FIRST ANNUAL REPORT OF THE COMMISSIONER OF MINERAL STATISTICS OF THE STATE OF MICHIGAN, FOR 1877-8 AND PREVIOUS YEARS.

BY AUTHORITY

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Contents

PREFACE.

OFFICE OF COMMISSIONER OF MINERAL STATISTICS,
Marquette, Michigan, Jan'y 1, 1878.
HON. CHARLES M. CROSWELL, Governor of Michigan:

Sir:—Herewith, in compliance with law, I have the honor to submit the first annual report of the commissioner of mineral statistics.

The report embraces the statistics for 1877-8, as required by the statute, and also, in order to completely exhibit the status of the mineral resources of the State, I have collated the statistics of previous years.

The arrangement of the topics, other than statistics, is as follows:

1. A popular geological sketch of the iron bearing series (Lower Huronian.)
2. Historical sketch of the iron district.
3. Description of the iron mines.
4. Historical and geological sketch of the copper district.
5. Lake Superior brownstones.
6. Slate,
7. Iron River silver district.
8. Ganister, or quartzite.
9. Marble.
10. Gypsum, or plaster.
11. Salt.

Prof. Charles D. Lawton prepared the historical sketch of the iron district, which I regard as the most reliable paper on the subject yet published. To him I am also indebted for the chapter on gypsum.

The chapter on copper is from the able pen of Hon. John H. Forster, whose thorough knowledge of the copper district and intimate connection, since its inception, with the practical development of that industry, together with that felicitous weaving of dry statistics into pleasing narrative, pre-eminently fitted him for the task. His paper is an invaluable contribution, which will be read and appreciated more and more as time passes.

I acknowledge my obligations to S. S. Garrigues, Ph. D., for his very interesting and replete account of the salt products of the State.

My thanks are due to the officers of the mining and furnace companies, as well as to the management of the Marquette, & Ontonagon Railroad and the Chicago & Northwestern for many courtesies.

To Mr. J. R. Grout, agent of the Detroit & Lake Superior Copper Smelting Works, and his assistants. Messrs. Z. W.. Wright and E. Reeder, I am indebted for accurate statistics of the production of the copper mines; also to L. G. Emerson, M. E., for valuable information.

Valuable assistance was given me by Hon. E. G. D. Holden, Secretary of State; Hon. Ralph Ely, Auditor General; Hon. H. R. Pratt, Deputy Auditor General, and Mr. E. Bow, in the office of the Secretary of State. Very many others have contributed to this report to whom I am under grateful obligations.

I have availed myself of information contained in the Geological Report of Michigan, 1873, and in the "Mineral Resources of Lake Superior," by Hon. A. P. Swineford.

It has not been possible to report on the coal mines or the blast furnaces; nor have I been able to complete a contemplated geological cross-section of the copper series. Considerable data relating to these subjects has been collected and reserved for a future report.

The compilation of statistics of previous years has consumed much more time than I anticipated would be required. No official compilation has before been attempted, and accordingly the data is necessarily scattered and in some respects unobtainable.

It is regretable that some typographical errors in the text were not discovered and corrected, especially in a few analyses of iron ores, wherein the decimal point was inadvertently misplaced; reference is, however, here made to a table of errata at the end of the volume.

It has been my endeavor to make this report of practical value to the people of the State, and with that aim in view I have spared neither time nor necessary expense in the compilation. It is submitted in full confidence that

the work will meet a want long felt—a compilation of statistics of the vast mineral resources of Michigan.

CHARLES E. WRIGHT, M. E.,
Commissioner of Mineral Statistics.

NOTE.—I understand that a bill will be introduced the coming session of the legislature to provide for a cabinet of minerals in the new capital building, representing the varied resources of the State. The cost of the collection would be small, while its value as a source of information could hardly be estimated.

GEOLOGY OF THE LAKE SUPERIOR IRON REGION.

It is desired within the limits of this report on the mineral statistics of the Upper Peninsula of Michigan, to present a brief but comprehensive view of the archean formation of this portion of the State. This season, however, will be considered, geologically, only the Laurentian and Lower Huronian* periods. So little is definitely known of the copper series, which overlie the Lower Huronian, that it is purposed next season to devote the greater part of this section of the report, to that district. I have collected considerable material relating to the copper region; but to publish it in its present crude state, would be doing neither this great interest nor myself justice.

To start with a clear record we will go back to the now generally accepted theory of the primitive condition of the earth; that is, when the surface of the molten mass of the globe had crusted over; that we may understand the source of the first sedimentary rocks, designated by most geologists, as the Laurentian. It is very questionable if any of the first rocks thus formed are extant; for, as the cooling of the globe progressed, the crust must have formed and reformed many times. This seems very natural, when we know that molten rock shrinks nearly 1-12 in cooling, which alone, would of necessity produce wide cracks here and there over the surface; and the contracting force would then cause the fiery liquid to shoot upwards and overflow the crust, which from the superimposed weight, would sink to be again lapped away by the seething bath beneath. This process, repeating itself over and over again, would, as we can readily imagine, afford us a very uneven surface. During this time we must suppose that the deposition of the sedimentary rocks, had in a measure begun; and it is highly probable, that even much of these early sediments were remelted: but this is a matter of speculation, and we will advance a step.

* This term "Lower Huronian" is used to distinguish it from the Copper series which by some is supposed to belong- to the Huronian rocks, and it is not impossible that this latter series may eventually be designated as the "Upper Huronian."

Our first rocks were mostly granitic; this is true, not only of the primitive, but also of the later Laurentian ones.—Among the latter, we frequently see coarsely crystalline massive granites, passing into gneissoid rocks; and these graduating into mica schists; and the latter even, as imperceptibly, into slate. So gradual is this change, that it is quite impossible to draw the line, separating each group by itself.

The cause of this great diversity of rocks, when derived from the same source, is to many, a matter of wonderment, though readily understood. Let us examine carefully, any exposed granite ledge. If it be of a feldspathic nature, the rate of decomposition will be proportionately rapid, and a slight blow, dealt on some of the disengaged blocks, will often break them into a thousand pieces, disproving the common phrase "as imperishable as granite." In fact, some of the more basic granites may be classed, as among those, the least able to bear the wear of time.

Taking some of these broken fragments, the feldspar is readily made out. It may have a milky texture, and crumble in the fingers, still, the unmistakable cleavage is there.

In the fire clay beds near Grand Rapids, Wisconsin, which .are nothing more than decomposed granite ledges, the original structure of the granite is plainly visible. The crystal form of the feldspar still remains, but its chemical composition is changed; for out of the feldspar has been dissolved the alkalies, leaving the white, greasy-feeling mineral, kaolinite, behind. The scales of mica are still perfect, but are more or less brittle; and the only unaltered mineral is the quartz, which may now be easily freed from the material that once held it so firmly.

Thus it is with the granite ledge before us. The moisture penetrates the rock, entering every seam and pore, the frost then opens the crevice still more, until the loosened rock is obliged to relax its hold, and "old gravity" hurls it down—not to its resting place, however; for the heat and cold, the wet and dry, co-workers of chemical action, all combine to lessen the size or break up the block, so that the mountain torrents are enabled to roll it along their rocky beds.

The boulder, in this rough-and-tumble journey, is either broken, or its corners become rounded. If it be a jointed block and easily fractured, the chances are that it will be reduced to pebbles, or ground into fine sand or silt. In any case above considered, the greater portion of our original block has disappeared, either as a sediment, or as we have already observed, in the feldspar, has been partially dissolved.

The disposition of the material in the former of these two conditions, is easily traced out. The coarser material is deposited first, which, too, is usually more of a silicious or quartzy nature. The finer portion is borne still farther, until the point is reached, where the specific gravity of the particle, overcomes the velocity of the current and the buoyancy of the water. These deposits, however, are subject to frequent changes, since a heavy freshet will often transport them farther along, and, on the other hand, a drouth will locate them nearer their source. This sorting out and grading of the material is constantly in operation on every hill side; and we thus have

depositions of variable degrees of fineness and of different chemical composition.

The material in solution is not so easily traced to the end. A large proportion of it is absorbed by the earth, where, meeting with other elements, it enters into new combinations. Another portion is taken up by vegetation; still another portion is conveyed in solution, to the sea or ocean, where, in case of the alkalies, it may combine with chlorine, affording the chloride of sodium—domestic salt—and other less common salts.

There are other sources of rock building material; still, they are as easily understood, whether they be of a mechanical, chemical, or organic nature; and we have only to conceive of these agents constantly at work and we thus see how it is that such great thickness of beds is possible.

When the different layers had attained considerable depth, the lower ones were necessarily subjected to an immense pressure. This, combined with the heat, would very soon harden them. Crystallization was no doubt progressing at the same time. The resultant of these mechanical and chemical forces are our so-called metamorphic rocks.

The granite and gneisses have about the same composition, the only esssntial difference in most cases being that the gneiss has preserved its original bedding planes, while the granite is massive. The cause of this is supposed to be by some partially due to the variation of temperature and pressure during metamorphism.

The Laurentian rocks of our Lake Superior country, are chiefly granite and gneissoid rocks; but, unlike those of Canada, have not thus far proved to be of much economic value. In Canada, the iron ore deposits occur largely in the Laurentian rocks, but in our region, when the experienced explorer "comes to granite" he turns away; for he knows only too well that the Laurentian fields have ever been to him as barren of iron ore as the Lower Huronian is of copper.

There are, however, narrow seams and fissures filled with galena, pyrites and quartz, which will often cheer up the heart of the novice, and cause him to believe that the galena is pure silver and the yellow pyrites, virgin gold; and that the only question is to devise some method by which they can be cheaply wrought. This may seem hardly credible; still I should not care to state how many times prospectors have brought to me small pieces of rock containing a few bright, yellow specks of copper pyrites, or silver gray ones of galena, or micaceous iron ore—the result, perhaps, of weeks, or even months, of hard, wearisome labor—only to find that they were worthless. If the explorer were honest in his convictions, his disappointment is correspondingly great; and as a rule he leaves behind him his former "bright prospects."

The fact that so little of value has been found within the Laurentian area, will account for our lack of knowledge of these rocks. It is possible that within the Laurentian fields are isolated knobs, or islands, of the primitive rocks; but as yet, I have never found or examined any granites from the Upper Peninsula, or from Wisconsin, that were other than metamorphic.

With the unaided eye, it is quite impossible to distinguish a metamorphic granite from an igneous one; but, since the lithologist has brought to his aid the microscope, it is a question that can in most cases be satisfactorily settled. We have seen that the materials of which the primitive granites are composed, was once in a fluid state, while that of the Laurentian rocks, is sedimentary. Each was then in an amorphic condition,-—the one a fluid, the other, possibly, a fine mud, and in the granites, approximately of the same chemical composition.

During the process of crystallization it is very natural that the crystals of quartz and feldspar should have enclosed portions of the original material from which they were derived, also small crystals of the accessory minerals.

Taking a small chip of an igneous granite and making a thin, transparent section of it, and then, by placing it under a powerful microscope, we see in the quartz grains small cavities filled with glass or stone material. On the other hand, a thin section of the metamorphic granite will show in the quartz grains, cavities filled with liquid. The latter having been included at a higher temperature than what it is at present, has shrunk in volume, thereby producing a small vacuum bubble, which is constantly dashing around in its narrow confines. The liquid is sometimes water or a salt solution, or, as I have observed in rocks from other localities, it may be condensed carbonic acid. These cavities are usually very minute, averaging not more than 1-1,000 of an inch across. Though apparently very insignificant, their importance can hardly be appreciated.

So far as my own observation goes, we have, among our archean rocks, two granites: one the Laurentian, and the other coming between the copper and iron series. They so nearly resemble each other in their lithological characteristics that it seemed for a long time quite impossible to distinguish them in hand specimens, or even in isolated outcrops with any degree of satisfaction. They are of the same mineralogical composition, and in other respects are much alike.

In a granite specimen from Wausau, Wisconsin, which Prof. R. D. Irving sent me two years ago for examination. I first discovered in granite the presence of liquid inclusions containing a small transparent cube of salt. Turning to my own cabinet of mounted sections, I soon found that these saline inclusions were confined entirely to the upper granite, overlying the iron bearing series. Here then, though trifling in itself, was an interesting discovery. Since then I have frequently applied this test and cannot assert positively that it has failed me in a single instance.

Our Laurentian rocks are often traversed by narrow dykes or fissures, filled with igneous rock material, such as basalt, or more frequently the filling is of a seggregated or sedimentary character. It is more than probable however, that the majority of the apparent

igneous veins, especially the dioritic ones—are the softened strata of the Huronian brought to a semi plastic condition by heat. To strengthen this view, one may often observe under the microscope, in thin sections of the diorite, a "fluidal" structure, showing crystals of hornblende, broken into pieces, and scattered along in one direction, still, not so greatly seperated but what we can readily see where the various fragments could be reunited.

Dr. Rominger, our present state geologist, has devoted considerable time to investigating this vein phenomena, in the immediate vicinity of Marquette, which I trust, from a purely scientific stand point, will throw some light upon this long neglected branch, of the geological history of the Upper Peninsula.

After the Laurentian rocks were formed, and even during their deposition, the crust beneath was gradually cooling and shrinking, subjecting the partially crystallized sedimentary rocks to a strong lateral pressure: this of itself would tend to bring out their latent heat, which would expand them, increasing the pressure still more, thereby causing the strata to become more or less wavy, or folded.

The surface of the earth at the close of the Laurentian, was, no doubt, very uneven: high mountain ranges existed where at present are only level plains, with nothing—save perchance, the dip of the strata—to denote their former presence.

The same destroying agencies that operated against the primitive rocks were even as active among the Laurentian, though probably the atmosphere was less acid, and the temperature much lower, in the latter than in the former: but there, no doubt, was more moisture, which would, in a measure, compensate for the partial loss of acidity.

Chiefly from the ruins of the Laurentian rocks have been formed the Lower Huronian strata, the home of the iron ore deposits of Michigan. This period was first divided by Major T. B. Brooks, in his geological report of Michigan, into nineteen different members, represented by Roman numerals. These have not all been classified, especially those at the base of the series. (See diagram of “Lower Huronian rocks.”)

Some objections were made last summer, (1876), by Dr. Rominger, as to the non-conformability of our so called Laurentian and Huronian series, on the ground that he had observed in several instances "a perfect conformability of these supposed distinct series." It seems perfectly natural to me that this should often occur; and were I to find ninety-nine places where an apparent conformability existed, and only one of decided non-nonconformability, the latter would, in my estimation, outweigh all the former.

At Penoka Gap, where the Wisconsin Central Railroad crosses the Range, may be seen as complete a case of non-conformability of the Laurentian and Huronian as the most skeptical could wish. The strike of the gneissoid granite there is S. 75° E., and the dip is about 70° degrees to the south while the plainly bedded Huronian strata, in direct contact, have a strike of north 70° east, and a dip of 65° degrees to the north. The Huronian series of the Penoka Range correlate very well with the Michigan members of the same period.

The first member of our diagram of the Huronian series is a feldspathic quartzite, and the next above, a garnetiferous mica schist. The other strata, until we reach No. V. of the diagram, are the unclassified ones, and are taken from a geological section of the Cascade range, given by Major Brooks in his geological report.

In writing this, is suggested the possibility of these latter members of this locality belonging to those above V. In that case, we should have to consider the prevailing dip of the formation to the north; and, consequently, assume that some of the members were overturned. This folding and tilting over of the strata, is not an unfrequent phase of the Huronian beds.—(See cross-section of the McComber mine.) At some future day I hope to work out this interesting structural problem. We will therefore, leave, for the present, this comparatively unsettled field, describing only the ores and mines, which latter will be considered farther along in this report.

Formation No. V. is represented chiefly by quartzite, silicious marble and novaculite, or "whetstone rock." See specimens Nos. 2, 3 and 4, of State collection. The quartzite is usually of the lighter shades of grayish white, or sometimes white. It is usually vitreous, and has a

coarsely granulated appearance. It is of sedimentary origin, as may be seen by the frequent occurence of ripple marks. Some of the largest out-crops of this rock are just south of Marquette, which extend for several miles westward.

The quartzite is now used by the Bessemer steel makers, as a lining for their converters, and is technically known as “gannister." Several thousand tons have been quarried and shipped for this purpose, and it is considered fully equal to the English article. Eventually, no doubt, when the requirements of the consumer are fully understood, this present infantile enterprise will become one of our important interests.

The marbles here are usually of a pinkish shade. They are silicious and often graduate into the quartzite. Formerly they were used quite extensively by the local blast furnaces, as flux; but at present, with the small margin of profit on pig iron, it does not pay to smelt limestone containing so much silica. A sample of the marble, from near the old Morgan furnace; gave me, on careful analysis, the following result:

Carb. of lime	49.10
Carb. of magnesia	41.00
Oxide of iron	.43
Silica	8.00
Undetermined	1.47
	100.00

Some portions of the marble are finely variegated with delicate shades of pink, yellow, drab, &c., and would make very beautiful mantles, table or stand tops. It is exceedingly fine grained and susceptible of a high polish.

Quite recently (Sept. 1878) has been found in the immediate vicinity of Ishpeming, some very superior varieties of marble and serpentine, which I shall describe farther along in another chapter.

The novaculite has furnished most excellent hones, equal in quality to the Turkish ones, and some of the large slabs, no doubt, would answer well for lithograph stone. The rock is more or less slaty in its structure and texture. It is usually of a pearly gray or grayish drab color. With the knife point it may be readily scratched; but is not easily abraded by mere friction.

It is to be regretted that this once remunerative industry —the manufacture of whetstones—has been allowed to remain idle so long. That there is money in it, is not denied; but it is a trade of which only a few know anything about, and therefore dislike to enter into it.

No. V. is sometimes represented by silicious slates, magnesian schists and argillites.

Turning to formation VI. we have chiefly silicous slaty schists, usually jaspery or magnetic. At the Republic mine may be seen, better than any where I know of, the different members from VI. to XIV. inclusive of our diagram, and we will therefore describe those of that locality. No. VI., there is an actinolo-magnetic quartz schist. (See spec. 5). It is banded with purplish brown layers of variable thickness, from that of a sheet of paper to two inches. On the weathered out crop, north-east of the mine, it presents a very pretty and interesting sight. Glacial action has worn smooth and polished the upturned edges of the nearly vertical strata: showing in detail, to the best advantage, the banded structure. This is not only true of No. VI., but of the succeeding members to No. XIV. No. VI. is extremely fine grained, and is strongly magnetic. In the hand specimen, even with the aid of a good lens, but little of a definite character can be said of the rock. A thin transparent section of the rock, placed under the microscope, shows it to be composed of small grains of quartz, bushy fragments and blades of actinolite, (fibrous hornblende), and minute crystal particles of magnetite; also an occasional imperfect crystal of feldspar.

No. VII. This formation is commonly known in the Iron Region, as greenstone, diorite or trap. That at the Republic range is a hornblende rock. It is medium to coarse grained in texture, and has a dark green color, which weathers or fades to a grayish white. It is massive and strongly jointed, rarely ever showing any signs of bedding. Under the microscope, a thin section of the rock is seen to consist chiefly of hornblende and quartz, with plain and striated feldspar, brownish scales of mica (biotite), and grains of magnetite. This formation in other localities is not confined to one kind of rock; but is represented by slates and magnesian schists. On the Penoka Range, at the gap, the greenstones are replaced by the slates; but farther westward, a few miles, the greenstones again occupy their old position.

No. VIII. is a banded ferruginous quartz schist, differing mainly from No. VI. in containing less actinolite; while many of the layers, on their polished edges, present a graphic appearance, from small dendritic fragments of brownish jasper. In some localities the magnetite entirely disappears, or is replaced by the red oxide of iron, affording then a jasper.

No. IX. is a hornblende rock, to all appearance the same as No. VII., but it contains more quartz and less feldspar and mica.

No. X. is a banded ferruginous quartz schist. In the Ishpeming district, it is a jasper; but west of there, where the magnetic ores are found, it is usually a magnetic schist. In this formation are located the so called soft hematite mines. In these mines it appears that the finely divided silica has been more or less dissolved out by alkaline thermal water, leaving the iron oxide and other bases behind. In some of these hematite deposits, so complete has been this process that only a very small per centum of the silica remains. (See description of McComber mine.) One fact worthy of mention here is that these mines are generally located where has been the greatest amount of disturbance. This tilting and bending of the strata has broken up the formation somewhat, and afforded the dissolving agents a better chance for gaining access to the silicious layers. These mines offer excellent opportunities for studying the complex structure so common to the Huronian rocks.

No. XL formation is a hornblende rock much like Nos. VII. and IX. and constitutes the last of the greenstone belts underlying the iron ore. It may be noted here that in these hornblende rocks, the quartz sometimes disappears, and the orthoclase is replaced by oligoclase, and there results a diorite. So far, however, as my own observations go, the hornblende rocks are much more abundant than the diorites; and it was for this reason that I chose the well-developed Republic range to illustrate in part the Huronian series.

No. XII. is a red banded jasper; and it generally forms the main foot-wall of our iron mines, though frequently a thin layer of chloritic, or talcose schist comes between the jasper and the ore. When the jasper is of a blood-red color, as is often the case, and the narrow bands have a wavy structure, it is then one of the most beautiful rocks we have. "With a little care in selecting, very good slabs could be obtained across the bedding planes, which, when dressed and polished, would surpass in beauty anything yet used for stand tops or other like ornamental purposes. A moment's examination of-one of the diamond drill cores out of this formation will soon convince any one of the fact.

From No. XII. of our diagram we pass to XIII., the home of the hard ore deposits of Michigan. It must not be inferred, however, that this member always affords first-class ore: for often it is second-class, and more frequently worthless rock. In some localities No. XIII. is very prolific in good ore, while in others it is quite barren. The ore is usually found in lenticular shaped masses. At the different iron mines of the Marquette district, may be seen all the known varieties of the magnetic and red oxides. In the former, we have the coarse granular to the fine steely kind—the one quite friable and easily wrought; the latter exceedingly hard and not easy to mine. Among the red oxides there is even a greater variety. Some are coarse grained, while, on the other hand, we have those of an almost impalpable texture, with all the intermediate grades. Some are massive, others are micaceous or slaty in structure. Some of the micaceous specular slate ores are very friable, and easily frittered away between the fingers. Like the magnetic ore, there are found the hard, steely specular ores, even more difficult to drill and mine than the magnetic. The so-called soft ores are usually mixtures of the red and yellow oxides, (hydrates), and rarely ever can be divided into strictly soft hematites and limonites. As the ores will be fully described in the chapter on the iron mines, we will leave them for the present.

In the ore beds and on either side of them, are lenticular shaped masses of magnesian schists, which sometimes overlie, and again underlie, the ore; there appearing to be no rule—save locally—for their occurrence. Turning to the true hanging wall of the ore, we have No. XIV., a quartzite or quarts conglomerate. The quartzite is usually of a grayish color, and is medium grained in texture. Sometimes it has a greenish tinge, owing to small leaves of chlorite scattered through it. This quartzite usually differs from the lower quartzite—already described in this chapter,—in being less vitreous, and is perhaps more arenaceous in texture though it requires considerable experience to distinguish them; and-even then, it is often quite impossible to do so. The quartzites of the Michigamme, Republic, Humboldt and Champion ranges, and at some other mines, are almost identical in appearance. The hanging walls of the Cascade and the Ishpeming mines, are a jaspery quartz, conglomerate, or breccia. In some instances, as at the Lake Superior mine, the quartzite passes into a chlorite quartzite, and then even into a chlorite schist. Some very interesting facts are now being brought to light, from a diamond drill hole driven down at Ishpeming, on the division line between the Lake Superior and Cleveland Iron companies. It shows very nicely the alternation of the chlorite schist and gray quartzite, and the frequent imperceptible gradation of the one with the other. The hole is now down several hundred feet.

Next on our diagram, is No. XV., a slate. The color is generally black, which is due to finely disseminated carbon. The cleavage is quite perfect, though not always sufficiently so to render it suitable for roofing purposes. Scattered through the slate, and along the joints, are numerous grains and small crystals of iron pyrites. For a full description of these slates, see special chapter on the same in this report.

Overlying No. XV. is No. XVI., a yellow limonitic schist. It is possible that this is only a decomposition of the more pyritiferous lenses of No. XV. or is derived in a like manner from No. XVII. which is an anthophyllo-actinolite schist. This is a dark gray rock approaching a black, which is caused by a variable percentage of the oxide of manganese. It is highly probable that some portions of this bed may locally prove sufficiently rich in manganese to render it valuable as a mixture in the manufacture of Bessemer steel iron. The rock, when examined under the microscope, presents a densely reticulated ground mass, made up of the fibrous actinolite and anthophyllite. So intimate is the mixture of these minerals that it is very difficult to distinguish one from another. In the thin section of the rock many of the crystal blades project from the edge, when it may be seen that in some of these the crystal axis and optical bisectrix, conincide (anthophyllite),* while in others it makes quite an angle (actinolite). There are some fine exposures of this rock in a railroad cut, on the north side of. Michigamme Lake. It is easily recognized on close examination; for apparently spattered over the surface of a fresh fracture, are the small thistle-blow like spots of anthophyllite or actinolite from one to three-eighths of an inch across. The rock is quite tough and not easily fractured.

No. XVIII. Major Brooks has designated as quartzite, and overlying it is a mica schist. It may be that No. XVIII. is a less micaceous variety of No. XIX.

No. XIX. of our diagram—a mica schist—has usually a bronzy cast from the brownish mica (biotite). Scattered in it are frequently saw-buck shaped crystals of

staurolite, and rounded dodecahedra of garnets. South of the Michigamme range, this formation is well developed; the same may be said of the Menominee range, near the mouths of the Michigamme and Paint rivers. Possibly at some future time we may extend the diagram of the Huronian series, so as to include a granite, which, in the Menominee district, overlies the mica schist; but for the present, we will consider No. XIX as the topmost member of the iron series or Lower Huronian.

*It is possible that this may be an actinolite crystal, wherein the cutting-plane of the section has passed at right angles to the clino-plane of the crystal, in which case, as will be readily understood by the mineralogist, the apparent optical bisectrix plane and the major axis of the crystal would become parallel.

Reviewing the ground just gone over, it must not be supposed that these members are always present in any one section, or that we can recognize in every instance an isolated member of the series. Still, I trust a careful study of the above diagram, will greatly aid the explorer in his search for iron ore deposits; and also assist the scientific student in his endeavors to solve the difficult problem, presented by the complicated geological structure of this region.

The question is often asked, "How do we account for our iron ore deposits?" Many theories have been advanced to answer this apparently simple question. Some believe in the replacement theory,—that is, that the iron ore beds were originally occupied by some other material, which has been dissolved out and replaced by iron oxide.

Others consider that the beds were primarily composed of jasper, or some other highly ferruginous rock, out of which has been dissolved the silica, leaving the iron oxide to be metamorphosed into the hard crystalline ore.

Others, again, hold that they are altered bog iron ore deposits, which latter—as is well known—are the result of the decomposing vegetation—usually the common bog of the swamps—being replaced by the hydrated per oxide of iron, a sort of a ferrifaction, so to speak.

Without adopting here, any one of the above theories, or advancing a new one in their stead, it may be well, before closing this chapter, to present a few of the facts, which I have observed during the past year or two, hoping they may throw a little light upon this interesting subject.

In the Michigamme mine was found, during the summer of 1877, a large piece of magnetic ore, weighing several hundred pounds, which had a concretionary structure exactly like that of brown iron ore. While at the mine last spring J. C. Fowle, the Superintendent, gave me an interesting specimen of specular ore, having on one side the cast of some mud cracks—very similar to the cut of one represented in Dana's work on Geology. In many of our iron mines are frequently seen octahedral crystals of specular ore (martite) after magnetite.

