STATE OF MICHIGAN.

MINES AND MINERAL STATISTICS

BY
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COMMISSIONER OF MINERAL STATISTICS.

BY AUTHORITY

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STATE OF MICHIGAN,
OFFICE OF THE COMMISSIONER OF MINERAL STATISTICS.
Lawton, Michigan, March 10, 1890.

HON. EDWIN B. WINANS,
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.

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PREFACE.

Act 9, Session Laws of Michigan, 1877, SECTION 1, Provides that it shall be the duty of the Governor, by and with the consent of the Senate, to appoint a Commissioner of Mineral Statistics, whose duty it shall be to make an annual report to the Governor setting forth in detail the mineral statistics for the year, with the progress and development of the milling and smelting industries.

SEC. 2. It shall be the duty of such Commissioner to make such geological surveys as are needed for fully carrying out the purposes of this act, to observe and to record by maps arid plans, when necessary, especial facts which may be developed in the progress of milling and exploration.

SEC. 3. And it shall also be his duty to collect each year typical suites of specimens of copper, iron, and other ores and rocks from the Archean formations, not less than ten in number, of the State, and examine them microscopically, to name and classify them, showing by geological sections their stratigraphical positions. Such collections to be at the disposal of the State Board of Education, to be distributed among the educational institutions of the State.

SEC. 4. That an annual appropriation of fifteen hundred dollars be made, which sum shall cover the compensation and expenses of said Commissioner for all surveys and explorations by him, or under his direction, and also cost of preparing an annual report, one thousand copies of which shall be printed and bound by the State Printer, and distributed under the direction of the State Geological survey.

Act 180, laws 1879, adds two sections as follows, to wit:

SEC. 5. Said Commissioner is hereby authorized to demand, and it shall be the duty of all corporations or individuals engaged in mining to make such reports under oath, as to product and other matters, as shall be required by him, on blanks to be furnished by said Commissioner for that purpose.

SEC. 6. It shall also be the duty of said Commissioner to report to the Auditor General on or before the first day of May, in each year, the amount of copper, iron, coal, or other mineral produced by each and every corporation or individual engaged in mining in this State during the preceding calendar year, which reports shall be the basis for computing the specific taxes chargeable against such corporations or individuals, on the amount of mineral produced by them, and in case any corporation or individual engaged in mining in this State shall neglect or refuse to make the reports required by section five of this act, at the time and in the manner therein specified, then it shall be the duty of said Commissioner of Mineral Statistics to report the amount of specific tax chargeable against such delinquent corporations or individuals.

Session 1882-3, SEC. 4 was amended to read as follows: "That an annual appropriation of two thousand and five hundred dollars, to be paid to such Commissioner in quarterly installments, be made, which sum shall cover the compensation and expenses of said commissioner, and for all surveys and explorations made by him or under his directions; and also include the cost of publication, under his direction and control, of one thousand copies of his report."

SEC. 4 was originally intended to signify that the Commissioner should pay the cost of printing his report, and accordingly the report for 1877-78 (both years in one volume) was printed at the expense of the Commissioner, The printing of the subsequent reports until 1883 was done at the expense of the State. Since

1883 the printing as well as every other expense connected with the office has been paid by the Commissioner. It will be readily seen that the expenses alone for preparing the reports of previous years constituted a considerable share of the appropriation, to say nothing of the labor of writing a volume of 200 to 300 pages from original notes each year, besides the labor and cost of preparing maps of mines, statistical tables, etc.

And added to the above duties is an extensive correspondence which has grown up. Letters asking for information, coming from all parts of the country and the world, the answering of which involves a good deal of time and some expense. I mention this since I am aware that the duties of the office and the *actual* compensation that the officer has received are not generally understood.

It will be seen that the duties of the office, except as to the last two sections of the law, are purely scientific and identical, or nearly so, with those which pertain to the office of State Geologist.

But in practice it was found better to make the reports of the Commissioner statistical and economic, avoiding lithology and introducing only economic geology to the descriptions of the mines and mineral formations. In this way, it was thought, the office could be made of the most practical benefit. But it has been found to be no small task to make a personal inspection of all the mines and to write of them and to make a volume annually, covering the same ground, that should be interesting and profitable to the reader. With the exception of the report for 1879, the present volume is the briefest of any that I have prepared or assisted in preparing. I had at first intended to make a voluminous report, and have nearly complete in manuscript a full description of all the mines and explorations in the State after the manner of former reports. On further reflection I have concluded to modify my previous plan and not to print the mine descriptions but to make the report as concise as possible, to omit no essential matter, but to do it all briefly.

Descriptions of particular mines have been avoided and they are only referred to or partially described in order to illustrate broader considerations of formations of the mining industries and of the country. This is the ninth report that I have written, commencing with that for 1880, and while it is the most diminutive of the series, I trust that it will not be found wanting in interest and value.

CHARLES D. LAWTON.

THE MINING INDUSTRY.

The importance of Michigan as a mining State is attested by the fact that during the year 1890 her mines furnished nearly one-half of all the iron ore produced in the United States. The aggregate of the shipments of iron ore from all the Lake Superior mines is in excess of one-half of the total production of the entire nation. But in this aggregate are included the output from the Vermillion iron ore range in Minnesota, and also the production of the Wisconsin mines, which belong to the Lake Superior district, making a sum total of nearly 9,000,000 of long tons.

The total production of iron ore in the United States in 1890 was probably about 17¼ million of tons, of which amount Michigan alone contributed 7,185,175 tons, which was worth in the markets of the lower lake ports probably $41,000,000. Leaving out the cost of transportation this ore was worth at the mines at least $26,000,000, a very remarkable showing for a region but recently so inaccessible and so rigorous in climate as Lake Superior. This comparison of the number of tons does not convey all the advantages to be credited to Lake Superior in the matter of its iron ore shipments. The quality of the ore produced is greatly in its favor. The, average of all the ore sent away from the Lake Superior mines in 1890 was above 62% in metallic iron, some of it 68%, while much of the ore produced in other districts of the country contains but 50%, and even less, of iron.

Again, about one-half of the total amount of the iron ore taken from the Lake Superior mines in 1890 was so-called Bessemer, that is, ore which contains so small a percentage of phosphorus as to be suitable for the manufacture of Bessemer steel metal. Some of the ores, sufficient in quantity to constitute a considerable proportion, contain but a small percentage of this destructive element, phosphorus, and at the same time are very rich in iron.

South of Lake Angeline, in Ishpeming, ore is mined that yields upward of 69% metallic iron, and with but a few thousands of one per cent of phosphorus, while very largely the Southern ores, and ores from other localities, not only hold a low percentage of iron but are in a high degree phosphoric.

Notwithstanding the important discoveries of iron ore that have been made in the various parts of the country in recent years, and the rapid strides that have been made in the south of late in the development of mines and iron manufacturing industries, the Lake Superior region is still in the ascendant. There is no opinion entertained anywhere that ores have been found in this country that will displace those from Lake Superior in the markets. They are far richer and far better than any other, and are more and more appreciated and in demand as their greater excellence becomes known and their comparative superiority over all other ores more

fully established. Elsewhere in the country there has been very rapid progress made in iron ore production; but the development of this industry in the Northern Peninsula of Michigan has been still more remarkable. Not only more remarkable than others in the magnitude of its production, but in the intelligent and substantial character of its progress.

There are no crude, "make-shift," hand to mouth methods of mining in vogue on Lake Superior. Through all the mines, from the largest to the smallest, there is progressive method in the work. Lake Superior mining, without question, is away in the foreground of the world's attainment in this industry.

The mining men of that region are keenly alive to every improvement elsewhere in the world, affecting their own work, and they are ever seeking to accomplish better results, not only by incorporating whatever that is good, which is brought to light elsewhere, but are constantly evolving from their own experience, some new method, some variation in the work, in the machinery too, that puts them each year in advance of the preceding.

There are many bright men connected with the firms engaged in the manufacture of mining machinery, hoisting plants, pumps, power drills, engines, compressors, etc., who are *en rapport* with the mining superintendents and their assistants. They are frequently on the ground and study the situation and comprehending what is required, aided by the suggestions of the men whose wants are to be met, they are able constantly to devise something better in the way of machinery. The rivalry among the great manufacturers of mining machinery to surpass one another in the value of their work, has been and is, of much advantage to the mining industries of Lake Superior. It is here that the want was felt, here were the ores that the world wanted, the great mines were here and the men on the ground, directing the work, with ability to comprehend what was required and with the progressive spirit that seeks to avail itself of every resource that shall the better secure the desired results. The manufacturers felt the demand, they were sure of the market, for whatever that was really more valuable in the way of mining machinery they could produce. And thus, in a measure, there has been a mutuality of interest, a working together of the mining men and the manufacturers of machinery, that has been an important factor in the great progress that Lake Suparior mining has made.

Explosives, too, are a wonderful agent. If the mines were confined to black powder as of yore, no matter how great the development had been in other respects, the prosperity that has been attained could not have been realized. In fact the two forces that in the progress of Lake Superior mining must be allowed to have precedence before all others are the air-drill and giant powder. The rocks of that region are very hard and little effect is produced in trying to penetrate them with hand drills. The giant air compressors, giving 60 pounds pressure on the drills at the rock face down in the mine, is the force now universally employed there to make the opening into which to insert the blast. And thus with the powerful explosive the most enduring rocks and firmest ores are speedily demolished. Holes for blasting are sometimes drilled to a depth of ten or more feet and several sticks of giant powder—half a dozen or more—are inserted and great masses of rock or ore are brought down.

It is safe to say that there is no better region in the world in which to study mining to advantage than on Lake Superior. Every method of mining, of shaft sinking, drifting, stoping, timbering, hoisting, ore handling, etc., that represents advanced mining, is the method adopted and practiced there. This may be said equally well of the iron mines and of the copper mines. In the latter not only is the mining work of the highest order, but the subsequent manipulation of the mineralized rock has been also brought to the greatest degree of perfection.

The boldest mining enterprise ever undertaken anywhere on this continent has been inaugurated and brought to a successful conclusion in the copper district of Lake Superior. The sinking of the No. 1 Tamarack shaft, which was begun eight years ago, was truly a notable event in mining history. To sink a shaft vertically into the earth 2,300 feet, upon a mere supposition, however probable, required much faith and courage, as well as money to defray the great cost. The work was pushed forward with remarkable celerity, and in two and a half years the problem was solved and the result proved the correctness of the theory entertained by the promoters of the enterprise. They were richly rewarded for their faith and the country has been made the gainer by this addition to its mineral wealth and by the the knowledge which this great exploration revealed of the hidden mysteries of the underlying rocks. From this shaft, penetrating so far down into the earth, soon was made to flow the largest amount of copper which was yielded by any mine except one in the State. As a further result of this work a second shaft was sunk and is now also in successful operation. Two others were started by the same company further north, to be sunk vertically 3,000 or more feet in depth to reach the same copper bearing ground. A portion of the estate was set off to a new organization. The Tamarack, Jr., which also began the work of sinking two vertical shafts, one of which has just reached the copper lode at a depth of 2,500 feet vertically from the surface. Apparently the undertaking, like the original one, will prove to be profitable. The Calumet & Hecla Co. is also, led by the success of its neighbor, sinking a downright shaft, to intercept the copper lode far below the present workings of the mine. So that instead of the one shaft, undertaken with uncertainty and doubt eight years ago, there are now sinking in all confidence six others, including the No. 2, the companion of the orginal, pioneer No. 1 shaft.

The circumstances attending the value of the Tamarack land wherein the mine has been opened are very notable. The company owns a large estate, but nowhere does the copper bearing belt in which is the Calumet &

Hecla mine come nearer to the surface on the Tamarack property than at the point where the No. 1 shaft was sunk to reach it, which was found to be 2,270 feet. To make this matter clear it may be well to enter here into a fuller explanation of the situation. In fact, however simple it all may be to intelligent people familiar to the ground, I find it is not so to others outside, since I am frequently questioned by letter and otherwise regarding this matter of why the Tamarack Co. had to sink so deep to reach the copper, etc. The copper bearing formation, commonly known as the Keweenaw series, is made up of a succession of belts or members lying one upon the other with considerable regularity and consisting of trap, sandstone and conglomerate rocks of igneous and aqueous origin. The traps were, of course, overflows of melted matter from deep seated sources, occurring at different periods and covering a previous overflow directly beneath it or spreading over an aqueous deposition of sand or of pebbles, in the one case a bed of sand rock or in the other conglomerate. Sometimes the overflow composed a soft and porus rock, generally constituting what is now designated as amygdaloid, that is the amygdaloid beds of Lake Superior are usually soft trap. The formation is crossed, in Keweenaw county, by fissure veins which frequently contain more or less copper. It is in these fissure veins and in the amygdaloid beds and conglomerate, that the copper occurs, and whenever found rich enough these deposits are worked for the native metal. It seems to be necessary to reiterate that the copper as it occurs in Michigan, is neither an ore nor an alloy, but pure native metal. It is never so good as when taken from the mine. The subsequent operation of smelting in order to cast it into ingots or bars, serves to deteriorate it by introducing oxygen. To some extent silver is found with the copper, but this also is pure arid native. It is attached to the copper in the same manner as may be done by galvanic action and is in no way alloyed or combined with it chemically.

The copper occurs in endless forms from the greatest degree of fineness to masses of hundreds of tons weight. It is designated under these heads by the miners: stamp copper, barrel work and mass, the former being that which is obtained by pounding up the rock cotaining fine copper under the stamp whence it is passed—floated away in water—over a system of sieves and jigs. The water carrying away the lighter rock and the copper settling and passing through the serves, by reason of its greater specific gravity. The barrel work, so called, comprise the pieces of copper that are relieved of the adhering rock, and are shipped to the smelting works, as is also the stamp mineral, in barrels. The mass copper, includes the heavy pieces. The copper obtained, before it is smelted is designated as mineral and is, if stamp work, from 65% to 82% pure metal, mass copper is about 90% pare, ordinarily.

The trend of the formation at Calumet bears about north 33° east, and the dip downward, inclination of the rocks to the northwest, is at an angle of about 37½° with the horizon.

The bed of conglomerate, which has proved so richly impregnated, with copper, known as the Calumet & Hecla conglomerate, is made up of water worn pebbles, boulders, bunches of sand rock, etc. Showing its origin as an ancient sea beach, that was later tilted with the formation, of which it is a member, to its present inclined position. The Calumet & Hecla Co. started their shafts from the surface in the outcrop of the conglomerate and have continued down in it, keeping in the lode with the shafts. And thus, while the Calumet & Hecla mine is about 4,000 feet deep, measured on the line of the dip of the formation, it is but 2,400 feet deep vertically. It was found, that the Calumet & Hecla mine was equally good in the bottom as near the surface; in fact that the increase in depth made no difference in the character or richness of the lode.

Reasoning from this fact it seemed pretty safe to assume that inasmuch as there was no change, so far as the conglomerate had been penetrated, it was likely to continue to be equally rich in copper to an indefinite depth, and as the Tamarack people own land further west, 3,000 feet west from the line of the outcrop along the surface of the conglomerate, they naturally were aware that they must possess a half mile and upwards beneath the surface of the land a rich deposit of copper. The matter finally resolved itself into the only question of how to reach it. A downright shaft—an aperture sunk through the overlying rock was of course the only alternative and this proceeding once resolved upon was speedily carried into execution. The shaft was located at the furthest point east that it was possible for the company to place it and be on their own lands. East of the shaft, from the line of its intersection with the conglomerate 2,270 feet below the surface, the conglomerate rises southeasterly towards the surface which it reaches at 3,000 feet away. It is in this ground above the shaft that is the Calumet & Hecla mine. The Calumet & Hecla Co., however, own along the line of the outcrop, a length of two miles and upwards. Their lands extend north and south of this Tamarack shaft a mile and more each way; and the conglomerate belt in its dip downward to the northwest reaches far below the present depth of the Tamarack mine.

In fact, this portion of the Tamarack lands is nearly surrounded by those of the Calumet & Hecla Co. Looked at in the light of an exploration, this work by the Tamarack Co. has been almost equally valuable to the Calumet & Hecla owners, since it has demonstrated the continued richness of their mine to a much greater depth than they have thus far penetrated.

Nos. 3 and 4 Tamarack shafts are situated about a mile to the north of No. 1, and also further west, so that they must be made deeper to reach the conglomerate. They are separated from Nos. 1 and 2 by an intervening quarter section of land of the Calumet & Hecla Co., in which that company is also sinking a shaft—the Red Jacket, so called—which is about midway between No. 3 and No. 2 Tamarack and on line between them. It is now 2,300 feet in depth, and is larger than any of the

others, being a six compartment shaft, the others being three compartment. The Red Jacket has been connected with the mine by a crosscut, i. e., a horizontal drift through the hanging wall northwesterly at right angles to the strike of the formation, driven from the mine at No. 4, inclined shaft, that is, the Red Jacket is in the vertical plane through the No. 4 shaft of Calumet mine. The crosscut is at the 36th level, 2,100 feet vertically below the surface, and is 1,700 feet long. At the 38th level, 2,220 feet down, a second crosscut has been begun to be driven east from the vertical shaft. It is expected that the downright shaft will intercept the conglomerate at about the 60th level of the mine, or about 3,500 feet vertically below the surface.

No. 4 inclined shaft, is, I think, the deepest in the mine, being at the 42d level. The mine is about a mile in length of working ground, and is 2,000 to 4,000 feet in depth on the incline. The shafts, thirteen in number, are all in the lode, and these are sustained by continuous pillars of the conglomerate, upon either side of every shaft, and since it has been found necessary to make these pillars 75 feet wide, there are 150 feet, including both sides, of copper rock, most of it rich, left along all the shafts. Rock that yields four to five per cent ingot copper is too valuable to be sacrificed to any method of mining, unless it is the only alternative. No doubt the effort will be made in time to recover as much as possible of these pillars, and to adopt some system of mining that shall obviate the necessity of their existence at all.

The sinking of the vertical Red Jacket shaft is a move in this direction. Since it is in rock and will connect with the lode by drifts also in rock, no pillars will be required except where the shaft goes through the lode, so that the lode can all be taken out, as is done in the Tamarack. From the point where the shaft intersects the lode, there will be a length above, to the surface, of about 6,000 feet, and below, the workings can be extended to the limits of the property. This ground, to be intercepted by the Calumet and Hecla downright, and the two northwesterly shafts of the Tamarack, is likely to be very rich, the inference being based upon the fact, that they are) in the apparent trend of the rich "shoots" as they are called, of the mine. It is singular, and an aggravating fact too, to the holder of lands adjacent to the Calumet and Hecla, on the line of the outcrop of this wonderful conglomerate belt, that it has thus far been found to be profitably workable, only to a very limited extent, beyond the limits of the Calumet and Hecla lines. That is, along the line of the outcrop of the lode, it has been found to carry copper only in the portion within this company's lines, except a small portion of the lode, of paying lode, that was cut off by the south line and was worked out by the Osceola company; and also the more recent good showing that has been made in the Centennial, the property lying next, on the north. Between the Osceola mine and the Centennial, measured along the line of the outcrop of the lode, the distance is about 13,500 feet, across sections 13, 14 and 23, T. 56, R. 33, and the richest portion of the lode is at about the center of this distance, and, as do all the copper contained portions of the lode, it extends northward as it goes downward; that is, it is not perpendicular to the strike of the formation, but makes an acute angle with it on the north side. Thus at the south end, the "Black Hills" "shoot" of copper, as the south end of the Calumet and Hecla mine is called, extended south into the Osceola company's land, but it inclined northward as it dipped down so that it was finally cut off by the boundary line, thus giving to the Osceola people only a triangular prism of productive deposit. The "Black Hills" or south Hecla mine has been largely worked of late; for two years, during the occurrence of the fires in the main mine, it became the chief source of supply for copper. The copper ground in the "Black Hills" is lower than it is in the body of the mine. Prior to the occurrence of the fire, when they were driven out of the old mine, only opening work had been done at the south end. Fortunately considerable ground has been made ready for stoping, and from this ground nearly alone, the normal production of copper was kept up. The Black Hills or south Hecla mine was opened by three shafts extending down about 1,000 feet, and the horizontal length of the mine was about 1,600 feet. It was separated from the Hecla mine proper by about half a mile of barren ground, in which several shafts, No. 4, 5, 6, 7, 8, had been started, but except the two first mentioned, had penetrated but a little way down, but more recently, since the mine has become extensively worked, Nos. 3, 6, 7 and 8, have been pushed down rapidly and the unproductive ground has given way to that which is good, probably the shaft, No. 6, the deepest, which is in excellent ground, has fully penetrated the "shoot" that outcrops further south, and which has been stoped from the surface down, in Nos. 9,10 and 11 shafts. The conglomerate, even within the bounds of the Calumet and Hecla lines, is not all rich.

