., C. E.,

COMMISSIONER OF MINERAL STATISTICS.



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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 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.

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 traffic, 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 fair 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 cap-

tains, 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 reckness in the matter of their blasts, and are injured or killed by a premature or unlooked 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 observ-

ance 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

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Mining Bureau.

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, in most 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 convertor 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 per centage 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 erroneousness 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 comes 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. 5. 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, chrom-

ium, 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, and 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	10,309	1874	94,708
1859	28,377	1875	87,283
1860	41,295	1876	98,480
1861	12,919	1877	80,340
1862	46,096	1878	83,120
1863	77,237	1879	112,921
1864	83,905	1880	120,622
1865	65,505	1881	118,939
1866	92,287	1882	93,670
1867	127,491	1883	71,278
1868	130,524	1884	76,626
1869	125,908	1885	67,657
1870	127,642		
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 in 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 cut-off; 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 off 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	66,520	25,450	.....	92,967
No. 3 mine	10,192	33,443	.....	43,625
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	6,343	1872	151,724
1857	13,201	1873	133,265
1858	7,909	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	143,320
1863	46,842	1879	113,108
1864	49,954	1880	187,234
1865	33,355	1881	197,843
1866	42,680	1882	304,341
1867	75,864	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, Isphpeming, 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—it 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 225 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 comes 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	50,201	1879	174,747
1866	68,002	1880	204,094
1867	114,935	1881	262,235
1868	105,745	1882	296,504
1869	125,560	1883	200,799
1870	166,582	1884	204,796
1871	158,074	1885	226,040
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	26,680
1870	44,793	1879	24,911
1871	45,939	1880	24,921
1872	38,381	1881	27,281
1873	44,368	1882	41,424
1874	40,255	1883	62,752
1875	40,914	1884	67,782
1876	37,750	1885	47,458
Total			706,057

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	70,103
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	58,502
1870	94,809	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 cross-cut 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	24,073	1877	19,113
1867	46,607	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	27,259
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 footwall 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 and 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			443,163

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 Angeline 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	20,964
1875		1882	33,396
1876	5,596	1883	
1877	3,897	1884	29,883
1878	4,259	1885	7,415
Total number of tons			146,062

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, 4, 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	7,232	1885	50,796
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 secs. 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	3,098
1883	12,314	1886	19,755
Total tons			40,569

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	.027	.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	20,192
1881	14,824	1884	2,146
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 up 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	31,933	1880	
1874	41,765	1881	2,746
1875	23,095	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	28,966	1880	52,944
1874	45,218	1881	57,115
1875	44,756	1882	43,712
1876	20,074	1883	42,533
1877	28,238	1884	28,757
1878	58,622	1885	12,372
Total number of tons			567,083

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 the 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