The McComber mine at Negaunee has furnished several minerals, among which are baryta or heavy spar, calcite, rhodochrosite, (carbonate of manganese), pyrolusite, (bin-oxide of manganese), kaolinite and pseudomorphs of pentagonally striated crystal cubes of hard hematite ore after pyrite. These cubes, when unaltered, are very hard and dense, the sides have a bright bluish black shining luster, much like that of a tarnished cube of pyrite.* The most interesting specimen we have to offer is a very small bit of manganiferous hematitic shale, bearing the impression of some fossil. I sent this fossil to Prof. G. J. Brush, of New Haven, who, with Professors Verrill, .Dana and Smith, pronounced it a fossil belonging to the lower fauna of life. Prof. Verrill, who is very familiar with these early fauna, said it reminded one of the foraminifera or bryozoa. I had hoped to obtain more material that this very interesting fact might be more definitely settled before the publication of this report, but for the present we must content ourselves with the above facts, trusting that the future will afford us something more tangible.

This article on the geology of our iron district would hardly be complete without noticing the Lower Silurian rocks,—represented in this region by the Potsdam and Calciferous sandstones, and the magnesian limestones, and delineating briefly the outlines of the Laurentian, Huronian and Lower Silurian periods. Begining with the Lower Silurian, we find in the southeastern portion of the city limits of Marquette, isolated patches and bays of brown sandstone, nearly horizontally bedded, and resting unconformably on and against the Huronian. The Lower Silurian member has an irregular shore line as we proceed southward from this locality. The first six miles its course is southwesterly, the sandstone resting on the Huronian. We continue south about fifteen miles, along a very crooked shore composed of granite; when following this dividing line we travel westward some twelve miles further; then in a gentle curve we return to our southward course, and in town 42, range 27 west, we cross a neck of Huronian nearly six miles wide. Leaving this we skirt along the granite beach for fifteen miles more, when we meet again the Huronian, which forms the coast of the Potsdam for twenty miles or more, where it intersects the Menominee river and enters Wisconsin.

*For further information on the occurrence of these minerals, see description of the McComber mine in the chapter on the iron mines.

Returning again to Marquette, we find the Potsdam sandstone skirting the south shore of Lake Superior nearly all the way to Keweenaw Bay, and from thence southwestward, there appears to have been an extensive Lower Silurian bay, having for its northwest shore, the Copper Range, or Upper Huronian. The formation before us has furnished very excellent brown sandstone for building purposes, and many of the variegated varieties obtained from the Marquette quarries cannot be surpassed for beauty or durability. In the Huronian period it would be practically impossible to define the shore lines of the Huronian sea, owing, as we have seen, to the bending and upheavel of the strata, and the subsequent erosion.

Our purpose, then, is not to describe original boundaries, but rather to trace out the upturned edges of the strata. Glancing over this section of the country we find the Huronian fields limited by granite, or covered by the overlying Silurian and drift. The general trend of the formation in the Marquette district is nearly east and west, and as we proceed westward from Marquette it gradually widens, until at Negaunee it appears to have attained its maximum width of about thirteen miles. The upper members of the Huronian are apparently wanting between Marquette and just east of Negaunee. The strata form a broad synclinal trough, resting on granite. The synclinal is corrugated in the direction of its axis with several minor folds. West and south of Negaunee and about Ishpeming, these minor corrugations are contorted and their upturned edges have a serpentine-like course. Nature here, apparently, in one of her uneasy moods, has, by disturbing the strata, brought to light her buried treasures, and rendered easy of development the several first-class specular iron ore mines about Negaunee and Ishpeming.

The Jackson mine at Negaunee is the oldest iron mine of the district and its products are largely sought for. At Ishpeming we have the Lake Superior, Barnum, Cleveland, New York, Lake Angelne and other mines. Their ores are of the best quality and average high in metallic iron.

North and south of Negaunee are located a number of soft hematite mines. These ores are in good demand by Bessemer pig iron makers, owing to their low precentage of phosphoric acid. Southward of Ishpeming are the Saginaw, Winthrop and other mines. The Saginaw ores are the first-class specular varieties.

As we continue westward from Ishpeming the formation again becomes more regular, though here, as east of Negaunee, may be observed the inferior folds. On the south rim of our broad synclinal are located the Washington, Edwards, Keystone and Champion mines. In the Washington and Edwards mines the ore—a fine quality of magnetic—occurs in pockets or irregular shaped lenses, while at the Keystone and Champion the ore belt is more uniform. At the Champion the vein or bed is nearly vertical, and on the lower level of the mine it is about one hundred feet wide. The ores, the magnetic and specular, are of a very superior quality, and in their present workings are very low in phosphorus and sulphur.

The Huronian, westward from Ishpeming, gradually narrows until it reaches Michigamme Lake, where it is only two miles wide. The northern edge of the trough maintains its course along the north shore of the lake, and includes within its iron belt the Michigamme and Spurr iron mines; also other undeveloped mines.

After we leave the Spurr mine the course of the formation appears to be west-northwest, and when we arrive at a point about eight miles south of L'Anse the formation takes a short turn to the northeast, but before reaching Lake Superior it dips under the Potsdam sandstone, and we return about five miles further to the northwest, in nearly a parallel direction on the northwest side of the Huron Mountains, along the Lower Silurian shore line to L'Anse. Coming back to the east end of Michigamme Lake, and tracing the southern rim of the synclinal, we find it makes a gradual southwesterly turn and in an easy curve comes around to s southeasterly direction, conforming in a measure to the east side of Michigamme Lake and its outlet. We continue on our course, passing the Kloman mine, and finally reach the Republic mine. The ores of these mines are mostly specular. In the Republic has been found a deposit of very pure magnetic: the specular ores are very rich in iron oxide and are favorably known to our iron men.

The formation has here made a horse shoe-like bend, twisting and contorting the strata, and returned in a north-westly direction along the southwest bank of the river. The strata are tilted at high angles, and in some instances are overturned. The dip, however, is usually away from the underlying granite, so that on each side of the river we find the strata inclining toward each other, thereby forming a narrow trough of less than one mile wide and six or seven miles long. On this range are located the Metropolis, Windsor, Canon, Erie and Magnetic mines. These mines are all on one of the lower iron belts. Immediately after we leave these mines the upturned edges of the Huronian begin to curve to the left, and in about one-half mile they have, a direction of nearly due south, which continues for three or four miles, when it makes a little more easting, and finally we come to a point some eighteen miles south of the Republic mine; then we proceed southeasterly and easterly for about thirteen miles, when we meet the Potsdam formation mentioned above, in town 42, range 27 west. Following our previous trail southward for five or six miles, across this Huronian neck, we arrive on its southern edge. Proceeding now westward on the dividing line of the Huronian and Laurentian for thirteen or fourteen miles, we turn to the southwest, then to the east and northeast for a short distance, and ultimately in a more uniform course to the southeast. We are now in the Menominee region. The formations are more regular and have a trend of west by north. On the Menominee range are several new iron mines which are doing well with fair prospects for the future. The ore, a soft specular averages well in metallic iron, is low in phosphorus and contains an appreciable amount of lime; qualities, which cannot fail to reccommend the ore to furnace men, especially to those seeking to make Bessemer pig iron. Having in a superficial manner considered the region best known to us, and in which we are most interested, we will tarry a moment on the borders of the geologically unexplored Laurentian. In the Menominee region is a small Laurentian island, bounded on the north, west and south by the Huronian, and on the east by the Silurian. Immediately north of this and separated only by a narrow Huronian bay is a much larger granite island belonging to the same period, limited on the north by the Marquette iron district (Huronian) and on the west and south by Huronian, and

to the east by Silurian. Still further north is another Laurentian island, even larger than the preceding. It is hemmed in on the north and east by Lake Superior and Potsdam Sandstone, to the west by the Huron Mountains, and on the south by the Marquette iron region. The first island has an area of about one hundred and fifty square miles; the second island of, say six hundred square miles, and the upper, or northern Laurentian island, probably numbers seven hundred square miles. With the Laurentian closes our chapter on the general outline of the geology of the Lake Superior iron region. A more detailed discription will be found in the portions of this report relating to mines, sandstones, slates, etc.

GENERAL HISTORICAL SKETCH OF THE IRON REGION.

The knowledge of the existence of copper on the South shore of Lake Superior, was co-incident with the discovery of the country. The crude implements and uncouth images, composed of this metal, found among the natives by the white men who first visited the region early in the 17th century, afforded ample evidence of its presence, in considerable quantity and native purity, somewhere in the vicinity, to be found and developed in later years,—furnishing the basis for large accumulations of individual wealth; for the building up and sustaining of populous communities; and for contributing to the world, in large measure, one of its most necessary and useful articles.

But none of the early missionaries, *voyageurs* or explorers, became aware, that imbedded in the rocks of this perilous and forbidding coast, existed in vast quantity and of extraordinary richness, another mineral, which, though coarser in texture and more common in occurrence, is of far greater importance in the world's industries,—the most powerful of the mineral agents which mother earth affords, to develope the civilization and prosperity of her children.

The copper, the presence of which was noted and recorded by the early discoverers, and the iron, of which they knew nothing, both existed in unparalelled measure, and to them is due the development which the region has undergone; having produced in the iron district, as in the copper, important and thriving cities and villages, railroads, canals, lines of vessels and many other less costly though necessary improvements.

The discovery of the existence of the iron ore in the Upper Peninsula of Michigan, of which she has contributed so largely to supply the demands of the country, and which has been chiefly instrumental in developing the region where it exists, is primarily due to the U. S. surveyors, who first noted its existence in place, in Sept. 1844, while running the east line of T. 47 N. R. 27 W. They were led to the discovery by observing that the needle of the solar compass, the instrument used in making the surveys, deflected largely from the normal direction, and surmising the existence of some local attraction, they sought for the cause, and found outcrops of magnetic iron ore—specimens of which they secured and preserved in the collection of minerals, which was made in connection with the linear surveys.

Thus it was more than two hundred years, subsequent to the discovery of copper on Lake Superior, ere the knowledge of the no less valuable fact, of the existence here also of iron, became known to the world. And two decades of years were yet to elapse before that shipment of ore began, which ere a like period transpired, grew into a stream of upwards of one million tons annually.

In 1845, the year following the discovery of iron by the U. S. surveyors, a party of explorers under Indian guidance, found near the same locality, the remarkable outcrop, which they secured by a “permit," and which became known as the "Jackson location;" they proposing to commence operations under the title of the Jackson Mining Co. The party who secured the mine were members of an organization which had been formed at Jackson, Mich., but a short time previously, July 23, 1845.

This is the earliest and best known of the iron enterprises on Lake Superior and for many years became leader, also, in importance and value. The first ore was taken from the mine in 1846, the year following its discovery; and in the subsequent year the construction of a forge was begun on the Carp river, which was completed early in 1848, the first iron being made on February 10th, of that year. Thus the Jackson Co. became the pioneer iron maker of Lake Superior.

In 1850 a few tons of ore were taken to Newcastle, Pa., and made into blooms; and two years thereafter amount was carried to Sharon, Pa., and melted iron. The first regular shipment to lower ports, comprising 5,000 tons, was made in 1856. During the four or fill succeeding years the operations of the company were attended with frequent changes, constant disappointment and financial embarrassment; but upon the breaking out of the war, the great demand created for iron, put the fortunes of the Jackson, as well as the other iron companies of the district, upon the high road to success. It became, probably, the most prosperous iron mining company in the country, perhaps in the world. The Marquette Iron Co., becoming afterwards what is known as the Cleveland, and out of which grew also the Lake Superior Iron Co., began its operations soon after the Jackson Co. A forge, with ten fires, was built by the company at what is now Marquette, and the manufactare of blooms begun. But like all bloomeries started in Marquette county, it was a failure. The cost of production was ever in excess of the market value of the iron. Transportation, at that period, was irregular and expensive—there being no canal at the Sault; no roads in the country; no skilled labor; no supplies for men and teams; no materials for construction and repairs, except

such as were obtained by the uncertain and unfrequent communication from below.

The consumption of ore, in the forges of the Jackson and Cleveland companies, amounted to about 25,000 tons and after 1856, the period when the shipments of ore began, the Jackson bloomery was finally abandoned; the other, having fortunately for the interest of those concerned, been burned two years previously.

The Pioneer furnace was the first built on Lake Superior: constructed near the Jackson mine, 13 miles from Marquette and completed, so as to make iron in July 1858. The Pioneer Iron Co. by whom the furnace was built, became subsequently merged into the Iron Cliffs Co.

The development of the Iron Region has been certainly remarkable. The population of Marquette Co., which, until recently, embraced all the iron district, comprised in 1851, barely 150 souls.—A dense, unbroken wilderness, isolated hundreds of miles from the outermost confines of civilization, with no means of approach or of return, except by water in summer, and over the snow, through interminable forests in the long dreary winter—severe in clime, presenting in its impenetrable cedar swamps, sterile sands and denuded granite hills, a most uninviting aspect: and even where the indications were the most favorable for agricultural development, the inducement can hardly be said to have been such as to persuade the farmer to forsake the comforts of civilized life and emigrate to this far away and inaccessible region.

And yet, during the brief period of a quarter of a century, it has accomplished a development which may well excite our wonder and admiration. And when we consider the magnitude of the industry which has caused it, its apparently unlimited capacity for enlargement, and the proportionate effect which this increase must occasion in the growth and importance of the country, we may well view with complacency the past and be pardoned for entertaining, seemingly, extravagant hopes of the prosperity which the future has in store for it.

The towns, with few exceptions, owe their origin to the mines, and all of them are largely the outgrowth of mining work. The city of Negaunee began its existence with the discovery and development of the Jackson mine. South of the town, and also within its limits, are a number of hematite mines, comprising the McComber, Rolling Mill, Grand Central etc., some of which are now idle; and among the important industries which contribute largely to its business, are the Pioneer furnaces. The Chicago & Northwestern, and the Marquette, Houghton & Ontonagon Railroads, form a junction here, and have branches extending to the different mining locations.

A short distance west of Negaunee, and upon the lines of these two roads, is the city of Ishpeming, which has become in number of population, the largest town on the Upper Peninsula. It is the business center for some of the most important mines, comprising the Cleveland, Lake Superior, Barnum, New York and Lake Angeline. The city contains a fine graded school building built of brick and roofed with the Huron Bay Slate, the best hotel in the region, some attractive dwellings, and other indications of intelligence and good taste; while its large blocks of stores, founderies, machine shops, &c., give evidence of business activity. Railroad tracks connecting with the main lines, extend to all the mines.

West from Ishpeming is a number of villages of greater or less importance, comprising Stoneville, Humboldt, Champion, Michigamme, and Iron City at the great Republic mine, the latter connecting with the M., H. & O. R. R., by a branch nine miles in length. The largest of these is Michigamme, which owes its existence to the development of the Michigamme mine. The Company began its operations by building a large saw mill, with machinery for making sash, doors, &c.: laid out the village and sold the lots, which were rapidly bought, and built upon, during the spring of 1872. In June of that year, a fire, that began in the woods, spread to the town and swept it from existence. It was speedily rebuilt, however, and within a few months thereafter, had several hundred houses, and a population of 1,300 persons. The village is on the line of the M., H. & O. R. R. and is well laid out, extending along the shore of Michigamme lake, a beautiful sheet of water several miles in extent, dotted with bold rocky islands conical in form and clothed with dark evergreen foliage.

L'Anse, where one of the earliest missions on Lake Superior was established, is also a village of considerable importance. It is at the head of Keweenaw Bay, 23 miles west of Michigamme, and is the present western terminus of the railroad. It is the shipping point for the ores of the Michigamme and Spurr Mt. mines, for the handling of which the railroad Co. has built an ore dock of sufficient capacity, and similar to those at Marquette and at Escanaba.

A few miles from L'Anse are some deposits of ore known as the Taylor mine, to which a branch railroad was built, but no mining has been done.

About four and one half miles from the shore of Huron Bay, a deep indentation of water which is separated from Keweenaw Bay by a long narrow tongue of land, are extensive deposits of slate of an excellent quality; a full description of these slate deposits will be found further along in this volume.

The work at these quarries began in 1872, and during the following year a number of houses was built, and at the present location has since grown up quite a village. A tram-road was constructed, extending from the quarries to the bay, at which point a suitable dock was also built. The deposits being so far from settlements, making it difficult and expensive to get material and supplies to the locality, and the necessity of sending abroad for skilled workmen to prepare the slate, caused the outlay to be great and the progress slow. The company has passed through many vicissitudes; yet like all projects of this sort, based upon the actual existence of an abundance of raw material of a suitable quality,

and which, when properly prepared has a good market demand, the obstacles, whatever they may be, are sure to be overcome, and success is certain in the end to crown the enterprise,

The early, and natural outlet for the products of all the mines which, until recently, were worked, was the harbour of Marquette; and from a few scattered houses which constituted the entire hamlet in 1853, has grown up, in a few brief years, upon the shores of this beautiful bay, the metropolis of the Upper Peninsula.

In its large and excellent harbour with its great curved sweep of shore line following the base of the low wooded mountains which form the back ground, in the magnificent prospect which the outlook over the great lake unceasingly affords, nature has given to it charms which art cannot rival. Marquette with a population of about 5,000 abounds in evidences of prosperity, intelligence and cultivated taste. Its large and elegant high school building constructed of the handsome brownstone from the quarries in the city, roofed with the dark blue slate from Huron bay: its fine church edifices, hotels, business blocks and private dwellings, some of them also of brownstone with slated-roofs; its clean, well paved and shaded streets: the water works which furnish to its citizens, the pure water drawn from the cool depths of Lake Superior: the streets and dwellings lighted with gas: the ample facilities for transportation and communication, afforded by railway, lines of steamboats, vessels, and telegraph, place it among the most favored cities of a state everywhere noted as abounding in charming villages and thriving cities.

Marquette has become somewhat of a watering place; and in common with many other Lake Superior towns, possesses attractions and advantages, as a summer resort, that are being appreciated and enjoyed, in an increased degree from year to year. Health seekers, pleasure seekers, artists and tourists, come to Lake Superior in considerable numbers. The excellent hotels afford ample accommodation for travelers and sojourners. The cool salubrious air brings health and vigor to the enervated frame. The speckled denizens of the mountain brooks tempt to piscatorial wanderings and gratify the epicurean appetite; while everywhere abound the unbroken forest, the rugged hills, the rocky gorges, the impenetrable glens, the picturesque lakes and beautiful water falls, to delight the artist and, in the fullest measure, afford to the lover of nature, in her wildest aspects, the enjoyment which he seeks.

The chief manufacturing industries at Marquette, are the Grace furnace, Rolling Mill furnace, Carp River furnace, Iron Bay Foundry, Railroad Shops, &c., and its extensive and valuable sandstone and quartz quarries, &c. The harbor, which is perhaps the best on the lake, is provided with two large ore docks belonging respectively to the M., H. & O. R. R. Co., and Cleveland Iron Co., and also with ample merchandise, docking and store house facilities.

At Escanaba, a town of considerable importance, which is situated near the mouth of the Escanaba river, on Little Bay de Noquet which is formed at the head of Green Bay, are also two extensive ore docks belonging to the Northwestern R. R. Co. The most costly charcoal blast furnace on Lake Superior is found at Escanaba. It was built by the Cascade Iron Co., but has never been successfully operated. Connection with the Lower Peninsula is made at this point by steamer making regular trips to and from Traverse bay.

At Fayette, in the same county, on Big Bay de Noquet, the Jackson Iron Co. has a furnace with two stacks, which has made an excellent record. In the vicinity of this place considerable farming has already begun, and the results have been such as to give favorable indication of the adaptability of the land to this purpose. The soil is of a limestone formation, and fine crops of wheat and other grains are raised. Delta county claims to be the banner county for farming; an agricultural fair was held at Escanaba this season for the exhibition of the products of its pioneer farms.

Menominee, near the mouth of the Menominee river which, in part, forms the dividing line between Michigan

and Wisconsin, has large lumber interests. It is also favorably situated for the manufacture of charcoal pig iron, and has a blast furnace with two stacks, which when the market demand is sufficient to consume the product, ought to be operated with remunerative results.

The extensive ore deposits that exist in Menominee are now being partially developed, and the entire range bids fair to become, in a few years, the scene of active mining operations. A large population of consumers will thus be provided, which with the unusual excellence of the lands embraced in this county, furnishes strong inducements to farmers for settlement.

Much of the land in Menominee county is no wise inferior in agricultural value to that in many of the most favored portions of the Lower Peninsula. This may seem a strong statement; but to one who has seen its fine sections covered with excellent hard wood, and noted the evident fertility of the soil, it will not appear an exaggeration. There are also large bodies of pine and much other sawing timber; and along the railroad may now be noticed quantities of cedar posts ready for shipment, giving indication that the product of the extensive areas of this valuable timber, found in Menominee and elsewhere on the Upper Peninsula, will be in demand as rapidly as transportation is afforded. Settlement would be much more rapid if the lands in the vicinity of the range could be purchased; it is mainly in the hands of speculators and of corporations who are averse to selling. The Commonwealth Iron Co. have arranged for the immigration of several hundred Swedish families, to whom they propose to sell lands as soon as the railroad shall be extended to the property. Eastern parties have also stated an intention of utilizing the excellent water power at Twin Falls, by erecting machinery for making paper, etc. of the poplar wood

which is also available at this point in sufficient quantity. The mines on the range will ship during the present season upwards of 70,000 tons of ore, which goes by the way of Escanaba.

The want of railway connection with the Lower Peninsula, such as would be effected through the construction of the projected line to Mackinac from Marquette, is grievously felt on Lake Superior, and the completion of this road would result in scarcely less value to the interests of Lower Michigan, since, while it would afford a much needed outlet to the people of this region, it would also open their markets to the farming and manufacturing interests of the Lower Peninsula. For it must be borne in mind, that the large amount of products necessarily consumed in the mining regions, is almost wholly imported, and that as communication now is, very little can find its way here from the lower part of this state. The only railroad reaching here from "below" starts from Chicago and passes through the state of Wisconsin, and constitutes the main artery which supplies the wants of the Lake Superior towns. If the Marquette & Mackinac railroad were constructed, connection would be furnished with Lansing, Detroit, and all parts of the state without passing beyond its borders; and such speedy communication between the two peninsulas would strongly tend to the formation of greater harmony of interests.

It is also a fact that the 150 miles of absolute wilderness through which the line extends, posesses great natural wealth, which can only be developed through the construction of a railroad. The immense quantities of valuable timber cannot otherwise be utilized, nor the excellent farming lands brought under cultivation. For here, as was said of the Menominee region, the surface, timber and soil of much of the land, strongly favor the assumption that it is adapted, in an admirable degree, to successful agriculture. Wheat, oats barley, buckwheat and the earlier varieties of corn can be profitably grown; while for the production of peas, potatoes, turnips, cabbage &c., the country cannot be excelled; the quality of the vegetables raised in this country is always superior and the yield generally satisfactory. There are also many indications favorable to the production of butter and cheese—the soil when cleared of timber is speedily clothed with an ever-green and springing turf of rich nutritious grass.

In the Lower Peninsula the pastures and meadows usually become dry and parched early in autumn, affording but little sustenance at that season for cattle; and the ground being bare much of the winter and during the spring months, undergoes a process of frequent freezing and thawing, which prevents the grass from attaining a sufficient growth to support cattle until late in the spring; thus generally rendering it necessary to fodder during seven months of the year. On the Upper Peninsula the grass remains green until covered with snow in the fall, which happens before the ground becomes severely frozen, and it remains covered during the winter.

Of course the ground by reason of this heavy covering does not freeze; and as soon as this mantle of snow is removed, through the genial warmth of returning spring, the dormant vegetation, which has so long lain warm and protected beneath it, springs rapidly into renewed life and activity; speedily affording sufficient nourishment for grazing animals. So that, in reality, the period during which foddering is necessary on Lake Superior, is not greatly in excess of that, which is required in Lower Michigan.

True, not all of the land in the Upper Peninsula is favorable to cultivation; much of it is sand, swamp, or rock; too poor, too difficult or impossible to cultivate. And as country of this character frequently prevails in the vicinity of the mines and towns and adjacent to the lines of railroads, persons coming here temporarily, and judging from what is apparent in the neighborhood where improvements already exist, and exagerating the severity of the winters, are apt to condemn the country as practically worthless for farming.

But fortunately the arable lands are greatly in excess; and whatever may be the drawbacks, and as yet they are manifold and great, the Lake Superior farmer will always possess an active home market, eager to absorb all his surplus production, at prices largely in advance of those realized elsewhere. Hay, of which necessarily large quantities are consumed in the mines, brings $15. and upwards per ton; and now butter sells at .25 per pound; eggs at .25 per dozen; potatoes at .75 per bushel; milk at .10 per quart. And at this season of the year, it is frequently assumed, by those unacquainted with the country, that Lake Superior is already a region of snow and frost; but in contrast to this mistaken opinion, I am to-day, Oct. 7th, sitting by an open window, and observe, in an adjacent garden, a person gathering tomatoes; and notice that the beets and cabbages are yet fresh and growing; and that the squashes and pumpkins, to be seen, are, apparantly, uninjured; and I am informed, that from a strawberry plat, which seems scarcely larger than the top of a dining room table, were picked the past season 113 quarts of berries, which attained an enormous size and were of excellent quality. Flowers are still blooming in many of the yards; and shade trees and shrubbery have not yet lost their foliage and greeness. The cows one sees about the streets and in the pastures, cropping the grass, which is fresh and ample for their wants, have the fatness and sleekness peculiar to animals where the herbage, upon which they feed, is rich and nutritious. The robins have not yet diappeared; for but' a few moments ago, one came and perched himself upon the fence within a few feet of me and some of his companions together with other smaller birds are visible at no great distance—the bright sunshine and pleasant air, of to-day, do not indicate a very near approach of winter.

The other important towns, situated in the eastern part of the Upper Peninsula, or connected with the iron industry, of which mention has not vet been made, are the villages of Mackinac and Sault Ste. Marie. The former

charmingly situated upon the shore of the beautiful island which bears its name, and protected from imaginary foes by the frowning cannon which overlook it from the walls of the ancient fort upon the high bluff beneath which it nestles, is too well and favorably known to render extended description necessary.

Mackinac island, situated in the straits which separates the two Peninsulas, is certainly a delightful spot; abounding in natural objects of great beauty and interest, and affording ample opportunity for scientific examination and for recreation. To those seeking rest and quiet, cool bracing air, pure water, and interesting natural scenery, combined with unlimited opportunity for such amusement and exercise as are afforded by fishing, boating, and forest excursions, no better place can be found. Situated in the pathway of vessels passing through the straits, it is easily accessible in summer, but in winter it is still greatly isolated: although the extension northward of railways in the Lower Peninsula, and the advancement of settlement in that direction, is rapidly tending to make it easily accessible at all seasons of the year. And when the railroad from there to Marquette shall be built, connecting it with the iron and copper region, as well, it will be on the great inland thoroughfare between the two Peninsulas, and in proximity to the point where the transfer of the freight and passengers will be made, which with the development of the adjacent country, thereby occasioned, must greatly increase its important. Both Mackinac and Sault Ste. Marie are among the oldest villages upon the lakes. A mission was established at the latter as early as in 1668, by the Jesuit fathers Marquette and Dablon. The river, to which the early missionaries gave the name of Ste. Marie, is the channel through which the waters of Lake Superior flow into Lake Huron. In this river occur the Sault, or rapids, which long before the advent of the early missionaries had been a favorite fishing ground for the Indians; here they resorted in large numbers at such seasons of the year as they were enabled to secure a plentiful supply of one of their most indispensable articles of food. It was hence an excellent point for a mission, the advantage of which the Jesuits were not slow to see, and which they did not fail to improve. Missionaries enjoyed here favorable opportunities for preaching to the Indians, and for endeavoring to convert them to Christianity.

The Jesuits sought only the conversion of the savages, and were followed by traders who bought furs of them in exchange for such trinkets and articles as pleased the savage fancy or met his wants; so that for two hundred years, it remained little else than a missionary station or trading post for intercourse and traffic with the Indians. In subsequent years, when expeditions for scientific and practical exploration, speculation, and for permanent development began, the Sault became the *point d'appui*, from which these expeditions set out for the unknown regions bordering the great lakes. Communication was early kept up with Detroit by small schooners and other light sailing craft; and from thence above the Sault, the journey had to be made in canoes or *batteaux* with Indians or French *voyageurs* for guides. All persons or freight, passing between the lakes, went through this point; and all outfit and material had to be carried over this portage. Much delay and! annoyance was necessarily occasioned, and thus, in the early-developments of the Lake Superior region, the Sault was an important place. The rapids, at Ste. Marie, are about one mile in length, and have a total fall of about seventeen feet, making a barrier in the river or strait which connects the lakes to communication between them.