There are bunches of barren ground in the bed—coarse, dark colored conglomerate and portions of sandstone that contain little or no copper. These portions of barren ground are sometimes extensive, as in the part just described between the "Black Hills" and Hecla mine near the surface. And again at the north end of the mine, at No. 5 shaft, the conglomerate was devoid of copper down to the thirty-third level; then it became rich and has continued to be so to the present depth, the 40th level; and all the levels going north below the thirty-third are in first-class copper-yielding conglomerate. There is a significance in this fact beyond its immediate value to the Calumet and Hecla mine. I mentioned on a previous page the Tamarack, Jr. This company owns three "forties," or a rectangle of land lying three-quarters of a mile north and south and a quarter of a mile in dimensions east and west. The land is 4,000 feet west from the line of the surface outcrop of the lode, and of the two shafts that were started from the surface to be sunk vertically to reach it, one of them has just pierced it 2,600 feet below the surface, and so far as shown up it is a good working lode. The Tamarack, Jr., shafts were started on the supposition that the land was in all

likelihood underlaid by the continuance of the rich conglomerate found in the lower level in No. 5 Calumet shaft, and the verity of the hypothesis seems to be realized. Nearly directly west of the Tamarack. Jr., shafts, half a mile, are the two north Tamarack shafts, which must penetrate to a depth of about 4,000 feet before the conglomerate is reached, but when this end is accomplished there is little doubt but very rich ground will be found. There is every reason to believe that the conglomerate belt continues to hold its place in the formation to a great depth, possibly beneath the waters of Lake Superior, and it is equally probable that the conglomerate will continue to be as well impregnated with copper at great depth as it is near the surface. So that to the Calumet and Hecla and to the Tamarack companies there is a great future. The former company holds the rich portion of the lode near the surface, but farther away the Tamarack has the advantage, since in time the underlay shafts of the Calumet and Hecla mine will go into Tamarack lands. If these lands westward to the lake contain the rich conglomerate, they contain untold wealth, which to obtain and realize is the problem. They must seek the copper at great depth, and how best to accomplish it will be the problem. However, there is nothing serious to apprehend in the mining problem of the future in this lode. The Tamarack Co. has already demonstrated that deep mining is no obstacle. With only one shaft, and that 2,500 feet down, through which depth everything must be lowered and every pound of rock or other matter must be raised, it has produced copper cheaper than any other company on Lake Superior and, I think, in the world. In 1889 the total cost per lb., including transportation and commission for selling in N. T., was but 6¼c., and in 1888 it was but 6c.

It is to this basis that ultimately all the estimates must come. The copper obtained must pay all the cost. And when the Tamarack Co. with only one shaft and that a half mile deep, and with but little opening made, can produce copper as cheaply or cheaper than does the Calumet & Hecla, it shows the advantage of its methods of mining, or rather the greater value of a vertical hoist as compared to an inclined one. Either shaft of the Tamarack could hoist a thousand tons of rock per day. They can send it to the surface, 3,000 feet, in less than a minute. Thus, the hoisting when brought to a vertical shaft is a small matter. The material is quickly whirled up to the surface and disposed of. The question will be to get the copper rock to the shaft to hoist. It is probable that future developments in electrical machinery will do much in this direction. No doubt but very soon much of the underground hoisting and tramming will be done by electrical motor power. Especially will it be important in deep mines like the Tamarack and Calumet & Hecla, where long tramming must result from extensive opening.

The Tamarack shafts Nos. 1 and 2 are already 3,000 feet deep and the conglomerate is dipping away from them more and more, and at the present depth of the shaft the conglomerate has receded to the west 900 feet and upwards. Through this space they must drift horizontally to reach the copper and through it also must the tramming be done to get the rock to the shaft. Of course this vertical sinking below the lode cannot go on indefinitely; auxiliary inclined shafts underground will have to be resorted to, and I think it is contemplated to sink down, parallel with the lode, in the foot wall in an amygdaloid belt, which has been encountered in the sinking and which is far enough away beneath the conglomerate to be secure. Short crosscuts will suffice from such a shaft to the conglomerate, and the rock can be thus hoisted up to the foot of the vertical shaft and thence to the surface.

The trouble with the Tamarack shafts, 1 and 2, is that the copper is all below the shafts. The shafts were so placed as to cut the lode at the highest point on the property, but in the case of the Tamarack, Jr., shafts, they are so placed as to give as much above the shafts as below, or nearly so. If the lode proves to be as rich as it is in No. 5 shaft, Calumet, in the Tamarack. Jr., it will be a very valuable property. It will produce a great deal of copper and produce it more cheaply than any company has ever done before.

Another enterprise in this remarkable copper bed must be mentioned, and that is the Centennial. The Centennial Co. owns Sec. 12, which lies north of the Calumet & Hecla and east of the Tamarack, Jr. The land is crossed by the outcrop of the Calumet & Hecla conglomerate and of course to the west of the outcrop is underlaid by it. Along the line of this outcrop some work was formerly done by an organization known as the Schoolcraft Co., but the conglomerate proved to be poor. It carried some copper, in places a fair amount of it, but as a whole the belt was too lean to pay and so the enterprise was a failure, through the fault of no one. But since the outcome of the operations of the Tamarack Co. and the results obtained in No. 5 Calumet shaft, as before explained, the question became mooted whether the conglomerate, although poor along the surface so far as tried, might not be a rich and paying lode at greater depth. The question was so pertinent and the facts seemed to point so strongly to an affirmative conclusion that it was determined to put the matter to the test, to solve the problem in the only possible way that a conclusive solution could be reached, that is to sink. Accordingly they are going down with a main shaft, down in the lode and propose to continue so doing until the limit of the property is reached or a paying portion of the lode is found.

The fact that the Calumet ground is found to be so rich in the bottom at the north end and that the drifts to the north, as far as they have extended them in the direction of the Centennial, continue well filled with copper and that the Tamarack, Jr., shaft situated west has reached the conglomerate and found it good, apparently, unquestionably place the Centennial upon a pretty good basis. Making the chances greatly in its favor, that they are destined to intercept paying ground in this shaft. But this is not all, it so happens that the matter has been put much further beyond the region of doubt as to the

ultimate favorable outcome, through the discovery of a fairly good copper yielding portion of the lode, further north, about midway of the vein between the northerly and southerly limits of the property. Here was encountered at the surface, on sinking through the dirt that covered the rock, a comparatively rich conglomerate, some of it as full of copper as any that can be seen in the Calumet & Hecla or Tamarack mines. This shaft, No. 6, was begun about a year ago and is now 360 feet deep and has cut much of the way very good ground—some of it very rich. They have drifted north from the shaft 300 feet in one level and have a vien eight feet wide and for more than half of the way in good paying lode. Lower down is a second, level north from the shaft that is driven in the lode 100 feet, and which is 10 or 12 feet wide and is very good stamp rock, this mine in this No. 6 shaft is looking so well and seems sure to furnish so much good stamp rock, that they are erecting a stamp head in the old mill and intend to supply sufficient rock to keep it going continually. By this means, no doubt, much of the cost of the exploring work will be met.

North of Centennial, at the Allouez, and still further on in the Seneca lands, the Calumet & Hecla conglomerate has been uncovered along the surface. But so far as tested it does not contain much copper. Away south at the Peninsula mine a long "crosscut" has been driven across the formation, from beneath in the mine, to find the Calumet & Hecla belt. But the test thus applied indicates that the conglomerate has disappeared as a distinct bed. With its usual characteristics, it could not be found.

It is wonderful the great value of this mineral deposit within the limits where it is rich. More than three-fourths of all the copper produced in Michigan mines is taken from this belt alone in the two mines at Red Jacket. There were six copper mines that paid dividends to the stockholders in 1890, which amounted in the aggregate to $3,090,000, of which amount $2,000,000 were paid by the Calumet & Hecla alone. The total dividends of these six companies to date amounts to the sum of $45,080,000, of which $34,850,000 must be credited to the Calumet & Hecla alone. The present value of these mines, according to the quoted market price of the stocks, is $38,000,000, of which sum $26,000,000 are due for the Calumet & Hecla. The others are valuable mines and have been and will continue to be profitable; but the Calumet & Hecla is so superlatively rich that it dwarfs the others in comparison. When the Tamarack shall have reached a productive point equal to its great neighbor, no doubt its showing will be even better, as it certainly will produce copper cheaper than the Calumet & Hecla does now. f

There are other conglomerate belts in the Keweenaw or upper Huronian formation, but only one of them has been worked for copper and this one has not thus far proved to be a paying lode. It lies northwest of the Calumet & Hecla belt, in other words overlies it at a distance, measured horizontally, of about 2,000 feet. Three important mines have been opened in this belt, to wit: the Peninsula, Allouez and the Conglomerate, the latter being in Keweenaw county, near the end of the peninsula, and is one of the oldest mining locations on Lake Superior, the name having been several times changed. The earlier mines, however, on this site, were worked in fissure veins which crossed the formation and produced copper in masses, but scarcely enough of the metal was found to make the enterprises self-supporting. Subsequently, eleven years ago, the Conglomerate belt, which immediately underlies the high greenstone bluff that constitutes the most prominent feature of the formation through Keweenaw county, was examined and some very rich conglomerate rock was found. The company organized at this time to operate in this lode, laid out for extensive operations. Nearly $1,000,000 were expended in opening the mine and providing machinery, stamp mill, railroad, erecting buildings, etc., all to no purpose, since the mine proved too poor to work with profit, and so, after the completion of the expensive and elaborate preparations, all operations ceased, and for six years past the mine has been wholly idle.

At some future time, no doubt, a more important mineral discovery may be made on this extensive estate that shall bring wealth to its fortunate possessors, redeeming its past disastrous financial history. In the meantime it is reported that negotiations are pending to extend the railroad that now reaches from the mine to Lac La Belle, where is the stamp mill, to Allouez to connect with the Calumet & Hancock R. R., thus making a complete line through the whole length of the Keweenaw peninsula and connection outside.

The purpose of this work, if it shall be consumated, is said to be to reach the stamp mill, so as to send the stamp rock from Tamarack, Jr., there to be manipulated. I do not know that anything of this kind will be done, but I hear it talked of and it seems to me to be a good plan.

Tamarack, Jr., will soon be a producing mine, the copper lode has been reached, and very soon rock can be supplied for the stamps; what better plan could be devised than to utilize the mill at Lac La Belle, which is one of the best on the lake and is well situated. The Allouez mine, on the southern border of Keweenaw county, is a large and well equipped mine opened in the same conglomerate, the mine and lode being named alike. It is a wide, coarse conglomerate, of which portions are rich enough to pay well for working, but too small a percentage of such ground has been found to meet the cost, and thus, though the mine has been operated through many years, frequent assessments have been necessary to make up what the sales of copper have failed to supply. The Peninsula, the third of the mines opened in the Allouez conglomerate, is also an old mine, formerly under another name, and then for many years idle. Like the others just described, it has some rich conglomerate, but either there is not enough that is rich or the mine is not opened extensively enough to supply the mill with rich rock and so leave the poor in the mine.

It is quite possible that both at the Peninsula and at the Allouez better results could be secured if the mines were more extensively worked; poor lodes, or deposits having very much poor ground and a little that is good, so that the good must be depended on to obtain any favorable outcome, should be extensively opened. Enough good ground must be found and made available for constant stoping and the worthless portion left standing in the mine. I don't think that there can be any other policy and be a successful one. With a rich lode like the Calumet & Hecla it is different; with this company the deposit is nearly all good and averages very rich. With lodes like the Allouez conglomerate, that appears, thus far, to average below the point for profitable working, the only possible hope can be to find enough ground that contains copper in paying quantity to obtain a good output. This can only be done by constantly exploring the ground and extending the "openings" so that none but such rich portions of the conglomerate as will pay for handling need be taken. This fact, however, is so well understood by milling men on the lake that it is no longer a subject for argument among them. It only happens that a mining company management, living in New York or elsewhere, who, not fully appreciating what those who have long been engaged in the work so well know, insist upon a restricted policy of operating, and who thus, by over-caution or misplaced economy, invite failure from the start.

It requires a good deal of money to open and fully equip a copper mine, on the modern plan, on Lake Superior, and when thus prepared it should be operated vigorously or not at all. Unless a company is prepared to put in a good deal of money, if necessary, so as to push the work to the utmost, assuming due economy and skill, it had better not begin at all.

I do not mean that the spending of a great deal of money and doing a vast amount of work in a Lake Superior copper mine are all that are required to make the mine successful. I only mean that if the indications are sufficiently favorable to make it worth while to operate at all, then it is best to work strongly and thoroughly. There are innumerable instances of failure of small copper mines on Lake Superior, and scarcely one where a mine has been worked on a limited scale has been a success. Ordinarily the copper lodes are only moderately rich; as the result of the most skillful working a low percentage of copper is obtained, even in those mines—with a few exceptions—that are made to pay. There are mines, which I have in my mind now, and which I have described and have stated in previous reports would pay well if operated on a sufficiently large scale, but which have been shut down and abandoned. Yet an examination of the mines and the percentage obtained from the rock at the stamp mill, the amount of copper obtained per fathom of ground stoped, and the percentage of the lode taken, to that rejected, etc., all show, in many instances, that the deposit is a good one, that the conditions are favorable, or can be made so, for operating a profitable mine. But a company with only one shaft, perhaps, working with hand drills and operating cornish stamps, must have ground as rich as the Calumet & Hecla to succeed at all. Powerful air compressors working air drills, high explosives, the most recent improved heavy mortars, plenty of water, all brought into the work with the greatest skill and economy and made to do their utmost, will even now make some idle mines that I wot of on Lake Superior, prosperous enterprises. The day of retail business in copper mining in Michigan has gone by. It has become a wholesale business and must be well conducted at that.

Besides the conglomerate belts there are numerous amygdaloid trap beds, some of which are well known copper bearing lodes and contain some of the best mines. The trappean range, which contains the copper mines, extends from the extremity of Keweenaw point southwesterly to the Montreal river, the southwestern boundary of the State. It is a long and narrow range rising to a general height of 600 ft. above Lake Superior, and in places, as at the extreme northeastern extremity, to upwards of 800 ft. and at the Porcupine Mts., south of the Ontonagon river, to 1,000 ft. in height. The range is made up of beds of both igneous and aqueous rocks, traps and conglomerates, and both contain copper. The variety of trap yielding copper is the amygdaloid. The range is no doubt the result of successive overflows and depositions. The conglomerate interbedded with the trap are made up of the fragments, more or less rounded and water worn, of the underlying trap. The amygdaloid trap belts, of course, run and dip with the formation, though they vary much in width, and are generally irregular. When an amygdaloid belt carries copper, especially if rich, it is soft and uniform in color and texture, very distinct in appearance from the trap beds inclosing it. It seldom happens that an amygdaloid deposit is uniformly impregnated with copper or that it all contains copper, even in small quantity. It is usually only portions of the deposit that are worth taking, "pockets" of amygdaloid, sometimes rich, and comprising more or less of the lode, generally scarcely half of it.

The amygdaloid beds furnish mostly stamp rock as do the conglomerates, but they also contain a much greater portion of "barrel work" and small mass copper. The amygdaloid mines can be to some extent, more cheaply worked than the conglomerate, for the reason that the rock is softer and thus more easily drilled and stamped. The wear on the shoes in stamping amygdaloid rock is almost nothing as compared to their wear in the mills crushing conglomerate. There are rich mines in amygdaloid, as well as very poor ones, and in some of the latter very extraordinary results have been obtained in mining work. I cannot find anywhere in the world so good record in mining work, as that shown by the copper mines of Michigan. It is marvelous, the skill, economy and and efficiency of their work.

The Osceola, a very large mine, hoisted in 1839, 208,299 tons of rock, of which 75,587 tons were sent to the mill, and the entire cost per ton, including all expenditures, was $2.21. At the Franklin, the total cost per ton of rock sent to the mill was $2.44. At the Quincy,

mining and stamping, cost per ton of rock, $2.87. At the Kearsage mine the total mining cost per ton of rock raised and treated was $2.49. At the Huron, the same year, the cost per ton of rock was $2.40. At the Atlantic the cost per ton was $1.53¼. These are all amygdaloid mines. The Tamarack, conglomerate, cost $3.00.

The foregoing figures include all expenses of mining, cost of the production of copper except smelting and selling the copper. It must be remembered that the mines are now very deep. The rock must be broken in the mine, hoisted to the surface, taken to the rock house, the good selected out and run through the breakers. Thence it goes by railroad to the stamp mill and must be pounded into fine mud under the ponderous mortars, carried by the streams of water through the washers and by the succession of complicated and effective manipulations finally separating the copper from the rock, which contains it and the entire work accomplished within the cost per ton of the figures above given. Of the mines above referred to the Atlantic shows the least cost per ton and at the same time its rock yields the least copper. The copper obtained from the rock in the several mines given are as follows:

Osceola,	25.82	lbs.	of	refined	copper	per	ton	of	rock	stamped.
Franklin,	30.68	"	"	"	"	"	"	"	"	"
Quincy,	54.38	"	"	"	"	"	"	"	"	"
Huron,	19.96	"	"	"	"	"	"	"	"	"
Kearsarge,	34.25	"	"	"	"	"	"	"	"	"
Tamarack,	65.21	"	"	"	"	"	"	"	"	"
Atlantic,	13.27	"	"	"	"	"	"	"	"	"

The Atlantic, it will be seen is seemingly much the poorest mine, in one sense it is so. Its rock yields much the smallest percentage of copper. And yet the Atlantic is a profitable mine; for many years it has not failed to pay a dividend to the stockholders. It has other advantages, however, that in some degree offset the low percentage of the rock and enable the company to mine and treat it correspondingly cheaper.

The favorable conditions are the uniform width of the lode, its regularity, the softness of the mineralized matter and the fact that the copper is distributed through it, all, so that none of it is rejected. Aside from this the mine and mill are well managed; but this is true of the others as well. The Atlantic can do its mining work much more cheaply than the others can because the lode is more regular, softer, and is uniformly charged with copper. The Atlantic rock yields but sixty-six hundredths of one per cent of ingot copper and it is a paying mine. Its dividend in 1890 was $100,000 and its total dividends to date amount to $610,000. So that it is plain to see that a one per cent rock under similar conditions as the Atlantic would be a rich mine. In fact they have come to understand that a one per cent rock is a good mine. The trouble is it is difficult to secure that. The Quincy is a very rich mine; but the high percentage given in the table above is due in part to the fact that the mine yields a good deal of "barrel work." There is more lump copper in the Quincy product than is found in any other mine on the lake. In 1861 the percentage of copper obtained was 2.55% and but for very few times since has the average for a year been below that, more frequently has the percentage of copper been 2.75 and upwards per cent. No other amygdaloid has been discovered so rich as the Pewabic lode, so called, in which is the Quincy mine; and nowhere else has this lode been found to be so well charged with copper as it is at the Quincy mine. Like the Calumet & Hecla conglomerate, which is so rich within a limited area, the Pewabic amygdaloid is in the same way wonderfully productive at the Quincy mine. The Pewabic and Franklin mines, lying close to the Quincy in the same lode, are also good; but not equally as rich as the Quincy. Further north, this lode has been examined for miles and many companies organized to work in it; but the vein did not prove rich enough to pay.

The Quincy mine is now in a very fortunate condition. Since to it is about to be added the Pewabic mine thus insuring to it an increased production and long life. The chief value of the Pewabic mine consisted in the fact that the company owned a quarter section of land lying west of the Quincy and Franklin and in which the Pewabic lode was so far below the surface as to lie under both mines. In fact the bottom workings of the two mines are stopped by the respective lines of this Pewabic estate and as along the lines of the Pewabic on two sides the ground is good it is thus known that the Pewabic has great value. The Pewabic company allowed its charter to lapse and according to the decisions of the courts the property had to be sold. It has just been purchased by the Quincy company for $800,000.

The Franklin mine, which has been very productive at the south and along on the Pewabic line is rapidly depleting of its best portion. The Franklin has plenty of land to the north but the lode becomes comparatively poor, hard and dry looking amygdaloid, quite different from the rich lode in the productive portions of the mine. There are other known copper bearing belts crossing the property and probably the company will crosscut from the mine and investigate them.

The Franklin is one of the best examples we have of the advantage of persevering, energetic management; a striking illustration of an old mine, almost abandoned, apparently ruined and worthless being brought to a first-class position, raised to the front rank and placed among the prosperous dividend paying mining enterprises. Its recent history is an instructive one and well worthy the study of any one interested in mining enterprises.

The Osceola is an amygdaloid mine that is second only in value to the Quincy. The lode is only about half as rich as the Quincy, but here the superiority ends and the Osceola looms up with a record that is one of the most creditable and inspiriting that our mining list, remarkable as the instances are, affords. The Osceola is not among the oldest of our copper mines. The company was organized in 1873, and then the purpose was to work in the Calumet & Hecla conglomerate, which had been discovered and found to be rich. Unfortunately, however, for the fortunes of the company, the productive portion of the conglomerate which the company possessed proved to be of limited extent. It was rich in copper close to the north line adjoining the Calumet &

Hecla boundary and continued so for a few hundred feet south when it became worthless. The lode bears north, 33° east, and dips about 37½° northwesterly so that it is plain to see that the vertical plane passing through the division line rapidly shortens the lode for the Osceola and lengthens it for the Calumet & Hecla.

A few years' work made it apparent to the Osceola people that they could see the full measure of their days unless some discovery could be speedily made to redeem their waning fortunes. Accordingly the amygdaloid deposit was found, lying about 800 feet to the east, and it was opened and developed and brought to a producing point with a rapidity that has been seldom paralleled.

The company, instead of going to the wall as at first seemed to be its fate, came to the front with a new mine. The work on the amygdaloid began in 1877, and now it is one of the most extensively opened mines on the lake. It is not a rich mine—if worked on a small scale it might be a poor one, and would be sure to be an unprofitable one. The Osceola is a successful, profitable mine, and the fact is greatly due to the enterprise and skill which have characterized its management. Of course there is good, workable ground, but it has to be found by driving through a great deal of poor. It is not an easy mine in which to push openings owing to the irregularity of the lode. It is full of perplexities—contorted and pockety. The rich bunches are separated often by long stretches of barren ground. But the mine is kept fully opened ahead, so that there is all the while an abundance of good stoping ground in sight to keep up the product.

The drifts follow the foot wall and are as crooked as a meadow stream, and in passing through them they seem frequently to be avenues through barren rock connecting the rich bunches of amygdaloid. These pockets of good ground take curious shapes, forming pipes and chimneys of rich rock extending through barren trap. The shafts go down on a uniform angle of inclination and are, owing to the irregularities of the lode, sometimes in the foot wall and again in the hanging. There is scarcely another mine with so irregular lode. The Osceola amygdaloid was richest at the north end adjoining the Calumet & Hecla, and as the levels grew shorter in that direction as the mine grew deeper, it began to seem that the mine would, after a while, become too poor to work; a condition that the policy of the Osceola management was not in accord with. And as the company owns the land in the line of the continuance of the deposit for a mile south, it was of course determined to ascertain the character of the lode in this direction, and there has seldom been an instance of such extensive exploring work as this has been; it has resulted very fortunately, and has assured the extension of the life of the Osceola mine indefinitely; increased its productive capacity and doubled its value. A shaft, designated as the Opechee, was sunk 1,450 feet south on the vein, of the most southerly shaft of the mine, and levels have been driven all this distance to connect, and this new ground from the 12th level down has been found to be workable, that is ground that it will pay to stope. The levels have been driven still further south, and the ground having been found to continue good, it is concluded to sink another shaft, No. 6, in that direction, far enough from No. 5 for mining, economy and convenience. The Osceola company has nearly a mile of length in the direction of the dip, so that both in depth and length the Osceola has ample dimensions for future work. As with the Calumet & Hecla conglomerate, the continued richness of which the Tamarack shaft has made known to us, so by the same agency we know that the Osceola amygdaloid remains unvaried in character to great depth, very far below the present bottom of the mine.

The deposit has been reached in both shafts of the Tamarack, 1 and 2, and found to be equally as good as it is in the Osceola mine. I myself obtained a rich piece of amygdaloid from the Osceola lode at a depth vertically below the surface of 3,000 feet in the Tamarack mine. It used to be a mooted question whether the copper lodes would be found to contain the metal at considerable depth. Years ago evidence seemed to be rather against their doing so, inasmuch as the Cliff, Minesota and National, which were very rich mines at first, but which when they became deep were found to be too poor to pay to work. The question of the continuance of the copper to great depth is at rest for the present. The Tamarack mine enables us to see that there is no change whatever in any of the lodes at a depth of 3,000 ft. They are the same as at near the surface. This is really a very important assurance. It tends to increase the confidence in the permanency of the mineral deposits of the copper region, and shows that whatever the forces were that secured the occurrence of the copper, they acted the same at great depth as at the surface. The conditions and forces acting must have been the same, regardless of depth, or else the copper must have been deposited before the tilting of the formation took place. The forces that deposited the copper were, no doubt, chemical and electrical. They are the only forces with which the same phenomena can be brought about that appear in the mines.

The other important amygdaloid copper lodes than those mentioned, which are worked at the present time, are the Isle Royal, Kearsarge and Ash Bed. The former takes its name from the company, which enjoys the distinction of being the first to commence operations at Portage Lake. The Isle Royal Co. having first worked on the Island of that name changed the scene of its operations to the south side of Portage Lake in 1852 and operated a mine in what became known thence forward as the Isle Royal lode. The Isle Royal mine has been idle many years; in fact the mine has not been operated on company account since 1870, and of the several mines, that following in the footsteps of the Isle Royal Co., soon after it began work also in that vicinity, in the same deposit, only one is now working, the Huron. Work at the Huron mine was begun in 1855 and was prosecuted intermittently until 1880, since which time it has gone, on steadily but not profitably. The mines in the Isle Royal lode have worked on too small a scale

and in too primitive a manner to be successful in so lean a deposit. The Huron is a well managed mine so far as its mine is concerned, every department of the work is thoroughly looked after, for it has for superintendent one of the most engertic and experienced mining men on the lake, who has given the mine close attention, but the company has met with some misfortunes in the way of loss of dam, destruction of stamp mill by fire, explosion of boilers, etc., which have added weight to the load that it already had to carry. Still the mine has kept working and I suppose hoping for better results, and it has always seemed that if the Huron were as well equipped as the Osceola with equally good facilities it could be made to pay. I base this supposition on my knowledge of the belt and of the company's statements of the yield of the rock.

The Isle Royal is a wide lode, full of masses and horses of trap. There is a great deal of hard, unproductive ground, but some good rock, and there are portions of the deposit that look extremely well. The prevailing mineral in the gangue is epidote, giving a greenish cast to the mineralized portions. The copper "makes" mainly along the foot, and fortunately a large percentage of the copper is barrel work. There are rich pockets in the lode, and one can well believe that efforts on a large scale would discover enough of them to make it pay. The Mabbs vein, so called, parallel to the Isle Royal, was worked in an early day, lately also, or ten years ago by the Grande Portage company, when I examined it and found it to be, I thought, a better vein than the Isle Royal.

The Kearsarge amygdaloid also takes its name from the company which is mining in it. The mine is located near the north line of the county— Houghton—and is owned or controlled by the same men who control the Osceola and Tamarack mines. They have adopted the course to fully explore the mine and to ascertain the capacities of the lode to produce copper before going to any expense further than what is requisite to perform this preliminary investigating work. In one respect the work has been very favorable. The company has made money. Enough copper has been obtained to pay for all the work that has been done. Within the past year a dividend of $80,000 was declared, and there is a large surplus besides. The mine as a whole has not turned out to be rich, but there is some rich ground and the lode is a soft one, easily worked, and they succeed in getting rock enough that carries a good percentage of copper to make the enterprise pay well. Of course, if they were to build a stamp mill, put in expensive machinery at the mine, etc., the surplus and a great deal more would be speedily absorbed. Before this is done, however, the company will know that the mine is rich enough and large enough to warrant the outgo. The men who control the Kearsarge seem to require that *all* their enterprises shall pay. Their mines are all profitable ones.

Just south of the Kearsarge is the Wolverine mine, which was opened ten years ago in the same amygaloid and afforded some very rich ground near the surface. But as a whole, after more extensive opening, the lode did not prove rich enough to pay, at least to pay according to the manner in which the work was done. The company failed and for several years the mine has been idle until now again other parties have taken hold of it, and intend to try and make a successful enterprise of it.

The representative mine in the "Ash Bed" is the Copper Falls, an old mine in the Keweenaw district. The Ash Bed, so called, is in the northerly slope of the range and is simply a bed of. soft, dark colored amygdaloid, that yields copper quite uniformly distributed. The Copper Falls mine originally was in a fissure vein called the Owl Creek, which yielded for a time, mass copper quite profusely. This fissure crosses the formation and of course cuts the successive beds of which it is composed, and among them the Ash Bed. The manner of working this Ash Bed is unique; formerly the "dirt" went to the surface through the shafts that descended from the top of the range, but ten years ago a tunnel was made, starting from the face of the hill on the west slope and following the Owl Creek vein into the mine. This horizontal tunnel intersects the mine in the ninth level and is, of course, at about right angles with it. The mine spreads away off to the east and the west of the adit, above and below it. At the mouth of the adit is the stamp mill, and the copper rock is brought to it through the tunnel in cars drawn by a tiny locomotive, which draws in the empty cars and hauls out the loaded ones. The main track is in the ninth level, and the cars are sent to the levels above or below on inclined tracks laid on the foot wall, which have an inclination of only 27° or 28° with the horizon. These tracks descending down the face of the lode correspond to underground shafts, only cars are run on the tracks instead of skips. There are two parallel tracks at each underground shaft, so that a descending empty car on one helps to draw up the loaded car on the other. The cars are filled at the stops, or in the same way that the tram cars are in any mine, and are pushed out to the incline and are sent up or down, as the case may be, to the main adit level where, when a sufficient number of them is accumulated for a train, the little locomotive hauls them out to the mill.

Another device in this mine is quite ingenious and effective, and that is the carrier for sending down the dirt from upper stopes to the pockets with shutes, that are placed along the main track of the level. The device is simply a wire rope stretched from the pocket to the stope on which is run a shieve that carries a scraper-shaped bucket, which is filled at the stope and run to the pocket, atomatically dumped, and run back again to the stope for another load. There are several other fissure veins besides the Owl Creek, but they do not carry copper. At all of these veins the formation is faulted about 25 feet, but there does not appear to be any change otherwise. The Ash Bed is a very regular formation, remarkably so. The foot and hanging walls are smooth, and the latter is fortunately exceedingly firm, so that very large spaces are left wholly unsupported; but the roof does not thereby show any disposition to fall. This firmness of the hanging wall in the Ash Bed is strongly in contrast with the hanging in the Tamarack and Calumet & Hecla

mines, where nearly every portion of it must be supported with timbers. The timbers are placed all through the mine, in the Tamarack, in rows only about the thickness of the timbers apart, the necessity arising from the fact that the hanging is fractured, and pieces will drop out as soon as the conglomerate is all taken away. Sometimes there is sandstone or poor conglomerate along on the hanging which may be left to help keep the trap in place.

The drawbacks in mining the Ash Bed to a profit are the flatness of the lode, the soft amygdaloid becomes, when broken up from the stope, much of it, like brown dirt, and will not, of itself, slide down the wall. It has to be shovelled down, which adds to the cost.

This would not matter so greatly if the lode were richer. Of late years the average percentage of copper obtained from the rock has been exceedingly low, lower than that of any other mine on the lake. It used to be estimated at about one per cent. If it were one per cent rock the Copper Falls would pay. In the upper levels the rock was richer, and now it is said to be showing exceedingly well again, some very rich ground having been encountered in the recent opening work. Of late years only about two-thirds of the lode has been found to be worth stoping and this even, has given only twelve or thirteen pounds of refined copper to the ton of rock, equal to about sixty-five ten thousandths per cent. A pretty discouraging outlook under the circumstances. But if the Ash Bed were double its present width, fourteen feet wide instead of seven or eight feet, and dipped at a high angle, so that the dirt would slide down from the stope to the level by the force of gravity, even then, poor as the lode is, it would pay to work. And in addition, if the lode carried one per cent of copper, it would then be a very valuable mine. As it is, the mine about pays its own way.

The work is very cheaply done. The total cost per ton of rock, inclusive of stamping, that is, all cost connected with the mine and stamp mill, is but $1.25. The total mining cost being but $1.00 per ton, and stamping 25 cents per ton.

The Ash Bed in the Copper Falls mine is opened about 1,500 feet in depth, or seventeen levels, and the levels extend west from the adit an extreme distance of 1,400 feet.

For a few years past considerable exploring has been done in the Owl Creek vein—the old fissure that was once so rich a mine. They have drifted south from the Ash Bed in the ninth level about 1,000 feet, and have cut amygdaloid lodes, but none better than the Ash Bed. The Copper Falls mine, in the fissure vein, was many years ago very productive. I have heard it stated by some of the most reliable miners on the lake, who worked in all the old mines in an early day, that they had seen more copper at one time in the Copper Falls mine than they had ever seen in any other mine. Through several levels the vein was almost solid copper. In those palmy days of the Copper Falls the mine yielded a good deal of silver also; native silver, occasionally, quite large masses of it. Most beautiful specimens of crystalized silver and crystalized copper have been found in the Copper Falls mine. The finest crystals of these metals I have ever seen were taken from this mine. In an early day, perhaps more than now, the silver which was discovered in the mines was appropriated by the miners. When they discovered a "vug" or other deposit of silver they would conceal the fact until opportunity was afforded to remove the metal, which was sold to dealers who were always ready to buy it. One man has told me that himself and three others secured $800 worth of silver at one time in the old Cliff mine.

With few exceptions all the mines of Keweenaw county were in fissure veins crossing the formation. Some of them were large producers, and two at least proved to be very profitable. The fissure veins crossing the formation and carrying copper, are confined to Keweenaw county, or to the northerly portion of the copper range. Elsewhere, except in the northeast thirty miles of the range, the copper occurs in beds; or, if in a vein, as at the Minesota, the vein runs with the formation. These veins gave only copper in the form of masses. The stamp rock was little regarded when the great mass mines, as the Cliff, Minesota, National, etc., were worked. The facilities for stamping were very meagre, but the mines were very rich in masses. No mines ever discovered in the State have been so rich as were the Cliff and Minesota. During the years of their greatest productiveness they gave in the best portions far more copper to the fathom of ground stoped than any mines that have been worked since. Portions of the Minesota mine, as well as the Cliff, contained a succession of masses of copper, so that nearly the only work necessary was to cut them up and hoist them to the surface. The greatest phenomenon in native copper that, probably, the world has ever seen was discovered in the Minesota mine in 1857, a compact mass of pure copper weighing 500 tons was found.

The Minesota vein lies between a belt of conglomerate and one of trap, and the vein matter frequently intruded into the conglomerate. I think, from all I can gather, that the conglomerate belt did not then, as it certainly does not now, carry copper of itself. It is in this respect unlike the Calumet & Hecla conglomerate, for instance, which has the copper distributed through it as part of the make-up of the belt per se.

The conglomerate which underlies the vein in the Minesota held vein matter only in cracks and fissures. Like a plastered wall, which should contain frequent cracks and holes that a subsequent coat of some other material spread over the surface should fill, so the vein matter and copper which accompany it seem to be contained in the conglomerate. They were in the conglomerate, but not a part of it. The superlatively rich ground in the Minesota mine was along the line of junction of the main vein, the one lying in the conglomerate and a "counter" vein or a vein that penetrated through the overlying trap. In this ground

where the union of the veins occurred were found the great masses of copper. The great 500 ton mass that was found nestled with innumerable other masses, was a smooth, compact body 46 feet long, 8½ feet maximum thickness, 18½ feet in width; its average width being 12½ feet and its average thickness 4 feet.

All that the Minesota mine ever cost the stockholders was $66,000, and they received back in dividends $1,920,000. The Old Cliff company paid out in the aggregate the sum of $110,000, and got back in dividends $2,227,660. But these mines, and others as well, that were so very rich for a time, ceased to yield copper in paying quantities and were finally abandoned. They have not been worked for many years. Why they should become poor simply as depth is attained it is impossible to show.

We see that the mere matter of depth has nothing to do with it, since other great mines, as before mentioned, in conglomerate and amygdaloid deposits do not show any change; and the Central, a fissure vein mine, not far from the Cliff, is twice its depth, and is still a good mine. The Old Cliff vein cut several amygdaloid beds, which gave more or less copper contiguous to the vein. One of these beds especially was good, noticeably so there, since stamp rock was not looked for. It would seem very desirable if this amygdaloid could be drifted in; it might develop a valuable mining deposit. No doubt the mine will undergo a thorough examination some time, and as there was once so much copper found, it would not be surprising if again it should be a great producer. There are other veins, some of which may hold copper in abundance. These can be found and proved best perhaps by drifting with the formation. Sink to an apparently good amygdaloid and then drift in it, and in that way there is a possibility of intercepting a good cross vein.

The Central Mining Co., has been pursuing this plan for several years past. The company have been driving from the mine northwesterly, following a conglomerate, which occupies the relative position of the Calumet and Hecla. They have reached the North Western vein, which is 1,700 feet away from the mine. It is hoped that the North Western, which was one of the veins earliest worked on Lake Superior, will be found to be rich in copper at the depth which the drift strikes it. The company has recently commenced drifting on the vein, and though I have not yet seen it, I am told that it is looking fairly well. The Central company owns the old North Western mining property, which is also crossed by the celebrated Owl Creek vein of the Copper Falls Co. Very likely the Central company will drift to discover this vein and test its productive value.

The Central is one of the deepest mines in the State, being 3,000 feet vertically down. It is not a large mine since the lower levels are only 600 to 800 feet in length. The shaft is in a "shoot" of good copper vein, and not much of value has been found beyond the limits of this "shoot." Sometimes the vein is but a mere trace, but where it contains copper it spreads out to several feet in width. The product has been mainly masses. It is one of the oldest mines and has been continuously operated since the vein was discovered in 1854. It is rare that a business enterprise can show a better record than the Central mine. All the money the stockholders ever advanced was $100,000, and they have received back for this outlay in the form of dividends, $1,950,000. The total expenditures have been, in round numbers, $7,000,000, all of which money, has been furnished by the sales of copper. In 1863 the first dividend was paid of $2.50 per share, and annually, every year since, a dividend has followed.

The Central is the only fissure vein copper mine that is now working in the State. Its discovery was the outcome of efforts made by parties working at the Cliff mine, and is credited to John Robingson and a party of men who were working under the direction of John Slawson, agent of that company. At that early day the explorers had learned to recognize the depressions due to the work of the "prehistoric miners," and it was by cleaning out one of the "ancient pits," that a mass of copper was found in a well defined vein. It proved a valuable discovery.

In the early days of mining in Keweenaw and Ontonagon counties, the wonderful occurrence of the great masses that were found in such quantity at the Cliff and the Minesota mines, stimulated mining enterprise in an extraordinary degree, and eager was the search for similar deposits. Along the face of the great Greenstone bluff, in Keweenaw, many fissures were traced and sanguine discoverers no doubt hoped to rival the great bonanzas.

But barely one among the score or more viens that were found and worked—some of them extensively—proved to be a profitable mine. When the mass of copper was found by the diligent workmen in the old "Indian pit," there was nothing to assure that the vein thus discovered had greater value than the many others that at the outset appeared to be equally promising. There are numberless mines in Keweenaw that have been abandoned for a quarter of a century but date their origin with that of the Central. The Central is the only one in the Keweenaw district, after the Cliff, that has not been a loss to its owners. These two alone made rich returns. They enable us to know that such do exist and the expectation of finding similar stores of wealth will ever stimulate to renewed search and expenditures. Mining men have faith in the future of Keweenaw county, and a mineral discovery of permanent value would suddenly give an old time impetus to effort in that interesting district.

In the Ontonagon district the only mines that ever paid any dividends are the Minesota and National, contiguous mines and working in the same vein. There are an almost endless number of old mines that were worked many years ago—in the "'50's"—but none of them were profitable enough to insure a very long life. They have since been operated more or less on tribute.