In the early travel and traffic between the lakes, articles of use or commerce were borne around this barrier, on the backs of men; later, mules and teams were employed, and previous to the building of the canal a tramway was used, and all materials of the rapidly increasing- commerce had to be transferred and reshipped in both directions. The necessity of a ship canal, to overcome this difficulty, was early foreseen by those best acquainted with the interests of Lake Superior, and its construction became finally imperative. The matter had been brought before congress as early as 1840, a bill having been introduced that year, asking for an appropriation of 100,000 acres of government lands for this purpose. But it was not until 1852 that definite action was taken. Congress, that year, granted 750,000 acres of land, to be devoted to the construction of a ship canal around the falls of Ste. Marie. The legislature of the state of Michigan having formally accepted the grant, work was begun, under contract with the State, by the Sault Ste. Marie Ship Canal Co.—an organization chartered under the laws of the State of New York for this purpose—in the following year, 1853.

Owing to causes necessarily incident to the construction of a work of such magnitude, under circumstances so unfavorable for procuring the large force of workingmen required, and for furnishing them with supplies, and for procuring the necessary tools, machinery, and other materials—the completion of the canal was not effected until 1855. The total cost of the work, inclusive of the expense of locating the lands which were granted in compensation therefor, was $1,000,000.

The building of this much needed channel of navigation gave an impetus to the commerce of Lake Superior that was speedily felt in the greatly increased prosperity of all industries in the region bordering upon it. From this period dates the first shipments of ore; and probably to no one thing is the iron region more indebted for its development and subsequent prosperity, than to this great public work. Prior to the building of the Peninsula railroad to Green Bay on Lake Michigan, ten years later, all the ore passed in this direction; without it, these enormous mineral deposits, rich and abundant as they are, could scarcely have been given to the markets of the world.

The General Government, by making a water-way through the St. Clair flats sufficient for the passage of the largest vessels, has succeeded in undoing the work of Nature—constructing a water course where, for

centuries, Nature has evidently been endeavoring to create dry land. The effect of the widening and deepening of this channel has been that vessels of far greater tonnage than has originally been anticipated, can be employed; and in order that such vessels may pass into Lake Superior, and for other important reasons, it soon became necessary that the canal also should be enlarged; the work of improvement was undertaken by the General Government, eight years ago, and Congressional appropriations to the amount of $800,000 were made for it. The Government is now engaged in the construction of a substantially new canal, which is designed, when completed, to be adequate to the wants of Commerce for all times to come. The capacity of the new lock will be 80 feet wide, 500 feet long, and with a lift of 18 feet, providing 16 feet of water on the mitre sill, at low water. The result of the enlargement will necessitate further improvements in the channel through Mud lake and the St. Clair flats.

Aside from the shipping interests with which it is associated, Sault Ste. Marie posesses little of present importance; it is in the east end of Chippewa comity, and has just completed a court house to inset the requirements of its legal profession. There are some large mills for the manufacture of lumber, etc., and considerable farming is carried on in the vicinity, which latter consists mainly in raising potatoes; large quantities of which, for many years have annually been produced. The crop, as elsewhere, in the Upper Peninsula, frequently remains in the ground until spring, when it is dug and marketed. The yield is almost certain to be abundant, and the business is a profitable one.

About 130 miles west of the Sault, and 40 miles east of Marquette, is the settlement of Munising, situated on the main land opposite Grand Island. A branch railroad, connecting with the projected line from Marquette to Mackinac, was surveyed to this point; and there are two blast furnaces,—the Munising and the Bay Furnaces,—in the vicinity. The latter, however, at Onota, is six miles distant, and was recently, while working partly destroyed by fire, and has not been rebuilt. Some farming has been undertaken at Munising, and the adaptability of the soil to this purpose is indicated by the fact that last season one person raised there four hundred bushels of wheat.

The construction of the Sault Canal was not the only important improvement in transportation facilities that became-necessary to meet the growing interests of the mines, for the ore had to be carried, somehow, to the lake for shipment, thirteen miles and upwards, of distance. At first this was accomplished over a rough wagon road, which became, at times, as may readily be inferred, almost impassible. Subsequently this gave way to a plank road, constructed by the Jackson and Cleveland Iron Companies. Upon this road longitudinal sleepers were ultimately placed and laid with strap rail, and it was operated with horse cars.

But all of these methods of transportation were only expedients; the necessity of a railroad from the mines to the lake was early realized, and with an increase of business the construction of one become imperative. The project was finally undertaken as an individual enterprise; but little progress being made, however, until the enactment of a general railroad law, in 1855, when an organization was effected, with the corporate title of the Iron Mountain R. R. The work was then pushed forward with vigor, resulting in the completion of the road in 1857.

About this time the project of connecting the mines, by rail, with lake Michigan became agitated, and in 1856 a large grant of land was secured for this, and other associated railroad enterprises. Numerous changes and transfers occured, but the lands were finally conferred on the Peninsula Railroad Company, by which the road, from Negaunee to Escanaba, was begun in 1863, and completed in the following year; a consolidation with the Chicago & Northwestern having been effected, the road became known as the Peninsula Division of that line. Up to 1870 the Chicago & Northwestern extended only to Ft. Howard, a distance of 242 miles from Chicago; in that year, however, the work of further extension was begun and completed to Escanaba in 1872, thus giving complete railroad communication from the lower region to Chicago, and under the efficient management of this great corporation.

Thus, to the enterprise and sagacity of the Chicago & Northwestern Company is due the fact that the people of Lake Superior enjoy the advantages and conveniences which accrue to them through this railway connection with the outside world; and in meeting the responsibility thus assumed of providing for the passenger travel and business traffic, the care and liberality shown by this company have been such as to meet the general commendation. The length of the Peninsula Division from Negaunee to Escanaba is 62½ miles, and the aggregate length of its branches amounts to 66 miles; making 138½ miles of track. The Company's ore docks at Escanaba have 352 pockets, having a total capacity of 24,000 tons; the docks are built in 14 to 20 feet of water; vessels carrying 1,600 tons, and drawing 18 feet of water, have loaded. The rolling stock of this Division, comprises 30 locomotives and 1,957 ore cars, and the amount of ore shipped over the line amounts to upwards of 400,000 tons annually, about 60,000 tons of which are from the Menominee Range.

The Marquette, Houghton & Ontonagon Railroad is the outgrowth of many railroad enterprises which have been formed during the period that has transpired since 1856, to meet the growing wants of the country, and to earn the grant of lands, which as before mentioned, was donated by Congress for this purpose. The present Company was incorporated in 1870, and the State having conferred upon it the unearned lands, work was begun in the Spring of 1871, and before the close of the following year, thirty additional miles of road were constructed, extending from its previous terminus, at Champion, to L'Anse, at the head of Keweenaw Bay, a total distance from Marquette of 66 miles. The further

extension of the road, provided for in the charter and in the grant of lands, to Houghton and to Ontonagon, it is unnecessary to add, is anxiously hoped for.

The road is well managed and provided with an equipment adequate to the wants of its business, and has an estate of upwards of 400,000 acres of land, which, extending for a distance of 50 miles along the great Iron Range, must doubtless embrace many valuable deposits of ore, some of which are already known. The total number of miles of road, including the branches extending to the mines, is 88½ miles; and the number of stations is 16, and of employes 400. Its equipment comprises 30 locomotives, 1,613 ore cars, 5 passenger and 4 express cars, freight box cars 28, platform cars 72, and of gravel and of other cars not mentioned, 78. The amount of iron ore transported over the road was in 1877, 600,000 tons, being 93 per cent, of the tonnage of its freight business, the total number of tons freight carried, being 951,687. At each of the termini, the company has an ore dock; the one at Marquette has a total length of 1,222½ feet, and the one at L'Anse of 546 feet. The docks are provided with "pockets" which hold from 55 to 100 tons each; these pockets are made somewhat in the form of a shute, to discharge their contents directly into the hold of vessels, and are filled from the ore cars, which are run over them. The company's dock at Marquette is 53 feet in width on top, and has four railroad tracks, and rises 38 feet above the water. There are 136 pockets on both sides of the dock, and from them eight vessels may be loading at the same time. 6,000 tons have been loaded in a single day. Vessels may be loaded in from one hour and. fifteen minutes to one hour and thirty minutes, varying with the capacity of the vessel; the average time of loading a vessel is about three hours. About one-third of the ore is taken in steam vessels, the remaining two-thirds in sailing vessels. This dock has a capacity of upwards of half a million of tons of ore for the entire season. The company have also substantial shops for construction and repairs.

When this road shall have completed its extensions, and the Mineral Range R. R. shall have reached the extremity of the Keweenaw peninsula; when the Menominee branch shall have penetrated through the wilderness of that valuable region; and the much desired road to the straits of Mackinac shall be built and extended thence to the Sault, then will the railway requirements of the Upper Peninsula be measurably met. Its important Sections will then be brought into communication with each other, and with the rest of the state. The development of its vast mineral resources will be more rapidly advanced; its great bodies of valuable timber be rendered available; its excellent farming lands will become accessible, and a more rapid settlement, increased activity and general prosperity must gradually result. The business of quarrying sandstone and preparing it for building, is slowly developing into an important one. Inexhaustible deposits of this rock, suitable for building, are found at various points, but the quarries at Marquette are the most advantageously situated for working at present. Buildings constructed of these beautifully colored stones, brown or richly variegated, and possessing great durability, have an outward elegance and a substantial character that no other material can give. Several public and private buildings in Marquette, with walls of this stone, are the admiration of all visitors.

None of the deposits of marble, many of which are known to exist, have yet been worked; but it is altogether probable that, with the future development of the country, some will be found of sufficient value to be in active demand.

Many years ago a whetstone quarry, near Marquette, was worked for a short time, but soon abandoned, not from lack of excellence in the quality of the material, but that the business did not then seem sufficiently profitable; doubtless it will sometime be again resumed, with better success.

Some of the deposits of plumbago or graphite, which are known, are believed to be sufficiently pure to answer for many of the purposes for which that substance is employed; but no special examination of any with view to its economic use has been made, and none of apparently good enough quality for the finer uses, has yet been discovered.

A valuable deposit of quartz, known as "gannister," has recently been opened in the vicinity of Marquette, and some demand for it already established. No doubt the interest will grow in importance as the quality becomes known and the necessity for this material increases.

Some promising deposits of serpentine rock are known, and one recently discovered near Ishpeming may possibly prove of much value.

The great business depression, which is so seriously felt throughout the entire country, affecting all branches of industry and all kinds of trade, has borne with particular severity upon the iron interests everywhere, closing blast furnaces and crippling the mines. And hence the check given to the activity of Lake Superior has been correspondingly great. During the years immediately preceding the panic of 1873, the development had been unprecedentedly rapid. The mines were worked to the utmost of their capacity, to meet the demand for their products. Heavy expenditures were made, to develop new mines. New furnaces were built, at ruinous cost, and all were run to their maximum limit. The mill men and dealers were strenuously seeking to supply the markets with lumber. Sailing vessels, steam barges, and propellers, tarried briefly in port, quickly discharging and receiving their freight, and, impatient of storm signals, spread every sail, or plied all steam, in the laudable endeavor to convey away the products of this country and to bring to it its supplies. Night and day, scarcely without pause, the great ore docks resounded with the sound of discharging ore. Explorers were everywhere traversing the woods, looking eagerly for sections of pine, or with dip compass and pick in hand, anxiously seeking for magnetic attractions, and carefully

examining boulders, outcrops, and ledges, in search of evidence of iron, or other valuable minerals. The U. S. Land Office was besieged with applications for maps, information, and for entries. Persons having "Notes" of pine lands to sell found ready customers. The mysterious accounts of extraordinary "finds" were poured into credulous ears, and favorable specimens were eagerly examined. The air was filled with rumors of wonderful discoveries, of gold, silver, copper, iron, and other valuable minerals. Wary capitalists were flocking here, ready to invest in shares, mining stocks, and lands, frequently where, except in imagination, the "show" promised but faintly a hope of realizing any return, save disappointment.

But with the advent of hard times, all this excitement passed away, and the ephemeral projects which owed their existence to, and drew their support from such an unhealthy condition of affairs, speedily collapsed. The staunch and legitimate industries, however, having a solid foundation, have continued active, and in a measure prosperous. Many new mines, though not altogether valueless: yet from want of capital, or from bad management, or that the quality of the ore which they afford was below the standard necessary to fulfill the requirements of the markets, have either maintained a precarious foothold, or have been obliged to suspend operations altogether—some never to be revived, and others, possibly, to renew work when more favorable times shall occur.

But the old mines, those of strength and of established reputation, have suffered very little diminution in their product. The shrinkage has been in the price received for it; but as there has been a corresponding falling off in the cost of labor, and of transportation, and in all other values, the cost of mining is much less than heretofore; so that, while the market price of ore has been greatly reduced, the greater economy in its production doubtless enables the companies to realize a fair degree of profit; and while the total product, as will be seen from the tabular statements, elsewhere contained, is slightly less than was attained in 1873, it still reaches the enormous yearly aggregate of 1,000,000 tons, possessing a present market value of about $5.000,000. A single mine, which only began work in 1872, has already attained to an annual shipment of 175,000 tons of ore, worth this season nearly $1,000,000. Certainly these figures hardly justify the assumption that the region, presenting the activity which they necessarily imply, can be dormant. Nevertheless, one cannot but anxiously hope for such a revival of business activity as shall rekindle the fires in the many now idle furnaces scattered over the peninsula; as shall utilize the immense forests of hard wood, so contiguous to the ore beds, and suitable for charcoal, as shall require in a greatly increased degree, the valuable sandstones and slates, so beautiful, so abundant, and durable for building; and as shall develop the many other incipient industries, the basis of which exists in inexhaustible quantity, in the mineral deposits of this region. Experience teaches that prices will rise as well as fall, that a period of depression is followed by one of activity and relief. The present is not the first time, since furnaces have been built on Lake Superior, that the cost of the production of pig iron has approached so near the price it would bring in market, or be even in excess of it, that the manufacture of it was practically inhibited. In the financial depression of 1857 the Pioneer Iron Company were obliged to sell their iron for $22 per ton, while it cost $24 to produce it. And in 1860 the property was leased for four years, the lessee agreeing to manufacture pig iron during the period of his lease, himself paying all expense therefor, including the delivery of it on board of vessels in Marquette, for $17.50 per ton. Certainly the price of iron has not yet fallen to that point, while the prospects of the region since that day have vastly improved.

All great reversals have their compensations, and no doubt the greatly increased care and economy, necessitated by the circumstances of the present time, will really result in more substantial benefit to this section, in the long run, than if the wild speculative period preceding the panic had continued. The work is now rapidly becoming more systematic, and partakes less of the hap hazard quality, which in a measure, characterized the earlier mining operations. The nature and the manner of the deposits, are being carefully studied and understood; scientific knowledge and practical experience go hand in hand, in the prosecution of the work, in the great mines.

Hereafter the skill of the analyst, the engineer, the experienced miner, and of the thoroughly qualified iron maker, will be required, to a greater degree than has heretofore prevailed, to meet the exigences of the more elaborate and expensive methods of mining that will be practiced in the future, and to fulfill the increasing requirements of the iron trade.

Explorations and investments still continue to be made: but recently to a greater extent in Menominee County than elsewhere. The developments in that region are of so promising a character as to stimulate those already owning lands there to examine them, and those who desire to purchase, to search for deposits, hoping doubtless to discover something that shall rival in value anything that has yet been found. Certainly there is enough to encourage them; for the mines now opened along the Menominee Range indicate a degree of value that ought to be satisfactory to any class of owners. The ore in the best mines is extraordinarily rich in iron, and there is unquestionably a vast amount of if. Probably no better opportunities for investments, on Lake Superior, have ever occurred than the present time affords. But, unfortunately for their interests, people seek in vestment mainly during periods of speculative excitement, when prices rule high. After the excitement dies out, and prices subside to their normal rate, few want to buy; then, only the wise ones seem to realize that this is the best time to invest. In a time of depression and financial embarassment one ought to be able, if ever, to secure desirable property at a price at least not in excess of its

real value. For, this reason, and from the fact that the value of mineral deposits here can be better determined, than heretofore, since much more is known about them, and a sufficiently safe estimate of the amount of ore in most of the mines may be made, and the quality, the market demand, and price, and cost of transportation, etc., are known—thus eliminating, in a measure, the element of uncertainty—it is as before stated, a most favorable time to invest in this region.

The country is, in reality, a comaprative wilderness; the greater part is yet to be examined, and offers an excellent field for exploration; desirable portions of it can be easily secured of the Government, if the land has not yet been entered, or, if already taken, can generally be purchased of the party owning it. The large amount of lands held by the R.R. Co.s, and the Portage Lake Canal Co., are offered for sale. The latter Co., and the M. H. & O. E. E. have each an office in Marquette for the sale of their lands; and the C. & N. W. Co., also have one at Escanaba. Through each of these offices purchases may be made, or any desired information obtained. The U. S. land office, for the Upper Peninsula, is at Marquette.

In tracing the development of the Upper Peninsula great credit must be given to the U. S. survey. The wisdom of the plan upon which the survey of this region was made, and the careful manner in which the work was executed, has ever since been apparent. Upon the maps of these surveys are recorded the topographical features of the land; the character of the timber and soil; the streams, water powers, lakes, etc., and also, what is more important to the explorer for minerals, are noted the magnetic variations, the outcrops, and ledges, the kinds of rock which compose them, and other observed geological facts. These data, given upon the plats, have been found to be accurate and reliable, and have led to the discovery of the greater portion of the valuable mineral deposits which have been found. Especially is this true of iron ore, much of which, being magnetic, the deposits are indicated by the influence which they exert upon the compass needle. In originally running the township and section lines of this peninsula, the surveyors were required to note down the magnetic bearing at each compass station, and these bearings are given on the recorded plats, along the surveyed lines, at the points at which they were taken; and a careful examination of localities, where unusual variations are found indicative upon the corresponding map, has led to the discovery of many important mines. A valuable chapter on exploration, giving full details, will be found in Maj. Brooks' report, 1873. The idea of combining geological examination of the country with the linear surveys, and of recording the results upon the same maps, is due to Dr. Douglass Houghton, the earliest state geologist; and the faithful execution of the work in a great measure, is to be credited to Wm. A. Burt, the inventor of the Solar Compass. Dr. Houghton's plans embraced a geological survey of the country as well as a linear one, but owing to his untimely death this result was only partially carried out. Enough, however, was done to entitle those who performed it to grateful recollection, and to sadly awaken a deep regret that the waves of the great lake had not spared the fitful spirit 4hey so ruthlessly engulfed, to the full accomplishment of the noble work he so admirably devised. An important adjunct to all other industries, is the press, and in this particular the Upper Peninsula is fortunately represented. The MINING JOURNAL, published at Marquette, is the largest of the papers issued, and is a truthful exponent of the interests of the iron region. The Houghton Mining Gazette, is an old, and long established paper, highly esteemed, both on Lake Superior, and throughout the country, for the reliable character of its information, relating to the copper and other interests; the Ontonagon Miner, the Northwestern Mining Journal, the Iron Home, the Negaunee Iron Herald, the Menominee Herald, the Escanaba Tribune, published respectively at Ontonagon, Hancock, Ishpeming, Negaunee, Menominee, and Escanaba, are all enterprising chroniclers of local and general intelligence. All the towns on Lake Superior have good schools, and some of the school edifices are very commodious and elegant, and good order and intelligence everywhere prevail. In a volume, entitled the Mineral Resources of Lake Superior, published by Hon. A. P. Swineford, of the Mining Journal, will be found much interesting matter relating to the Upper Peninsula; also in Maj. T. B. Brook's report, the preliminary chapter of which is devoted to the early history, etc., of the iron region, 1873.

IRON MINES.

THE JACKSON IRON COMPANY

Is the oldest iron mine; of this region. The opening of the mine with its attendant trials and temporary disappointments, but final success, are so intimately associated with the early history of the Iron District that whatsoever is of interest will be found embodied in that chapter. Capt. Henry Merry, its able and efficient agent, has had charge of the mine since 1858, and how well he has performed his duty not only the condition of the mine, but the high price at which the stock has ever been held, attest.

Few, if any, mistakes have been made, which is something remarkable, considering geologically the very irregular structure of the ore formation. It is ever the ambition of mining captains to win a maximum amount of ore with the least quantity of rock at a minimum cost, without compromising the safety of the miner; and it would seem as if this ideal had been as nearly realized in the Jackson mine as is possible under the circumstances. This object, when once attained, is apparently very simple; but to appreciate fully its accomplishment one should have a foretaste of the many difficulties that are strewn in the pathway to consummation. To day we have ore in abundance; but to-morrow, a barrier of rock may rise up before us,

cutting off the deposit. The question now is, is its continuation ahead of us, below or above us? to the right or to the left of us?

This seeking after the ore may be likened to the surgeon probing for the bullet; only that the latter has a path to guide him, and a complete knowledge of the anatomy of the ground before him, though great skill and care are necessary in either case, since a mistake may prove as fatal to the interests of the former as to the life of the patient. It will therefore be understood how essential it is for the mining captain to constantly observe and study the facts that are continually passing before him, and to correlate and systematize his results, so that he will eventually be enabled to decide with a considerable degree of certainty the position of the deposit when suddenly cut off by the very nature of the disturbing element, thereby lessening, in a remarkable degree, the chances of failure.

Just here allow me to advise all honest seekers after the geological history of our Iron or Copper districts, to go first of all to the mining captain, and obtain from him the very cream of years of experience. Let him tell it in his own way; and when furnished, should any ideas advanced not exactly coincide with preconceived ones of your own, do not discard them, but note them all the more carefully, and when "the round" is finished then endeavor, unbiased, to combine what you have.

To describe the Jackson mine intelligibly, without the aid of cross sections and plans, would be quite impossible and it is therefore reserved for a future number of this report to do the mine justice.

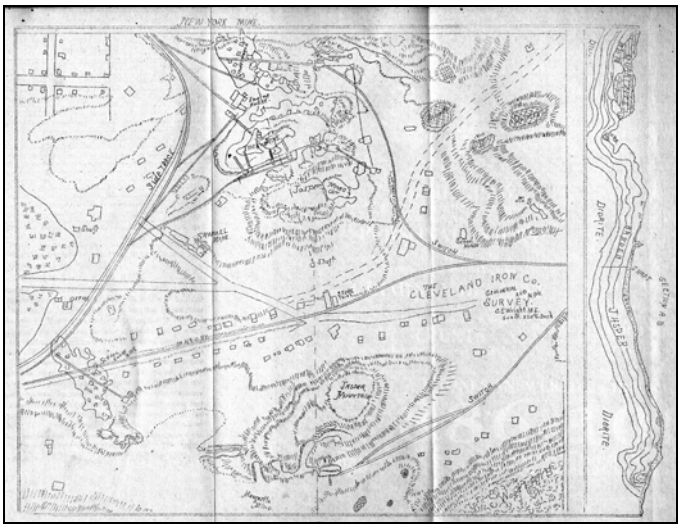
If a stranger, unused to mines, but versed in mythology, were to stroll through the mine workings on some Sunday, climbing in and out of the open pits, or creeping along on the narrow pathways around some of those huge "horses" or masses of shining Jasper, peering into the long side drifts or tunnels, where the sunlight never penetrates, then too, seeing the iron smoke-stacks reaching down to something beneath, he might easily imagine himself in the abode of the ancient Titans; or, perchance, were a heavy blast to go off making the ground tremble under his feet, he might suppose it was old Vulcan himself forging thunderbolts for Jupiter. The bottom of these open pits are certainly not the place for a timid person; for the high, narrow walls of Jasper, reaching far upwards, frowning down upon one in such a "lowly" position, are not pleasing subjects to contemplate, especially when a booming blast somewhere below you fairly makes everything shake.

The cause of all this "general crookedness" and a want of uniformity, which meets one at every step in going through the mine, is, as has been already intimated, chiefly due to the very irregular occurrence of the ore deposits. The original stratum, if I may be allowed to use the term, with the Jasper and other strata of the series, appears to have been sharply folded and faulted, the harder and tougher beds often buckling into the softer ones, thereby giving them frequently a lenticular shape.

In some instances the ore stratum has folded on itself, affording a bed of double thickness, and where the upper-portion of the fold has been worn away, as is usually the case, it will lead the unwary miner to believe that it is a single stratum, continuing downward and up again somewhere in the direction of the dip; instances of this kind are surely vexing enough, but even more so are they when a fault comes in and slides the strata past each other, thus complicating the problem still more. The shipments from the mine are as follows:

YEAR.	GROSS TONS.
1856	447
1857	12,442
1858	10,309
1859	28,377
1860	41,295
1861	12,919
1862	46,096
1863	77,237
1864	83,905
1865	65,505
1866	92,287
1867	127,491
1868	130,524
1869	125,908
1870	127,642
1871	132,297
1872	119,910
1873	130,131
1874	94,708
1875	87,283
1876	98,480
1877	80,340
Total,	1,725,533

THE CLEVELAND IRON COMPANY,



Which shares with the Jackson the honor of being the first developed mine in the District, filed articles of association in March, 1853, with a capital stock of $500,000 in 20,000 shares. The corporators were John Outhwaite, Morgan L. Hewitt, S. Chamberlain, Samuel L. Mather, Isaac L. Hewitt and E. M. Clark. Previous to 1855 was mined and used at their forges 3,000 tons of ore, and during that year the first shipments were made. it will be noticed by reference to the accompanying map of this mine, that the company's workings are somewhat

scattered; all of their openings, however, do not appear on the sketch.

No. 1 Pit is a small opening located in the northwest corner of Section 11. It is about 100 feet long by 50 feet wide, but at the bottom, some 60 feet down, it has narrowed to an average width of less than 10 feet. The deposit is probably a sharp contact fold, similar to that in an old pit just east of here which is now mined out.

Nos. 2 and 3 pits nearly adjoin No. 1 on the southwest; these two are now merged into one. Standing at the head of the main incline of this mine and facing west, we have before us an open pit, 300 feet long by 150 feet wide, which pitches at an angle of about 25 degrees to the southwesterly. On the north and east sides of this pit the foot wall comes to the surface, while the south and west sides are limited by nearly vertical headings or walls of massive quartzite. At the southwest corner of the pit it is over 100 feet deep. Under this immense body of rock they have mined out the ore, leaving huge supporting pillars of ore, to prevent the roof of quartzite from falling.

Passing down and into the under ground workings, (see map of mine,) we find that they extend at present (May, 1878,) about 400 feet westerly, and average 250 feet north and south. The vein of ore varies from ten to forty feet in thickness, averaging about 25 feet. The ore is a fine quality of specular and is very rich. An average sample, consisting of several hundred pieces, collected this season by myself from their stock pile of over 30,000 tons, afforded, on partial analysis, 66.90 per cent, of metallic iron, and only 1.62 of silica.

The lowest point in the pit is 150 feet from the surface. The ore is now brought to the surface by one double incline and two single ones, all starting from one point above, and are operated by the same engine. These inclines, as well as the hoisting machinery, were constructed and put into operation in 1877, and altogether are as complete as anything of the kind in the iron district. The machinery was made at the Iron Bay Foundry, Marquette, which of itself is a sufficient guarantee for its efficiency.

Immediately south of No. 9, is the incline pit, which a few years ago had one of the largest "shows of ore" of any mine in the county.