The mines in the Evergreen range, the Mass, Knowlton, Ridge, Adventure, etc., all small mines, but really very good mines, have been worked; some of them quite a little on company account and a good showing made, all things considered. The Evergreen range, so called, is thoroughly copper bearing. The Knowlton vein is a good one and it is likely that there may be others even better. We have found that the mineral-bearing lodes are not equally charged with copper everywhere; that they are poor in one place or in many places, does not determine that they may not be rich somewhere and *vice versa*. There are many miles of the copper range between Portage Lake and the Fire Steel river that have been but little explored. To all outward appearance there is no more promising portion of the range than this. It is regarded as a section of vast possibilities.

Only recently, during the past summer, Mr. Jay A. Hubbell has done some exploring at an old mining location, the Winona, which was explored slightly in 1864 and a few years thereafter; Mr. Hubbell's work indicates almost to a certainty that the property holds a first rate amygdaloid deposit, that would surely pay to work. This I was told by a conservative mining superintendent recently, who saw the pits and shaft in the fall, before they were allowed to fill with water. The location is N. W. ¼ Sec. 29, T. 52, N. R. 36 W. The difficulty with this part of the range is its inaccessibility. It is a long way from Portage Lake and a long distance from Ontonagon. It is contemplated to build a railroad along this part of the range from Houghton south; such a thoroughfare would be of much advantage in many ways.

The National Mining Co. has within the past year pumped the water out of the mine and proposes to explore the old conglomerate vine, which in former times gave both to that company and to the Minesota the abundance of copper which they obtained. For several years the National Company has been exploring a parallel amygdaloid belt, but it did not prove to be rich enough to pay to work and now they are going to try their fortunes in the conglomerate vein, and it must be regarded as a wise thing to do, since they have the machinery and other facilities for pushing forward the work after the modern plan, and certainly a vein that was once so very productive may yet again be found to be equally so. It is not uncommon to find lean places in the mineral lode. In fact it is always the case in the Michigan copper mines that more or less of the lode is worthless and generally the percentage of ground that holds copper in paying quantity is less than that which does not. So the National-Minesota conglomerate vein, may be as rich somewhere further down as it was in the upper lode years ago.

Somewhat of a set back was given to the mining interests of Ontonagon county eight years ago by two enterprises that had a disastrous termination. They were the Belt and the Nonesuch mines. The former is an English company that purchased three abandoned, contiguous mines and organized the Belt Copper Co., Limited, to operate them. Most extraordinary statements were made by the mining engineers sent out to examine and report on this property, and much money was secured and expended but not much copper was found. At the end of two years all work on the location came to a standstill and has not been since resumed. The other enterprise—the Nonesuch—is a mine in the Porcupine Mountain range, a sandstone belt inclosed in slate. The sandstone in the upper levels at the Nonesuch are apparently richly impregnated with copper, but the richness was more apparent than real, since the copper is in fine, thin scales, that are very light—very showy but having little weight.

Capt. Thomas Hooper was working the mine on a lease. He was operating in a limited, economical way and getting good results. Capitalists took hold of it, bought out Capt. Hooper and commenced to operate on a large scale; that is, the company expended a great deal of money in preparing to operate on a large scale, but never operated. When the preparations were complete it was decided to quit and the location was abandoned utterly. Nearly or quite $500,000 were expended by the company for which there was no return. The plan was to crush the rock and wash it to about 20% copper and run it into vats containing chloride of sodium, having the bottoms of the tanks covered with old railroad iron. The solution being kept to 200° Fahrenheit, the copper held in suspension would be precipitated upon the iron to be scraped off and put into barrels. I fully described this undertaking, as well as that of the Belt, in the Commissioner's Report of 1882.

It is pleasant to note that there is a little silver lining to the somber cloud, which just now overhangs the mining interests of Michigan. The remarkable depression which unfortunately prevails in the iron business has not so seriously affected the copper mines. They are certainly in a fairly prosperous condition now, and have just completed one of the most profitable years in the history of copper mining on the lake. The reaction which had taken place in the price of copper and of copper mining stocks before the close of the year 1889, continued all through 1890 and still in the beginning of 1891; although there is a little falling off in price and in demand for copper, the outlook is very favorable. It is reasonably certain that for the current year, and probably for a much longer period, the price of copper will be greater than the mining companies hoped for after the failure of the syndicate. How little the future can be foreseen in these matters is shown in the fact that the strongest mining companies entered into the agreement with the French syndicate to fix the price of copper in the world's markets, and agreed to take 13½ cents per pound for the metal. They esteemed this price so large as to be a sufficient temptation to justify the creation of the abnormal trust to handle the copper.

When the syndicate failed it was generally apprehended by mining men that the price of copper would fall below the cost of production, except by the largest and most favored mines. Meetings were held in France and

London, attended by American producers and large foreign holders and producers of copper to arrange for the amount to be put upon the market, so that the price should not be suffered to fall too low. Failing to agree, matters took their own course, and great was the apprehension felt among those deeply interested. It was prophesied that nine or ten cents must be looked for as the coming price of copper, and mines must adjust their affairs accordingly. But, left to itself, the market adjusted to a much better basis than when subject to the unnatural forcing and antagonizing process adopted by the syndicate. Very soon a better feeling began to prevail, confidence was restored. The antagonism of the manufacturers ceased and their retaliatory measures of restricting consumption, gave place to heavy purchases of metal. The surplus speedily began to shrink and the mines to meet the demand for metal put on all force and pushed their production to the utmost. Mining shares were in the ascendant and they soon recovered all that they had lost of market value, following the downfall of the syndicate. The year opened with the average price of copper in New York in January at $14^{4}/_{5}$ cents and closed with an average price in December of $15^{9}/_{10}$ cents, the average price for the whole year being 15¾ cents per pound.

In September and October the price reached 17 cents.

The prices of the stocks of the producing mines seemed to reach their maximum in midsummer; as, for instance, the Tamarack, which advanced from $160 per share in January to $227 in June and July; Quincy, from $75 to $132 in the same period. It is quite possible that the subsequent falling off in price of the metal and of the stocks was due to the sudden stringency in the money market, affecting all industries and especially all stocks, rather than to any over-production or otherwise falling off in demand; that is, that the decrease in demand was only the result of inability all around to pay. Europe has had a serious financial crisis, and all industries were greatly affected, and that the price of copper and of copper stocks has withstood so well shows how firmly the metal is fixed as a necessity in the present material progress of the world. The advent of electricity as a motor and illuminating power, has created a great and rapidly increasing use for copper wire, and as the pure native metal from the Michigan mines has far greater tensile strength and is a far better conductor of electricity than any other copper in the world. It thus has a primary advantage in the world's markets in this new field for its uses.

More and more, it is likely that electricity will be employed to do the labor and lighting of the world, to move its machinery and illuminate its cities, its mines and dwellings and manufactories.

Into this new and important field electricity enters as a chief agent. Coal, petroleum and gas shrink away from the competition, and gradually, no doubt, this newly understood power which so far transcends them all, will also supersede them.

It is for these reasons: The superiority of Michigan copper over all others, and the discovery of this new field for its uses, that lead to the conclusion that the price of copper, notwithstanding the increase of production, is pretty sure to remain at a high figure. It is not likely to fall below the point of profitable production for every Michigan copper mine now working.

The fact that all the copper produced is smelted right there in the copper district, is an important one, and further, the establishment of a copper rolling mill is a move in the right direction. It is of great benefit to the country to not only produce the raw copper, but to work it up into wire and sheets, as far as possible. It gives employment to labor, builds up the towns and brings money and business into the region.

Lake Linden is now a busy, pleasant town. It is surprising to find a so substantial, well built village, with so many evidences of wealth and prosperity. The shores of Torch Lake are lined with stamp mills, smelting works, dwellings and the various structures devoted to industry and habitation.

Not many years ago I heard it said by a prominent railroad and mining man, that there would never be a railroad built to Houghton, or to any other point in the copper country from the "outside," for the reason that copper mining, he said, did not furnish business for a railroad. Unlike the iron country, that required that the ore be carried to the lake ports for shipment, the extension of the M. H. & O. R. R. to L'Anse, was for the purpose of earning the grant of lands, open up an iron mining section, as it was supposed, and provide for carrying ore to L'Anse, at the head of Keweenaw bay. In point of fact, the mines on the line of this extension have not greatly prospered, and the ore dock that was built, has gone into disuse, no ore going from the mines in that direction. But the road did not terminate permanently at L'Anse, it was extended to Houghton and there connects with two narrow guage railroads running to Calumet, Lake Linden, and other points in the Portage Lake copper district. The accessibility, society, and the possession, in a high degree, of all those things that go to make up the comforts of modern life so fully found now in the copper district at Portage Lake, are in great contrast to the corresponding conditions of the pioneer days, or even down to quite recent days, before the advent of the railroad, when during some portions of the year there was no way of getting into or out of the country, or about in it, except on foot. In summer, communication outside, was made by vessel, and in winter, when snow had fallen, then, for several months, communication was comparatively easy. There were no summer roads suitable for vehicles, extending outside the country, and those within were generally poor and of course impassable for quite a period during the break up in the spring. Going back to the earliest days of mining in the copper region of Lake Superior, the country was practically, in that day, one of the most isolated of the whole nation; other regions may have been farther away from civilization, but the Lake Superior country was wild

and rough and cold. It was on the line of no thoroughfare. It was away off in the frigid north by itself. To reach there, one must undertake a long and difficult journey, and to get away was equally difficult. The attractions for such a toilsome accomplishment were meager indeed, assured privation and uncertain reward. There were brave, stalwart, able men among those early pioneers, and though they endured much, life with them was not without its compensations, and reminiscences now of that olden time, are to the survivors, a pleasant pastime. Unfortunately for neighborly intercourse, the mining districts in the early times were far apart, all in Keweenaw county and Ontonagon county, separated by seventy miles of wilderness, through which was no road, or scarcely a trail or settler. Men making the journey must carry food with them and make provision for sleeping out all night; nevertheless the journey was frequently made by men in either district, anxious to see their friends or the mines in the other end of the range. In the summer boats would be going occasionally along the coast, and would make stops at Eagle Harbor and Ontonagon, so that men could thus make the trip. Later, when mining began at Portage Lake, men making the journey by land would try and reach a mining location at that point the first day, and make the end of their journey on the following one. Of course intercourse between sections so far apart, and when visiting was attended with so much difficulty, could not be frequent, but when made the visit was thoroughly enjoyed. When an important arrival from Ontonagon, for instance, was announced at Eagle Harbor, down in Keweenaw, everyone at all the mining localities united to do him honor. "The latch string hung out" at every house, and the visitor had only to enter in and partake. A gentleman, now a wealthy and influential citizen of Marquette, who was among the earliest to settle there, related to me recently the story of a visit that he made to Eagle River forty years ago. Eagle River was at that time the county seat of the entire region and he went there afoot and alone, in the winter, for some records at the clerk's office. He expected to get away in a day or two, but found that such haste did not accord with the ideas of hospitality entertained by the people who constituted themselves his hosts. He was informed that his papers could not be ready under two weeks, and that in the meantime he must consider himself as the guest of the community. He was taken to the store and requested to select an entire new outfit of clothing, the best that the store afforded, so that he would be ready for the balls that would be given in his honor.

A full round of pleasure followed until the time of departure when he was requested to select from the stock in the store some article as a souvenir of his visit. He took two cans of cove oysters. Being young, with an appetite, and from New England, the oysters were a rarity that seemed to him preferable to anything else. It so happened that his choice was a fortunate one, as the sequel proved, for expecting to make the first day the Catholic mission at Baraga, he encountered a storm and lost his way and was out all night, and the oysters were his only food.

Lake Superior is a very cold country; the winters are long and severe. The snows become deep and travel is frequently difficult; but the early trials which the pioneers had to endure, and the extreme isolation of the region drew the hearts of the people closely together. They ever had warm hearts and warm firesides, and hospitality and friendship everywhere abounded.

The primitive days for copper mining there have long gone by. It is no longer an isolated, dependent region. It is accessible by boats in summer and by lines of railway at all seasons; telegraphic lines give instant communication with all parts of the world. The reputation of its great mines and the wonderful skill and boldness shown in their mining work, are world wide. It is a region of great prosperity and of great natural wealth. Its resources are abundant and permanent, and thus its future is assured. It has good society, well graded and thorough public schools; a new technical mining school, that already ranks first, of its kind, in the nation; rapidly growing towns with industrious, law abiding population. In all there is no portion of Michigan, it seems to me, that has a brighter future than the copper district of Portage Lake.

The question is sometimes asked me if there is not a tendency to increase in heat as the mine increases in depth. I find no cause for apprehension on this score. However deeply the mines may penetrate into the earth, a proper arrangement for ventilation will secure as good air in the deepest mines as will be found in the shallow ones. The rocks themselves show no increase of temperature as great depth is attained.

The following statistics regarding Michigan copper mines are of value:

Production of Michigan Copper Mines.

Name of Mine.	Product 1890.		Total product to date.	
	Tons.	Pounds.	Tons.	Pounds.
Atlantic	1,800	1,973	25,509	1,047
Allouez	708	1,829	12,131	1,576
Adventure	10	849	599	1,821
Arcadian	17	37	34	1,006
Calumet & Hecla	29,934	106	336,447	1,673
Central	706	1,201	22,847	1,006
Copper Falls	237	1,390	11,067	449
Evergreen Bluff	7	1,304	715	1,917
Franklin	2,819	112	34,560	241
Hilton	9	642	61	1,688
Huron	803	777	11,320	756
Knowlton	11	1,145	235	1,138
Kearsarge	709	1,050	2,188	1,180
National	38	1,470	5,750	1,963
Osceola	2,647	1,584	27,960	245
Lac La Belle	1	1,490	2,636	193
Mass	10		2,506	1,730
Peninsula	554	660	2,466	238
Quincy	4,032	258	57,173	416
Ridge	10	1,490	2,641	483
Tamarack	5,063	1,483	21,877	1,942
Total	50,303	1,051	580,870	805
Grand total of the aggregate copper production of Michigan			663,899	1,439

Total value of Michigan copper production in 1890 at 15 3-4 cents per pound, the average price for the year, in N. Y. = $15,845,427.28.

Average price per pound of lake copper at New York.

Year..	1860	1861	1862	1863	1864	1865	1866	1867	1868	1869	1870	1871	1872	1873	1874	1875
	22½	19½	25¾	32¾	46¼	36¼	33¾	23½	23¾	23½	20¾	22¾	33	29	23¾	22½
Year.....	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890	
	21	18¾	16¾	17½	20¼	18½	18½	15¾	13¾	11½	11	11½	16¾	13¾	15¾	

Average price for each month in the year 1890 was as follows.

Jan. cts.	Feb. cts.	Mar. cts.	Apr. cts.	May. cts.	June. cts.	July. cts.	Aug. cts.	Sept. cts.	Oct. cts.	Nov. cts.	Dec. cts.	Year. cts.
16 4-5	14½	14½	14 2-5	15½	16	16 4-5	15 2-5	17	16 9-10	16 4-5	15 9-10	15 3-4

FLUCTUATIONS OF PRICES OF COPPER MINING STOCKS IN BOSTON DURING 1890.

Name and Location of Company.	Par value.	January.		February.		March.		April.		May.		June.	
		H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.
Allouez, Mich.	25	2.00	1.25	2.50	1.75	3.50	2.38	4.00	3.00	7.25	3.88	9.75	6.00
Arnold, Mich.	25			.50	.17	.40	.30	.43	.30	1.00	.43	2.50	.90
Atlantic, Mich.	25	16.13	13.50	14.00	12.50	14.00	13.00	16.00	13.50	24.00	16.00	28.00	22.00
Aztec, Mich.	25	.10	.09	.10	.07	.10	.07	.09	.08	.22	.08	.75	.22
Cal. & Hec., Mich.	25	271.00	240.00	260.00	253.00	260.00	258.00	280.00	253.00	315.00	281.00	323.00	308.00
Centennial, Mich.				28.00	24.00	25.00	19.00	25.75	18.00	46.50	24.00	40.25	37.00
Central, Mich.	25			13.00		8.00		10.00	8.00	12.50	13.75	34.00	24.50
Copper Falls, Mich.									.25	9.88	5.00	11.00	9.88
Dana, Mich.		.35	.20									.50	.25
Hanover, Mich.		.25	.20									.60	.30
Mesnard, Mich.	25	.50	.45	.75	.35	.38	.35	.50	.33	1.13	.50	1.15	.90
Humboldt, Mich.	25	.20	.12	.15	.12	.12	.12	.15	.10	.28	.12	.70	.25
Hungarian, Mich.	25	.20		.17	.15	.15		.15		.30	.05	.60	.40
Huron, Mich.	25	4.50	3.50	4.25	3.00	3.63	3.50	3.75	3.13	7.00	3.00	6.25	2.75
Kearsarge, Mich.	25	10.00	7.75	10.88	9.25	13.00	8.75	15.63	11.25	25.00	13.50	29.50	20.00
National, Mich.	25	2.88	2.50	2.00		1.75	1.50	2.50	1.25	5.00	1.50	3.50	2.00
Native, Mich.		.35				.07	.06	.07	.05	.30	.07	.35	.25
Osceola, Mich.	25	31.00	30.50	29.00	25.50	30.50	26.00	32.25	27.25	41.00	32.25	48.38	38.50
Pewabic, Mich.	25	9.75	7.00	9.75	8.50	8.25		9.00		10.00	8.00	12.50	9.50
Pontiac, Mich.	25	.38	.30	.25	.20	.28	.25			.60	.32	.70	.45
Quincy, Mich.	25	75.00	60.00	71.00	70.00	72.00	68.00	85.00	72.00	105.00	85.00	132.50	108.00
Ridge, Mich.	25	1.25	.75	1.05	1.03	1.13		1.13	1.00	2.00	1.00	2.00	1.38
Rockland, Mich.										.75		.80	
South Side, Mich.	25	.32	.30	.28	.20	.18	.15	.15	.12	.28	.18	.38	.28
Star, Mich.		.38								.60	.32	.48	.25
St. Louis, Mich.												.50	
Tamarack, Mich.	25	160.00	149.00	163.00	156.00	160.00	156.00	178.00	159.00	190½	173.00	227.00	197.00
Tecumseh, Mich.												.40	
Washington, Mich.	25	.28	23½	.30	.18	.15		.15	.14	.35	.20	.65	.28
Winthrop, Mich.												.40	.15

FLUCTUATIONS OF PRICES OF MINING STOCKS—*Continued.*

Name and Location of Company.	July.		August.		September.		October.		November.		December.		Sales.
	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.	L.	
Allouez, Mich.	10.25	8.50	9.50	7.50	9.50	5.50	7.00	4.13	6.00	4.25	4.50	3.00	216,199
Arnold, Mich.	3.00	1.68	2.25	1.50	2.00	1.50	1.50		1.05				74,412
Atlantic, Mich.	28.00	22.00	25.50	20.00	25.00	18.75	22.50	16.50	18.00	14.00	17.00	15.00	68,239
Aztec, Mich.	.43	.32	.40	.27									
Cal. & Hec., Mich.	316.00	294.00	310.00	295.00	310.00	295.00	309.50	275.00	280.00	259.00	275.00	240.00	13,013
Centennial, Mich.	39.50	32.00	34.50	21.00	30.00	21.00	24.00	15.00	16.50	12.00	21.00	12.25	112,952
Central, Mich.	20.00		24.00		25.00	24.00	30.00		19.00	18.00			4,434
Copper Falls, Mich.	11.50	11.00					6.00						4,800
Dana, Mich.	.45	.40	.60	.35	.43	.35							1,650
Hanover, Mich.			.38		.35	.28							18,400
Mesnard, Mich.	1.00		.80										8,375
Humboldt, Mich.	.65	.45	.61	.50	.63	.55							18,100
Hungarian, Mich.	.60	.52½	.60	.45	.43	.40	.25						15,000
Huron, Mich.	9.25	2.75	8.50	6.75	8.13	5.38	5.50	4.75	5.00	3.50	4.00	3.50	136,280
Kearsarge, Mich.	24.50	21.00	24.50	18.00	20.25	15.00	19.00	12.00	15.00	10.50	14.50	9.00	221,800
National, Mich.	2.50	1.75	2.38	1.88	2.88	2.00	1.75	1.32	1.75	1.25	3.25	2.00	36,202
Native, Mich.	.30	.25	.30	.21	.24	.20			.16				38,920
Osceola, Mich.	47.88	43.25	46.00	38.00	46.25	40.00	43.50	35.00	37.00	30.00	36.00	31.00	171,696
Pewabic, Mich.	10.00				14.00		14.50				10.00		7,025
Pontiac, Mich.	.55		.58	.45	.43	.38							18,250
Quincy, Mich.	131.00	120.00	130.00	123.00	130.00	115.00	117.00	90.00	102.00	75.00	95.00	81.00	19,099
Ridge, Mich.	1.50	1.38	1.25	1.00	1.38	1.00	1.25	.63	.88	.75			21,975
Rockland, Mich.													100
South Side, Mich.	.38	.28	.37	.25	.25								16,000
Star, Mich.	.40	.30	.38	.35	.40	.30							6,900
St. Louis, Mich.													100
Tamarack, Mich.	227.00	205.00	218.00	205.00	218.00	185.00	185.00	153.00	161.00	142.50	157.00	123.00	14,881
Tecumseh, Mich.	9.00	5.00	4.50	3.13	4.50	4.00	2.50	2.00	2.50	1.50	2.00		4,000
Washington, Mich.	.60	.45	.48	.30	.38	.33							29,860
Winthrop, Mich.	.35				.20								1,300

Only one copper mine in the State has made an assessment upon its capital stock in the past year, the Allouez $2.50 per share = $40,000. Making a total of its assessments to date $1,360,000.

*Copper production of Arizona, 1890.	Pounds.
Copper Queen	9,408,000
Holbrook & Cave	3,047,310
Old Dominion	1,782,190
Arizona Copper	4,062,281
Detroit	4,999,980
United Verde	5,675,602
Other Mines	167,737
Total	35,720,000

* Engineering and Mining Journal, New York.

*Copper production of Montana, 1890.	Pounds.
Anaconda	64,046,812
Parrott	9,000,000
Boston & Montana	28,822,934
Clark's Colusa	
Butte Red. Wks	3,300,000
Col. S. & M.	11,071,122
Butte & Boston	5,357,723
All others	1,351,589
Total	122,950,000

Production, Consumption and Stocks of Copper in the United States in 1890.

	Pounds.
Lake Superior	100,607,151
Arizona	35,720,000
Montana	122,950,000
New Mexico	870,000
California	2,140,000
Colorado	6,760,000
Utah	600,000
Other sources	3,000,000
Total from domestic ores	272,547,151
Total from foreign ores	6,300,000
Total production	279,847,151
Stocks beginning of year	65,000,000
Available supply	344,847,151
*Deduct exports in ore, matte, etc.	50,000,000
Deduct consumption	294,847,151 214,610,000
Stocks on hand end of year	80,237,151

*November and December partly estimated.

Copper Production of the United States 1890.

	Pounds.
Lake Superior	100,607,151
Arizona	35,720,000
Montana	122,950,000
New Mexico	850,000
California	2,140,000
Colorado	6,760,000
Utah	600,000
Wyoming, Nevada, Idaho, Middle States, New England, Southern States, Lead refiners	3,900,000
Domestic production	272,547,151
Imported ores	6,300,000
Total production	279,847,151
Stocks January 1	65,000,000
Available supply	344,847,151

Principal Copper Supplies of the World.‡

Countries.	1888. †Tons.	1889. †Tons.	Countries.	1889. †Tons.	1888. †Tons.
Algiers	190	50	Norway:		
Argentine Republic	190	150	Vigsnaes	1,007	1,020
Australia	8,900	7,450	Other Norwegian	250	350
Austria	800	1,010	Peru	375	250
Bolivia:			Russia	4,070	4,700
Coro-coro	* 1,300	1,450	Sweden	* 1,000	1,030
Canada	* 2,500	* 2,250	Spain and Portugal:		
Chili	24,250	21,240	Rio Tinto	*32,000	29,700
Cape of Good Hope:			Tharsis	*11,000	* 11,000
Cape Copper Co.	5,600	5,800	Mason and Barry	* 5,250	* 7,000
Namaqua Copper Co.	* 1,800	1,700	Servilla	1,250	1,709
England	1,500	1,456	Portugueza	* 900	* 900
Germany:			Other mines	* 6,500	* 7,000
Mansfeld	15,500	14,880	U. S. of America:		
Other German	* 1,850	* 1,850	Lake Superior	38,769	38,650
Hungary	300	858	Montana	46,518	43,706
Italy	* 3,500	3,500	Arizona	14,419	14,062
Japan	15,000	11,000	Other States	6,048	5,295
Mexico:			Venezuela:		
Rojeo Co.	3,250	2,566	New Quebrada	5,563	4,000
Other Mexican	500	200			
Newfoundland:					
Betts Cove	1,115	1,300	Total production	262,990	259,126
Tilt Cove	700	750			

Average of prices on the 1st of each month ..... { Chili bars £82 7s. 6d. } { £49 10s. 6d. } { G. M. Bs. 76 }

*Estimated. † In English tons of fine copper. ‡Compiled by Henry R. Merton & Co., London.
Engineering and Mining Journal, New York.

In opening this report I began by touching on the iron business, but became diverted to considering the copper mines and copper interests, and now to go back to the beginning, we will resume the original subject.

IRON.

A year ago the most favorable condition, seemingly, existed for the Lake Superior mining interests that had prevailed for many years. Long before the opening of 1890, the coming season's product of ore had all been sold, and at an advance of from 50cts to $1.25 per ton above the prices that had prevailed in 1889. The season has been an active one and a profitable one for the mines; but now a reaction has set in, and much anxiety and apprehension are felt regarding the business for the coming year. No ore up to this time, the opening of the year 1891, has been sold; and there is so large an amount on hand at the lower lake ports as to seem to preclude the expectation of any immediate large demand. The quantity of ore now on hand in Cleveland and other Lake Erie ports, January, 1891, is given at 3,800,000 gross tons, which, it is stated, is a million and a quarter tons larger in amount than ever before. But none of it, it is said, is unsold.

The highest price received for ore in 1890 was by the Pittsburgh and Lake Angeline Co. —$7.25 per ton, hard ores,—66 per cent ore, giving also only .020% phosphorus. Champion and Republic ores- the best hard ores in the district—specular and magnetic, sold for $6.50 per ton, an advance of $1.00 over previous year's price. Bessemer hematite sold for from $5.25 to $6.50. Cleveland and Lake Superior ores, Non Bessemer No. 1, sold for $6.00.

Florence Iron River, Crystal Falls mines having ores 58% to 60% brought $425 to $4.50. In 1889 these same ores sold for $3.50 to $4.00 per ton.

That more ore was not sold previous to the opening of the year 1890, was the fault of the mine owners themselves. So much ore had been sold and sold so rapidly, that the mining men began to think they were selling too cheaply, and prices of ore were advanced twenty-five cents on a ton, which, with the fact, that the fever for buying had possibly begun to wane, anyway, checked the business of making contracts, and thereafter low grade non Bessemer ore was sold only in parcels from time to time. The prices becoming, from October to the end of the season, the same as they were in 1889.

Lake freights, at the opening of the season, were $1.35 from Ashland and Two Harbors, and $1.25 from Marquette, $1.10, Escanaba. These rates were modified respectively to $1.10, $1.00, and 85 cents.

There were imported into the United States in 1890, chiefly from Spain and Cuba, about 2,800,000 tons of ore. No doubt, were it not for the duty, this import would be so great as to seriously cripple the iron mines in this country. The high price paid for mining labor on Lake Superior as compared to that paid abroad, makes a large addition to the relative mining cost. If the same facilities existed for mining, handling and transporting Cuban ores, that prevail as to those of Lake Superior, they could be landed at Baltimore and put upon the American iron market at a price to compete closely with any of our own ores, assuming all Government restrictions to be removed. Fortunately for our Lake Superior ore interests, there is a market growing up nearer to the mines, that will more and more absorb the ores. Chicago, especially, is becoming a large manufacturing city and consumes a great deal of iron ore. The great west and northwest is the region of the future empire of this continent. It is now, and still more will become the region of consumption of iron, and it maybe found cheaper to save the transportation of ore from Lake Superior to the far away coal fields of the east, to be made into iron and machinery, etc., that are mainly returned again to the west for consumption, by bringing the fuel nearer to the ore, bringing it into the region where the iron is to be used.

In this connection a most excellent plan has been recently broached; which is to bring coke to Marquette and manufacture pig iron there, not only pig iron but steel, machinery, etc. An important advantage could be had in utilizing ores that it does not now pay to ship away, on account of the low percentage of iron which they carry, but which could be smelted at Marquette at a profit, and made into pipes and heavy castings, which form of iron these ores are adapted to make and for which there is extended use. There is an almost inexhaustible amount of low grade ore in the Marquette district and in the Menominee as well. I have especially in mind the limonite ores in what used to be called the north range, in which are the Pascoe, Webster, Imperial, Beaufort, etc, mines.

These ores run from 48% to 58% in metallic iron, .25% and upwards in phosphorus, and hold enough lime to flux them. They also hold 10% of water and from 4% upwards of silica. There is so little profit in mining and shipping them that it does not generally pay to work the mines. They are all idle save the Imperial, and that, perhaps, has a little better ore than the others. But if they could be smelted at Marquette in coke furnaces, they afford the basis for making cheap iron. The only uncertain factor in the problem is the coke, whether that can be procured in quantity cheaply enough, and be readily and cheaply transported to Marquette. One would think that there would be no such obstacles in the way of transporting coke to Marquette that could not be overcome. Only provide for furnishing the coke cheaply and Marquette and the Lake Superior region will have added great iron smelting and manufacturing industries to its already imperial interests. It is probable that the vessels that carry the ore to Lake Erie ports can return laden with coal which can be coked at Marquette, or elsewhere, where the coke is to be used. This is already done to some extent at Superior City, at the end of the lake, and it certainly can be done on a large scale at Marquette or at Escanaba.

It is probable that there will be considerable falling off in ore production as compared to last year. Mines all over the peninsula have reduced their forces to quite an

extent, and it is likely that there will be still greater reduction before spring. Throughout the summer there was a lack of labor. Good men may be said to have been scarce, still no trouble was experienced, entire harmony prevailed, and the few strikes that occurred at Ishpeming and at Negaunee, late in the season were for local causes. There were no strikes nor labor troubles during the rush of the working season. Shipping was delayed a good deal, and thus, incidentally, mining also, by the want of room to store the ore at Cleveland and other ports. The docks were kept all the while crowded.

The price of pig iron is very low; charcoal pig iron has never been lower than it is now, and yet it was made from high priced ore and high priced coke, so the furnace men have been in an unfortunate position, and the business between the ore producers and the ore consumers will not adjust itself immediately; not until after the opening of navigation will sales of ore take place, then the volume of ore now on hand in Cleveland and elsewhere, will be used up, or nearly so, and the contracts made last year will be worked off and purchases of ore will be made, and at a reduced basis of cost. The situation now is not greatly different from what it was two years ago, in the fall of 1888 and until the summer of 1889. No contracts were made for ore; up to the opening of navigation the mines in the Gogebic range were holding their ore, then unsold. But before the season had advanced much farther, it became evident that the ore was all wanted and mines that had been idle through the winter and in the spring and were full of water, were started up, the water pumped out and every effort put forth for the rest of the season to get out every pound of ore possible. It looks to me as if we were destined to somewhat of a like experience in 1891. The furnace men are trying to get down the price of ore and of coke and of transportation.

Ore will be supplied at 50 cents to $1.00 per ton less than it was in 1890, and coke has gone down 25 cents per ton, being now $1.90.

The furnace men have had an unfortunate year, no doubt, and they do not feel hopeful, but the great business of the country must go on, and the multiple uses for iron are all the while increasing and will be met, and so the ore, which is the first factor in the great iron manufacturing industries, will be wanted.

The production of pig iron in the United States has multiplied nearly three fold in ten years, it having amounted in 1890 to more than nine and a half millions of tons.

The average prices for iron in New York for 1890, were as follows:

Pig iron, No. 1, foundry	$17.60
" " " 2, "	16.65
Forge	15.91
Bessemer pig	18.93
Steel rails	28.93
Ferro manganese 80 %	63.35

CHARCOAL PIG IRON.—PRICES JANUARY 1, 1891.

No. 1 foundry, in New York	$24.00
" 2 " " " "	22.50
Cold blast	26.00
Hot blast	24.50

Statistics of Pig Iron, Rails, etc., from 1860 to 1889, Inclusive.

Year.	Miles of railroad built.	Iron rails made in United States. Net tons.	Steel rails made in United States. Net tons.	Total rails made in United States. Net tons.	Rails imported. Net tons.	Approximate rail consumption. Net tons.	Pig iron made in United States. Net tons.	Pig iron imported. Tons of 2,000 lbs.
1860	1,846	205,038	None.	205,038	136,836	341,874	919,770	80,178
1861	651	189,818	None.	189,818	83,429	273,247	731,544	82,909
1862	834	213,912	None.	213,912	9,044	222,956	787,662	24,921
1863	1,050	275,768	None.	275,768	19,139	294,907	947,604	34,729
1864	738	335,369	None.	335,369	132,960	468,329	1,135,996	111,490
1865	1,177	356,292	None.	356,292	86,820	443,112	931,582	56,730
1866	1,716	430,778	None.	430,778	87,368	518,146	1,350,343	114,679
1867	2,449	459,558	2,550	462,108	163,049	625,157	1,461,626	125,467
1868	2,979	499,489	9,225	506,714	230,081	736,795	1,603,000	125,380
1869	4,615	583,936	9,650	593,586	313,163	906,749	1,916,641	158,412
1870	6,070	586,000	34,000	620,000	399,153	1,019,153	1,865,000	171,677
1871	7,379	737,483	38,250	775,733	566,202	1,341,935	1,911,608	245,535
1872	5,878	905,930	94,070	1,000,000	530,850	1,530,850	2,854,558	295,967
1873	4,097	761,062	129,015	890,077	258,772	1,148,849	2,868,278	154,708
1874	2,117	584,469	144,944	729,413	108,311	837,724	2,689,413	61,165
1875	1,711	501,649	290,863	792,512	19,448	811,960	2,266,581	66,457
1876	2,712	467,168	412,461	879,629	287	879,916	2,093,236	88,072
1877	2,280	332,540	432,169	764,709	35	764,744	2,314,585	66,961
1878	2,679	322,890	550,398	882,685	10	882,695	2,577,361	74,484
1879	4,817	420,160	683,964	1,113,273	44,147	1,157,420	3,070,875	340,672
1880	6,712	493,762	954,460	1,461,837	290,689	1,752,526	4,295,414	784,968
1881	9,847	488,581	1,330,302	1,894,100	386,321	2,280,421	4,641,564	530,835
1882	11,569	227,874	1,438,155	1,688,794	224,127	1,912,921	5,178,122	604,978
1883	6,743	64,954	1,286,554	1,360,694	38,977	1,399,671	5,146,972	361,396
1884	3,924	25,560	1,119,291	1,144,851	3,168	1,148,019	4,589,613	206,381
1885	2,980	14,815	1,079,400	1,094,215	2,452	1,096,667	4,529,869	164,319
1886	5,100	23,679	1,768,922	1,792,601	46,578	1,839,179	6,365,328	405,180
1887	12,872	23,062	2,373,335	2,396,397	154,369	2,550,766	7,187,206	523,625
1888	6,901	14,252	1,557,892	1,572,144	70,602	1,642,746	7,268,507	220,905
1889	5,155	10,258	1,694,610	1,704,868	6,962	1,711,830	8,516,079	159,298

Year.	Total steel ingots made in the United States (including crucible). Net tons.	Rolled iron, except rails, made in the United States. Net tons.	Prices per ton of 2,240 pounds. Pig iron.	Iron rails.	Steel rails.	Pig iron produced in Great Britain. Tons of 2,000 pounds.	Immigration. Number of persons.	Year.
1860	....	....	$22¾	$48	....	4,285,962	....	1860
1861	....	....	20¼	42⅜	....	4,157,877	89,724	1861
1862	....	....	23⅞	41¾	....	4,416,685	89,007	1862
1863	....	....	35¼	70⅜	....	5,051,245	174,524	1863
1864	....	536,958	59¼	126	....	5,340,049	193,195	1864
1865	....	500,048	46⅞	98⅜	....	5,397,564	247,453	1865
1866	....	595,311	46⅞	86¾	....	5,066,764	314,917	1866
1867	....	579,838	44⅛	83⅛	....	5,332,346	310,965	1867
1868	30,000	598,286	39¼	78⅞	$158½	5,566,631	289,145	1868
1869	35,000	642,420	40⅝	77¼	132¼	6,160,248	385,287	1869
1870	77,000	705,000	33¼	72¾	106¾	6,679,137	356,303	1870
1871	82,000	710,000	35⅛	70⅜	102½	7,422,440	346,938	1871
1872	160,108	941,992	48⅞	85⅛	112	7,530,960	437,750	1872
1873	222,652	1,076,368	42¾	76⅝	120½	7,354,425	422,545	1873
1874	241,614	1,110,147	30¼	58¾	94¼	6,710,377	260,814	1874
1875	436,575	1,097,867	25½	47¾	68¾	7,120,317	191,231	1875
1876	597,174	1,042,101	22¼	41¼	59¼	7,342,717	157,440	1876
1877	637,972	1,144,219	18⅞	35¼	45½	7,401,704	130,502	1877
1878	819,814	1,232,686	17⅝	33¾	42¼	7,146,777	158,205	1878
1879	1,047,506	1,627,324	21½	41¼	48¼	6,714,787	250,565	1879
1880	1,397,015	1,838,906	28½	49¼	67½	8,679,141	593,703	1880
1881	1,778,912	2,155,346	25⅛	47⅛	61⅛	9,282,648	720,045	1881
1882	1,945,095	2,265,957	25¾	45⅝	48½	9,617,082	730,349	1882
1883	1,874,359	2,281,920	22⅜	Not quoted.	37¾	9,552,816	570,316	1883
1884	1,736,985	1,981,747	19⅞	....	30¾	8,749,184	464,346	1884
1885	1,917,350	1,789,711	18	....	28½	8,305,325	382,361	1885
1886	2,870,006	2,259,943	18¾	....	34½	8,850,924	392,887	1886
1887	3,739,760	2,565,438	21	....	37⅛	8,466,660	516,928	1887
1888	3,247,378	2,397,402	18⅞	....	29¾	8,958,345	525,019	1888
1889	3,792,020	2,576,127	17¾	....	29⅜	9,234,736	431,985	1889

* Engineering and Mining Journal, N. Y.

The facilities for handling the ore from Michigan mines are improving and extending constantly. Ore is now sent from the mines, for shipment by water, to Marquette, Escanaba, Gladstone, Ashland, St. Ignace, and in another year or two will probably go also to L'Anse and Huron Bay.

Railroad facilities are extending and improving all the while. The old roads, the C. & N. W., the D. S. S. & A., and the M. L. S. & W., are far better equipped now for handling ore, expeditiously and in quantity, than they were formerly. They have larger cars and more of them, more powerful locomotives, and far greater ore dock capacity; so that a vessel coming for a load of ore is filled and sent on its way very quickly. Vessels have been loaded—2,000 tons of ore—both at Marquette and Escanaba, in one hour's time.

A railroad built for carrying ore has been graded from Escanaba, through Iron Mountain to Crystal Falls, and to reach other points on the range. It is known as the Schlesinger road,—the Escanaba, Iron Mountain and Western. Another road is building from Champion to Huron Bay, the grading is well under way and ore dock also. It is known as the Turner road, Hon. James M. Turner, of Lansing, Mich., being the manager. A recent organization has been made to build a road from Watersmeet to L'Anse, to make an outlet for the Gogebic ores and for other ores that may be found on the line of the projected road. A few years ago if one wanted to travel from one place to another in the upper peninsula, he had to go afoot. It will be soon so cut up with railroads that one can reach any point with entire facility by rail. There is not much trouble as it is, but it is improving in this respect all the time.

It is now understood that iron ore exists in the peninsula of Michigan in much greater quantity than was formerly supposed. The ore bearing-rocks are more extensive than was at first outlined. The deposits of ore are larger

and richer and it is probable that they extend much deeper into the earth than was earlier the belief.