The pit near the surface was 500 feet long and from 150 to 200 feet wide, with a "floor" of nearly all ore, and dipping apparently vertical; but now 150 feet down, it has proven to be a sharp contact fold, wherein the southerly portion of the fold came to the surface and originally lapped over the jasper mountain on its foot wall side, while the northerly portion of the same in the eastern half of the pit, after making the turn at the bottom comes within 70 feet of the surface, and then dips at an angle of 35 degrees to the northwest. The entire pit, however, has a lateral pitch to the southwesterly. In the westerly end, on the north side, the ore vein dips at a low angle to the northwest. The vein here varies from 10 to 30 feet thick, with a working face 130 feet long. In the eastern end of the pit they are now under and mining toward No. 5 pit (see map). The ore is of an excellent quality, and averages about the same as that from No. 3 pit already noted. The ore is brought to the surface over four inclines.

Passing over into the underground workings of No. 4 pit, which is really a northerly extension of the incline pit, we find the vein has very much narrowed, and owing to this fact, and the insecure character of the roof, mining operations were stopped and no work has been done there for some time save by "Scrammers," who, too frequently, care less for their heads than for their pockets.

Leaving No. 4 we pass south a few steps to No. 5 pit—at the bottom 140 feet long by 45 feet wide, at its west end, and not more than 10 feet at the east end. On the surface the vein was much larger, being about 80 feet wide and 150 feet long. This vein, no doubt, was originally continuous with the incline mine, and like that, is a sharp synclinal fold. The lowest point in the pit is 130 feet below datum.*

To the southeast of the No. 5, is a small opening, and around the jasper bluff is the Little Mountain mine. These are irregular deposits which require considerable experience to be worked profitably. Continuing around the jasper hill, in a westerly direction, we pass some small openings and finally come to the Saw Mill mine.

This is 350 feet southwest by south from the nearest point of the incline pit, and is probably on the same vein as that deposit. The deepest workings here are 72 feet deep. It is an irregular shaped deposit, and has an apparent dip to the southwest, which will probably change to a westerly one as the workings are extended. The ore is a very hard specular variety, fully equal to that of the Incline mine.

Seven hundred feet southwest of the saw mill mine is the school house mine. The workings in this mine are entirely underground, and have been so for a number of years. The dip of the vein is to the northwest, varying from 15 to 30 degrees, and the thickness is from 3 to 30 feet.

*Datum is on the same level as the top of sill of old engine house.

The hanging wall is quite regular, but not so with the foot wall; at some points the dip of it flattens, at others it is steeper, narrowing the vein in the former instance, and widening it in the latter. Near the bottom of the mine the vein widens out to 30 feet, but a little further down the foot wall flattened in its dip, narrowing the vein so much as to render the mining of it no longer profitable. My impression, however is, that this narrowing is only of a local character, similar in its nature to those above this point in this mine, and that -the vein will again widen out below. On the northeast side of the mine the workings are limited by a "fault" or slip in the formation; that is, the strata on the northeast side of the fault have been pushed upward, carrying with them the stratum of ore. The "slickenside" striae are very plain, and from them

can be easily made out the direction of the "throw." In addition to this, the heading of rock, limiting the working, is a banded jasper—the foot-wail of the ore. On the southwest side is a corresponding fault which limits the workings in that direction. The "heading" or "breast" here, is a gray quartzite and jasper conglomerate—the hanging wall of the ore.

Glancing at the ground plan of this mine it will be noticed how nearly parallel are the workings just considered; showing that the two faults have a common direction. The large fault in the Lake Superior mine, two-thirds of a mile east of here, has about the same course; whether we can locally make out any system to these troublesome freaks of nature, is a problem reserved for the future. Taking a hasty glance at the sketch of the mine with the folded and crooked cross section, the irregular shape of the ore beds, and not forgetting, the faulting or slipping of the strata, to confuse matters still more we see that even iron mining, as simple as it may appear to some, is not a business suited to novices.

The fine condition of the mine, and the few accidents that have occurred, as well as the completeness of the mine appointments, and the perfect system in all the details of the management, coupled with the good will of the employes towards the employers, reflect much credit upon the agent and the superintendent of the mine. For the past season they have been using, quite extensively, the diamond drill in baring holes down at different points, to determine the position of the ore stratum. Some of the results have been very interesting, but we will wait for others and then, in our next annual report, will show by a geological cross-section their practical application. The annual shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1854	3,000
1855	1,449
1856	6,343
1857	13,204
1858	7,909
1859	15,787
1860	40,091
1861	11,795
1862	40,364
1863	46,842
1864	44,959
1865	33,355
1866	42,680
1867	75,864
1868	102,112
1869	106,133
1870	132,884
1871	142,658
1872	151,724
1873	133,265
1874	105,858
1875	129,881
1876	145,661
1877	151,554
Total,	1,685,372

Adjoining the Cleveland workings on the north, and contiguous thereto, are those of the

NEW YORK IRON MINE.

This company was incorporated April 8th, 1865; capital stock $250,000 in 10,000 shares. The stock is now held by S. J. Tilden and W. L. Wetmore. The land was leased from A. R. Harlow, of Marquette, and comprises the S. E. ¼ of the S. E. ¼ of Sec. 2, T. 47, R. 27. Actual mining commenced in 1864, and during that year was shipped 8,000 tons of ore. The product gradually increased to 94,809 tons in 1870. For several years it appeared as if there were two independent veins of ore, each having on the surface nearly an east and west direction, and a dip of 33 degrees to the south, and separated by about 50 feet of rock—the northerly deposit apparently dipping under the southerly one; but after a depth of one hundred feet had been attained in the former bed, the foot and hanging walls rapidly approached each other, cutting out the ore altogether. The upper vein, the southerly one, has produced the most ore. The extent of the workings on this vein is about 850 feet east and west. At the easterly end they have mined out down to the Cleveland line. At the westerly end the workings are 160 feet vertically beneath the surface, and the present breast of the ore there is forty feet from the south line of the property. The ore formation at this point makes a gradual turn to the north, and in a horizontal drift 117 feet below the surface it may be seen that the formation even swings around to a northwesterly direction and joins the northerly deposit.

During the past season I have made a careful mining and geological survey of this mine, which has developed some interesting and valuable facts. It has shown that the northerly deposits, above alluded to, is a sharp synclinal contact-fold, and that it and the southerly deposit are of the same stratum, and were originally joined by a sharp anticlinal or inverted trough-like fold. To satisfy the present conditions, we must assume the upper portion of the folds, above considered, to have been worn away, which would afford us, apparently, two parallel strata of ore, separated by a ‘bar" of rock. The entire formation "pitches" to the west.

North of these workings, before reaching the north line of the property, there occurs, in my opinion, two other complete synclinal and anticlinal folds. These seeming facts will probably be demonstrated during the coming season, and they, in connection with those expected from the Cleveland diamond drill holes, directly south of here, will furnish us with the data for one of the most complete and valuable geological cross-sections ever made of this distinct.

The ore is a very rich specular, and ranks high among furnacemen, as making a strong foundry iron. This mine, for its size, has probably proved more profitable than any other of the district; and the management, which has resulted so favorably with the present excellent condition of the mine, reflects great credit on Capt. W. E. Dickinson, the superintendent, to whose skill these results are largely due. The mine shipments are as follows:

YEAR.	GROSS TONS.
1864	8,000
1865	12,214
1866	33,761
1867	43,302
1868	45,665
1869	71,456
1870	94,809
1871	76,381
1872	68,950
1873	70,882
1874	77,017
1875	70,103
1876	58,863
1877	55,581
Total,	786,984

In the southwest portion of the city of Ishpeming is the

LAKE SUPERIOR IRON COMPANY'S MINES.

This company was organized in March, 1873; Capital stock $300,000, in 12,000 shares; after this the stock was increased to $500,000. The incorporates were Samuel P. Ely, Geo. H. Ely, and Alva Strong, of Rochester, N. T., and Heman B. Ely, and Anson Gorton, of Marquette, Mich.

Operations were begun in the summer of 1857, on 120 acres of land, situated in sections 9 and 10, T. 47, R, 27. Subsequent purchases have increased the total number of acres to 6,551. The principal openings, however, are located within the original 120 acre tract though there are other important mines belonging to and operated by this company, known as the Section 19; the Section 16; the Lowthian, and the New England, which are described under the Saginaw Range. It would be quite impossible to convey an intelligible idea of the stratigraphical structure of this mine without the aid of geological plans and cross-sections. I have made of this mine a geological and mining survey during the past season, but wishing to embody the results of some explorations which the company are now making, I shall defer until the next season the presentation of some interesting cross-sections of this mine which the accumulated results will enable me to make. The structure is very complicated. The main deposit is, apparently, a synclinal trough having nearly an east and west trend, and pitching to the west. The trough is wide, with sharp minor waves or folds along its bottom; while a fault, starting from the south east side and dipping at a high angle to the southwesterly, traverses diagonally, in a northwesterly direction, the trough and its minor waves above alluded to. To confuse the structure still more a throw in the formation has taken place along the plane of the fault; whereby the southerly portion of the series is lower than that on the northerly side of the fault. The direction of the movement is not at right angles to the axis of the synclinal, but forms a very oblique angle thereto. It is very evident that to operate a mine, so irregular in its structure, to the best ad vantage requires much experience and constant care and study. Even then we cannot always anticipate what is before us; the only safe ground, therefore, is to keep the exploration sufficiently ahead of the mine working. At the beginning of 1877 the outlook of the mine was not bright; but subsequent discoveries have established it in its former position in the front rank among our most productive mines. The ore, a specular slate and granular specular, is, when properly selected, of the best quality, and a satisfactory guarantee to consumers of pig iron is, that it was manufactured from this ore.

About 200 feet southeast from the opening just considered, are extensive hematite workings. There are several small openings in the immediate vicinity, but to locate them intelligibly, a plan of the mine is required. Last season Mr. C. B. Ball, the agent of the mine, sunk a shaft at a short distance from the company's office, that has since developed the existence of a large deposit of rich specular ore, which bids fair to surpass any of the kind which the company now have. At the present writing they have mined out a chamber at the bottom of the shaft, one hundred feet long by forty feet wide, and twenty feet high, without finding any foot or hanging wall to the ore. An analysis of several email fragments, collected by myself as an average, from the bottom of the mine, afforded 65.80 per cent, of metallic iron, and 8.60 per cent, of silica. West of the main opening first considered, some 600 feet, is another promising opening, known as their No. 7. The vein is about 20 feet thick; it has a good strong hanging wall of quartzite, and a foot wall of banded jasper. The quality of the ore and its adaptability to the manufacture of Bessemer steel is not equaled by any of the mines of the Ishpeming district. An average analysis of the ore afforded me:

Metallic Iron	65.50
Phosphorus	.03
Silica	3.87

Another analysis of the ore gave only .02 of phosphorus, which needs no comment of mine to be appreciated by Bessemer steel makers. The machinery and other appointments of the mine are very complete, and the excellent condition of everything about the location betokens good management and unremitting care by its local officers, seconded by those residing east. The present officers of the company are Joseph S. Fay, President; Richard S. Fay, Treasurer; A. G. Tenny, Secretary; G. B. Ball, Agent, and Capt. J. D. Day, Superintendent. The total number of gross tons of ore shipped by the Lake Superior Iron Company are given in the following table:

YEAR.	L. S. MINE.	SECTION 19.	SECTION 16.	LOWTHIAN.	TOTAL.
1858	.....	.....	.....	.....	4,858
1859	.....	.....	.....	.....	24,698
1860	.....	.....	.....	.....	33,015
1861	.....	.....	.....	.....	25,193
1862	.....	.....	.....	.....	37,709
1863	.....	.....	.....	.....	78,976
1864	.....	.....	.....	.....	86,771
1865	.....	.....	.....	.....	50,201
1866	.....	.....	.....	.....	68,002
1867	.....	.....	.....	.....	119 935
1868	.....	.....	.....	.....	105,747
1869	.....	.....	.....	.....	125,560
1870	.....	.....	.....	.....	166,582
1871	.....	.....	.....	.....	135,047
1872	.....	.....	.....	.....	185,070
1873	.....	.....	.....	.....	158,428
1874	97,271	7,040	.....	.....	104,311
1875	105,560	13,805	.....	.....	119,365
1876	97,474	12,861	215	.....	110,570
1877	98,670	15,662	5,666	9,021	127,349
Total....	.....	.....	.....	.....	1,880,139

Adjoining the Lake Superior Mine workings, on the west, are those of the

BARNUM MINE,

Which is owned and operated by the Iron Cliffs Company. The first shipments were made in 1868, and have continued very regular ever since, averaging about forty thousand tons each year. The vein on which they are low working, dip& about 55 degrees to the south, and the strike is a little north of west. The workings embrace about 700 feet of the vein, and the deepest point in the mine is about 293 feet, measured on the angle of dip. The average thickness of the ore deposit is about 13 feet, which is a fine quality of specular slate ore. The hanging wall is a chloritic schist and quartzite, and the foot wall a jasper. The mine begins to present some of the complicated features of the Lake Superior mine, already noted in the description of that mine. The mine is well equipped, and ably managed, as its condition attests. Captain Win. Sedgwick, the superintendent, has held this position for several years. The shipments are as follows:

YEAR.	GROSS TONS.
1868	14,383
1869	37,503
1870	44,793
1871	45,939
1872	38,381
1873	44,388
1874	40,256
1875	40,914
1876	37,750
1877	38,341
Total,	382,648

THE LAKE ANGELINE MINE

Belongs to the Pittsburgh and Lake Angeline Company. The mine is one of the Ishpeming group, and is located on the south shore of Lake Angeline. The formation has here nearly an east and west trend, and the dip is to the north. The foot wall of the mine is a decomposed, jaspery schist, which is underlaid by the diorite bluff that rises, on the south side, to 150 feet above the lake. The hanging wall of the present workings is a hematitic schist. The deepest part of the mine is near its eastern portion, and is 100 feet below the lake level. The lenses of ore pitch to the west. The entire workings embrace about 1,000 feet of the vein, which varies greatly in its width; the widest place in the bottom, at present, being about 50 feet. Formerly the lake shore was less than 100 feet from the mine pits, but now with a large accumulation of waste material used as filling, they have a splendid frontage of some 300 feet of dry land. This soft hematite schist, is almost impervious to water, and the result is that the lake water scarcely, if at all, finds any access to the pits.

The mine is well managed, and, in a quiet way, produces considerable ore. The ore, a hard and soft hematite, is of a good quality, and, when properly assorted, averages well in metallic iron; it is low in phosphorus, which property renders it desirable for the manufacture of Bessemer steel. The officers of the company are: John Outhwaite, President; L. E. Holden, Secretary and Treasurer; A. Kidder, General Agent, and Capt. Harvey Diamond, Superintendent. The mine shipments are as follows:

YEAR	GROSS TONS.
1864	19,500
1865	20,151
1866	24,073
1867	46,607
1868	26,651
1869	39,694
1870	53,467
1871	33,645
1872	35,221
1873	43,933
1874	30,499
1875	30,282
1876	22,539
1877	19,113
Total,	445,375

From Lake Angeline mine, going south and around the east end of the greenstone ridge, we reach, in less than a mile, the

SALISBURY MINE,

Which is one of the mines belonging to and worked by the Iron Cliffs Company. It is a large open pit, 850 feet long and about 80 feet deep. The lens, or body of ore, dips about

60 degrees to the south, and has an average width of 35 feet. The ore is a very superior quality of soft hematite. A partial analysis of this ore made for the company last June afforded as follows:

Metallic iron	68.20
Silica	.52

This hardly could be considered an average, still when we consider that it is quite impossible to select out the richer ore from that which is fairly good, it shows that the ore is of a very excellent quality. Other analyses of this ore which I have made go to verify this supposition.

The hanging wall is a greenstone and the foot wall a chloritic schist. The hoisting machinery consists of a steam cylinder 16-inch diameter by 30-inch stroke engine, and two friction drums, and is well provided with pumping machinery, &c. Everything about the mine speaks well for the local management, and the careful supervision of T. J. Houston, Esq., General Manager of the Iron Cliffs Company. The shipments have been as follows:

YEAR.	GROSS TONS.
1872	545
1873	11,023
1874	6,730
1875	4,571
1876	20,510
1877	37,868
Total,	81,247

SAGINAW RANGE.

SAGINAW MINING CO.

The mine is situated on the N. W. ¼ of the N. E. ¼ of Section 19, T. 47, E. 27; besides this forty is embraced four others, cornering around the center of this section. This property was first worked in October, 1871, by Messrs. Maas, Lonstorf & Mitchell, of Negaunee. In the fall of 1873 the lessees sold out to parties representing the Cleveland Rolling Mill company, for a consideration of $300,000, and very soon thereafter the Saginaw Mining company was organized, which company have continued active mining ever since. The product of the mine is brought to the surface through four shafts sunk on the lay of the vein. No. 1 shaft, the most westerly one, is down 170 feet, and has an inclination of 45 degrees to the north. The average thickness of the vein is about six feet. No work has been done on the west side of this shaft, but on the east side a stope 20 feet high has been driven 20 feet east. In No. 2 shaft, 400 feet east of No. 1, a depth of 360 feet, on the lay of the vein, has been reached. To the west of the shaft they stoped out 150 feet, when a crossing of rock limited the working, and the same proved to be the case on the east side after they had stoped out 160 feet. These crossings have a lateral pitch to the west of 86 degrees. The bed of ore varies in thickness from 5 to 30 feet. No. 3 shaft is located 300 feet east from No. 2, and is down 325 feet. The dip of the vein is 45 degrees, and its thickness is from 6 to 20 feet. The vein was very irregular down to the first level. To this level they stoped out at either side one hundred feet, when they struck a crossing of rock. From this point the crossings rapidly approached each other, until at 325 feet they came together. No. 4 shaft, the most easterly one is 250 feet from No. 3. The thickness of the vein here varies from 15 to 25 feet. On the west side of the shaft, down to the first level—100 feet from the surface—has been stoped out 100 feet, while to the east the workings extend some 80 feet to the boundary line between this company and Section 19 mine. Twenty-five feet below this level a crossing of rock came in from the Section 19 side, while on the west side of the shaft the crossing pitched westward; this gradually carried the entire deposit of No. 4 in that direction. The inclination of the east and west side being nearly the same, the length of the bed—180 feet—was, therefore, very uniform for 255 feet down to the bottom of the present workings. The thickness of the vein in this shaft is from 15 to 25 feet. Taking a general view of the field just gone over, we find that the length of the mine is 1030 feet east and west, and that the deepest workings are 360 feet on the lay. In No. 1 shaft but little has been done, partially owing to the character of the ore and to a large influx of water. In No. 2 mine shaft the workings are 310 feet in length. Between Nos. 1 and 2 is a block of unexplored ground 130 feet in length, while down to the first level, between Nos. 2 and 3, the crossing is only 40 feet long; but as either end of No. 3 working inclines towards the other, the crossing widens until, at the bottom of No 3, it extends across and nearly joins the crossing between No. 3 and 4. It is a remarkable fact that the length of the deposits of Nos. 3 and 4 should be so nearly the same, the former 200 feet, and the latter 180 feet. This, however, continues down only to the first level, when No. 3 begins to narrow, as we have already seen. The lens structure of the ore bed is quite apparent in No. 3 shaft, and it will be interesting to know where the upper end of the next lens below is located, as its relative position will furnish, to a certain extent, a key to the location of the other unknown lenses beneath; for, I believe that all the present workings will, sooner or later, terminate as in No. 3; but, with the proper amount of prospective work, the annual product of the mine need not be materially lessened for want of ore—at least for many years to come. The hanging wall of the mine is a jaspery quartz conglomerate, and the foot wall proper is a banded jasper, with usually a thin layer of talcose rock between it and the ore. One trouble they have to contend with is the large amount of water to be raised, which constitutes in their case a very important item in the cost of mining. The ore drills hard, but, in blasting—owing to the jointed structure of the formation—very little block-holing is required, and were it not for the unusual amount of water, the cost of the ore would be nearly as low as at any other mine in the district. The ore is all specular, but varies greatly In texture and structure. Much of it is from a fine steely to coarsely granular, while some of it is slaty. No. 1 shaft is a mixed, slaty ore; in Nos. 2 and 4 the ore is a slate and granular; while No. 3 has furnished only granular ore. The granular variety has disseminated through it whitish spots of impure kaolinite, a silicate of alumina. These spots are probably decomposed bunches of felsite. The alumina is a very necessary constituent of furnace cinder, and ores containing it are usually preferred by manufacturers of pig iron. The ore is well mined in every respect, and the condition of the mine reflects much credit on the able management of its superintendent, Capt. Samuel Mitchell. Considerable attention is given to handling of the ore, in order to reduce the cost to a minimum, and it would seem that this point has nearly been attained. During the shipping season the ore is handled only once, and in the winter is stocked, without the aid of horses or carts, near the side tracks, where it may be loaded directly into the cars in the spring. Branch tracks from the two competing railways of this district afford them excellent shipping facilities. The mine shipments have been as follows:

YEAR.	GROSS TONS.
1872	18,503
1873	37,138
1874	45,452
1875	52,006
1876	57,122
1877	44,006
Total,	254,227

The officers of the company are: A. B. Stone, President, Cleveland, Ohio; A. G. Stone, Secretary and Treasurer, Cleveland, Ohio; Capt Samuel Mitchell, Agent and Superintendent.

THE ALBION MINE

Was opened by the Messrs. St. Clair Brothers in 1871. The property is contiguous to the Saginaw mine—adjoining it on the west. It was worked by the above parties under a lease from Messrs. E. Breitung and S. L. Smith, and considerable work was done; but the results were not altogether satisfactory, and after two years of unsuccessful operations the lessees abandoned the mine and gave up the lease. The total shipments of the mine were 1,168 tons of specular ore.

Immediately west of the Albion mine, and located on the N. W. ¼ of the N. W. ¼ of Section 19, T. 47, R. 27, is the

GOODRICH MINE,

Which is owned by Capt. Goodrich, of Chicago. The formation is very irregular, and the results, thus far, have not been, financially, satisfactory. The shipments from the mine are as follows:

YEAR.	GROSS TONS.
1873	3,258
1874	3,048
1875	1,718
1877	503
Total,	8,527

THE SECTION 19 MINE

Adjoins the Saginaw mine on the east, and is situated in the N. E. ¼ of the N. E. ¼ of Sec. 19, T. 47, R. 27. It is owned and operated by the Lake Superior Iron Company. The first ore was mined in Nov., 1871. The formation, as in the Saginaw, has a strike of east and west, and a variable dip to the north. No. 1 shaft is located near their west boundary line. This shaft has an inclination of 45 degrees, and was sunk 100 feet on the lay, when the crossing of rock, already alluded to in the Saginaw mine, cut out the ore altogether. No. 2 shaft is 480 feet east from No. 1; the workings are down 200 feet, and they have stoped out 180 feet to the west and 250 feet to the east. The average dip of the vein is 49 degrees; its thickness on the west side is 10 feet, and on the east it averages about 16 feet thick. The hanging wall is a jaspery quartz conglomerate, and the foot wall proper is a banded jasper. Everything about the mine is in fine working order, and the mine itself is in good condition. Capt. P. T. Tracy, until lately superintendent, had just cause to feel proud of his mine. The ore is chiefly a granular variety. It is rich in iron and contains quite a percentage of alumina, as may be seen from the soft, whitish, greasy feeling mineral disseminated through it. They are now sinking to another level, and they expect soon to have some fine stopes on either side of No. 2 shaft. The mine is quite dry, and is, no doubt, partially drained by the Saginaw mine. The mine shipments, in part, will be found under the Lake Superior mine.

THE NEW ENGLAND.

Is the next mine to the east, and is situated in the E. ½ of the N. W. ¼ of Sec. 20, T. 47, R. 27. This property was formerly mainly owned by Capt. E. B. Ward, of Detroit, and was opened in 1866. H. G. Williams operated the mine for a long time under a contract. The ore is chiefly a soft hematite, though a narrow bed of good specular ore was mined for several years; but it did not prove sufficiently remunerative, and was finally given up. The hematite ore deposit is considered to be in formation XII. The mine has now come into the possession of the Lake Superior Iron Company. The shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1866	3,150
1867	9,075
1868	8,257
1869	14,148
1870	24,871
1871	33,359
1872	17,465
1873	181
Total,	110,506

Adjoining the New England Mine, on the east, is the

LOWTHIAN MINE.

It is owned and operated by the Lake Superior Iron Company. The mine consists of a large open pit, about 250 feet long by 125 feet wide. The formation dips about 30 degrees to the north, The ore is a good quality of soft hematite. A single skip road brings up the product of the mine, and the ore, during the shipping season, is dumped into pockets and from thence passes into the cars. The appointments, for a small mine, are very complete, and conveniently arranged. The total shipments are 9,265 gross tons.

THE WINTHROP MINE

Is situated about one-half mile east of the Lowthian mine. The mining property embraces the southwest quarter of section 21. T. 47, R. 27. It was owned by Messrs. A. B. Meeker, A. G. Clark, and H. J. Colwell. In 1870 it was opened by Messrs. Richardson and Wood. The property, last August, 1877 was leased by Messrs. H. J. Colwell and the St. Clair brothers, and is now known as the Winthrop Hematite Company.

The mine at present (January, 1878,) is a large open pit, about 300 feet long by 200 feet wide on the surface, and 150 feet deep. The bed of ore is, probably, in formation XII. and dips about 60 degrees to the north. The apparent thickness of the vein, at the bottom, is not far from 40 feet. The hoisting machinery answers very well the present requirements. A double skip road is so arranged that when the loaded car is drawn up the weight of the car itself is counter balanced by the empty one going down.

The ore, when well selected, is an excellent quality of soft hematite, and at one time was a favorite among furnacemen. The percentage of iron was above 60 per

cent., and the phosphorus was very low, and it is hoped that its present lessees will, by careful selection, win back its old friends. It is highly probable that specular ore will be found to the north of this, in formation XIII., immediately overlying XII. Branch lines from the two competing railroads furnish them with good shipping facilities. The shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1870	3,469
1871	7,319
1872	14,239
1873	31,150
1874	8,248
1875	8,622
1876	27,236
1877	12,549
Total,	112,832

Adjoining the Winthrop, on the east, is the

SHENANGO MINE,

Which is really only a continuation of the former mine, and to a stranger the two would appear as one mine, as they both form a large open pit. The land on which the mine is located is owned by the Pittsburgh & Lake Angeline Company. The Shenango Iron Company was organized in September, 1872, with a capital stock of $500,000. The officers are: C. Donkersley, President, Marquette; Geo. C. Reis, New Castle, Pa., Vice-President; H. D. Smith, Appleton, Wis., Secretary and Treasurer. The first ore was mined on a contract by Messrs. Orthey & Hurd. At present, 1877, it is worked by Messrs. Mitchell & Stone, and is known as the Mitchell Iron Co. The shipments are as follows:

YEAR.	GROSS TONS.
1872	197
1873	8,552
1874	7,699
1876	5,506
1877	3,897
Total,	25,941

THE HOWELL-HOPPOCK

Is located about one-half a mile south of the Shenango. But little work has been done here, and the ore is hardly up to the standard; the shipments are:

YEAR.	GROSS TONS.
1873	1,240
1874	966
Total,	2,206

THE FOSTER MINE

Belongs to the Iron Cliffs company, and is one of the oldest soft hematite mines of the district. It is located about three miles south of Ishpeming on the southwest quarter of section 23, T. 47, R. 27. The mine was opened during the spring of 1865, and worked with considerable force until sometime in the season of 1873, when the production gradually decreased, as may be seen by reference to the annual shipments.

The ore occurs in lens-shaped masses or pockets, having for its hanging wall a greenstone, and for its foot wall a talcose schist. The workings, or open pits, aggregate about 500 feet in length, and the deepest of them are 70 feet. The average width of the vein is 15 feet.

The shipments from the mine are as follows:

YEAR.	GROSS TONS.
1868 and previous	6,000
1869	14,540
1870	23,458
1871	13,532
1872	18,684
1873	18,107
1874	4,719
1875	847
1876	125
Total,	100,012

The other mines owned and operated by the Iron Cliffs company are the Excelsior, Miller, Rowland, Gilmore, and Section 18 mines. Their shipments in gross tons are:

YEAR.	EXCELSIOR.	ROWLAND.	MILLER.	GILMORE.	SECTION 18.
1872	755	.....	.....	.....	.....
1873	.....	2,003	3,612	102	1,405
1874	1,014	570	1,144	.....	.....
1875	3,039	398	.....	.....	.....
1876	2,688	62	.....	.....	.....
1877	.....	196	.....	.....	.....
Total....	7,486	2,908	4,756	102	1,405

The Pioneer opening, at the Jackson mine, is worked by the Iron Cliffs Company but as this ore is included in the Jackson mine shipments, we will not give it here.