A friend with whom I was traveling recently, told me that he was working a mine in the Cumberland iron district, England, that was worked three hundred years ago, and that it is a good mine yet. He, himself, was operating it at a profit. I expect that three hundred years hence, if the world needs ore, men will be mining it in the northern peninsula of Michigan, as abundantly as they do now. I see no reason to assume but that the ores, in instances where the conditions are favorable, will extend to great depth. The rocks of the iron district of Michigan are designated as Laurentian and Huronion, the latter series being the iron bearing. All the rocks, whether Laurentain or Huronion, in this district the south shore of Lake Superior, were originally, without doubt, sedimentary, and were greatly altered by subsequent heat and pressure. The Laurentian rocks of the iron region are granitic, passing into gneiss and mica schists. Granite was the source from which the later rocks were formed, by the decomposition of the granite and the subsequent gathering together of the materials in different proportions and in different forms the various rocks were built up. They are feldspathic, silicious, micaceous, etc., or they are coarse or fine, according to predominating elements that entered into their composition, or whether the pre-existing rocks of which they are made-up, were ground into mud or gravel. All the forces of nature are brought into play in rock building, but in the iron district the forces that are recognized as chiefly instrumental in the rock building of that region are igneous, aqueous, chemical and mechanical, and these agencies destroyed the Laurentian and, with the materials thus derived, built up the schists, jaspellites, quartzites, greenstones, etc., which form the Huronion or iron bearing series of Michigan.

The conditions under which ore occurs are not everywhere the same, though all localities afford indications which the experienced explorer learns to recognize; and he knows by the signs which he finds in the rocks themselves whether the locality is favorable or unfavorable to his hopes. Explorers are far more intelligent now than they were twenty years ago; that is, I mean, they know far more about the rocks than explorers did then. It is surprising to look back over the earlier period in the iron district and think how little was known about the country; what crude notions prevailed regarding the rocks and the ores. Experience is a great teacher, and there has been so much searching for ore in the past quarter of a century, so much exploring, that the work has developed a good deal of knowledge. Competent explorers now know pretty well where to explore; they know the rocks, recognize where they are right for the occurance of ore. Explorers and mining men know ore now much better than they used to; years ago, what is now called rock was taken and shipped for ore, in some cases. There are now a good many chemists in the mining country, a number of independent laboratories, where any "finds of mineral" can be sent to be analyzed and every iron mining company that produces any considerable amount of ore has a chemist and laboratory for analyzing its own ores. A great deal of attention and care are now given to this matter of analyzing ores. They sample the stopes in the mine separately and the cars of ore and the stock piles and thus know all the while the quality of the ore. Twenty years ago there was not a chemist or engineer employed by any of the iron mines, now they all have one. Then, to obtain an analysis the ore had to be sent east. Having analyses so frequently made has been a great help in the matter of exploration for ore; by comparing ores and their analyses so often men have learned to know the ores and to judge of them. They have become expert in noticing differences.

In speaking of this subject of exploring I must give credit to Major T. B. Brooks; his report on the iron region 1869-73 is invaluable and was, practically, the pioneer work in this field. His personal influence, the instruction and information which he imparted while a resident of Marquette and engaged in the prosecution of his scientific work, were of great value to the men whom he employed to assist him in the work, and thus was of much importance to the country. His office and his work were a school of instruction at a time when instruction in this field was much needed. By his practical work and through his report, he disseminated fundamental ideas regarding ores—iron bearing rocks, the formations of the iron region topography, field book notes, the use of the dial and the dip compass, the magnetism of rocks, methods of mining, quality of ores, amount of shipments, cost of mining, etc., etc., all of which facts have been of much importance to this country. Judging it from the standpoint of economic geology his report on the iron region of Michigan is a most valuable one. It is always well, I think, to remember where obligation lies.

Following Major Brooks, Mr. Chas. E. Wright came into the country and opened an office in Marquette in 1873, where he remained until his death in 1888. Mr. Wright was admirably qualified by nature, observation and training for the work of an expert in iron mining and metallurgy and thus he immediately became and continued to be an important factor in the development of the iron region. His untimely death was a misfortune to the country that men have not yet ceased to deplore. Mr. Wright was in the prime of his life at the zenith of his powers. He had acquired experience and a knowledge of the country which in his hands were invaluable. He had accumulated a great amount of material and facts which he was prepared to correlate, elaborate and publish. To be thus cut off in the midst of his usefulness, with his work unfinished, was indeed a calamity.

His plans embraced a complete examination of every section of the peninsula following the linear surveys, and he had nearly completed in detail his inspection of the iron bearing rocks. He had studied the specimens, had gathered the facts and was just in readiness to commence the task of writing his report, that should cover the Huronion system, when death overtook him. Fortunately his facts, most of them, were recorded on

the skeleton maps that he had arranged for the purpose. On these he had placed, the exact location, the strike, dip and kind of rock of every outcrop that was found on every quarter section of land, examined in detail. His specimens were numbered, determined and catalogued, so that much is not lost; but his work had been nearly all preparatory, and time was required for the full rounding of his fame and for the full realization of the usefulness of his work.

As with the fame and labors of the lamented Douglass Houghton, the earliest State geologist, whose life was so sadly extinguished beneath the waves of Lake Superior, the brain of the silent master was needed to interpret. We may well regret that both these State geologists, young and gifted and devoted to science, could not have been spared to the full accomplishment of the noble work which each had so admirably devised.

Speaking in a general way, the rocks which are associated with the ore in the Marquette iron district are jasper, quartzite, chloritic schist, silicious schist, or flag, ferruginous schists, argillaceous slates, greenstone, etc., with these occur, intercalated, the beds of the different varieties of iron ore. It does not appear that the topographical position of the rocks can be relied upon as a certain guide in prospecting for iron ore. It is rather the rocks themselves than their elevation or depression that afford the best indications. Some mines are up in the side hill, others in the swamp, and again, in precisely similar positions for the same occurrence of ore, no ore may be found. Men used to think because the Jackson, Champion, Republic, etc., were in high ground, that high ground was the place to look for ore, and so it is the place to observe the outcrops. At other places, as at Iron Mountain, the east Negaunee mines, etc., the ore occurs beneath low, wet surface, but it does not follow that for this reason ore will be found in other places with similar surroundings. One can judge of the nature, or the kind of rock underlying any locality, by a careful noting of the outcrops, where they nearest occur, and understanding how the surface shape is determined by the rocks which support it. The form of the ground is one of the indications only.

The portion of the upper peninsula which presents the most irregular topographical features is the Marquette iron district. It is everywhere hilly, if not mountainous, but they are not in easily defined ranges like the hills of the copper district.

The best known ridges in the district are the quartzite range in which is found Mt. Mesnard, near Marquette, and which extends westerly south of Ishpeming, and the great greenstone ridge, which is found rising so prominently west of Lake Michigamme. The whole region is exceedingly varied in its topography but as well are the rocks, and it is seen that all this surface irregularity of this iron district is due to the change in the rocks. The Menominee iron district, lying south of the Marquette range, has greater regularity, and still far more uniform is the Gogebic range, which may be found to be the westerly prolongation of the Menominee.

The rocks of the iron region, as are those of the copper, and the later sandstone common to both, are generally stratified or bedded and the immense deposits of clay slates in the Huron mountains district, have in addition to the usual bedding planes, planes of cleavage and are also jointed as are many other rocks in the region. The bedding planes, planes of stratification, are of course those of original deposition, while the jointed structures and cleavage planes are due to subsequent forces, heat and pressure, more especially the latter. Bedding planes are no longer easy to trace. The rocks were so subjected to pressure that they became folded, forming ridges and synclinals, which were doubled and contorted by lateral pressure. The cracks, resulting from these applied strains, becoming filled, formed veins and dykes, the veins however do not contain iron ore. It is common to speak of veins of ore, but such do not exist in reality; the term is only a convenient expression.

The ore is found in the form of pockets or lenses, or as one of the beds in the formation. In looking for ore in any locality, it is sought to know the foot wall rock or the hanging, and to be able to recognize them when found. The ore, if it occurs at all, will be found between them. In the Marquette hard ore district, the hanging is invariably quartzite, frequently separated from the ore by "soap rock." The ore may be in jasper, jasper schist, etc., but the ultimate covering is the quartzite. The ore occurs in the Marquette district much more in folds than it does elsewhere. The great mines at Ishpeming, the Cleveland, Lake Superior, Pittsburgh and Lake Angeline, the Volunteer mine, the mines at Lake Michigamme, etc., are all in folds of the formation the quartzite overlying the ore. At Ishpeming there are a succession of troughs, having their axis east and west, which are formed by the wavy character of the crust. The Pittsburgh and Lake Angeline mine is in one of these folds, and is succeeded, to the north, by another fold, in which depression is contained the waters of Lake Angeline and beneath the water and extending on to the west, is the great body of soft ore, lying in a fold and constituting the Lake Superior hematite mine, and the newly opened mine east of it, of the Cleveland company. Again to the north succeed several sharp folds, which contain the several hard ore pits of the Lake Superior Iron Co., and the old Barnum. The extension of these folds to the west is cut off by the abrupt, high diorite bluff which borders the south margin of Lake Angeline. North of the diorite is the broader synclinal underlying the body of the city of Ishpeming, and containing the Cleveland, New York, and Cliff shaft mines. The axis of this trough is tilted up to the east so that the rim of the basin can be traced clear around at the east end, at the incline pit of the Cleveland mine, while at the Cliff, three-fourths of a mile west, it is four hundred feet and upwards to the ore. The New York mine is in the northeast corner of the basin, in the northeasterly upturn of the fold, and the ore has been worked out down on the fold to the line of the Cleveland land. The two mines open into one another.

East of the rim of this basin the formation changes, becoming a plane with loose jasper ledges under the

surface, but broken up by numerous hills of diorite. East of the Cleveland mine the fold of the Ishpeming basin has been denuded and borne away.

Lake Michigamme is also in the basin of a fold of quartzite and underlying jasper with ore intercalated. At the east end of the lake is the Champion, with the rocks dipping to the north at 83° with the horizon, and further west, south of the- lake at the Magnetic mine, etc., the rocks, jasper and quartzite, all dip north under the lake, while at the Michigamme mine north of the lake, the rocks dip south under the lake. At the Republic. the formation is a high ridge of jasper rising abruptly to a height of three hundred feet above the waters of Smith's bay, a sheet of water formed by the Michigamme river and which, except for its connection with the river, is as a small inland lake. The direction of the bluff partakes of the form of a horse shoe, following around the margin of the bay, on the east side, from the north, and curving finally to the west, dipping towards the bay. The ore is in the jasper, between the jasper and the quartzite, the latter overlying the formation. The regularity which the formation originally possessed has been lost by the subsequent action of the mechanical forces of the earth, which forced it together laterally, kinking and faulting it, making in the formation sharp minor folds that placed the ore, in places, at right angles with the formation, as separate lenses of ore; thus we have at the Republic instead of a continuous run of ore between well defined walls, conforming with the dip and strike of the formation, a succession of lenses lying across the formation, which make as many independent pits. They all, as they go down, converge and possibly form a basin of ore far below the level of the bay.

The general trend of the formations of the iron districts is east and west, but locally there is great modification, as in the region of the Michigamme, Hemlock and Paint river, etc., the trend is north and south, or northwest and south-east. It is so also, east of Crystal Falls at the Hollister mine and south at the Dunn, Mastodon, etc. At the Vulcan, Norway, Clapin, Florence, etc., the trend is east and west. The general clip of the formation is to the north, but of course this is locally modified by the folding of the formation. A matter that has not been clearly made out yet, is the fact that in the east end of the Menominee range, to the west beyond Keel ridge, the dip is to the south, and a very prominent bluff of limestone forms the footwall of the ore, that is, the ore is above it. At Iron Mountain, however. at the Clapin, Ludington, etc., mines, the dip of the formation is to the north and the limestone is in the hanging wall of the ore. There is no change in the rocks. The slates and limestone are identical, the dip is reversed. Mr. J. T. Jones of the Hamilton Ore Co., is of the opinion that the formation at Iron Mountain is the south branch of the fold, which dips north and comes up with a southerly dip north of Lake Antoine, where the limestone, etc., appear, dipping south.

The rocks in which the ore occurs both at Iron Mountain and further east at the Vulcan, is a soft, friable, black argillite that crumbles and disintegrates on exposure, and which, low in the mine has no sustaining power. The drifts, whether in foot or hanging wall, crumble and crush down so as to soon become impassable. Further west, at Crystal Falls, the jasper ferruginous schists in which the ore is found, are firm and generally make a good roof to the mine. In the mines about Crystal Falls one sees large rooms where the ore has been removed.

THE GOGEBIC IRON RANGE.

I cannot cease to marvel and wonder at it, so much now and so wild and unknown, so brief a period ago. The contrast is indeed very great. Its fine growing cities, teeming with life and activity and the fabulous stores of mineral where only a few years ago was no living soul nor individual possession, are truly wonderful facts. Not a few there are who doubtless reflect with chagrin upon a shortsightedness that witheld them from investment, which perchance, never so small at the time might have secured to them hi the sequel a sufficient fortune.

I find it necessary to explain that the Gogebic range lies partly in Michigan and partly in Wisconsin. The general average direction is a little south of west and the range is divided between the two States by the Montreal river, the mutual boundary of the two great commonwealths. West of the Montreal are many mines, all in the State of Wisconsin, but none so large as are found east of the boundary in the State of Michigan. In Wisconsin nearly every "forty" has been, more or less tested along the range from the river nearly to Penokee gap, and east for a like distance of 30 miles, to Gogebic lake. The year has shown no very important "finds" of ore but the mines have held their own in good shape and show well for the future.

The ore formation in the Gogebic range is the most regular of any in the whole iron region. Here the rocks of the iron series and of the copper series come together and run parallel with each other. The traps becoming- very like the greenstones of the Marquette range. The Gogebic iron range trends east and west and the rocks dip at a high angle to the north. The ore occurs in the jaspery, ferruginous schists lying on, immediately or not far from a broad belt of fragmental quartzite which is one of the most marked features of the Gogebic ore formation. This belt has been a wonderful guide in the matter of explorations, even more than has been the quartzite of the Marquette range or the limestone of the Menominee. With the exceptions of the Brotherton mine and a few others lying east of the Black river all the mines have the quartzite, most of the large ore bodies lie directly upon it and none are more than 400 ft. away from it. The exception made of the mines east of Black river are for the reason, that here the quartzite has disappeared, from what cause does not readily appear. It may have wedged out at the surface and might be found again deeper down. It may have changed its character so as not to be recognizable. There are indications that this is the case. The narrowest portion of the range is from the State line east to Black river and

here are the best mines. I spoke of the strike as being east and west. The general trend is slightly southwesterly. The formation bends a little in places but as a whole it is surprisingly regular. There is none other so much so anywhere in the region. You can stand upon one of the high bluffs, as at the Colby, or Puriton, etc., and see for a long distance either way the shaft houses of the different mines in line one after the other.

The topographical features of the Gogebic country are of a much milder, uniform type than in any other iron range. The hills are less abrupt, smoother, the whole surface gentler and more agreeably rolling. The timber is, much of it, fine hardwood and the soil a heavy fertile loam, excellently well adapted to the production of such crops as are suitable to so cold a climate. This applies to the iron range. The south copper range, that also occurs in this district, is much more rugged and of very different aspect. The ore deposits of the Marquette range have the quartzite for hanging wall. In the Gogebic district the quartzite is the foot wall and the hanging is one or another of the variety of schists or iron slates belonging with the ore. The quartzite foot wall becomes, occasionally, decomposed and is simply sand or friable rock; but generally it is very hard and firm. In the ore occurs, sometimes, more or less, bunches of sand and occasionally there is a stope in which are so many of these little bunches of sand that they render the ore nearly worthless. They were once, no doubt, solid rock in which the percolating waters dissolved out some element, that thus left the particles without cohesion among themselves. There is a good deal of jasper slate, iron slate in the ore formation and possibly the ore deposits may owe their origin, more or less, to the percolating through these slates, of alkaline waters that dissolved out the silica and carried it away in solution leaving the iron oxide. Of course this theory is applicable to other localities as well. East of the Black river to Sunday lake is a wide iron range in which, there is nothing to guide the explorations. Rich iron slates abound and some ore, but no deposit of ore large enough to be called a mine has been found. At Sunday lake and east are several promising mines. The formation maintains its regularity in strike and dip and with the exception of the facts that the foot wall, fragmental quartzite has disappeared and that there are no "soap stone dykes" the formations are the same.

The ore of the Gogebic range mines, is practically the same in all. The variation is due, mainly, to the mixture of sand which gets into the ore sometimes in some places; and in all the mines there is more or less hard concretionary limonite ore also some specular ore. The hard ore is more frequently than otherwise adjacent to the dykes. The hard ores usually contains a greater percentage of phosphorus. The Gogebic ores average very uniform in quality above 61% in metallic iron; when quite clean giving 62 to 64% ; and .040 to .042% phos. It is soft, rather brown, umber colored ore that makes a very handsome stock pile. One cannot see more attractive ones anywhere than he will find at the Ashland, Aurora, etc., mines in the spring.

It seems remarkable now that the Gogebic range, which has proved so rich and valuable in ore should have remained for so long a period practically unknown. Major T. B. Brooks, in his State report of the Michigan iron region, published in 1878, several times alludes to the Huronion area of Gogebic, and in a general way he attempts to outline it. He examined that portion of the peninsula in 1871, with Prof. Pumpelly. It is probable that the stagnation in business, the utter prostration of the country financially, following the panic of 1873, had much to do with the fact that so little interest was taken in this district for so long a time after its existence as a possible iron region became known. Examination of the Menominee iron region had begun quite earnestly before the panic, and valuable discoveries of iron ore were soon after made, so that, even with the depressed condition of the iron market and the business of the country, the opening of the Menominee district continued to progress. But there was not interest enough in iron, the outlook for the future was not bright enough to lead people to penetrate further into the wilderness to seek to explore new regions. Not until six or seven years afterwards was any attention given to what is now the Gogebic range. Then the Lake Superior Ship Canal Railway and Iron Co., which had entered-a large quantity of lands on this Huronian belt, began somewhat to examine them, and Mr. Frank Brotherton, an intelligent and greatly esteemed explorer in their employ, traced the line of magnetic attractions along near the quartzite belt which subsequently was found to be the footwall of the ore. This was in 1879. About this time also, and in the following year especially, when options were freely taken and much exploring done, it was in this year, 1880, that Cap. Nat, D. Moore made the first discovery of ore on Sec. 15, T. 47 N., R. 46 W. The Cambria Iron and Steel Co. of Johnstown, Pa., explored the next section west in 1881, and while finding ore did not meet with the success that induced the company to stay. The company gave up its options after spending a good deal of money in the range, and bought the Vulcan and Norway mines in the Menominee district. It thus held the earliest option in the Colby mine, and did the most extensive exploring of any of the pioneer workers in the district. In 1881-82-83, exploring was in progress all along the range, but not until Oct. 1884, when the Milwaukee, Lake Shore and Western completed its line from Ashland to the range, 40 miles, was any ore sent out—1,000 tons from the Colby. In the following year, the ore dock at the bay having been completed, the Colby sent out 84,312 tons. Probably no ore, at least so great an amount of it, was ever produced so cheaply, as that obtained in 1885 and ‘86 at the Colby mine. The railroad cars were filled right from the stopes, the track being built into the open cut from the west end of the bluff, where the ore outcropped, just beneath the soil that covered it. The ore lay on the footwall and on the dyke ninety feet wide, descending to the east along the footwall, which dips north as it goes down. The ore lense was covered with a jaspery quartzite called capping. Four hundred feet to the north was a second lense, also on the dyke and pitching down to the east in

the same way. These two, which at that time, were designated as the north and south veins, were really the same deposit of ore. They lay on the same dyke but were separated by a sag in the capping coming down to the dyke.

The theory early prevailed that there were two well defined parallel ore veins, that extended through the entire range. One on the quartzite foot wall called the south vein and the other 400 feet or more north of it. Of course there is nothing corresponding to a vein in its true sense. The ore at several places where the foot wall occurs is found both on the foot and at a few hundred feet north of it, but there is no difference in the rocks. The so called capping seems to separate the ore deposits and the same underlying dyke constitutes the bottom. These dykes are the most remarkable feature of the Gogebic mines. That is, there is no where else any thing exactly corresponding to them. They cut the formation, coming from below through the foot wall and up to the surface to the north of it. In the majority of cases the dykes dip to the south and east, the line of intersection along the foot wall forming the bottom of a trough, which goes down northeasterly. Sometimes, however, the dyke underlying the ore lies flat, that is it does not dip continuously to the east but extends for a long distance, dipping neither way except that it rolls or waves in its course. Such a dyke underlies the ore at the Anvil mine. It apparently lies beneath the Black river and rises up the hill west of it through the East Douglas, etc., to the Eureka where it makes a roll and dips down to the west and so on making risings and falls as it goes on west through the Eureka, Anvil and Palms. The dyke is 300 feet and more below the surface along the foot and comes to the surface that is to the drift along a few hundred feet north of the foot; but where it ends west I do not know, it may be the main dyke of the Colby mine and thus terminate at the bluff at the west end of that mine. Dykes are found in all the mines west of Black river, but some of them are small and do not cut off the ore. The ore is on both sides, above arid below the dyke, such dykes are found in the Ashland, Norrie and other mines. But there is also a main underlying dyke, which, generally, terminates the ore. Such a one is the flat dyke first discribed, which has been sunk under at the Eureka and Anvil but thus far no ore found. Also at the Ashland, Norrie, Aurora and Colby mines. These all have an underlying dyke or dykes that cut off the ore. In most instances no ore or very little ore has been found under the main dyke in the mines. This is true at the Colby; but the Colby dyke starts from the west side of the property and dips down to the east and underlies all the land of the company to the east. It is deep down and there is a mile and a quarter of distance so that there is abundant chances for an endless quantity of ore above the dyke.

The Ashland starting from the bluff forming the east margin of the narrow valley of the Montreal river and extending east has a succession of dykes all dipping south and east, i. e., "pitching down" to the east. The ore occurs between them. They are, perhaps, branches or "fingers" from the main dyke, which is the one starting from the west end and which, of course, underlies all the others. The Ashland company has bored and sunk below this main dyke a long distance but has not found much ore. They have a narrow deposit of good ore under the dyke but not encouraging in quantity. But at the Norrie the case is far more encouraging. The Norrie joins the Ashland on the east and both companies work up to the line. A dyke goes into the Norrie from the Ashland, that is it comes up to the surface in the Ashland dipping down into the north as it goes east. The Norrie company has worked upon this dyke stopping the ore and lately has sunk two shafts through it, 47 feet in. thickness of dyke, and came into ore directly under the dyke. I went down into the mine the other day and walked in a drift, several hundred feet under the dyke, all the way in ore as good as any ore in the mine. They had crosscutted fifty feet and more and had not found the full width yet. The fact is there is every evidence that the Ashland ore continues on through the Norrie, so that underlying the dyke that was supposed to be the final bed of the Norrie ore is the other great body, the Ashland ore. It gives to the Norrie a most wonderful prospect.

The Norrie with the East Norrie has a length of three-fourths of a mile and the next three-fourths of a mile east of it is the Aurora. The Aurora has a main dyke that comes to the surface at some distance east of the west line and all the ore thus far found in the Aurora mine is above this dyke, a lense of ore lying with its long axis inclined down to the northeast, bounded by the foot wall the dyke and the capping: but going into the East Norrie we see that that great body of ore is, apparently, going into the Aurora. The openings of the East Norrie mine are within a few hundred feet of the Aurora line and the ore body is undiminished in size. The Aurora people have set a diamond drill to cross the formation and ascertain regarding the continuance of the Norrie ore on the Aurora. I have much faith that it will be found there and thus believe that the future of the Aurora mine is not confined to the small amount of ore which, apparently, remains above the dyke. It seems to me that the mines, which have large bodies of ore lying west of them are very likely to get this ore, more or less of it, in its continuance east. Thus the Norrie which has the Ashland west of it is getting the same lense of ore, further down, on its property; and the Aurora also is likely to have equal good luck by having the East Nome ore lense on its land under the main dyke which now forms the bottom of the mine.

The Gogebic iron range, though so young and with such an unfortunate early histoy of speculation and many attendant evils, is proving to be, in some respects, the most progressive of our mining districts. I refer more especially to the lighting of the mines, which in the Gogebic range is done, in the Michigan mines, wholly or in part, by electricity. The Aurora mine, for instance, is wholly lighted by electricity; you can descend the shafts, go through the levels, to the stopes, etc., without using a candle or endangering yourself by reason of darkness.

The Penokee arid Gogebic Development Co., that owns the Aurora, is preparing to light the Colby and the Palms mines, which it also owns, with electricity. The company is erecting a large electrical plant at Bessemer, sufficient to light the town and the mines. Other companies, as the Ashland and the Norrie, use electric lights in the mines, especially in the shafts, and this is a great advantage. It is infinitely pleasanter and safer to have the space about the shaft thoroughly lighted at every level as it is with electricity, than to depend on the dim light of candles. In other parts of the mine too, the better light enables the men to accomplish more work, and should, too, render them more safe. Thus far the electrical lighting is a little more expensive, but the other advantages compensate somewhat, and it is expected that the electric lighting itself can be done cheaper by and by.

The Milwaukee, Lake Shore and Western R. R. Co., was the first to introduce the large ore cars, holding twenty tons and upwards. No others have been used on the Gogebic range, but in the older ranges, up to the time of the introduction of the larger cars in the Gogebic, only cars holding seven to eight tons were used. These have not fully passed out of use yet, but the larger ones are found to be far better. The growth of the towns in the Gogebic range is one of the most noticeable facts. Bessemer and Ironwood, in Gogebic county, are both fine, substantial cities. I do not know of another instance in the State of growth and development equal to Ironwood. It was a miserable locality to start with. The town started in the low, wet, cedar swamp, stumps, boulders, mud and nastiness. It has taken a good deal of effort to secure drainage, grade the streets, etc., but now it is a fine, well appointed city, with good walks, graded roadways, fine brick and brownstone business blocks, two commodious, well conducted hotels, a complete system of public arid private electric lighting, water-works, etc., and a population of 9,000 people, and all in six years. Ironwood has to compete with Hurley as there is only the Montreal river, a stream of insignificant proportions, to separate them. Hurley is on the west side, in the state of Wisconsin, and had a long way the start of Ironwood, since it was quite a place before any beginning at all was made in Ironwood. Hurley had many stores, a bank, a fine hotel, and great business activity when Ironwood was an uncleared cedar swamp. But the Michigan town surpasses its rival now; it has more activity and thrift, and a far better moral tone.

Bessemer is the county seat and is a fine town. It owes its origin to the Colby mine, which was the early bonanza of the range, as the Norrie is now. Bessemer is in a good situation, the ground is favorable for the development of a town. There are three railroads here, the M. L. S. & W., the Wisconsin Central and the D. S. S. & A. The Colby mine is on the lull to the south, 160 feet above the level at the L. S. depot. From the location is a fine prospect to the north, over the copper range in the direction of Lake Superior. The comity buildings are built of Portage Entry sandstone and are very substantial and tasteful. Bessemer has been somewhat quiet for the past two years, owing to the reduction of work at the Colby. and other of the mines in the vicinity, but since the prospects of the Colby have so greatly revived, and also at other locations, the outlook has improved; there is a corresponding encouragement for business activity and growth of Bessemer. In 1884 there was no election precinct in Gogebic county, the territory was then a part of Ontonagon county, and the Gogebic iron range was not esteemed of importance enough at that time by the board of supervisors, to give to the population there a separate voting place. They must go to Ontonagon to vote, and as that place was too far away, they did not vote at all. How far it surpasses now the county from which it was detached, in growth and prosperity!

The Gogebic range is not what it was thought to be at the time of the early excitement; and yet, the aggregate production of. ore is fully as great, no doubt, as was ever anticipated it would be. Its total output in 1890 exceeded that of the Menominee range; and one of its mines yielded more ore than did any other mine in the State, and can furnish an equal amount for 1891 without opening another foot of ground. The Norrie has by far the most ore in sight of any mine in the State. In truth, however, the fact of the Gogebic range furnishing more ore than the Menominee, is not for the reason that it necessarily has more ore, but for the reason that it has more ore of a kind that is in demand. The Gogebic ore is Bessemer and will sell, while most of the ore in the Menominee range is non-Bessemer, and there is less demand for it.

The Gogebic range has not been worked long enough yet to enable us to know what its future will be. The dykes are a serious matter, and much depends on how the mines develop beneath the dykes. At the Norrie, as previously described, they have the Ashland ore under the dyke in undiminished quantity. The prospect is good for a like result at the Aurora; but ill many other places the explorations beneath the dykes have led to nothing satisfactory. There is a good deal of diligent exploration constantly in progress at the mines, and at various locations. Some of these were formerly valued very highly, and explored a good deal with the almost certain expectation of finding ore, but they did not find enough to give commercial value to the properties. Some of these properties have been further explored within the past year, and in instances, the search has not yet been abandoned but I did not learn of the finding of any large body of ore when I went over the range recently. But the important mines are in good shape and show as much ore as is ever seen at the close of the shipping season. They can easily duplicate the product of 1890.

Table showing market price of Lake Superior ores for successive years. Also vessel freights to lower lake ports. These are for standard ores. The price of ore as previously explained varies with the quality as determined by analysis.

Years.	Two Harbors.	Ashland.	Gladstone.	From Escanaba.	Rates of lake freights from Marquette.	Price standard non-Bessemer ore.	Price standard Bessemer ore.
1856					$3 00	$8 00	$8 00
1857					3 00	8 00	8 00
1858					2 00 to $2 50	6 50	6 50
1859					2 00 to 2 50	6 00	6 00
1860					2 00 to 2 50	5 50	5 25
1861					2 00 to 3 00	5 00	5 25
1862					2 25 to 4 50	5 37½	5 25
1863					3 00 to 4 00	7 50	7 50
1864					3 00 to 5 00	8 50	8 50
1865					2 05 to 5 00	7 50	7 50
1866				$2 50 to $5 75	2 75 to 6 50	4 50 to 14 00	9 50
1867				1 05 to 3 05	2 00 to 4 00	8 50 to 13 50	10 50
1868				1 06 to 2 06	2 25 to 3 25	8 25	8 25
1869				1 05 to 2 05	2 75 to 6 50	9 50	8 25
1870				1 65 to 2 50	2 65 to 3 25	8 05 to 9 50	8 50
1871				1 50 to 2 50	2 05 to 4 00	8 00	8 00
1872				2 00 to 5 25	2 85 to 6 00	7 50	9 00
1873				2 30 to 3 00	3 25 to 4 00	9 00	12 00
1874				1 30 to 1 40	1 60 to 2 50	7 00	9 00
1875				1 10 to 1 30	1 30 to 1 50	5 50	7 00
1876				70 to 1 40	1 25 to 2 20	4 50	6 75
1877				65 to 1 50	1 25 to 2 00	4 25	6 50
1878				60 to 1 15	1 00 to 1 50	4 25	5 50
1879				70 to 2 10	1 25 to 3 00	4 75	6 25
1880				1 50 to 2 00	2 00 to 2 75	8 00	9 25
1881				1 00 to 1 60	2 00 to 2 30	7 00	9 00
1882				90 to 1 40	1 25 to 2 00	6 25	9 00
1883				90 to 1 50	1 30 to 1 75	5 00	6 25
1884				65	1 00	4 50	5 75
1885		$1 07 to $1 65		1 00	1 40	4 25	5 50
1886		1 02 to 3 00		1 85	1 75	4 75	5 50
1887		1 75 to 2 75		1 75	2 25	5 25	7 25
1888	$1 02 to $1 60	1 02 to 1 08		90 to 1 45	1 10 to 1 15	4 75	5 50
1889	1 25 to 1 90	1 25 to 90	$ 90 to $1 25	90 to 1 25	90 to 1 25	4 25	5 50
1890	1 35 to 1 10	1 35 to 1 00	85 to 1 00	1 10 to 1 60	1 25 to 1 10	4 80 to 6 00	6 50
1891							

Total shipments of ore, long tons, from all Lake Superior mines, Michigan, Wisconsin and Minnesota.

Years.	Michigan mines. Tons of ore.	Wisconsin mines in Menominee and Gogebic ranges.	Minnesota mines in Vermillion range.
Previous	75,081		
1854	3,000		
1855	1,449		
1856	6,700		
1857	25,646		
1858	22,876		
1859	68,832		
1860	114,410		
1861	49,909		
1862	124,389		
1863	203,055		
1864	247,030		
1865	192,738		
1866	296,713		
1867	365,364		
1868	310,522		
1869	629,097		
1870	859,507		
1871	813,984		
1872	948,253		
1873	1,105,234		
1874	880,934		
1875	881,193		
1876	980,311		
1877	1,025,129		
1878	1,127,583		
1879	1,420,745		
1880	1,948,336	14,143	
1881	2,238,729	197,911	
1882	2,056,931	276,020	
1883	2,518,048	62,175	
1884	2,225,140	34,612	62,124
1885	2,203,100	55,181	225,484
1886	3,179,511	170,294	306,386
1887	3,916,339	409,104	284,252
1888	4,113,861	381,140	511,958
1889	5,329,858	619,822	844,782
1890	7,185,139	918,854	890,014
Total	50,766,109	3,210,256	3,782,005

Table showing the amounts of ore sent out through the several harbors and by rail:

		Long tons.
Shipped by vessel from	Escanaba	3,792,009
" " " "	Marquette	1,267,777
" " " "	St. Ignace	21,501
" " " "	Gladstone	82,902
" " " "	Ashland	1,618,296
" " " "	Two Harbors	880,014
" " rail (estimated)		1,321,544
Total		8,984,043

Amount of ore from the several ranges, 1890, inclusive of the mines in Wisconsin and Minnesota as well as those in Michigan:

					Tons.
Marquettee	range,	number	tons	produced	2,961,463
Menominee	"	"	"	"	2,280,085
Gogebic	"	"	"	"	2,862,481
Vermillion	"	"	"	"	880,014
Total					8,984,043

Table showing product of Michigan mines in the several iron ranges, 1890:

		Tons.
Menominee	range	1,944,789
Marquette	"	2,961,463
Gogebic	"	2,278,983
Total		7,185,139

Table of iron ore production.

Name of Mine.	Production 1890. Tons 2240 lbs.	Aggregate production to date. Tons.
American	19,476	69,320
Anvil	44,154	122,961
Aragon	47,977	49,651
Armenia	36,640	74,454
Ashland	428,380	1,105,700
Aurora	240,686	1,090,388
Bessie	36	36
Brotherton	92,985	240,913
Buffalo	100,464	222,349
Barnum (old mine)	12,559	698,448
Chapin	742,854	3,234,054
Cleveland	331,744	3,488,345
Champion	223,443	2,515,427
Cambria	80,359	571,434
Crystal Falls	3,975	3,975
Comet	3,882	3,882
Curry	73,163	190,542
Cyclops	7,361	273,918
Colby	192,941	1,116,418
Dexter	9,819	40,648
Detroit	6,343	138,413
Dunn	160,958	432,152
Excelsior	254	12,096
Eureka	21,794	21,794
East New York	36,431	79,520
East Vulcan	71,128	See W. Vulcan.
East Norrie	141,228	320,922
Fitch	16,550	16,550
Foster	23,041	231,595
Federal	30,902	344,331
First National	1,406	3,480
Grand Rapids	26,429	65,629
Hamilton	17,072	35,127
Humboldt	21,250	695,194
Hollister	2,020	2,020
Hortense	16,246	
Iron River	195,254	863,380
Iron Star	71,719	225,200
Iron Cliff (New Barnum)	175,031	664,051
Imperial	38,461	88,294
Jackson	124,693	1,050,131
Lake Superior	418,340	4,987,346
Lillie	31,812	343,968
Lowell	6,244	61,642
Lucy	61,185	417,985
Ludington	97,356	849,562
Mangnuate	6,845	6,845
Munsfield	18,302	18,302
Mastodon	66,539	323,504
Michigamme	80,612	741,922
Milwaukee	24,763	374,371
Millie	39,232	109,649
Monitor	31,139	45,072
Nanaimo	3,461	110,937
New York	856	1,055,258
Negaunee	76,489	305,470
Newport	71,489	316,331
Norway	61,716	1,182,586
Norrie	716,852	1,960,900
North Norrie	48,480	48,480
Pabst	172,069	358,020
Palms	50,501	110,719
Paint River	62,500	165,895
Pewabic	36,991	96,961
Perkins	11,981	400,491

Table of iron ore production—Continued.

Name of Mine.	Production 1890. Tons 2240 lbs.	Aggregate production to date. Tons.
Pittsburgh and Lake Angeline	261,681	1,805,342
Prince of Wales	32,114	32,114
Queen	156,962	236,612
Republic	220,066	3,536,723
Ruby	10,929	81,929
Republic Reduction Co.	7,915	46,863
Salisbury	84,861	695,230
Sunday Lake	6,011	11,679
Sheridan	1,000	1,500
Shafer	60,077	125,895
South Mastodon	1,476	5,236
Volunteer	141,524	654,377
Walpole	2,940	15,164
Wheat	15,141	110,146
West Vulcan	31,868	1,198,150
Winthrop and Mitchell	109,526	1,127,025
Youngstown	44,990	155,517
Total	7,185,175	47,094,881
Total production, including mines not given above		50,766,145

PIG IRON.

Statistics of Production of Pig Iron in Michigan Blast Furnaces, 1890 and several previous years.

Name of Company.	1886.	1887.	1888.	1889.	1890.
Eureka Iron and Steel Works, Wyandotte	11,608½	12,484	10,565	15,568	16,704
Gaylord Iron Company, Detroit	8,093	6,360	8,858	6,455	9,656
Detroit Iron Furnace Company, Detroit	6,741	15,272	17,496	15,842	16,567
Union Iron Company, Detroit	6,000	8,758	8,782	11,893	12,106
Peninsular Iron Company, Detroit	5,268	9,207	9,301	9,515	8,991
Bangor Furnace Company, Bangor	12,941	8,201	7,096		
Elk Rapids Iron Company, Elk Rapids	17,434½	11,888	15,726	20,181	19,446
Spring Lake Iron Company, Fruitport	17,768	18,381	14,811	20,376	18,818
Carp River Furnace, Marquette					
Jackson Iron Company, Fayette	10,581	13,825½	14,706	12,049	7,961
Vulcan Iron Company, Newberry	17,890	11,854	16,580	16,909	19,931
Deer Lake Iron Company, Ishpeming	10,808½	10,165½	8,717	10,168	9,855
Iron Cliff Company, Negaunee, Pioneer	11,079	18,587	23,285	24,678	26,298
Antrim Iron Company, Mancelona	9,414	16,240	18,158	22,958	37,001
Pine Lake Iron Company, Ironton	5,050	10,342	12,320	12,520	13,000
Martel Furnace Company, St. Ignace	7,466	10,830	9,352		12,094
Gogebic Furnace Company, Iron River		8,700			
Total	148,952		187,062	198,745	225,537

GYPSUM PRODUCTION.

Table showing the amount of Land and Calcined Plaster product in the State in the years given, and the aggregate for previous years:

Years.	Land Plaster, tons.	Stucco, bbls. 300 lbs each.	Years.	Land Plaster, tons.	Stucco, bbls. 300 lbs each.
Years previous to 1866	100,000	80,000	1878	40,000	18,346
1866	14,604		1879	43,638	50,800
1867	17,439		1880	49,739	106,004
1868	28,887	34,996	1881	31,178	112,812
1869	29,096	41,187	1882	37,821	135,655
1870	41,437	46,179	1883	30,225	201,134
1871	41,126	8,055	1884	27,898	156,677
1872	43,536	50,768	1885	28,181	141,375
1873	44,972	82,457	1886	29,398	153,274
1874	39,126	82,449	1887	28,794	170,145
1875	37,019	44,120	1888	22,177	196,698
1876	30,111	64,896	1889	19,821	201,380
1877	40,000	55,000	1890	29,500	238,700
Totals				920,436	2,408,383

A description of plaster deposit quarries is given in previous reports, particularly in that of 1881.

Table showing the amount of Land Plaster produced by the different Companies in Michigan in the years indicated.