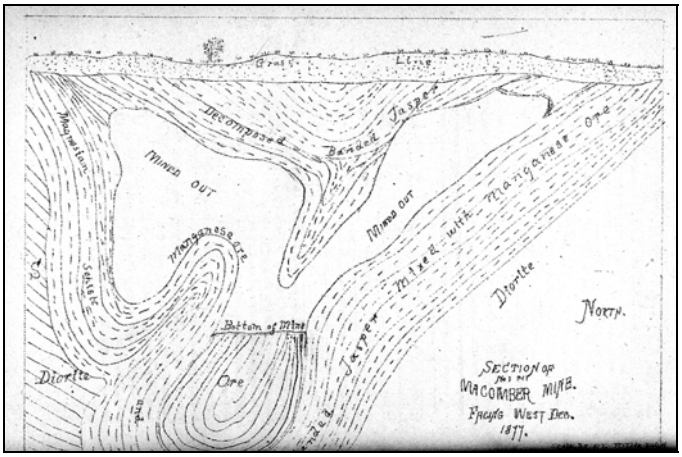
NEGAUNEE HEMATITE MINES.

Just south of Negaunee, only a few minutes, walk, is a range of hills having nearly an east and west trend; on their north slope, facing the town, may be seen several small openings of the different mining Companies organized within the past ten years. Some of these openings are mere test pits—the mine existing only in name. The McComber, Rolling mill, and New York Hematite (formerly Grand Central) mines are among the largest of their class of any in the district. The ores are the soft hematite and limonites, and are, when properly selected, of a good quality, averaging well in metallic iron, and exceptionally low in phosphorus, a desideratum now sought for by the Bessemer Steel makers. Some of them are rich in manganese, sufficiently so for the manufacture of Spiegel iron which, in quality, fully equals, if not excels, the foreign article, because of its low percentage in phosphorus; at least it surpasses anything yet produced in our own country. To describe all of these mines would only be a repetition; we will therefore select some one of them:

THE McCOMBER MINE

Was first opened by Win. C. McComber, in 1870. In 1872, the leasehold from James P. Pendill, Esq., the owner of the land, was sold to the McComber Iron Company, which was organized August 14th, 1872;

Capital stock 500,000, in 20,000 shares. The officers are S. L. Mather, Cleveland, Ohio, President and Treasurer; Fred A. Morse, of same city, Secretary; Jay C. Morse, Marquette, General Agent, and Capt D. H. Bacon, Superintendent.



The mine workings are located on the N. W. ¼ of the N. W. ¼ of Sec. 7, T. 47, R. 26, and at present are limited to five large open pits, though it is their intention to begin, as soon as practicable, regular under ground mining.

The formation is very irregular and the strata much folded, as may be seen from the sectional sketch of the west end of No. 1 pit. The ore "*in situ*" has the same banded structure as the jasper which it frequently resembles, and it sometimes passes very gradually into this rock. The stratum from which the ore is wrought is No. X. of the Huronian series; hence, the banded jaspery structure is not surprising. It is more than probable that the hematite deposits along this entire range were, originally, hard, highly silicious and more or less felsitic beds of jasper, that have been acted upon by thermal alkaline waters, which have dissolved out the silica and left the alkaline bases oxides of iron manganese, lime, magnesia and alumina, behind. By this operation the percentage of iron oxide would be increased. Some of the beds of jasper, no doubt, were largely feldspathic, as is evident from small bunches and specks of a soft, whitish, greasy feeling mineral kaolinite disseminated through the ore.*

*See sketch opposite of page, 24 which was made since the above was written.

The mine has produced many very interesting minerals, such as rhodochrosite, a carbonate of manganese; pyrolusite, a binoxide of manganese; baryta, and some pseudomorphs of hematite after pyrite. These latter possess more interest to the mineralogist than to the miner. These crystal cubes are very hard, and, outwardly, resemble a stained crystal of iron pyrites. The facets have often a bright metallic luster and are finely striated after the pentagonal form, so characteristic of the pyrite. The powder is of a deep red color, and in none of them have I been able to discover, on a fresh fracture, any of the unaltered pyrite. Though these pseudomorphs may have but little interest to the miner, still they add another fact to strengthen the theory of thermal alkaline water, as the agent which has transferred the worthless jasper into a merchantable iron ore. What is surprising is the low percentage of silica contained in these ores. An average sample collected by myself from No. 1 pit, in March, 1877, afforded, on careful analysis, the following result:

Oxide of Iron	71.430
Oxide of Manganese	17.250
Alumina	2.200
Phosphoric Acid	.073
Sulphuric Acid	.073
Silica	2.050
Water Combined	5 320
Undetermined	1.604
	100.000

Metallic Iron	49 80
Metallic Manganese	10.90
Phosphorus	.034
Sulphur	.021

An average of several analyses taken from different pits, gave:

Metallic iron	60.33
Metallic Manganese	1.46

The greater portion of the manganese ore occurs in pockets, which in some instances are 25 feet across, and are very rich in this desirable ingredient. This, with the very small percentage of silica and phosphorous, and the appreciable amount of alumina, renders it one of the very best of ores for the manufacture of spiegel iron; in fact, as has been already noted, it is ahead of anything of the kind yet discovered in the United States, and fully equal to the best of foreign manganiferous ores. The other ores, less manganiferous, in this mine, are fairly low in phosphorous and silica, average well in metallic iron, and contain quite a percentage of alumina.

When we consider the wavy structure of this range, it seems highly probable that there must be other parallel belts of this ore to the north of the present workings of the McComber mine. Whether the silica has been sufficiently dissolved out to render them good merchantable ores, is a question that can only be determined by actual exploration.

During the past season 1877, the company have replaced the machinery that was damaged by fire with a very complete plant, from the Iron Bay Foundry of Marquette. The mine, though a small one, has all the conveniences of the larger ones.

Late in the season of, 1877, just at the close of navigation, Messrs. J. C. Morse and Col. Jas. Pickands, stockholders of the mine, determined to demonstrate the adaptability of the ores to the manufacture of spiegel iron. An excellent opportunity offered itself in the Munising Furnace, which was then being "blown out" for repairs, &c. Availing themselves of this they hastily sent, on a tug boat, some 50 tons of ore from the McComber mine. Only a part of this was of their best quality, as no time could now be lost in selecting. Fluxing the furnace properly for this process, the first run was a spotted, or a partially spiegelized iron; but the next cast gave a

beautiful spiegel pig iron. The crystal facets of the spiegel were an inch ore more across; in fact the result was even more flattering than we had hoped for, considering the quality of the ore treated. A partial analysis made by myself of the pig iron afforded the following:

Iron	85.490
Manganese	10.600
Sulphur	.028
Phosphorus	.120
Silicon	.681
Carbon &c	3.081
	100.000

The annual shipments from this mine have been as follows:

YEAR.	GROSS TONS.
1870	4,866
1871	15,942
1872	25,030
1873	37,332
1874	2,642
1875	10,357
1876	17,282
1877	19,691
Total,	134,142

Adjoining the McComber on the east is the

NEGAUNEE MINE.

It was worked in 1871 and 1872 and then laid idle until the present year. The ore is a maganiferous soft hematite, and very similar to that of the McComber mine. The shipments have been as follows:

YEAR.	GROSS TONS.
1871	4,787
1872	9,154
Total,	13,941

Immediately north of the Negaunee mine is the

GRAND CENTRAL IRON COMPANY'S MINE.

It was first worked in 1870 under a sub-lease from Hon. Ed. Breitung, by S. S. Burt and J. S. Waterman. In 1874, owing to the stress of hard times, following the panic of '73, they forfeited their lease, and in 1875 it was again subleased to M. T. Gaffney, Esq., Negaunee. The ore, when properly selected, is a fine quality of "soft hematite" and brown iron ore. The following are the shipments:

YEAR.	GROSS TONS.
1870	1,809
1871	2,921
1872	9,925
1873	6,629
1875	750
1876	456
1877	3,307
Total,	25,797

THE ROLLING MILL MINE

Adjoins the Negaunee property on the south. Work was first begun at the Rolling Mill mine late in the season of 1871. The mine is very conveniently located, both for mining and for the transportation of the ore. The deposit has the form of an immense horse shoe, the walls on either side inclining towards the other at a high angle. A fault and throw diagonally across the two arms of the horse shoe appears to have slightly complicated the structure. The ore is of an excellent quality of soft hematite and brown iron ore, and when carefully assorted is as good as any ore of this class which is mined in the district, but unlike the McComber or the Negaunee mine ores, it contains but very little manganese. W. W. Wheaton, Esq., is the General Manager, and Captain James Bale is the superintendent. The shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1871	236
1872	6,772
1873	13,112
1874	14,796
1875	33,638
1876	50,997
1877	38,901
Total,	158,452

Only a few steps to the south are the workings of the

HIMROD HEMATITE COMPANY.

This company was organized Nov. 27, 1872. Capital stock $500,000, in 20,000 shares. After shipping 5,065 tons of ore in 1873, the company ceased mining operations, and have not resumed. The ore is similar to that of the adjacent Rolling Mill mine, but does not average as well in quality. Adjoining the Rolling Mill mine on the east are the mine workings of the Green Bay Iron Company. The following comprise their total shipments:

YEAR.	GROSS TONS.
1872	7,633
1873	1,949
Total	9,582

Contiguous to the Green Bay Iron Company on the east, is the

ALLEN MINE,

Which has made the following shipments:

YEAR.	GROSS TONS.
1872	8,707
1868	510
1869	130
Total	9,347

This embraces, I believe, all the iron mines of the Negaunee range—excepting the South Jackson—which have made any shipments of ore.

About one mile north and west of Negaunee is the Teal Lake range. The Bessemer, Cambria and Cleveland Hematite mines belong to this range.

THE BESSEMER IRON COMPANY.

This company was organized in February, 1876. The mine property comprises 70 acres of land located in the S. E. ¼ of section 35, town 48, range twenty seven, and is worked under a lease from the Teal Lake Iron Company. It is a little more than a mile from Negaunee, and is situated on the south shore of Teal Lake. A branch from the C. & N. W. R'y. to the mine affords them excellent shipping facility. The first ore was mined in July, 1876, and shipped to Cleveland. In the present workings (Dec. 1877) they have attained a depth of 54 feet below the surface. The mine is very much like many of our other soft hematite ones, consisting of a large open pit, the steepness of whose sides depends on the stability of the wall rock. The vein is some 60 feet thick, with an occasional horse of rock interstratified with the ore. The formation has a strike of nearly east and west, and dips about 45 degrees to the south. This belt probably belongs to No. X. of the iron series. The ore is a very good quality of soft hematite, and some portions of it contain quite a percentage of kaolinite—a silicate of alumina. An average sample collected from different portions of the pit, in July, 1876, afforded on partial analysis:

Oxide of Iron	87.54
Phosphoric Acid	.19
Sulphur	.92
Silica	3.20
Metallic Iron	61.28
Phosphorus	.082

The officers of the company are Charles M. Wheeler, Marquette, President; Jas. H. King, Painesville, O., Treasurer; G. Jones, Negaunee, Secretary; C. M. Wheeler, Agent.

The shipments are as follows:

YEAR.	GROSS TONS.
1875	144
1876	6,801
1877	10,127
Total	17,072

CAMBRIA IRON COMPANY.

This property lies immediately east of the Bessemer, and was leased from the Teal Lake Iron Company early in 1876. The mine is on the same belt as the Bessemer, and the bed has about the same strike, but the dip of the formation is a few degrees less. Just at present—Dec., 1877,—they are contending with some large horses or lenses of rock, but this is a phase of all our soft hematite iron mines, though in some more common than in others. They are now sinking on the dip of the vein and intend to go through a heading of rock, expecting to meet another lens of ore further down which, from the past experience in other mines of the district, is quite reasonable. The hard and soft hematite ores occur in this mine and, when well selected, are of an excellent quality. The shipments are as follows:

YEAR.	GROSS TONS.
1876	6,329
1877	10,082
Total	16,411

CASCADE RANGE.

In this district—some four miles south of Negaunee—great activity prevailed during the years of 1870 to 1873. Preparations were begun on an extensive scale to meet the requirements of an expectant large business. Commodious frame buildings were built and a branch railway constructed to connect with the Chicago & Northwestern Railway; and, in fact, everything was done that seemed to be necessary to carry on such business.

The deposit of iron ore appeared to be, practically, inexhaustible, and the quality was unquestioned: the locations of the mines were exceedingly favorable, and nothing seemed wanting to the fulfillment of their brightest anticipations.

The panic of 1873 came, and with it a lack of demand for the ores which the majority of the mines on this range furnished.

The Palmer mine, or "west end Cascade" and, possibly, the Pittsburgh and Lake Superior mine of this range, are the only mines which are enabled to furnish the quality of iron ore demanded by furnacemen. The showing of ore, at the former of these two locations, is certainly very good, both as to quality and quantity. The bed of ore in the larger pit of the workings, dips about 55 degrees to the northwest, and the strike is southwesterly. This pit is about 230 feet long and 115 feet down, on the lay of the vein; near the center of the working, the vein branches—one portion to the northwesterly and the other one to the northerly. Turning southeast and passing over a few steps to another pit, we find the strike of the vein to be nearly north and south and the dip about 60 degrees to easterly; this pit is about 150 feet long, and is deeper than the first one we examine. The ore bed varies from 6 to 30 feet in thickness, and in the first pit, just described, are some very fine stopes of ore, which is a specular slate and granular specular, and is of a good quality. The capacity of the mine itself is somewhat greater than that of its present equipment; put in proper shape, the mine could produce, as it now appears, at least 40,000 tons annually. The other mines, leased and opened by the Cascade Company on this range, are the Emma and the Bagaley; but these latter have not been worked since 1871. The mine is at present under the able management of Joseph Kirkpatrick, Esq., who gives it his personal attention.

The total shipments of the Palmer, Bagaley and Emma mines are as follows:

YEAR.	GROSS TONS.
1871	4,171
1872	39,495
1873	41,204
1874	16,106
1875	4,070
1876	15,324
1877	20,211
Total	140,581

THE PITTSBURGH AND LAKE SUPERIOR,

Already mentioned in connection with the Palmer, adjoins that mine; the ore, a specular slate variety, is of a good quality, but requires unremitting care to separate it from the specular schists occurring with it. Operations were suspended there until the fall of 1877, when mining was again resumed by Messrs. Bacon and Morse, of Negaunee. The shipments are as follows:

YEAR.	GROSS TONS.
1872	1,160
1873	21,498
1874	1,362
Total,	24,020

The other mines on the Cascade range, that have been opened but are now lying idle—owing chiefly to the quality of their ores—are the Carr, Gribben and Home. They will probably remain in their present condition so long as the high standard of Lake Superior iron ore is held where it now is. The respective shipments of these mines, are as follows:

CARR

YEAR.	GROSS TONS.
1873	1,432
1874	948
Total,	2,380

GRIBBEN MINE,

1873	3,599

HOME MINE,

1873	1,091
1874	2,139
Total,	3,230

WASHINGTON IRON COMPANY.

This company was organized in July, 1864, with a capital stock of $500,000, in 20,000 shares. The corporators were Hon. Edward Breitung, I. B. B .Case, Esq., Samuel P. Ely Esq., Joseph S. Fay and Edwin Parsons. The company own 1,000 acres of land, located in the northeast part of T. 47, R 29, and the mine is just south of the M. H. & O. R. R. The improvements made by the company are quite extensive, but changes met in the formation of the ore beds, not always possible to anticipate, rendered some of these expenses of little value; hence the lack of dividends, the financial embarrassment and the temporary suspension of of mining. The different openings and their respective positions, are faithfully represented on a map of this mine published with the geological report of Michigan, for 1872-3. The first ore was shipped in 1865, and in 1876 the mine was leased by Messrs. Maas, Lonstorf and Mitchell, of Negaunee, who, for certain reasons, have taken the name of,

THE HUMBOLDT IRON Co.

The present parties have done and are doing considerable work in the way of explorations which have amply repaid them. West of the main engine house, about 25 feet, they have sunk what is called the No. 2 shaft. The first hundred feet of the shaft is vertical, then it makes an angle of 43 degrees to the north, and continues on this pitch for 100 feet farther. A drift was then driven 20 feet to the north, where they "struck" a fine bed of ore some 25 feet thick. This bed has nearly an east and west trend, and its dip, on the lower level is very high to the north. On the east side of the shaft the ore is a rich magnetic variety, fine to coarse grained in texture, and quite free from rock; a fine stope has been driven to the eastward on this ore, for nearly 100 feet; and it is proposed to continue in this direction, under the old workings of the former company, leaving a good roof so as to be entirely independent of any possible insecurity of the old mine. At the eastern end, however, will be built a skip road to do away with the otherwise too long tramming. On the west side of No. 2 shaft comes in a fine deposit of specular slate ore, resembling very much, that of the Republic mine; it is quite friable, and has a dull, leaden sound when struck. It will be seen that the shaft happened to come very near what appears to be the junction of two lenses of ore, the one specular, and the other magnetic. This is a common phenomenon in some of our magnetic mines. The prospect for ore, from present indications, (Dec. 1877) is certainly very flattering. An average sample of these ores, consisting of a large number of small pieces, taken by myself, from different parts of the stopes at the bottom of the shaft and from the stock piles, for partial analysis, afforded respectively as follows:

Magnetic ore all kinds, metallic iron	68.30
Silica	3.02
Specular slate ore, metallic iron	65.14
Silica	3.33

The ore is well adapted to foundry purposes, but contains rather too much phosphorus to be smelted by itself, for the manufacture of Bessemer pig. The company are now constructing a railroad switch to connect with the branch of the M. H. & O. R. R. to the Edwards mine. At the upper end of the switch they are building ore pockets and docks, which, when completed, will be very convenient, and will materially lessen the cost of handling the ore,—a consideration too frequently overlooked in mining districts. The old Washington or Franklin mine, now known as the west Humboldt mine, is included in the same lease and forms a part of the Humboldt mine. It Is located just west and south of the Edwards mine, and at present promises very fairly. The vein or bed of ore has a dip of 65 degrees to the northward, and a strike of nearly east and west, and averages from 10 to 12 feet in thickness. The mine is now down about 100 feet, on the dip of the vein, and at the bottom they have developed about 200 feet on the strike. The ore occurs in lenses, and is inter-stratified with lens shaped horses of rock; an average sample from the mine and stock piles, afforded,

Metallic iron	67.51
Silica	3.94

This mine, under the present management, cannot fail to resume its former position among the first class mines of the district. The shipments from this mine have been as follows:

YEAR.	GROSS TONS.
1865	4,782
1866	15,150
1867	25,440
1868	35,757
1869	58,462
1870	79,762
1871	48,725
1872	38,841
1873	38,014
1874	27,890
1875	9,642
1876	3,333
1877	16,545
Total	402,343

EDWARDS MINE.

This property, lying contiguous to that of the Humboldt, was first operated under lease from J. W. Edwards, by the Pittsburgh & Lake Angeline company. Work was begun in 1865, and the first ore was shipped during the following season. This company operated the mine successfully, under the able management of A. Kidder, Esq., until 1873, when, owing to the stress of hard times, they surrendered their lease—Mr. Edwards purchasing of them the mine machinery. The quality of the ore up to this date gave entire satisfaction. The mine, from its very beginning, was worked as an underground one, the only instance of the kind in our iron district. Judge Edwards immediately made arrangements to continue mining, but before he had fairly commenced the engine house was unfortunately consumed by fire—ruining the machinery. He then purchased the Kloman mine machinery, and within less than two months had it in operation at his mine. Soon after this Mr. Edwards sold the mine to W. W. Wheaton Esq., who then took possession and assumed the general management. Mr. Wheaton, with his indomitable energy, desiring to realize early from the mine, and wishing also to use a portion of the product as a mixture in the Rolling Mill furnace at Marquette, of which he had charge, began mining on the stopes of ore left by his predecessors, and thereby failed to do sufficient prospective work. The result is that the mine to day, to one not acquainted with our iron ore deposits, appears nearly worked out, which may, in a measure, be true of the lenses of ore in sight. At the west end of the mine is a narrow bed of very fine specular ore which is, possibly, the point of a lens, and may widen out into a large deposit or lens of good ore. In the east end of the mine the present outlook is no better; still, I cannot attribute this unpleasant aspect to the mine itself, for there is no question, in my own mind, but what good magnetic ore is near at hand and only needs the requisite amount of labor and time to develop it. The beds of ore in this mine, since the very commencement, have been found to occur in lenticular shaped masses, or, as Mr. C. H. Hall so aptly expresses it, "it has a pumpkin seed structure, the one overlapping the other;" and the longer axis of the seed, instead of being horizontal, is nearly always inclined, and usually at a high angle, so that in considering the position of these lenses we should mention the dip of the formation, its strike and the pitch of the lens for this latter is an important fact to the miner. The deepest part of the mine is nearly 400 feet down, measured on the dip of the formation, which is 50 degrees to the north. The extreme limits of the workings, on the east and west ends, are 560 feet apart. All the ore in the mine is brought to the surface over two skip roads, and is chiefly magnetic, with some fine quality of specular slate. The mine ship-merits are as follows:

YEAR.	GROSS TONS.
1866	2,843
1867	4,928
1868	17,360
1869	21,450
1870	24,232
1871	26,437
1872	26,026
1873	39,281
1874	2,849
1875	12,804
1876	19,420
1877	10,591
Total	208,221

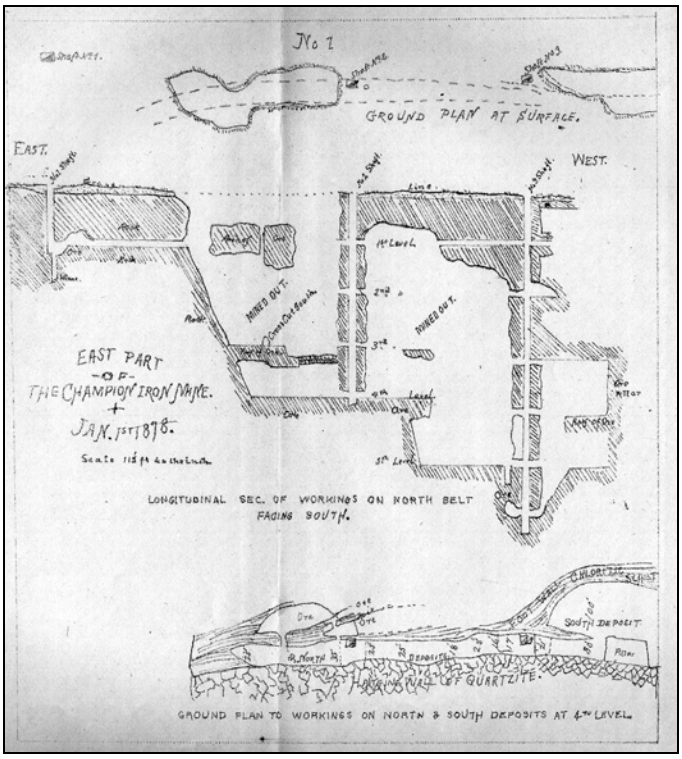
THE CHAMPION IRON COMPANY

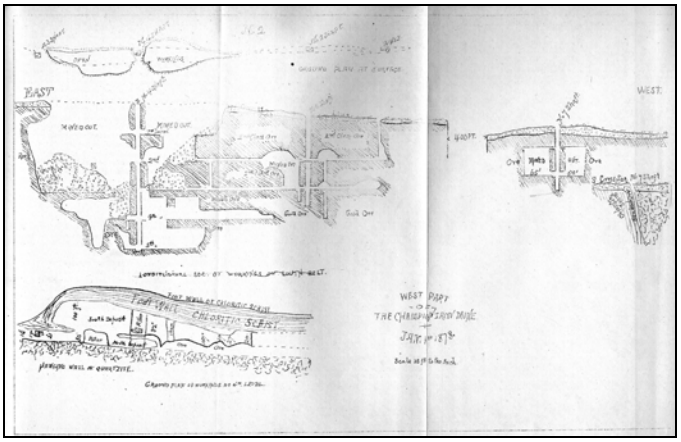
Was organized August 26th, 1869, with a capital stock of $500,000 in 20,000 shares. The corporators were J. S. Fay, of Boston, Edwin Parsons, of New York, T. C. Foster, of Cambridge Mass., and S. P. Ely and Peter White, of Marquette. The company own some 1,600 acres of land, embracing that on which the mine is located, being the S. ½ of Sec. 31, T. 48, N., R. 29 W.; the workings are about one-third of a mile from the main line of the M. H. & O. R. R., with which it is connected by a branch. The mine is 1,117 feet above Lake Superior, and its product is a granular magnetic and a specular slate ore; the former of these varieties, however, predominates.

A few years ago, owing to want of care in selecting the ore, considerable fault was found with its quality; but for the past three years, under the direction and watchful care of its agent and superintendent, it has again come to the front rank of our first-class mines, and is now, as it justly deserves to be, a favorite among furnacemen. This, however, is readily accounted for, since its first-class ore averages in metallic iron, above the present high standard, and the percentage of phosphorus contained is less than five hundredths of one percentum.

The workings are underground; but before going below the surface, let us tarry a moment above. The hoisting machinery, one of the attractions, was made at the Delamater Iron works after plans furnished by Geo. H. Reynolds, modified and improved, in many important particulars, by Messrs A. Kidder and D. H. Merritt. There are six large drums, arranged three on each side of the driving shaft, which latter is kept constantly revolving by two powerful engines, placed one at each end of it. For compactness and facility with which it can be operated, it is difficult to conceive of anything more complete, though there are some minor points that require service to prove their practicability; still, these are details that can be remedied without affecting the principle or arrangement of the plant. To each engine is attached an air

compressing cylinder. The company have a small machine shop where their ordinary repairing is done.





The formation in the mine has an east and west trend, and dips about 80 degrees to the north, though in some places, especially at the widest part of the lenses of ore, it even dips to the south. The hanging wall is a massive gray quartzite while under the ore lies a thin bed of magnesian schist. The true foot wall, however, is a jaspery or magnetic schist. The workings embrace about 1,900 feet of the vein, and the ore is brought to the surface through six shafts, located at convenient distances apart. Between No. 5 and No. 7 is a blank, left for No. 6 shaft. Beginning with No. 1 shaft, (Feb., 1878,) the most easterly—see diagram of mine—we find the shaft down to the first level, sixty feet below the surface, and a winze has been sunk 14 feet deep in the west side of this shaft, sufficient to develop a 12 foot vein of ore, which can be mined out at any time, should the production in the western pits fall short for a season. In No. 2 shaft, which is down to the fourth level, or 240 feet from the surface, all the available ore in the north deposit to this level has been taken out, as appears on the diagram; but from the nature of the foot wall they were induced to drive a drift to the south on the third level—110 feet east from the shaft— which, within a short distance, resulted in finding a fine lens of magnetic ore, 100 feet long by 30 feet wide at the centre, and which extended above the third and below the fourth levels. At the easterly point of this lens is, apparently, the beginning of another lens of specular slate ore. On the fourth level, just east of the shaft, a drift was driven. south, passing through the point of another lens of fine magnetic ore which widens out to nearly thirty feet in stoping west. They have "raised" on this lens some 85 feet, and at this height it holds its thickness; but a drift driven directly over it, on the level above—only 25 feet higher up—failed to intersect it. Since our diagram was made the lens has suddenly terminated to the west, on the fourth level, in two-abrupt forks. These lenses are very deceptive, at one moment raising our expectations to the utmost, leading us to-believe that we have a veritable bonanza, to be as quickly dispelled by a provoking "heading" or "horse" of rock intruding itself without any warning; and as we have not the magic wand of the conjurer, and can lay no claims to the art of divination, we needs must submit as graciously as possible to these strange freaks of nature, resolving next time-to be more conservative. But, perhaps, at some future day, when this lens structure is more thoroughly understood, we may be enabled to deduce a system by which their hidden position and their unknown magnitude may be determined; but until then we must continue as at present, and trust chiefly to "luck" and vague "indications." Glancing a moment at the diagram, it will be noticed that the heading of rock, limiting the workings to the east of No. 2 shaft, pitches about 70 degrees to the westerly. On the bottom of the fourth level we have a floor of ore averaging about 20 feet wide. In No. 3 shaft they are mining on the east side, between the fourth and fifth levels, a sixty foot stope of splendid magnetic ore, averaging 25 feet thick, and to the west of the shaft there is a similar stope of ore—this shaft has now been sunk to the sixth level with winzes at either side. The company have adopted a system of mining wherein, for the future, No. 3 shaft will be the only one in which any sinking is required. The stopes from this shaft will be carried each way to No. 1 and 2 on the east and Nos. 4 and 5 on the west, leaving pillars on one side to protect these shafts; other intermediate pillars will be left, which will be arranged so as to break joints as much as possible, thereby preventing the occurrence of long cracks or open joints in the hanging wall. This method, though not new, still, where it can be applied, as in the present case, is very economical, since it reduces the sinking and drifting account to a minimum. Proceeding westward on the fourth level, we pass through a small drift and enter what is called the south deposit, another large lens of ore, and just beyond this place, or where the point of rock terminates—as is shown on the ground plan of the diagram—we have an aggregate thickness of over 100 feet, measured across the formation. Standing on the edge of a stope and facing west, we look

downward and see here and there in the apparent far distance, the moving to and fro of the small lamps of the busy miners, whose forms are only dimly outlined by the feeble rays, making them appear more like evil spirits; an impression which is enhanced by the clanging of the drills and hammers, the heavy reports of the blasts, the rumbling of the skips moving up and down the shafts, and all these sounds echoed and re-echoed from invisible walls, pillars and roof, create in the mind an impression akin to awe and fear. It must be a strange feeling to one not accustomed to mines to creep around in such gloomy places, realizing that if their light should become extinguished by a sudden draught of air or from some unlucky drop of water, they dare not move a single step, since a false one might send them headlong upon the jagged blocks of ore below. With this great width of vein it requires the very best judgment and skill to win the maximum amount of ore and still leave the roofs and sides perfectly secure; to understand how well these conditions have been fulfilled needs something more than a written description. Center pillars have been left, which are connected by strong arches sprung to buttresses left on the sides opposite these pillars, and the pillars themselves are also connected by arches. This is a general outline, still the details are even more interesting. The south portion of the south deposit is a fine specular ore; the mining in No. 4 pit is chiefly done between the fourth and fifth levels. A sharp bend to the south in the quartzite, between No. 4 and 5 shafts, narrows the ore vein to only a few feet. No. 5 shaft is down to the fourth level, and between this and third level there promises from present indications to be considerable slate ore. We now have left only No. 7 shaft, which is down 100 feet to the first level, and is stoped out 65 feet on the east side and fifty feet or the west side of the shaft. The ore is a superior quality of specular slate, and resembles very much the Republic slate-ore. The vein averages about 16 feet on the west side, and from 3 to 7 seven feet on the east side of the shaft; they have sunk about thirty feet below this level with encouraging results. Returning now to the surface, we find the product of the mine is divided into three classes. The first-class ore is that in which no rock or iron pyrites can be seen, and it will average 67 per centum of metallic iron; the second-class will average about 65 percentum of metallic-iron—it is really a first-class ore, and in ordinary times would be accepted as such; the third-class is about a second-class, and even the lean ore that goes to the rock dump will average above 50 per centum of metallic iron, causing one-to think that they are too radical on the grading of ores; still, it is, perhaps, the surest way to avoid trouble with consumers, who are now only too ready to avail themselves of the slightest pretext to depreciate the price of ore. The-officers of the company are Joseph S. Fay, of Boston, president; W. P. Fay, treasurer; A. Kidder, general agent, and; Capt. Jas. Pascoe, superintendent. The shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1868	6,255
1869	21,535
1870	73,161
1871	67,588
1872	68,404
1873	72,782
1874	47,097
1875	56,877
1876	66,002
1877	70,883
Total	550,584

REPUBLIC IRON COMPANY

Was organized Oct. 20th, 1870, with a capital stock of $500,000 in 20,000 shares. The corporators were Hon. Ed. Breitung, S. P. Ely, and E. D. Parsons. The company own 1,953 acres of land. The property, originally explored by S. C. Smith, Esq., was entered by James St. Clair in Dec., 1854. The mine is located in section 7, town 46, range 29, and is 37 miles west from Marquette, on a branch line which connects with the M., H. & O. R. R., at Humboldt. This branch, which is nine miles in length, was completed in Oct., 1872, and after this date, before navigation closed, the mining company shipped 11,025 tons of ore.

The ore stratum, as well as the associated overlying quartzite and underlying ferruginous schists and massive greenstone strata, originally horizontally bedded, have, by lateral pressure from the northeast and southwest, been sharply folded, while subsequent glacial action and other agencies have worn away, above a certain horizon, the entire iron bearing series, leaving us the remaining strata, with their upturned edges, apparently bent in the form of a large oxbow, the arms of which have a northwesterly trend—the bend or bow being at the southeast side.

Possibly we can more clearly understand how this present structure was brought about if we will suppose the Huronian strata we are now considering, and the underlying granite to have been bent upwards by lateral pressure. It is plainly evident if a weak line existed in the granite stratum, for any distance, that our arch would naturally bend sharply downward along this line, and should this line of least resistance suddenly terminate there would occur a trough like depression, which would become more apparent if the overlying strata were worn away down to the granite. This condition we have already assumed in the first example.

Returning to our oxbow, we find its sides or upturned edges dipping nearly vertical, except at the southeast end, where it dips about 60 degrees to the northwest; the prevailing dip or inclination of the strata is towards the center of the trough. The trough extends northwesterly about eight miles, where its sides rapidly diverge from each other; its average width for this distance is less than a mile from outside to outside. The Michigamme river follows along the basin of this trough, and at the Republic mine widens out into a beautiful bay. The arms of the bow at this point are about one-half mile apart. The mine workings are located on the north arm

and at the lower end of the oxbow, and extend altogether, on the course of the vein, about three-fourths of a mile.

The ore stratum has for its hanging wall proper a massive gray quartzite, similar to that of nearly all our hard ore mines, while the foot wall is banded jasper. The mine is divided into fourteen pits—numbered from one to ten; the remaining four are known as the Gibson, Ely, Morgan and Perkins.

The first pit we meet, as we approach the mine, (March, 1878,) along the ore belt, is No. 10; then, some 350 feet farther along, we reach No. 9 pit, which is entered by a tunnel 200 feet long, driven in from the south side of the hill and intersecting the vein about 80 feet below the surface; the vein, at this point, is about ten feet thick. The pit is open all the way up to the surface, and has been worked 50 feet to the northwest of the tunnel and 100 feet to the southeast, but the vein narrowing at either end, they concluded to abandon the pit for the present; possibly, when the main workings are continued in this direction, at a lower level, it may be found that the vein has widened out sufficiently to pay for mining.

Continuing our course, we come to No. 8 pit, 250 feet from No.9; it is, however, only a small opening, and is not now worked. The company propose to drive a tunnel, somewhere between here and No. 7 tunnel, from the south slope of the hill to intersect the vein.

About 550 feet southeasterly from No. 8, is the mouth of a tunnel leading into No.7 pit. The tunnel level is 80 feet above the lake or bay.* Passing through the tunnel we enter No. 7 pit, nearly opposite No. 7 shaft, and descending on the elevator or cage, working in the shaft, we come upon the 3d level—27 feet below the lake. The first thing that attracts attention is a huge "horse" of jasper one hundred feet long, with an average thickness of fifteen feet, on either side of which is about ten feet of pure specular slate ore. The "horse" pitches or inclines at a high angle to the northwest; turning ourselves in that direction, we soon reach the end of the jasper horse—the shaft being near its center and on its foot wall side. Leaving the horse we have a vein of splendid specular slate ore some 30 feet thick, which a little more than holds its own in thickness for 75 feet. Within this area they are working a stope of ore 45 feet high; climbing up this stope, which is 18 feet above the lake level, we continue and, at the end of our 75 feet, find the beginning of another jasper horse which again divides the vein. The ore vein on the southwest side of the horse being quite narrow, apparently about five feet on an average, they left it for the present and mined out on the northeast side, where the vein averages about ten feet. This horse is about 100 feet long, and as soon as we pass it we have another run of first-class specular slate ore for 90 feet more, averaging 25 feet thick. From this point we climb up another stope, about 40 feet high, where the vein gradually narrows, and for the next 40 feet it averages only ten feet thick.

*The bay or lake is 914 feet above Lake Superior.

Returning now to No. 7 shaft, we find a tunnel driven into the foot wall, for the purpose of cutting a narrow lens of ore: on the level above a winze has been sunk in this lens down to this level, and the tunnel is expected to meet it. Going southeasterly from the shaft, we pass the end of the jasper horse already noticed, and have before us a fine stope of ore fifty feet high; climbing to the top of this, we proceed only a few steps before we come to the point of another jasper horse, somewhat larger then the others, and the ore vein is again divided, leaving about ten feet on each side of the jasper horse. Passing around on the south side of the horse, and when about one-third the way along, we descend some 15 feet. This point terminates No. 7 pit, and is 160 feet from No.7 shaft.

Continuing, we enter No. 6 pit, and at the southeast end of the jasper horse we have a vein of nearly pure specular slate ore, over 50 feet thick; about 40 feet from the end or the horse we descend to the 3d level, which is 41 feet lower than the lake. Turning around, we have before us a stope fifty feet high by forty feet wide, of solid slate ore, save a narrow seam of chloritic schist (soapstone) near the hanging wall side. The vein here, as in No. 7 pit, dips about 80 degrees to the southwest. Looking upward we can see a narrow ribbon of day-light over 200 feet above us, broken here and there by pillars of ore left to prevent the walls from closing in. When we are told of the many tens of thousands of tons of ore which have been mined out of this deep opening, and begin to realize the enormous weight of these huge supporting pillars, sprung from wall to wall, it seems that they must surely fall and crush everything beneath. Resuming again our way, the vein gradually narrows, and at 250 feet from where we entered No. 6 pit, we come to a double cage shaft, the southeasterly limit of No. 6 pit. On the northwest side of the shaft has been left twenty-five feet of ore, and on the opposite side thirty feet of ore, to protect the shaft.

The shaft is now being sunk 50 feet to what will be the 4th level; this is accomplished without interfering, in the least, with the working of the mine. It is done by sinking the shaft ten feet lower than the level, then timbering across; this constitutes the bottom of the working shaft. A winze is now sunk on the hanging wall side of the shaft, and when down far enough the shaft is sunk under the false bottom along with the winze to the next level, and everything made ready to begin stoping on either side of the shaft, so that all that remains to be done is to clear away the false bottom, make the connections, and within five hours time the cage is gliding up and down the new shaft. Leaving the shaft we enter No. 5 pit, and are confronted with a stope of ore 50 feet high and 45 feet wide, which extends back from its upper edge to over 100 feet, widening out at the far side—230 feet from the shaft—to 70 feet thick, making, certainly, one of the finest stopes of ore in our iron district. Along the hanging wall side is a vein of chloritic schist some six feet thick, and between this schist and the hanging wall quartzite, comes in the thin point of a lens of granular magnetic ore.

Passing from No. 5 pit through a drift driven in the chloritic schist, we enter No. 4 pit. Here the magnetic ore has widened to 40 feet. To the northeast of the magnetic lens, and separated by the narrow seam of chloritic schist noted in No. 5 pit, is a fine body of specular slate ore, presenting a face 50 feet high; mounting to the top of this stope, we find it averages about 80 feet northeast and southwest, and 75 feet at right angles to this line; between this pit and No. 5 has been left an immense pillar of ore, 35 feet thick and over 100 feet long, measured horizontally, or say 500 tons of ore for every foot measured vertically. The foot wall of jasper in No. 4, after a couple of sharp folds to the southeast on this east side of the deposit, makes a bend to the southwest, and when within say, 10 feet of the magnetic ore lens, turns abruptly to the southeasterly. The stratum of specular ore conforms to the headings of the foot wall, and forms two spurs of ore in the above folds of the jasper, about 50 feet long and ten feet wide at the center. Returning to the magnetic ore, we find at the boundary line of tins pit and No. 3 pit— which is about 150 feet southeasterly from the division of in Nos. 4 and 5 pits—that the vein of magnetic ore is about 35 feet thick. The ore is of an excellent quality, very free from any impurities; some of it is coarse grained and quite friable, while other varieties are even steely in texture.

As we enter No. 3 pit, which is opposite to the abrupt turn of the foot wall to the southeast, we find the entire formation gradually swinging around to the south. Underlying the magnetic ore is the thin bed of chloritic schist, and under this again, is our vein of specular slate ore, now narrowed down to three feet. Continuing southeasterly in No. 3 pit, for 80 feet, we come to a skip road where the magnetic ore is about 20 feet thick; but it gradually lessens in width for the next 100 feet beyond the skip road, when it is suddenly terminated by a heading of jasper cutting obliquely across the vein. The formation dips about 60 degrees to the southwest in this pit. When we examine this heading on the surface, and trace it through No. 2 pit, it appears to be a fault wherein the formation in No. 2 pit has dropped backward or has been thrown forward in No. 3 pit—in other words, we have a left hand throw. Leaving No. 3 pit, the level of which is 9 feet above the lake, we pass over into No. 2 pit, and begin again at the fault. The formation here has a southwesterly trend, and the ore is very unlike anything we have thus far examined. It is course to medium grained, slightly magnetic, and gives a brownish-red powder; much of it is true martite, that is, specular ore crystallized after magnetite. It would be quite impossible to distinguish it from the magnetic ore by its texture, but a stroke of the hammer upon it, affording the above reddish powder, detects it at once. What is interesting, practically as well as scientifically, is that it occupies the same position and bears the same relation to the underlying chloritic schist and narrow vein of slate ore as did the magnetic ore on the other side of the fault in No. 3 pit. Following it south for 120 feet to No. 2 skip road, it averages about 15 feet thick; but just beyond this point the underlying chloritic schist cuts across, in an easy curve, to the hanging wall side, and the specular slate ore, which has occupied thus far such a subordinate position in Nos. 3 and 2 pits, again widens out to about 15 feet in thickness. Below the level where we now are—which is 40 feet above the lake—they have sunk to another level, and are stoping on either side from the skip road. To the southwest of the skip road, for 120 feet, the vein averages about 15 feet in thickness, when it then narrows down to two or three feet, and so continues for thirty feet, when we come to No. 1 pit, which is very irregular. The ore makes a sharp spur-fold to the southeast into the jasper for about 45 feet, then in a south westerly direction continues for 100 feet, and folds sharply around a jasper point. This pit will average, altogether, about 100 feet long by 15 feet wide. The ore is a good quality of specular slate. They are now mining on the first level below the adit level. Passing around the jasper point we come to the Gibson pit, which is formed by the ore stratum making another sharp spur fold into the foot wall. The axis of this fold pitches about 60 degrees to the northwest. The ore is a superior quality of specular slate; but at present the pit is idle, and the ore at the bottom will, probably, be mined from No. 1 pit at a lower level.

Following around to the southwest for 400 feet we come to the Ely pit; which was first opened in 1872. The workings are about 200 feet long, with a skip road at the center; the vein dips about 60 degrees to the west, and has an average thickness of 15 feet. They are now down on the lay about 90 feet with a skip shaft, and have on this level, at either side, a 30 foot stope of ore, which is a first class specular slate. Leaving this pit, we go about 300 feet west to the Morgan pit, which was opened in January, 1877. The workings are now about 150 feet long, and the vein averages, say, 18 feet in thickness, and they are now down 50 feet below the surface, and have a working stope of 30 feet. The ore is an excellent quality of specular slate. The Perkins pit, about 300 feet further along from the Morgan pit, consists of what now appears to be two irregular deposits of specular ore, about 15 feet by 30, with a bar of rock between them. These include all the workings of the Republic mine.

Turning our attention now to the huge stock piles of ore, which, as they appear glistening in the sun, look more like heaps of polished steel, and clambering over them, seeking sharply for rock or ether matter on which to base an adverse criticism, we are, in the end, however careful our inspection, obliged to acknowledge ourselves discomfited, for they are stock piles of ore in every sense of the word; but when we reflect for a moment, it is not surprising that they are so free from rock, since there is no dirt to discolor it, or disguise the bright lustre of the specular ore which is so strongly in contrast to the dull hued rock, thus rendering it an easy matter to distinguish and to separate them; though still, some of the slate ore is laminated with seams of jasper, which then renders it more difficult to detect, but a glance at an end fracture usually reveals its presence. Satisfying ourselves as to

the purity of the first-class stock piles, we turn to examine the machinery.

Inside the engine house we hear the rumbling of the engines and hoisting drums, but see no signs of exhaust steam. Entering the building we find everything appears to work nicely; but in the place of steam the engines are operated with compressed air, furnished by compressors located at a fall in the Michigamme river, just below the bay or lake, some 5,000 feet distant from the engine house. The compressing cylinders—four in number—are two feet in diameter by five feet stroke, and are driven by two of Swain's sixty-six inch turbines, under a sixteen feet head of water, which afford seven hundred horse power. The wrought iron pipe conducting the air to the mine is 15 inches in diameter, and the air, as it leaves the compressors, is pretty warm, but soon cools. Exactly how much power is lost by this cooling, and the friction, I never have as yet determined. The first item of loss could be very readily ascertained by multiplying the number of pounds of air by the difference of the temperature of the air as it leaves the compressor and as it enters the engine at the mine, and this product again by the specific heat of air; then dividing this last product by 8,000. the quotient would be equal to the number of pounds of pure carbon representing the above loss. The loss from friction, however, could not be so nearly estimated; another variable element to consider is the condensation of the moisture in the atmosphere; still, the loss of heat as given above, I think, would exceed all other losses from whatever sources.

The advantages of compressed air as a motor, when obtained at so little cost, as in the present instance, are hardly apparent to the casual observer. There is but little danger, when the pipes are properly arranged, from freezing in winter, and but little oil is required in the engine cylinders; the drilling machines can be handled with greater ease; and ventilation is much improved.

The success of this compressed air plant, costing nearly one hundred thousand dollars, is chiefly due to the skill and untiring energy of Mr. David Morgan, the president of the company, who personally supervised the construction of this important undertaking. The result of Mr. Morgan's long experience is everywhere visible about the location—in the mine, as well as on the surface—aided I should add, by Capt. Peter Pascoe, who has been the superintendent ever since the mine was first opened; and to all who are interested in mining I can safely reccommend them to Capt. Pascoe as one ever willing to show them the mine, omitting none of its best points.

The present officers of the company are David Morgan, president; W. D. Rees, agent; Capt Peter Pascoe, superintendent. The shipments from this mine are as follows:

YEAR.	GROSS TONS.
1872	11,025
1873	105,453
1874	122,639
1875	119,726
1876	120,095
1877	165,836
Total	644,774

At a distance of about one-mile northwest of the Republic, and on the same vein is the

KLOMAN MINE.

The ore is similar to that of the Republic, and in 1873 and, 74, the mine was worked with considerable vigor. The vein is nearly vertical in its dip, and much narrower than at the Republic. In 1875, for some cause not generally known, operations here were brought to a close, and the machinery was sold and taken away. I find no reason for assuming, however, that this sudden and unexpected move on the part of the management was due to any apparent or real change in the mine, either as to the quality or the quantity of the ore. The mine shipments are as follows:

YEAR.	GROSS TONS.
1873	21,271
1874	34,348
1875	8,059
Total	63,678

The other mines northwest of the Kloman, located on or near the Michigamme river, are, as we meet them in their order, the Metropolis, Windsor, Erie, Cannon, Chippewa, Magnetic, Section 19 and the Berea; but only two of them, the Erie and the Magnetic hare made any shipments of ore, the former having shipped 1,058 tons, and the latter 50. These two, together with Section 19, give indications that promise future results of some value—the latter belongs to the M., H. & O. R. R. Co. Considerable exploring has been done all along this range, especially on the southwest side of the river; more has been done by the Magnetic Iron Company in this direction than by any of the others, and it is to be hoped they may, at no distant period, determine results that shall reward them for their perseverance and expenditure.

MICHIGAMME RANGE.

THE MICHIGAMME COMPANY,

Was organized in Nov., 1870, with W. H. Barnum, Pres't; James Hood, Sec'y and Treas.; Jacob Houghton, Sup't. The company own 1,400 acres of land situated on the north side of Lake Michigamme.

Mining operations were begun here in 1872, in the south half of sections 19 and 20, T. 48, R. 30, though mainly in section 19. The M., H. & O. R. R. extension to L'Anse passing close by the mine, was completed in the winter of 1872. The general trend of the formation at the mine is nearly east and west, and the dip, though slightly variable, averages about 50 degrees to the south. The hanging wall is a massive gray quartzite, and the foot

wall a ferruginous or magnetic schist. Immediately to the north is a high range of greenstone, while to the south the ground is low, probably underlaid by black slate and actinolite schist. The engine and hoisting machinery, made by S. F. Hodge of Detroit, are among the largest to be found in the district, and the engine house, a large stone building, rests upon a solid rock foundation on the foot wall side of the vein. The shaft house, as well as the skip road, is constructed with a view to permanency no!; commonly found in the beginning of the operations of our iron companies. In fact, the appointments of the ruining plant are very complete and well calculated to meet all possible requirements of a large business, and show the work of a thorough understanding of the future necessities of such an enterprise. We will now examine the mine as it appears at this time—the spring of 1878—and begin with No. 1, the most easterly pit or shaft. The ore is a medium grained magnetic, of a very superior quality, averaging high in metallic iron and low in phosphorus. It is very free from actinolite—or white hornblende as the miners term it—which occurs in some of the westerly openings. The pit is an open one and is, probably, about 70 feet deep, and say 35 feet long by 20 feet wide, at the bottom. On the west side they have started a drift 40 feet above the lower level, and have driven it 75 feet to the west on the hanging wall side. At the mouth of the drift the vein of ore was 20 feet wide; but as the foot wall was not teen, only clean magnetic ore on that side, it is impossible to say how thick the vein may average; possibly, it may widen, or on the other hand it may be less than twenty feet; at any rate, one thing is certain—we have to begin with, a stope 40 feet high by 20 feet wide, and have very good reasons for supposing it to continue for 75 feet more. At present the ore is hoisted by a derrick operated by a small friction engine. Turning westward we meet some open pits not worked at present, and come to No. 4 shaft. By means of ladders we go down to the adit level, along which a railroad track is laid, and which extends to a short distance beyond No. 1 shaft. It is a gradual down grade from this latter point all through the mine as we go eastward, and connects finally with the main line of the M., H. & O. R. R. From this level we continue down No. 4 shaft, two levels more, and reach No. 2 level. Turning eastward and proceeding 190 feet, we reach the eastern limit of this pit; at this point is a winze shaft connecting with the end above, affording on the west side of it a trapezoid shaped block of ore, which is 45 feet on the top and about 20 feet on the bottom by, say, 15 feet thick. This shape is owing to a crossing of mixed ore, some 30 feet wide, pitching to the east and south at an angle of about 45 degrees. To the west side of the shaft, 120 feet on the second level, we find a crossing of chloritic rock and mixed ore which limits the working in this direction. This crossing, so far as developed, appears to pitch about 50 degrees to the southeasterly.

Continuing now 60 feet down to the 3d level, we have on. the east side a 27 foot stope of strictly first-class magnetic ore, 70 feet long by 18 feet thick; above this has been left a pillar 25 feet thick, but it is the intention of the company to take away 15 feet on its upper side by an underhand stope. On the west side of the shaft is a stope of ore 60 feet high averaging about 20 feet thick, which will, probably, be cut off by the above crossing, leaving some 20 feet on the top and say 40 feet on the bottom of the stope yet to be mined. From the 3d level the shaft has been sunk 46 feet, and on either side are winzes connected at the bottom by a short drift. It is expected that this will give them to the east a 46 foot stope of ore 160 feet long by 18 feet thick; on the west side the stope will, probably, be about 50 feet long.

Passing out of No. 4 shaft we proceed along the adit level to No. 5 shaft, 440 feet west of No. 4. This shaft is sunk 160 feet below the adit level, or down to the third level. To the east, on the second level, they have stoped to about 140 feet from the shaft, but between the second and third levels, a distance of 65 feet, is unbroken ground for 300 feet to the east. To the west of the shaft nothing remains above the second level, between this shaft and No. 6 shaft, except the supporting pillars and a pyramid of mixed ore situated midway between the shafts. About 40 feet down from the second level, and 75 feet west from No. 5 shaft, we have the face of a stope 75 feet long, 40 feet high and about 9 feet thick. The thickness of the vein, on the third level, has not been determined as yet.

Out of No. 5 shaft, we pass the engine house in going to No. 6 shaft; down this we go some 70 feet, to the adit level, and are now nearly 400 feet west from No. 5 shaft, No. 6 is 165 feet down from the adit level, or down 235 feet all told. For 90 feet below the adit the ore has been mined out to No. 5 shaft, and 175 feet to the west. At this westerly point we have a 65 foot stope of ore, averaging about 12 feet wide; climbing to the top of its steep face, we find a crossing of jasper-conglomerate cutting off the ore, which on the adit level is 30 feet wide, and pitches to the southwest about 60 degrees. If it continues in this same course we will have a pyramid of ore about 60 feet on the base. Below the second level the shaft, as already observed, has been sunk 75 feet, also the winze at either side, and we have, therefore, a stope of unknown ground over 200 feet long by 75 feet high. At No. 7 shaft they are carrying a sixty-five foot stope to the west on the adit level, which level is 105 feet from the surface. The vein here is about 10 feet thick.

No. 7 is sunk 75 feet below the adit, and the winzes on either side are just begun. Standing at the top of No. 7 shaft and looking east may be seen two or three right hand throws along the ore belt. The juncture or faulting line of these is much broken, and the material lying in the crevices or breaks, is highly stained with iron oxide, and in some instances we have a soft hematite ore. It has been reported that complaints were made against this ore because of the occurrence of fibrous hornblende (actinolite) disseminated in the ore which, on exposure to the sun, appears to bleach out, when it contrasts very strongly with the dark back ground of magnetic ore. The ore from Nos. 1 and 4 pits, which will constitute the bulk of this year's product, is of a first class quality, and there

is no reason why the highest grade of strictly first-class ore cannot be produced from these openings; and furthermore, the ore from these openings is very low in phosphorus, and is therefore well adapted to the manufacture of Bessemer pig iron. Altogether, viewing the mine from an impartial standpoint, its prospects for first class ore appear much brighter then they were one year ago. The shipments from the mine are as follows:

YEAR.	GROSS TONS.
1872	141
1873	28,966
1874	45,218
1875	44,756
1876	70,074
1877	28,238
Total	217,393

THE SPURR MINE

Is about one mile west from the Michigamme mine, on the M., H. & O. R. R., and is 39 miles from Marquette and 24 miles from L'Anse, and is on the same range as the Michigamme. The Spurr Mountain Mining company was organized Aug. 16th, 1872, with a capital stock of $500,000, in 20,000 shares. The property embraces the north half of the S. W. ¼ and the south half of the N. W. ¼ of section 24, town 48, range 30.

Work was commenced in 1872. It was then an unbroken wilderness and the first thing to do, after exploring the deposit, was to make a clearing, erect dwelling houses, offices, barns, &c.

The vein or stratum of ore has nearly an east and west trend, and dips about 45 degrees to the south.