Name of Company.	Number of Tons of Land Plaster produced by Michigan Companies.											
	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
Godfrey & Bro.	9,117	9,000	6,422	6,080	5,682	4,303	4,467	4,560	3,167	3,157	3,150	2,100
Grand Rapids Plaster Co.	8,970	12,000	6,375	7,512	5,013	3,041	1,113	3,832	4,517	2,715	3,220	1,800
Loren Day	7,000	10,000	6,093	6,801	4,400	3,052	4,059	3,714	3,565	2,150	2,850	1,950
Union Mills	4,500	7,500	6,716	8,298	5,500	3,185	3,661	2,687	3,102	2,670	3,000	1,700
D. Noble & Co.	10,585	9,550	6,572	6,087	4,000	3,202	3,900	1,947	3,104	2,010	2,100	1,700
† Smith, Bullard & Co.	1,586	1,500	1,000	2,993	4,600	4,122	4,246	6,019	5,569	3,750	1,013	* 225
Alabastine Co.					4,032	6,090	3,606	5,098	1,958	1,278	3,030	2,950
Geo. H. White & Co.	1,900											
Totals	43,658	49,570	33,178	37,821	38,225	27,898	28,181	29,398	28,794	22,177	19,821	12,725

Table showing the amount of Stucco produced by the different Companies in Michigan, in the years indicated.

Name of Company.	Number of Barrels of Stucco produced by Michigan Companies.†											
	1879.	1880.	1881.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
Godfrey & Bro.		21,000	27,500	30,274	37,000	30,434	30,942	28,273	30,281	36,656	36,670	38,000
Grand Rapids Plaster Co.		23,500	20,400	32,584	40,000	24,390	26,498	28,627	32,386	34,751	44,175	37,000
Loren Day					12,000	18,108	11,193	11,327	15,175	13,967	18,560	8,100
Union Mills		35,000	34,918	23,074	30,000	21,176	15,654	18,027	21,959	30,161	31,935	32,300
D. Noble & Co.		24,504	30,000	27,093	38,000	30,298	26,344	28,770	34,235	33,121	38,940	11,000
Smith, Bullard & Co.				11,817	30,961	23,961	20,706	27,113	21,152	25,106	12,000	55,200
Alabastine Co.					13,172	11,321	10,147	11,147	14,930	17,157	24,400	27,100
Totals		106,104	112,818	135,655	201,133	156,677	141,375	153,274	170,145	196,699	206,380	238,700

* Also 15,000 tons of rock plaster.

† Stucco is reckoned 7 bbls to the ton.

THE COAL PRODUCTION OF MICHIGAN.

Coal is found in this State over a pretty wide area, in Huron, Arenac, Shiawassee, Clinton, Ingham, Eaton, Jackson and in other counties; but it has only been extensively mined in Shiawassee and Jackson counties, principally in the latter. Coal mining has for many years been a prominent industry in and about Jackson. It is less profitable than it used to be. It is difficult to mine coal in Michigan at a profit in competition with Ohio and Pennsylvania. In our State the coal seams are comparatively thin, never more than 4 feet and generally, when worked, 2½ to 3½ feet thick. The mines are very wet, taking all the surface drainage, and are frequently poorly provided with rock covering, so that sometimes, even when the coal seam is of workable thickness the coal cannot be mined by reason of the insecurity of the overlying rock.

Michigan coal is of good quality for steam making purposes and is said to be well adapted to locomotive use. There are really many places where a few tons are gotten out and used for blacksmith and other similar purposes but as a whole the production of this mineral in this State does not increase. Every year there is a local stir somewhere over an alleged remarkable discovery of coal, but usually no important results transpire. The good mines, so far, have been near Jackson and at Corunna, though it is said that the investigations which have been made at Sebewaing in Huron county will result in the opening of a valuable mine and consequent large production of coal. The coal is mined at 60 to 80 feet below the surface.

The total production of the State for every year given has been as follows:

	Tons.		Tons.
1867	380,000	1884	81,712
1877	69,647	1885	58,676
1878	85,312	1886	49,848
1879	82,015	1887	36,545
1880	128,083	1888	59,281
1881	130,190	1889	57,665
1882	135,339	1890	71,991
1883	71,296		

The following are the companies that produced coal in Michigan in 1889:

Name of Company.	Product in 1890, Tons.	Aggregate product, Tons.
R. H. Emerson & Co., Jackson, Mich.	10,000	534,216
Standard Mining Co., Jackson, Mich.	44,362	79,984
Bennett Sewer Pipe Co., Jackson, Mich.	4,878	16,358
Poole Mining Co., Jackson, Mich.	8,234	18,454
Corunna Coal Co., Corunna, Mich.	12,000	160,398
Star Coal Co., Grand Ledge, Mich.	560	585
Starks Mine, Grand Ledge, Mich.	891	1,235
Eureka Coal Co., Grand Ledge, Mich.	352	627
Grand Ledge Coal Mining Co.	614	974
Total	71,991	

SALT.

There are 122 salt manufacturing companies in the State, 97 of which were in operation in the year 1890, having a capacity of production of 5,950,000 barrels.

The salt producing territory is divided by the Inspector into 9 districts, consisting of: 1, Saginaw county; 2, Bay; 3, Huron; 4, St. Clair; 5, Iosco; 6, Midland; 7, Manistee; 8, Mason; 9, Gratiot.

Table showing production in each county in 1890.

County.	Fine, barrels.	Bulk, barrels.	Fine Packers, barrels.	Packers, barrels.	Solar, barrels.	Second Quality, barrels.	Total barrels, 1890.
Saginaw	695,393	306,127	308	1,659	18,896	25,571	1,006,854
Bay	581,073	214,787	462	3,138		20,644	820,103
Manistee	826,293	84,527	3,716	12,091		79,298	1,006,525
Mason	333,371	16,013	2,270			15,468	368,022
Huron	32,676	23,966		37			55,681
St. Clair	235,754	81,123	1,619	5,812		708	242,011
Iosco	289,232						289,232
Midland	46,812	1,453	55			1,389	49,009
Grand total	2,921,003	725,998	9,430	20,337	18,896	143,073	3,838,637

Comparative table of yearly production.

Year.	Fine.	Packers.	Solar.	Second quality.	Common coarse.	Total.
1869	513,908	123,008	15,264	19,177		516,258
1870	568,336	17,989	15,507	19,650		621,352
1871	635,923	14,677	37,645	19,930		728,725
1872	672,034	11,110	31,461	19,826		724,481
1873	746,702	23,871	32,267	20,706		873,346
1874	993,757	20,090	29,391	16,741		1,059,979
1875	1,027,866	19,233	24,336	19,410		1,091,895
1876	1,402,430	14,283	24,283	21,668		1,462,729
1877	1,510,841	20,939	22,518	26,818		1,660,997
1878	1,770,301	19,267	33,541	32,615		1,855,884
1879	1,997,350	15,641	18,020	29,027		2,058,040
1880	2,589,037	16,891	22,287	48,623		2,676,388
1881	2,673,910	13,885	9,683	52,821		2,750,299
1882	3,028,542	17,208	31,325	60,132		3,037,317
1883	2,828,097	15,424	16,735	33,525		2,894,672
1884	3,087,031	19,308	16,057	38,508		3,161,806
1885	3,230,626	15,480	19,849	31,428		3,297,403
1886	3,548,331	22,221	31,177	71,235	3,893	3,677,257
1887	3,108,070	19,395	13,966	73,905	178,978	3,944,309
1888	3,730,319	18,126	30,174	87,694	18,915	3,886,228
1889	3,721,009	19,780	17,017	88,455	4,978	3,846,979
1890	3,656,921	20,337	18,896	143,073		3,838,937
Total						49,592,622
Salt manufactured prior to 1869						3,282,117
Total amount of salt produced in Michigan to date						52,874,739

The following figures show the average net price per barrel received by manufacturers for salt:

Year.	Price.	Year.	Price.
1866	$1 80	1879	$1 02
1867	1 77	1880	75
1868	1 85	1881	85[illegible]
1869	1 58	1882	70
1870	1 32	1883	81
1871	1 40	1884	75[illegible]
1872	1 46	1885	70
1873	1 87	1886	60
1874	1 19	1887	57 4
1875	1 10	1888	58 5
1876	1 05	1889	54 3
1877	85	1890	55
1878	85		

STONE.

BROWNSTONE.

The business of quarrying sandstone of valuable quality for fine buildings, etc., is increasing on Lake Superior. The old operators in this line have enlarged their business and several new companies have been formed and preparations made for quarrying and preparing building stone for market.

The largest operators in this State are Furst, Jacobs & Co., and the Portage Lake Red Sandstone Co. The former quarry both at Marquette and Portage Entry but work up the stones into merchantable blocks only at Marquette. It is estimated that they have doubled their capacity for production and will furnish twice as much stone in 1891 as in any previous year. In 1890 Furst, Jacobs & Co. produced in the Marquette quarries 106,000 cubic feet of block stone, 2,872 cubic feet coursing stone, 1,642 cords rubble. At Portage Entry quarry the product was 449,465 cubic feet of block stone, 2,055 cubic feet of coursing stone and 374 cords rubble stone. The companies dividends in 1890 amounted to $100,000. The Portage Entry Bed Sandstone Co. shipped about the same amount. The stone has been used in almost every city in the land, New York, Chicago, Denver, New Orleans, etc., and is everywhere admired and leads every other variety from whatever locality.

Among the important companies organized lately to quarry sandstone are

THE ROCK RIVER BROWNSTONE COMPANY.

This company has commenced operations near Rock River station in Alger county, where are extensive deposits of sandstone.

THE MICHIGAN REDSTONE COMPANY,

whose location is at Portage Entry has done preliminary work and is now ready to operate commercially. The quarry is known as the Messmer property.

SLATE.

The production of this mineral has ceased for the time being. Mr. Turner, the president of the Michigan Slate Co., is building a railroad from the slate company's location on Huron Bay to Champion, etc. Also building an ore dock at the Huron Bay terminus. The purpose is to open up the country through which the road passes, 35 miles, and to carry iron ore.

It has been suggested that the slate could be pulverized and thus become an excellent material for making brick. The trouble with the manufacture of roofing slate, is that the rock is fractured, there is too much waste. The material, that is the quality is of the best, but there is a great loss through the fracture of the rock.

GOLD.

There is less excitement regarding gold exploration than there was a few years ago, still interest in the matter keeps up, and it is possible that in the new field, designated as the north gold range, or Dead River gold district, some "finds" may be made that will surpass any heretofore made known. Mr. Juluis Ropes and others at Ishpeming, who have given a good deal of attention to gold exploration, are quite confident of success in this recently examined territory. Fine specimens have been procured and better veins, veins in granite, carrying gold have been found. It is expected that as soon as the snow has melted considerable activity will prevail in the matter of gold exploration.

Of the mines that have been operated, the

MICHIGAN COMPANY

is preparing to make a thorough test of its rock by having it crushed at the Ropes mill, and ascertain its percentage of gold. It has been done before with good results and they propose to try it again. The Peninsula rock, 40 tons of it will be treated in the same way. There is nothing special to add about the Peninsula, Superior, etc., gold companies; but little has been done.

THE ROPES MINE

continues to be operated. The company treated in 1890, 31,578 tons of rock in the mill, from which was obtained $2.45 per ton. The cost of milling and treating the rock was $1.98 per ton.

The amount of bullion for the year was, gold, $54,681.88; silver, $2,037.71. There were produced in concentrates, gold, $16,450.82; silver, $6,397.86. The mint charges and charges for reduction of concentrates amounted to $14,327.51, and the net proceeds were $65,240.67.

Total production of the mine to date, $348,063.68, of which sum $313,837.71 was gold.

The assets of the company amount to $116,119.02.

The total depth of the mine is 640 feet, to the 13th level, being an extension of 88 feet the past year, also 190 feet of winzes made and 893 feet of drifting done. Of course they find some rich rock but the average seems to be low, lower than it has been previous years. It is becoming richer again in the bottom.

MINE INSPECTORS' REPORTS.

Table giving the number of gross tons of iron ore mined, number of persons employed underground and on surface, and number of fatal accidents from September 1, 1889, to September 1, 1890, in Gogebic county.

C. M. Boss, *Inspector.*

Name of Mine.	Location.	Gross tons of ore mined.	Number persons underground.	Number persons surface.	Total number persons.	Fatal accidents underground.	Fatal accidents surface.	Total fatal accidents.
Anvil	Bessemer, Mich.	45,000	87	32	119	1	.....	1
Ashland	Ironwood, Mich.	417,519	446	163	609	1	.....	1
Aurora	Ironwood, Mich.	256,972	417	109	526	8	.....	8
Brotherton	Wakefield, Mich.	82,331	143	35	178	.....	.....	.....
Colby	Bessemer, Mich.	167,718	308	97	405	3	.....	3
Comet	Wakefield, Mich.	4,020	10	18	28	.....	.....	.....
Eureka	Bessemer, Mich.	28,561	38	22	60	.....	.....	.....
Federal	Bessemer, Mich.	13,485	32	16	48	1	.....	1
Mount Hope	Ironwood, Mich.	98,870	134	42	176	.....	.....	.....
Norrie	Ironwood, Mich.	865,000	1,100	250	1,350	.....	.....	.....
Palast	Ironwood, Mich.	165,666	236	48	284	.....	.....	.....
Palms	Bessemer, Mich.	47,815	72	27	99	2	.....	2
Phœnix	Bessemer, Mich.	12,800	25	7	32	.....	.....	.....
Ruby	Bessemer, Mich.	11,661	32	6	38	.....	.....	.....
Various explorations	.....	.....	86	42	128	2	.....	2
Totals		2,211,124	3,041	1,062	4,103	16	.....	16

Record of accidents in mines in Menominee county.

J. B. Knight, *Inspector.*

Mine.	No. men employed.	No. fatal accidents.	No. non-fatal accidents.	No. persons killed.	No. persons injured.	No. men employed to each man killed.	No. men employed to each man injured.
East Vulcan	260	3	6	3	6	98	47
West Vulcan	185	.....	8	.....	8	.....	23
Curry	250	1	9	1	9	250	28
Aragon	176	1	7	1	7	176	25
Harrison	35	1	.....	1	.....	35	.....
Perkins	30	.....	.....	.....	.....	.....	.....
Norway	235	1	7	1	7	235	31
Cyclops	11	.....	.....	.....	.....	.....	.....
Pewabic	159	1	2	1	2	159	79
Walpole	60	.....	.....	.....	.....	.....	.....
Millie	142	1	2	1	2	142	71
Chapin	1,705	6	64	7	65	252	26
Old Ludington	25	.....	.....	.....	.....	.....	.....
New Ludington	851	2	7	2	11	176	32
Hamilton	201	2	.....	2	.....	100	.....
Smaller mines	127	.....	.....	.....	.....	.....	.....
Totals	4,062	19	112	20	130	201	33

KEWEENAW COUNTY.

List of fatal mine accidents, 1890.

J. G. Reckard, *Inspector.*

Name of Mine.	Nationality of Victim.	Cause of Accident.	Judgment of Jury.
Central	Finlander	Fall of ground	Carelessness of victim.
Central	Englishman	Fell in the mine	Carelessness of victim.
Central	Finlander	Fell into shaft	Carelessness of victim.

Total number of miners and laborers working underground in the county of Keweenaw is 846. Average death rate for the year, 1 to 282 employed.

List of mines and number of men employed in each in 1890.

Name of Mine.	No. of Men.
Central	270
Allouez	300
Copper Falls	276
Total	846

HOUGHTON COUNTY.

List of mine accidents from Sept. 1, 1889, to Sept. 1, 1890.

JOSIAH HALL, *Inspector.*

Name of Mine.	Nationality of Victim.	Occupation.	Cause of Accident.
Calumet & Hecla	Swede	Miner	Blast.
Calumet & Hecla	Finlander	Miner	Blast.
Tamarack	Irish	Miner	Fell down shaft.
Huron	Finlander	Miner	Blast.
Huron	Finlander	Miner	Fell down shaft.
S. Hecla	Finlander	Timberman	Fell down winze.
Peninsula	Polander	Fireman	Scalded.
Atlantic	German	Watchman	Fell down shaft.
Osceola	Finlander	Miner	Explosion of dynamite.
Osceola	Irish	Miner	Explosion of dynamite.
Osceola	Polander	Helper	Explosion of dynamite.
South Hecla	Italian	Trammer	Fall of vein rock.
South Hecla	Austrian	Trammer	Fall of rock in mine.
South Hecla	Finlander	Laborer	Struck by skip.
Tamarack	Austrian	Laborer	Struck by plumb bob.
Osceola	Polander	Trammer	Fall of conglomerate.
Centennial	Finlander	Laborer	Fall of hanging rock.
Huron	English	Wheeler boss	Fall of hanging rock.
Calumet	Austrian	Trammer	Fall of skip.
Tamarack	Austrian	Laborer	Fall of bucket.
Tamarack	English	Timberman	Fall of bucket.
Tamarack	English	Pumpman	Suffocated.
Tamarack	English	Miner	Suffocated.
South Hecla	Austrian	Trammer	Fall of rock.
South Hecla	Austrian	Trammer	Fall of rock.
South Hecla	Austrian	Trammer	Fall of rock.
South Hecla	Italian	Trammer	Fall of rock.
Osceola	Irish	Miner	Suffocated.
Osceola	Irish	Miner	Blast.
Atlantic	Swede	Laborer	Fall of hanging rock.
Tamarack	Finlander	Laborer	Fell down winze.
Tamarack	Austrian	Laborer	Fell down shaft.
Huron	Italian	Miner	Fall of conglomerate.
South Hecla	Irish	Miner	Fell into shaft.
South Hecla	Austrian	Trammer	Struck by skip.

In Ontonagon county there were no fatal mine accidents in 1890, and I have been unable to obtain complete data for Iron county.

MARQUETTE COUNTY.

List of fatal mine accidents in Marquette county, 1890.

ANTHONY BROAD, *Inspector.*

Name of Mine.	Nationality.	Occupation.	Cause of Death.
Lake Superior	Swede	Miner	Fall of rock down shaft.
Lake Superior	English	Miner	Fall of rock in shaft.
Lake Superior	English	Miner	Breaking of ore chute.
Lake Superior	Finn	Trammer	Breaking of ore chute.
Lake Superior	English	Miner	Fall of rock in mine.
Winthrop	English	Miner	Hit by bucket in shaft.
Mitchell	American	Pipeman	Fell down shaft.
East Jackson	American	Engineer	Fell down shaft.
Jackson	Finn	Miner	Explosion.
Jackson	Finn	Miner	Fell into chute.
Jackson	Finn	Miner	Fall of rock.
Jackson	Finn	Miner	Fall of rock.
Queen	Irish	Trammer	Fell down shaft.
Queen	Finn	Trammer	Fall of rock in mine.
Buffalo	Finn	Trammer	Explosion.
Buffalo	Swede	Miner	Explosion.
Buffalo	Swede	Trammer	Explosion.
Prince of Wales	Finn	Miner	Explosion.
Prince of Wales	Finn	Miner	Explosion.
Prince of Wales	Finn	Trammer	Fell down shaft (drowned).
Lucy	Swede	Miner	Fall of rock.
Michigamme	Swede	Miner	Riding in skip.
Michigamme	Swede	Miner	Riding in skip.
Michigamme	French	Miner	Riding in skip.
Michigamme	Irish	Miner	Riding in skip.
Lake Angeline	Swede	Skip tender	Fell down shaft.
Cleshire	Swede	Miner	Fall of rock.
East New York	Swede	Trammer	Lifting ore.
Cleveland	Swede	Blaster	Blast.
Cleveland	Swede	Blaster	Blast.
Cleveland	Finn	Trammer	Fall of rock.
Cleveland	English	Miner	Fall of rock.
Cleveland	Swede	Trammer	Struck by timber in mine.
Cleveland	Finn	Miner	Fall of rock.
Republic	French	Miner	Explosion.
Republic	Swede	Miner	Fall of rock.
Republic	Belgian	Mule driver	Fell into pit.
Republic	Swede	Miner	Fall of rock.
Republic	Swede	Miner	Fall of rock.
Salisbury	Swede	Carpenter	Fall of shaft house.
Salisbury	Swede	Carpenter	Fall of shaft house.
Salisbury	Finn	Trammer	Fall of rock.
Champion	English	Miner	Fall of rock.
Champion	Swede	Trammer	Fall of rock.
Champion	Finn	Trammer	Fell down stope.
Champion	Swede	Miner	Fall of rock.
Volunteer	Swede	Miner	Fall of rock.

ERRATA.

[original document]

Page 60.—Table of Products, the South Buffalo should be added: Production 1890-1, 46,383 tons; total, 245,363 tons.

The Hortense.—Aggregate production, 30,571 tons.