The workings occupy about 900 feet of the vein; the principal mining has been done on the western half of this stretch. The ore is magnetic, averaging very fair in metallic iron, and is well adapted for foundry or mill iron purposes. To the back of the vein is a bluff some forty feet high, composed of jasper and banded ferruginous schist. Overlying the ore is usually a thin layer of chloritic schist which, in some places, is thickly impregnated with garnet crystals more or less completely changed into chlorite. These crystals vary in size from a small pea to an inch or more in diameter. The hanging wall proper is a massive gray quartzite.

The mine is divided into four shafts, No. 1 being the most westerly. This shaft is down 170 feet on the dip of the vein from the surface. The vein has been worked to one hundred feet to the west of the shaft, and within this area was a large body of ore, measuring at its widest part some 50 feet thick. It is really a chimney or lens of ore, with its axis pitching about 45 degrees to the southeasterly, but which narrows to 20 feet at about half way down, and then continues of nearly the same thickness for the remainder of the distance, as far as developed. The vein, on the west side or end of this opening, appears to be cut off by an irregular or zig-zag like heading of rock which, apparently, in its general course conforms to the pitch of the lens of ore.

No. 2 shaft, 140 feet east of No. 1, is down 220 feet from the surface. About half way down the foot wall gradually approaches the hanging wall, narrowing the vein from 3 to 7 feet, but when within 80 feet of the bottom it again widens out from 6 to 15 feet. On the lower level it is stoped out for 100 feet east of the shaft, and at this point there is a stope of good magnetic ore 40 feet high by 6 feet thick. To the west, on this same level, it has been stoped away for some 90 feet, and considerable ore still remains between this point and No. 1 shaft. About 20 feet to the east of No. 2, on this level, has been sunk a winze 20 feet deep, then a short drift driven west to the main shaft, where they sunk 22 feet further. Another winze has been started about 40 feet to the west of the shaft. It was purposed to sink altogether 70 feet, and then begin stoping to either side of the shaft. The ore from No. 1 and 2 shafts is brought up in skip cars over an incline, and dumped automatically into pockets. Nos. 3 and 4 pits are operated by derricks.

No. 3 shaft, 140 feet from No. 2 shaft, is down 100 feet, and the ore vein averaged for this distance about ten feet thick; but at the bottom the foot wall approaching the hanging, narrowed the vein to 6 feet thick. This pit has been stoped away entirely, to either side down to this level. At the bottom a sump or extension of the shaft, some 25 feet wide by 20 feet deep, has been made.

No. 4 pit is 200 feet east from No. 3, and is only down 75 feet. The vein averaged from 5 to 6 feet. From this point for 320 feet east we have an open pit from 30 to 60 feet deep, and a variable thickness of the ore vein from 2 to 7 feet.

The mining machinery, made at the Iron Bay Foundry, Marquette, is very complete, and for the requirements of the mine cannot be surpassed. It has four drums and a Cornish pump attachment, with ample steam and engine power to drive them. The mine switches and railroad sidings are very conveniently located.

The mine has been laboring under one very serious embarrassment, and that is a lack of ready capital. The first result of this is in not having sufficient new ground opened ahead to mine advantageously. Secondly, a higher price must be paid for labor, and thirdly, labor in reality “running the mine,” and accomplishing less for a day's work, thereby lessening the capacity of the mine. It is only too plainly evident that when such conditions exist, under the present depressed state of the iron business, the question of failure is only a matter of time. The officers of the company are H. N. Walker, Esq., of Detroit, president; Col. Freeman Norvell, general manager; Capt. William Morrison, superintendent. The shipments of the mine have been as follows:

YEAR.	GROSS TONS.
1873	31,933
1874	41,765
1875	23,095
1876	20,276
1877	22,801
Total,	139,870

THE STEWARD MINE

Is located on the M., H. & O. R. R., and adjoins the Spurr, being about one-fourth of a mile west from that mine. It is on the same vein as the Spurr, and the ore is very similar. The formation dips about 60 degrees to the south, and the general trend is about east and west. The principal work that has been done is confined to two shafts, which are about 100 feet apart and sunk fifty feet on the lay. In the east shaft they have stoped away at the top, under the roof, about 80 feet to the eastward, and say 50 feet to the westward; while at the bottom the foot of the stopes are only 20 feet to either side of the shaft. The vein averages about 5½ feet thick, but is somewhat mixed with lean ore and fibrous hornblende, requiring considerable care in selecting. In the west shaft no work is being done at present. They have stoped out about 25 feet on the east side of the shaft and averages 15 feet to the west for half way down the shaft. At the bottom has been driven a drift some twenty feet to the west; this vein averages about 6 feet thick, but is even more mixed than in the east shaft. The mine, in 1877, was operated by Messrs. Curley & Gleason, but at present—1878—it is worked by Mr. M. Gleason. The shipments from the mine have been as follows:

YEAR.	GROSS TONS.
1874	305
1877	992
Total,	1,297

Returning now to Negaunee we go south 18 miles along the line of the C. & N. W. R. R. to the Smith Mine Junction and thence, following the Smith mine branch, to

THE SILAS C. SMITH IRON COMPANY'S MINE,

Which is somewhat isolated and but little known to outsiders. The prevalent opinion among those not interested or familiar with this mine is that the ore is rather lean and not first-class. This summer (1877) I examined this mine and was most agreeably surprised. The mine is located on the S. E. ¼ of section 18, town 45, range 25. The branch from the Chicago & Northwestern railway gives them excellent shipping facilities. At the mine the railroad track, coming from the east and southeast, follows around on the northerly side of a hill, and at the mine intersects the northern bounds of the present workings. From this point as we go southward, the hill, for some 900 feet, gradually ascends, when we come upon the table lands, which have an elevation of 80 feet above the railroad track at the mine.

Entering the mine through the railroad tunnel, we pass in on the "adit level" and find ourselves in an open pit about 150 feet long by 50 feet wide at the south end, and 70 feet wide at the north end. Near the mouth of the tunnel is an open pit about 30 feet across and say 20 feet deep; in the northeast corner of this pit is a shallow shaft with “blue, soft specular ore in the bottom, and on the south side of the pit is the same kind of ore, which continues from the bottom of the pit on this side to near the upper edge of the pit. An average sample of this ore, consisting of some twenty pieces, collected by myself afforded me, on careful analysis, the following result:

Peroxide of Iron	86.730
Alumina	1.840
Oxide of Lime	4.820
Oxide of Magnesia	2.500
Phosphoric Acid	.087
Sulphur	.041
Silica	.320
Water	3.500
Metallic Iron	60.71
Phosphorus	.033

This ore resembles very much the soft specular of the Menominee range, not only in its physical or outward appearance, but also in its chemical composition, and it is very probable that these two ranges belong to the same geological horizon.

Proceeding now with our examination of the mine, we continue southward along the adit level or present bottom of the main open pit and pass over a narrow crossing of rock and mixed ore, which disappears, in a few steps, to the foot wall side and leaves us a vein of soft hematite ore twenty-five feet thick. This vein continues to the south end of the adit level—a distance of over 100 feet. Just before reaching this we notice a drift driven easterly into the hanging wall side. The drift passed through about four feet of silicious schist and then intersected another vein of soft hematite ore. It, however, may be the same vein with a narrow horse of rock, which apparently divides the deposit at this point. At the south east corner of this level a small drift has been driven southward to give drainage to the ore above. Facing now south, we have before us a fine twenty foot stope of "putty hematite” as Capt. Wood aptly terms it,” while above and beyond this is another stope of the same ore, eight feet high. At first it was attempted to carry forward the two stopes as one, but the peculiar nature of the ore deposit rendered it unsafe to continue this plan, and they were obliged to terrace or divide the stope as above described. An average sample taken by myself of this pre for analysis afforded the following:

Oxide of Iron	85 86
Oxide of Alumina	1 44
Oxide of Lime	1.19
Oxide of Magnesia	.25
Phosphoric Acid	.09
Silica	1.92
Water	8.20
Metallic Iron	60.10
Phosphorus	.04

This ore is a singular variety of hematite, and resembles a bronze colored putty. It is very free from grit and, no doubt, would make a very durable mineral paint. The above average analysis is not surpassed by any of the soft hematites of the Marquette iron district. Since my visit to the mine, Mr. J. J. Pierce, the President of the company, informs me that subsequent mining and explorations have shown that the ore vein continues, with the exception of a crossway of rock or so, for two or

three hundred feet further south, with strong indications of a much greater extension in that direction. The workings, passing as they do into the side of the hill, will have to the south a good drainage for some time to come. The location of the mine is very favorable, and the hardwood lands surrounding tin mine will supply it with cheap fuel for many years; the land when cleared is well adapted to agriculture, which will eventually lessen very materially the cost of living; in fact, the more enterprising of the miners will, by improving their spare time during the summer season, be enabled to raise their own vegetables and garden fruits. The officers of the company are J. J. Pierce, President, Sharpsville, Pa.; J. F. Stevens, Agent, Negaunee, Mich.; Capt. A. Wood, Superintendent, Smith Mine. The mine shipments are:

YEAR.	GROSS TONS.
1872	13,445
1873	9,329
1875	188
1876	225
1877	8,433
Total,	31,620

MENOMINEE RANGE.

The product of the mines of this range find now an outlet over a branch railway, built in 1877, by the Chicago & Northwestern Co., which connects with their main line at a point twenty-five miles below Escanaba. The principal stations on this Mennonite River Railway, as the branch is named, are, as we meet them in going westward from the above point, Waucedah, twelve miles, Vulcan, eighteen miles, and Quinnesec, twenty-four miles, respectively, from the junction. At all of these stations substantial depots and warehouses have been erected, which would do credit to many of oar older and larger towns; in fact, the stranger on alighting from the train is at once favorably impressed with these well built and cleanly kept station houses. The road bed, for a new road, is in excellent condition; the gradients are not heavy and the curves are easy; a train of forty car loads of ore, averaging from six to seven tons of ore to the car, is easily drawn by the light twenty-five ton locomotives used on this branch. During the construction of this road it was an open question as to whether it would pay; but even now the brighter expectations of the more sanguine have been more than realized, and it is to be hoped that the encouragement received from this fact will induce the C. & N.-W. Co., to extend the branch further west, that the Commonwealth and other promising ore deposits, may also have an outlet. The first mines we come to in our journey westward from the Junction, are the Emmett and Breen, at Waucedah. They are conveniently located to the north of the main R. R. track on a short Y switch branch.

THE EMMETT MINE,

The most easterly one, is on the edge of an open swamp or "meadow." The formation dips to the south at an angle of 60 degrees, and has nearly an east and west trend. The mine workings embrace about five hundred feet of the vein, though explorations have shown that this is not the extent of the vein. The ore belt consists of two distinct varieties of ore; a bluish colored “soft specular ore*" lies on the hanging wall side, and a soft brown ore on the foot wall side of the vein. In some places the beds are contiguous; in others they are separated by a narrow belt of lean ore, or rock. As yet it is impossible to give any definite data respecting the thickness of the ore beds, as neither the foot wall of the brown ore, nor the hanging wall of the blue ore, has been found. The main open pit, located in the west end of the main workings, is about 200 feet long and 70 feet wide by 35 feet deep. The brown ore, near the center of this pit, as far as developed, has a thickness, at right angle to the bedding, of 50 feet, and the soft specular ore, immediately overlying it, is, at present, 25 feet thick, with fair prospects of extending much farther south.

*This ore is really a soft specular variety, as it consists of an aggregation of minute crystal particles of specular ore, and in this respect differs from our so-called soft hematites, which are chiefly an amorphous mass of the red and yellow oxides of iron.

A person familiar with mining would naturally wonder why the company did not ascertain the extent and position of their ore belt so that everything pertaining to mining could be, at the commencement, most advantageously located; such as buildings, railroad tracks, ore docks, waste rock piles, etc. The reason why this was not done is that the company have been so pressed with orders for their ore that their entire energies have been given, as far as possible, to the filling of these orders—certainly a very happy state of affairs in the present depressed condition of the iron ore market.

The workings east of the main pit, are not as extensive, and the ore appears to be more mixed. In the extreme east end, in the blue ore, there occurs a pocket of this ore mixed with iron pyrites. They were experimenting on this, endeavoring to eliminate the sulphur by calcination—they had piled a lot of the ore on logs. It was very evident that this was a new business to them, from the large amount of fuel they used, which would partially fuse some of the ore and pyrites, thereby making the matter worse. The soft specular ore is of an excellent quality and well adapted to the requirements of steel makers, as the following analysis will show:

Oxide of Iron	93.85
Alumina	.72
Lime	.87
Manganese	.60
Sulphur	.09
Phosphoric Acid	.11
Silica	1.40
Carbonic Acid, &c	2.36
	100.00
Metallic Iron	65.70
Phosphorus	0.47

The brown iron ore will make a good foundry iron, or would answer well as a mixture for other purposes; an average analysis of a large number of samples sent me by the company, afforded the following results:

Oxide of Iron	81.570
Oxide of Lime	3.150
Oxide of Magnesia	1.800
Sulphur	.056
Phosphoric Acid	.295
Silica	5.550
Water, Carbonic Acid, &c.	7.579
	100.000
Metallic iron	60.33
Metallic Phosphorus	.129

The phosphorus in this is rather high, which may, in a measure, be accounted for by the fact that the samples were taken near the surface, where the swamp water had free access to the ore, and the probabilities are that the phosphorus will decrease as they go deeper.

South of the workings, they have sunk several test pits, which, in some instances, have shown good ore, and m others fair indications of ore. The ore at present is brought to the surface by means of two derricks, one operated by an attachment to the steam pumping engine, and the other by a horse-whim. At the time of my visit, (Oct. 1878), the miners of the Breen mine had been transferred to the Emmett, and the combined force of some fifty men made the iron buckets "spin up and down" at a lively rate.

The mine, in some respects, might be considered a wet one, owing largely, no doubt, to the seeping in of the water from the swamp. To obviate this latter cause, several plans are suggested; one is to carry the waters of the Hamilton creek, which flow through the swamp, in a wooden laundry across the swamp, and then to pump the mine water directly into this aqueduct. This project, from present appearances, seems very feasible; another plan, if the hanging wall should prove sufficiently firm, is to build a coffer dam along it, in front of the mine workings. This latter plan, if the above conditions should permit, would not be very expensive as the material could be obtained from the waste rock and dirt without any extra cost.

Altogether the ore, at present, is mined very cheaply.

The officers of the company are Hon. E. S. Ingalls, chairman; Bartley Breen, sec'y; Thomas Breen, treas. and sup't.

The mine shipments for this season will be given in the tables for 1878 at the end of this report.

Adjoining the Emmett mine are the older workings of the

BREEN MINE,

Which is located on the N. W. ¼ of the N. E. ¼ of Section 22, T. 39, R. 28. The company also own the north half of the N. W. ¼ of this section. The first exploring on this property was done in 1870, by S. P. Saxton, the present secretary and treasurer of the company. These explorations consisted of several test pits sunk at different points on and near the present site of the mine workings, also of two long trenches dug across the formation, which demonstrates the probable existence of soft specular ore in paying quantities. In 1873 the Milwaukee Iron Co. drove a drift, 26 feet long, northward from the south side of the hill, just above the level of the swamp, which developed a 16 foot vein of soft specular ore; later, the Menominee Mining Company was organized, and in the spring of 1877 began mining operations and shipped, during that year, 5,812 gross tons of ore, but in May, 1878, the company abandoned their lease, when the owners of the property continued the work of mining.

The ore in this mine, thus far, is nearly all of the soft specular blue variety, and is of a good quality, as may be seen by the following analysis made from an average of a large box of pieces of the ore sent me by Mr. Saxton:

Oxide of iron	83.86
Oxide of lime	2.70
Oxide of magnesia	1.60
Sulphur	.02
Phosphoric acid	.10
Silica	6.76
Carb. acid &c.	4.96
	100.00
Metallic iron	58.70
Metallic phosphorus	0.44

The noticable percentage of lime and magnesia will be quickly seen and appreciated by furnace men. The ore deposit, so far as developed, is not very regular, which causes much annoyance, but on the other hand, the formation has some features that are interesting to the geologist. The eastern opening of this mine, which is west and north of the Emmett workings, is geologically the most complicated; they stripped the earth from what at first appeared to be a large deposit of blue ore, which has a very uniform dip of 60 degrees to the south, and a strike of nearly east and west, conforming therein to the prevailing lay of the formation of this locality. The deposit, on the north side of the opening, is covered with sandstone. After mining down from one to six feet, however, they came unexpectedly upon sandstone—certainly a new phase in this range; on the east end of the pit there is but little to denote any disturbance. Traversing the center line of the opening, in an east and west direction, is a vein of very good ore dipping under the sandstone. On the south side is a large boulder, some four feet across, composed of lean hematite schist, identical with those forming the leaner portions of the ore belt, which is embedded in the sandstone, and which has a dip to the north. The sandstone conforms to all the irregularities of the boulder, as it does also to the abruptly terminating ends of the layers or laminæ of the overlying slaty blue ore and schist, already noted. The hypothesis that these overlying tilted ferruginous schists are more recent than the undelying sandstone, is not to be entertained for a moment; and the only theory which explains most clearly to my mind the facts observed, is that these schists, during the silurian period, formed a bold cliff, which during the deposition of the sandstone at its base, was undermined by lie waves of the silurian sea beating against it, and that a dip or slide occurred whereby the stratigraphical position of a portion of the mass was not changed, but that the loose fragments were tumbled down burying themselves in the sandy

beach below. Near the center of the opening they sank a small shaft, which, within a few feet, passed through the sandstone and into very good ore again.

Only a short distance west from the opening just considered, is a much larger one—the main opening of the mine. From this has been taken the greater part of the ore shipped from the mine. At first it promised much, but the good ore, in the course of mining, too soon gave place to worthless ferruginous slaty schists. My opinion is that the soft specular ore deposits of this mine were originally lean specular schists out of which has been dissolved the silica, after the same manner, no doubt, as were the jasper beds of the Marquette soft hematite mines (see description of the McComber mine); to support this hypothesis, we have in this same opening, near the centre of a wide northerly branch of the same, a mass of horizontally bedded sandstone from 30 to 50 feet across in different directions, and, say, 25 feet thick. It is, apparently, a large pot hole worn out of the ferruginous schists which has been filled with sand and finally altered into sandstone. This boulder was, therefore, completely surrounded by these lean schists. Immediately around the boulder was a fine quality of blue ore, which varied in thickness from ten to thirty feet. If the "dissolving out" theory be correct, the above facts are precisely what we should expect to find. Dr. N. P. Hulst, agent of the Menominee Mining Company, a careful scientific observer, as well as a thorough chemist, told me that he had often found pieces of blue ore that were very open in texture, and presented every appearance as if something had been dissolved out of them, which had lead him to the conclusion that the dissolving out theory, in some instances combined with replacement theory, would largely account for these "unusual" deposits of ore. The bulk of the ore of this opening was found along the south base of the hill. West of this opening, and on higher ground, is another irregular shaped pit. The ore deposit appears to dip down nearly vertical; beginning at the east end of the pit the deposit extends westward for about seventy feet, when it turns abruptly to the south, cutting across the plainly stratified jaspery schists; the width varies from 6 to 20 feet, and on this southerly arm they have stoped out some seventy feet in length by twenty-five feet deep. The impression now is that a considerable deposit of ore lies at the base of the side hill and in front of the openings already considered. The officers of this company are Hon. E. S. Ingalls, president; Hartley Breen, vice-president; S. P. Saxton, secretary and superintendent; Thomas Breen, treasurer.

THE VULCAN MINE,

A little more than six miles from Waucedah, is worked by the Menominee Mining company. It was opened by this company in March, 1877, and during that year, after August, about the time when the railroad was completed to this point, they shipped 4,593 tons of ore.

The mine is favorably located near the summit of a hill, and enjoys every advantage for good drainage. The workings consist of a large open pit 280 feet long by, say, 75 feet across at its widest part. The mine is now entered on the adit level through a tunnel sixty feet long, and all the ore from the mine passes out on this level over a narrow guage tramway, and is dumped directly into pockets and from thence the ore is loaded, by means of "shutes," into the railway cars below. The adit level is 30 feet above the railway track, abreast of the ore pockets, and about 550 feet above Lake Michigan. It also intersects the vein of ore 40 feet below the original surface, though at present but little ore remains in the main pit above this level.

Glancing at a ground plan sketch of the mine the workings or open pit presents a lenticular shape, thinning out at either end. The formation dips about 60 degrees to the south, and has a strike of N. 75 W. Entering now the mine we find ourselves near the center of the workings at the widest place of the deposit; on the east side of the center they have mined the ore down twenty feet below this level for, say fifty feet to the west; on this lower level the ore is stoped away, on the north side, for some 60 feet from the center in that direction, and for, say 25 feet wide. Along on the top of the south half of this stope is the tramway which brings the ore from the west end workings. As already noted, the vein narrows to either side of the center; whether it widens again or pinches out entirely, or the possibility of another lens of ore being in the foot or hanging wall sides, immediately to east or west, future operations can only decide, and the same may be said of the continuation of the ore as we go downward. At present there is a large amount of ore in sight, which can be cheaply mined, and the near approach of the close of the shipping season will enable them to do some necessary dead work, such as removing a portion of the hanging wall, and preparing for underground mining. It is an open question with me as to how they will support the roof of the underground workings; for I doubt very much if the soft specular blue ore, composing the vein, will stand as pillars or supports; since it is quickly affected by the weather—slaking and crumbling into fragments within a short time. Fortunately, however, if timbering is resorted to, they have an abundance of heavy pine that will answer well for "stulls" or similar purposes. The trouble with timbering will be in the wider places of the deposit, and will depend much upon the character of the hanging wall or roof. The ore thus far, in the Vulcan mine, has been well and cheaply mined, and it is fair to assume that the good judgment and careful management which will be necessary to duplicate the record of this year will not be found wanting for the coming season. The ore of this mine is of a good quality and well adapted to steel purposes; will work by itself, or will make an excellent mixture for other ores; it reduces easily in the furnace, as its porus nature affords the reducing gases of the furnace an easy access to the iron oxide. Two analyses of the ore are as follows:

	No. 1.	No. 2.
Metallic iron	60.13	62.29
Insoluble silica	12.63	
Soluble silica	.28	5.84
Alumina	.31	
Lime	.09	1.31
Magnesia	.03	
Phosphorus	0.27	0.22
Water	6.45	

No. 1 is a complete analysis made by J. B. Britton, and No. 2 is a partial analysis made by myself, Oct. 1878. The mine is connected with the main track by a Y switch, which leaves the main line about one mile west of Vulcan station. About the mine are several substantial buildings, and at Vulcan station a small village has already sprung up. On the west side of the village Dr. N. P. Hulst, the agent of the Menominee Mining Co., has a beautiful residence, which commands a fine view of a small lake a short distance to the west.

From the Vulcan mine we go northwesterly about two miles to the

NORWAY MINE,

Located on the N. E. ¼ of the S. E. ¼ of section 5, T. 39, R. 29. This is a new opening worked by the Menominee Mining Company, under a lease from the Portage Lake Canal Company. The first work was done here In August, 1878, and since that date has been built to the mine, a switch one mile in length, ore pockets constructed along the side of the track, several buildings erected, and now, (Oct. 24th,) they can ship easily 300 to 400 tons daily. The ore formation here is somewhat irregular; it has an east and west trend, and in the present workings there appears to be a narrow synclinal trough which pitches at a low angle to the west—though hardly enough work has been done to form a very clear idea of the structure. The ore is of two kinds—one a soft specular, and the other a hard, steely, specular variety, very much like the Cleveland mine ore. The former variety composes about 85 per cent, of all the ore. An average analysis of the soft specular ore sent me by Dr. N. P. Hulst, the agent of the company, afforded as follows:

Oxide of iron	85.200
Alumina	2.300
Lime	4.100
Magnesia	.620
Sulphur	.022
Phosphoric acid	.040
Silica	7.500
Metallic iron	59.64
Metallic phosphorus	.018

Another analysis made by myself gave:

Metallic iron	63.50
Metallic phosphorus	.017
Silica	7.420

From the Norway we go wrest along the switch about one thousand feet when we come to another newly fledged mine known as

THE CYCLOPS,

Which is worked under a lease by the Menominee Mining Co. This opening has certainly an extraordinary record. Oct. 1st, of this year, work was first done here and now, Oct. 24th, it is shipping, daily, 150 tons of good ore, at a cost not to exceed 20 cents per ton. The stripping of earth, is light, probably, not averaging more than two feet. The vein has a strike of nearly east and west, and dips 45 degrees to the north. The opening is on the south slope of a hill, and will therefore have good drainage; as neither the foot nor hanging walls have been seen, it is impossible to give the thickness of the vein; but at present they have opened out across the vein sufficient to develop 30 feet of the thickness. The ore is similar to the Norway; an average analysis sent me in Nov. 1878, by J. J. Hagerman president of the Menominee Mining Co. afforded:

Oxide of iron	95.90
Oxide of manganese	Trace
Oxide of lime	.36
Oxide of magnesia	.30
Alumina	.62
Sulphur	.01
Phosphoric acid	.04
Silica	1.30
Undetermined	1.47
	100 000
Metallic iron	67.13
Metallic phosphorus	.018

Altogether the prospects of the Cyclops are very bright, as much so as any of the mines on the Menominee range. The shipments of this mine for the season will be found in the tables for 1878 at the end of this report.

There now remains of the shipping mines only one to describe—the Quinnesec. The Quinnesec mine is located on the S. E. ¼ of Sec. 34, T. 40, R. 30. Explorations were made here early in 1873 by the Hon. J. L. Buell, of Menominee, Mich. Mr. Buell sunk several test pits across the vein, and then connected them by drifts; he also sunk a shaft some 70 feet deep, demonstrating the existence of soft specular blue ore in paying quantities. During the following winter he shipped, by means of sleighs, some fifty tons of the ore to the Menominee furnace, where it was smelted with very satisfactory results.

In Sept., 1877, the Menominee Mining Co., who now have a lease of the mine, after some more exploring, began the stripping of the vein and other preparatory work for the opening of the mine. The first ore they shipped from the mine was in March, 1878.

Visiting the mine to day, Oct. 23d, we find the very pleasant village of Quinnesec, which has a large, commodious hotel; dry goods and grocery stores; a drug store; a school house; several pleasant residences—among the latter is particularly noticeable a fine residence belonging to Mr. Buell. The Chicago and Northwestern Railway Co., with their usual foresight, have built an attractive depot and freight house. Turning now our attention to the mine, we find a branch track 2,300 feet long connecting with the main track on the east side of Quinnesec village. At the mine end of the

branch, on the north side of the town, are constructed substantial ore pockets with a capacity of 200 tons each. The pockets are 32 feet high, and on the top of them is laid a double tram-road. Going westward and up the east end slope of the ridge—that rises to over 200 feet farther west—we reach the adit level of the mine, 20 feet above the level of the pockets. The adit tunnel is driven due west from its mouth; it is in now 250 feet; the first one hundred feet was through earth, and the remaining distance in ore. The tunnel has been rather a wet one, owing to the thinness of its roof. Continuing up the slope we pass along the double gravity tram-road which transports the ore down to the pockets from the level 50 feet above the adit.

On this upper level the first workings we meet is an open pit 90 feet long by 35 feet wide and 30 feet deep. In the east end of the pit is a shaft 20 feet deep, or sunk to the adit level, and it is purposed to “hole" the adit tunnel into the bottom of this shaft, which point is 350 feet from the mouth of the tunnel. The formation dips about 70 degrees to the north, and the strike is about east and west. The bottom of the open pit is all good ore, but at its east end a crossing of lean ore fifty feet wide cuts off the good ore. To the west, of this crossing the ore comes in again and continues for 200 feet west, when the ore on the foot wall gradually passes into lean ore again, very soon making the de posit too narrow to work profitably.

On the west side of the first crossing of rock a winze has been sunk near the hanging, on the dip of the formation, down to the adit level, and from the bottom of the winze a drift has been driven west. The first 20 feet of the drift was rock; then they struck a fine deposit of soft specular blue ore. A few steps further along in this drift we enter a large chamber twenty-five to thirty feet wide, and some twenty feet high, with no rock or lean ore on either side. Eighty feet west from No. 1 winze is No. 2 winze, which is also sunk to the adit level (50 feet deep.) The above chamber extends some forty feet beyond the bottom of No. 2 winze.

Returning to the surface, or to the 50 foot level, and continuing westward again, we soon reach the point already alluded to, where the deposit narrows, and find on the hanging wall side a large drift driven westward for 50 feet, which was partially in ore for the first half of the distance, but near the end the rock extended way across. Returning to the mouth of the drift, and then proceeding westward once more. we clamber up and over two benches, and at 130 feet we find a large shaft on the foot wall side sunk 40 feet on the dip of the vein. The formation here is not very regular, the ore appearing first on one side and then on the other. The collar of the shaft is about 130 feet vertically above the adit level. Between the shaft and the lower workings, just considered, is a narrow vein of ore varying from two to six feet in width. The Quinnesec ore is nearly all of the soft specular blue colored variety, somewhat similar to the Vulcan. It is of a superior quality, as the following analyses attest:

	No. 1.	No 2
Metallic iron	65.70	65.30
Alumina	.83	1.29
Lime	.50	.48
Manganese	.15	.03
Phosphorus	.03	.034
Sulphur	02	.039
Silica	2.10	Insol.Res. 4.360

No. 1 is an average analysis which I made of ore collected by myself from the mine in 1873. No. 2 analysis was made by J. B. Britton in 1877. The excellent qualities of this ore and its adaptability to the manufacture of Bessemer pig iron, are too plainly apparent from the above analyses to require any comments to make them understood by the consumers. The mine has many natural advantages; its elevation will afford it good drainage for years to come, and in all probability will furnish a large amount of iron ore before the level of railroad track is attained. To a stranger the condition of the mine is not of the best, owing, in part, to a heavy overhanging capping of sandstone. It is, however, fairly braced up with stulls. Dr. N. P. Hulst, the agent of the mine, told me this was only temporary, owing to the fact that, at present, they are greatly pressed to fill the orders for their ore before the close of navigation, and as soon this was over they were going to blast away this overhanging cap rock, and open out some new stopes for next season's work. The company have a large store where dry goods and groceries are sold at reasonable rates, so that the miners can obtain good board and lodging for $3.50 per week. The officers of the Menominee Mining Company are, president, J. J. Hagerman, Esq., Milwaukee, Wis.; secretary and treasurer, Geo. D. Van Dyke, Esq., Milwaukee, Wis.; agent, Dr. N. P. Hulst, Vulcan, Mich. The present cost of mining ore is less on the Menominee range than in the Marquette district; the ore is easy to drill and to mine, requiring scarcely any block-holing and but little sledging to reduce it to the proper size for shipping; but as soon as depth is attained, so that the side walls will need trimming back, or that underground mining is resorted to, then will the cost of mining—considering the disintegrating nature of the ore, when exposed to the action of the atmosphere—be fully equal to the Marquette ores. The very small amount of phosphorus, and the noticeable percentage of lime and magnesia, will render them desirable mixtures for some of the Marquette ores containing too much phosphorus to make Bessemer steel pig iron, and for this reason the two ores could, in some instances, be handled to a good advantage by the same commission agent.

There are several promising iron properties on the Menominee range; some of them are conveniently located near the line of railroad, others, less fortunate, are ready to ship ore but cannot for want of transportation. The most prominent of the latter is the Commonwealth mine, located about 2½ miles south of the Menominee river on Sec. 34, T. 40, R. 18, Wis. The mine, probably, has more ore in sight with a fair prospect of its continuance, than any of the other mines of this district. The formation dips about 65 degrees to the south, and the strike is nearly east and west. At right

angles to the strike they have uncovered an aggregate thickness of over 100 feet of soft specular red ore, which averages well in metallic iron, and which will answer well for foundry or mill iron purposes.

STATISTICS OF MICHIGAN COMPILED BY CHAS. E. WRIGHT, M. E., COMMISSIONER OF MINERAL STATISTICS.

NAMES OF FURNACE CO'S.	Previous to 1872.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	TOTALS.
1 Pioneer Furnaces	77,577	7,059	7,388	10,708	15,302	11,236	2,801	9,790	123,661
1 Iron Cliffs Furnace				4,784	358				5,142
1 Collins Iron Company‡	36,366	3,431	2,000						41,797
1 Northern Iron Company†	15,059								15,059
1 Bancroft Iron Company‡	35,021	4,250	4,100	3,688	3,977	3,982			55,018
1 Morgan Iron Company‡	31,092	4,356	6,324	5,923	5,977	3,258	663		57,573
1 Champion Iron Company‡	28,572	5,066	3,940	1,583					39,161
1 Michigan Iron Company‡	23,344	4,000	4,467	6,621	3,004				41,431
1 Greenwood Iron Company‡	25,140	4,212	4,416	4,839	1,305				40,252
2 Fayette Furnace	24,620	9,982	11,960	11,079	10,647	10,015	3,969	9,686	91,959
3 Manistique Iron Company‡	7,557	2,700	2,237	6,062	4,230	2,407	3,280		28,493
3 Bay Furnace‡	7,095	4,900	8,260	8,320	9,225	8,119	4,250		50,206
1 Deer Lake Iron Company‡	7,893	2,720	3,447	6,524	4,615				25,199
1 *Marquette & Pacific R. M. Co'.	1,610	4,364	1,138	3,238	10,940	10,514	6,856		39,259
1 *Grace Furnace‡			7,800	3,546					11,346
1 Carp River Iron Company				1,431		1,272	3,176	4,464	10,343
1 Peat Furnace		115	509						624
4 Menominee Iron Company			2,250	4,702	5,720	4,829	3,647	2,319	25,506
2 Escanaba Furnace Company			5,175	5,803	70				5,048
5 Michigan Central Iron Co	10,518	3,551	4,818	3,451	1,230				23,568
5 Bangor Furnace Company		688	3,600	6,219	5,324	10,288	10,207	10,311	50,641
6 Peninsular Iron Company	33,752	4,834	4,531	2,049	2,401	2,472	5,310	4,583	59,932
6 Eureka Furnace	60,000	2,078	1,572	569	1,250	3,421	4,458		73,353
7 Leland Furnace						3,000	2,000		5,000
8 Frankfort Furnace			10,200	3,656	4,961				18,817
9 Elk Rapids Furnace				5,803	8,033	7,100	11,325	11,310	44,571
6 Detroit & L. S. Iron M'n'f'g Co.	30,494	4,731	4,061	3,808	4,831	1,580	4,895	1,940	61,360
Totals	443,306	73,310	99,795	114,563	107,159	82,774	70,097	55,453	1,045,148

1 Furnaces in Marquette County.
2 Furnaces in Delta County.
3 Furnaces in Schoolcraft County.
4 Furnace in Menominee County.
5 Furnaces in Van Buren County.
6 Furnaces in Wayne County.
7 Furnace in Leelenaw County.
8 Furnace in Benzie County.
9 Furnace in Antrim County.
‡ Swineford's History.
† Previous to 1874.
* Coal or Coke.
Caseville Furnace—no returns.
Union Furnace—no returns.
Ward Furnace—no returns.
* Hamtramack Furnace—not in blast since 1873.

TABLE SHOWING AMOUNT OF COAL PRODUCED FOR 1877-8, AND TOTAL FOR PREVIOUS YEARS, PARTLY ESTIMATED.

	Previous to 1877.	1877.	1878.
Jackson mines	350,000	67,497	*55,715
Corunna mines			21,000
Other mines		1,500	1,000
Total net tons	350,000	69,197	77,715

*Doc. 1st.

LAKE SUPERIOR COPPER MINING INDUSTRY.

The copper mines of Lake Superior are of comparatively recent origin, yet they are rapidly attaining a world-wide reputation, not only in respect to the large yield of mineral, but for the peculiar excellence of the refined copper which they offer to consumers in home and foreign markets. These mines are a source of wealth and power to the State, and are deserving of the fostering care of the government. They, in connection with the celebrated iron mines of Marquette county, give prominence and chief value to that vast integral portion of the State of Michigan known as the Upper Peninsula. They have been the means, above all others, of redeeming the north-land from a savage state, and extending the blessings of civilization to our most remotest borders. Such a country, of so great and varied resources requiring development, and with such a brilliant future, may safely be commended to the intelligent consideration of the legislature, and of every patriotic citizen of our great State. The Centennial Exposition drew to our shores many gentlemen of rank, learned and distinguished as geologists, mineralogists, and mining engineers. Before departing from the United States they visited the mines of Lake Superior, and, after a careful examination, they gave expression to the most flattering comments in regard to the mineral resources of the country, and of the skill and energy displayed, as well as the wonderful progress made in the art of mining. It is not possible that our own people are less appreciative of this inheritance than foreigners.

The remoteness of Lake Superior from the older and more populous sections of the State; the vast wilderness in both the peninsulas intervening without connecting roads and the natural channels of inter-communication—the lakes and rivers being closed by ice for one half of each year—are serious obstacles which have operated to separate the people of the two sections, preventing familiar intercourse and perfect unity. Indeed, these natural barriers have given rise to some sectional feeling, and good and patriotic men have entertained the belief that the Upper Peninsula should be set off, and the new territory of Superior created. But it is hoped that a just and equitable spirit may govern the counsels of the *majority*, and the speedy construction of the contemplated Marquette and Mackinaw railway may remove any irritation that may possibly exist. The railroad just mentioned, completed, would be truly a *union road*; it would bring the two sections into close daily communication, and would be materially advantageous. It is the iron link now indispensable to a more perfect union of interest and sentiment.

The object of this paper is to sketch the early history "of the copper mines, portray pioneer efforts in that section, note the progress made in settlement and civilization, give some account of the mines, including their present condition and future prospects; trace outlines of topography and geology, present a statement as to climate, soil, agriculture, internal improvements, population, general business and resources—in short all such information as may be of interest. Of course, a paper of this kind must necessarily be brief and incomplete, for, to describe in adequate terms this wonderful region, would require a large volume and a pen more able than that held by the present writer. *He* will find reward for labor bestowed should he succeed in attracting a more earnest attention to the merits of the Upper Peninsula, in which beloved portion of our State many years of his active life were passed.

Prior to the discovery of copper on the south shore of Lake Superior, the chief sources of supply of this valuable metal were the mines of Cornwall, England, those of Continental Europe, and Chili, in South America. There were workers in brass in the days of Tubal Cain, before the Flood; brass implies copper, hence it is inferred that copper mines were worked at an early day in the history of man. We know that the Lake Superior copper fields were wrought by a people of whom we have no history, termed the "ancient miners." It is supposed by Mr. Jacob Houghton that these "ancient miners" lived in the stone age of the race; may we not gravely surmise that they were the progenitors of the Tubal Cains of the bronze age, and that the copper used in the formation of brazen images was imported from America, via the fabled island of Atlantas, which for the time being, like so many other islands and continents, is hidden under the sea ?

In the year 1841, Dr. Douglass Houghton, the eminent and lamented state geologist of Michigan, after ten years of hard labor in the wilderness, presented his report to the Legislature, and the eyes of the people were opened. It was ascertained definitely and certainly that copper and iron *in situ* existed in the Upper Peninsula; that veins of these minerals could be worked with profit and success, and that the region would eventually become the theatre of prosperous mining.

The existence of copper upon the shores of Lake Superior has been known for more than two hundred years. Marquette, Mesnard, Allouez and other eminent Frenchmen wrote about it; Carver, Henry, Cass, Schoolcraft, and others that might be mentioned, observed copper "float" on the shores of the Lake, and pieces of the metal in the hands of the Indians. But these discoveries led to no practical results; the narratives and records of these daring and accomplished explorers and geographers were interesting and instructive; they were printed and mapped, read by the few, and then put away in the library. Mr. Alexander Henry, an Englishman, in the years 1770-72 did, however, undertake regular mining on the Ontonagon river, a stream flowing into Lake Superior from the south shore. He was deluded by a large mass of float copper lying on the clay banks of the river. He sank a shaft through the clay and came to sandstone, but found no vein. He was not on the Trap or copper bearing range; he was unsuccessful in his venture, and after losing time and money he left the country.

It would seem as though the time was not yet ripe; that the rich copper field that had lain fallow for so many ages, (since the day of the ancient miners), must still continue to be hidden by the "drift" and the dense forests of the region. The Indian, with superstitious awe, must still remain in dread of the evil Sawabic; wave after wave of immigration must advance westward in steady progression before the rocky hills of Lake Superior shall receive intelligent examination, and awake to the clinking of the miner's hammer and drill and to the booming of explosives.

But Dr. Houghton's report, above mentioned, was the tocsin that called the hardy pioneer to conquests on new and inviting fields in the far-off Lake Superior region. The business of exploring and mining is new to him, but he enters into it with the same zeal and indomitable energy as that displayed by his brother who builded his log cabin in the oak openings of southern Michigan, or set his plow in the fat soil of the prairies of Illinois.

It is worthy of mention that the opening of the copper mines was an event which preceded only by a few years the discovery of gold in California and Australia—a discovery that set the whole world in motion—and then was there witnessed a gigantic movement of peoples which in magnitude and beneficial results surpassed the Crusades. The wealth of the world was greatly augmented; there was a new distribution of the inhabitants of the earth, and vast territories, hitherto remote and almost unknown, speedily became populous states with sovereign influence.

Only about thirty-six years ago the vast territory washed by the waters of Lakes Huron, Michigan and Superior, in the northern division of Michigan, was an almost unbroken wilderness. The missionary and fur-trading village of Sault Ste. Marie had existed since 1668; the founder of the mission was the noble father Marquette. There was an humble mission at L'Anse, situated midway between the east and west end of the lake on the south shore, and a mission at La Pointe on one of the Apostle Islands, founded by Allouez in the year 1665. At Fort William, on the north shore, there was a trading post belonging to the Huron Bay Fur company. In the year 1844, a small stockade was completed at Copper Harbor, and named Fort Wilkins; one company of U. S. infantry was posted there. About the same time, perhaps a year or two earlier, an United States land office or agency was established on Porter's island, on the north side of the harbor. These establishments formed a nucleus of settlement—the stars and stripes waved a welcome from the tall flag-staff to all comers. The writer well remembers, after a lapse of thirty-one years, the thrill that ran through his breast as he beheld the good old flag floating above the trees on his approach to Copper Harbor, after tedious coasting along shores that were well termed "a howling wilderness." Copper Harbor was a safe and convenient port, and copper was found right on its shores. It immediately became an objective point—a depot of supplies, and the busy centre of field operations. During the season 'of 1845 and '46, the rocky, wooded shores of the Harbor were gleaming with white tents and teeming with life; it was a grand encampment of eager adventurers. In 1846, a sub-land agency was established at the mouth of Ontonagon river. This river afforded a good harbor for small coasting boats, and speedily became a lively camp—after Copper Harbor it became a second *point d'appui* for copper or mineral explorers. From these two harbors the large fleet of canoes, Mackinaw boats, whale boats, *batteaux* and small sloops sailed and paddled all around the mighty lake, visiting every cove, bay, creek and river. There were no roads in the wilderness, hence exploring parties clung to the water ways as long as possible, and when it became necessary to take to the land their boat was hauled ashore and, with surplus provisions, cached or covered with brush. The explorer, then shouldering his pack, his pick and shovel and compass, struck out boldly into the forest. If the U. S. surveyors engaged in making the linear surveys had preceded him, he followed a "blazed" line; but if the country had not been thus marked, the compass, or *instinct*, was his only guide. Days and weeks were passed in toilsome march through the "deep tangled wood," trap outcrops and ranges were carefully searched for veins, rapid topographical sketches were made and mineral locations selected for entry at the land office, or as a basis for a "permit," which being granted by the government would enable him to mine for copper and other ores. After a day of toil and hardship, he

made his camp fire by some stream; a cup of tea, some hard-bread and pork constituted his simple diet, unless he was fortunate enough to garnish his feast with a brook trout captured from the stream at his feet, by no means a rare occurrence. Every rivulet and brook in this well watered country swarmed with these gamey "speckled beauties." The spruce and fir groves were well supplied with ruffled grouse and porcupines, both so tame that they could be knocked over with a stick, or spitted on a Jacob staff. The woods swarmed with mosquitoes, black flies and gnats, and while there was a certain harmony in the droning of these insects, their direct attacks did not tend to "soothe the savage breast" of the irritable homo. Sweet-smelling evergreen boughs—pine, spruce, cedar or hemlock,—spread upon the leaves, with a log for a pillow, a pair of blankets wrapped around him, formed an inviting couch. Other covering there was none, save the solemn trees and the vaulted arch of heaven. Exposure to storm and rain could not be avoided, but the sublime reverberations among the hills of a Lake Superior thunder storm reconciled the drenched explorer to a wet jacket. The grand and noble views often granted to him as he attained some superior eminence, a Mt. Pisgah of the wilderness, fully compensated for all his toil in the low grounds and pestilent cedar swamps. The bright sunlight alone, after days spent in the gloomy forest, is most cheering. He seats himself on the edge of a cliff, lights his home-made pipe, fashioned out of the knot of a maple, and slowly puffing, looks. Far below him and stretching away to the south as far as the eye can reach, lays a vast unbroken forest, the variegated foliage, softened by distance, resembles a beautiful natural carpet, which the looms of Persia or Turkey could not copy. In another direction sharp, conical peaks, towering aloft, are clearly defined against the blue sky, and awaken hopes in the breast of the ever practical explorer, or copper hunter, of new and rich finds in their hidden recesses. The great solemn lake bounding the northern horizon, so distant that the rippling of a summer breeze on its face is not seen, looks like the "deep, dark blue ocean." But the copper hunter has other joys; when he is so fortunate as to find a rich vein of mineral his excitement and delight is such as not to be described. The result of such a discovery is generally a sudden rush for the lake shore, a launching of the boat, and a hasty descent upon the first land office, in order to record "location."

After this hard campaign, look at our explorer as he lounges about the agency—his apparel is coarse and tattered, his face bronzed and bearded, but his health is perfect, and he comes from the woods robust and iron-nerved as an Indian returning from a long successful hunt. He is a perfect picture of our northern pioneer—brave, alert, sagacious and enterprising; sometimes stormy and belligerent.

In the earlier days of settlement, indeed, until quite recently, Lake Superior could be practically reached only by the way of the lakes. Embarking at Detroit, the chief commercial city of Michigan, the voyage carried us through Lake St. Clair and the beautiful river of the same name; across Lake Huron and up the picturesque St. Mary's river to the falls. The Sault Ste. Marie was the head of navigation in that direction. Passengers and freight destined for the upper country had to be transferred across a portage one mile long. Subsequently, a tram road was built across the divide, later still, so rapidly does the business of the mines increase, the United States government made a large land grant to aid in the construction of a ship canal. This canal, with two stone locks, was opened for navigation in 1855. Since the completion of this important work steamers and vessels of the largest class, have passed through it into Lake Superior. Prior to its completion Lake Superior was navigated by a small fleet of inferior steam and sail vessels, most of which had their origin in the lower lakes and were hauled across the portage. At this date, 1878, the canal is being enlarged, the water deepened to 16 feet, and one immense lock 515 feet long, and 80 feet wide constructing. The lower reaches of the river, in shoal places, are being dredged to 18 feet. The United States treasury is supplying funds for the work, and it is under the supervision of U. S. engineers. Daily lines of large, safe and neat steamers now sail from Buffalo, N. Y., Cleveland, O. Detroit, from Chicago, Ill., and Milwaukee, Wisconsin, to all important points on Lake Superior. There is likewise a large fleet of sail vessels engaged in the same trade.

The Superior country is now approached by four railroad liness, namely: by the Chicago and Northwestern, at Marquette, the Wisconsin Central at Ashland, the Northern Pacific and the St. Paul and Duluth, at Duluth. There are also local railways of importance in the Upper Peninsula, namely: the Marquette, Houghton and Ontonagon R. R. and the Mineral Range Railroad.

The copper mines under consideration are situated on the south shore of Lake Superior and on Isle Royale, in the Upper Peninsula of the state of Michigan, United States of America. Active mining is prosecuted in the counties of Keweenaw, Isle Royale, Houghton and Ontonagon. Copper ore has been found in Marquette and Baraga counties. About Lat. 47° W. Long. 88 ° West Greenwich.

The copper or Trap range, reaching from the extremity of Keweenaw point to the Porcupine mountains, is about 150 miles long, having a variable width of from four to seven miles. There is another district in Michigan known as Isle Royale, the Minong of early travelers. These travelers viewed this island with peculiar favor, regarding it as the most promising ground for the production of copper; for these reasons, doubtless. On the rocky shores of the island the belts of trap were denuded—cleaned of earth or drift—so that the small veins with copper glistening in the gangue can be seen by the most casual observer. The shingle beaches also contained much float and pebbles of copper metal which could not fail to attract the notice of the *voyageurs* as they, wind-bound, paced up and down the beach or loitered around

the camp fire. Isle Royale is 40 miles long by 5 miles in width.

If we take a map of Michigan and look for Lake Superior, our attention will be fixed by a long narrow point, which, starting from the south shore, projects in a northeasterly direction nearly half-way across the lake. If, as some of the old writers described it, the configuration of Lake Superior is a bent bow, then this point is the shaft, with the feather end held in the Porcupine mountains. This shaft is the famous Keweenaw point, the chief *locale* of the copper mines. In strictness and in accordance with local acceptation, the term Keweenaw point only applies to the land lying northeast of Portage Lake. But, since the completion of the ship canal across the portage, the term must be changed; for, in fact, Keweenaw point is an island. So, for convenience, we shall assume that Keweenaw point is an extension with the Trap range. This trap range forms the back bone of this particular section; its average elevation above the lake is, say 600 feet; some peaks or ranges, as for example, mount Houghton, Wheal Kate and the Porcupines, attain a height of from 800 to 1,200 feet. The trap range is-flanked by comparatively low, level country, underlaid by the red sandstone formation. On the coast line, at various points, picturesque cliffs of red and variegated sandstone tower above the lake, with deep water at the base. For reaches of several miles, these cliffs present a bold front to the lake and, in stormy weather, the mighty waves beat and surge up against them with sullen, impotent rage. In winter, when these rocks are covered with ice, formed by spray freezing as it fell, or by a crystallized water fall, they present a very prized jet rare appearance. In the earlier days, when small boats were used in coasting, these frowning, iron bound shores were the terror of navigators. At numerous points along the trap range, owing to the tilting of the formation, at an angle of say 55° from the horizon, occur picturesque knobs and cliffs from one to two hundred feet in height. These cliffs face to the southeast, have rough, weather-worn, broken outlines, and very much resemble battlements. On the northwest side they slope gradually down to the lake level, or conforming sandstone. Small lakes and beaver ponds are common features of the landscape. Streams springing from them meander at first slowly through the tangled copse, but coining to the junction of the sandstone and trap on the southeast they leap down in foaming cascades, a sheer descent of one hundred feet, or more, and then hurry away to mingle with the flood of the great lake. There are no large streams having their source in the trap range, owing to the narrowness of the water shed. There are some noticable breaks in the trap range, the greatest of which is the great gorge or trough of Portage Lake. This trough strongly resembles and suggests the work of a glacier. The Ontonagon river also crosses the range at the bottom of a deep gorge, which must have been formed by a dynamic agent greater than the present river. Originally the country was densely wooded, but in the vicinity of the mines the land is being rapidly cleared for economic purposes.

As a rule, the drift on the range is deep; vegetable mould on top, sand, gravel, clay, hard pan and boulders down to the bed rock. But at many points the conglomerates and trappean rocks are denuded; at other points immense deposits of erratic boulders, the talus of ice-bergs are spread over the surface. Yet the range is by no means so rugged as might be inferred; there is much level country, and the engineer experiences no serious difficulty in making common roads and railroads. It is true, steep gradients must be overcome in ascending from the lake level to the summit of the range, but after that is accomplished the rest is easy.

Such were the physical features of the copper country when the pioneer entered into possession of the land. It was not a land flowing with milk and honey; far otherwise. It was a hard, forbidding wilderness to grapple with; it called for the exercise of the most exalted courage, the most enduring soul-strength. It was a land of isolation, of snow and frost, of almost desert barrenness in regard to a supply of the simplest food necessary to support life.

GEOLOGY.

As mining was to be his chief business, a knowledge of the rocks and vein phenomena had to be acquired. As a rule, this man was not familiar with the science of geology rand mineralogy, or with the arts of mining and exploring; of these he scarcely understood the first principles. But this tyro, who was in time to become the skillful explorer and successful manager of mine affairs, was a bold man and full of expedients. Everything was to be learned by practical experiment, by diligent application, and at the expense of toil, hardships and sufferings untold.

The geology of the country was not well understood even by men of science; many novel features were presented that would have puzzled a Dana or a Lyell. What wonder then that our pioneer miner, under these adverse circumstances, did often at first blunder and stumble, fail, and lose his time and money. In view of his final, splendid achievements, a mantle of charity should be permitted to cover his early mistakes.

As a preliminary step to mining, veins and lodes of value had to be discovered. The explorer after some dear-bought experience learned that in the trap range only he must look for metalliferous veins of character. He had been wandering far and near, indefinitely, in search of cupriferous and argentiferous deposits, in regions as likely to contain what he wanted as the limestones of Niagara or the sandstones and shale of lower Michigan. His efforts must be concentrated; the trap range, described on a former page, is his stage. The trap range, or "mineral range" consists of beds of trappean rocks, or melaphyr of varying thickness, with belts of conglomerate intercalated. The conglomerates vary in width from a mere line to several hundred feet. The trappean rocks of the series also vary in thickness from twenty to more than one hundred feet, and are often

highly amygdaloidal in character. These beds have a general northeasterly or southwesterly course, following the general-sweep or curvature of Keweenaw point; they dip to the northwest, at varying angles, in different localities, from 45° to 55°. At Portage Lake the course, or trend, of the belts is N. 35° east.

In this formation copper and associated silver are found in either fissure veins, contact veins, or in amygdaloid and conglomerate lodes or belts.

The true, or fissure veins of working value, are confined to that sub-division of the copper region known as the Keweenaw district, in Keweenaw county. These veins cut across the formation with a course north, a few degrees west, with a slight dip to the east. Mines based upon these fissure veins, as for example, the "old Cliff" and Central, have proven of great value and persistence in depth. The famous *mass copper*, which has astonished the world, is produced by these mines.

Workable contact veins are rare; but the Minesota mine,, once so famous as a producer of mass copper, and situated in the Ontonagon district, Ontonagon county, was in a contact vein, as are also its neighbors, the National and Rockland mines.

The amygdaloid and conglomerate beds, belts or lodes of the Portage Lake district, third in order of cupriferous deposits, and latest known, are very productive and persistent in depth. In the language of the country the amygdaloidal and epidotic beds containing copper are called "lodes" while the conglomerates are termed "belts." These belts-and lodes have the same course and dip as the "country," or associated rocks, and are a part and parcel of the formation. They are unlike true veins, having no regular well! defined walls. These lodes and belts that are so rich in copper, do not, in character of "vein rock," to a casual observer, seem to differ one particle from neighboring belts which contain no copper. Why copper, in ample quantity, should seek a home in this belt and not in that, is a mystery. Who will please solve it? These belts and lodes, containing small mass and stamp copper, have been worked, thus far, most extensively and profitably in the Portage Lake district, but they are found of value in Ontonagon county, as well as in Keweenaw. They are also found, both conglomerates and amygdaloid, in the district of Isle Royale; small fissure veins have been wrought on that island.

In the Porcupine mountain district, beds of grayish sandstone have been found, containing from three to four per cent, of copper. The grains of copper are exceedingly comminuted, and evenly blended with the indurated sand. The Nonesuch mine rock affords an example.

In the Iron River section veins of silver ore have been discovered, quite recently, in beds of sandstone and slate. Their value is prospective.

In the early days, the fissure vein was the one exclusively sought for; it was considered *the one thing needful*. In fact, nobody knew anything about metalliferous beds of copper, and as a matter of course they did not trouble themselves about the unknown. The discovery of fissure veins was a comparatively easy task. The south side of the range presented many bold escarpments—tall ranges of cliffs formed by the tilting of the formation—veins crossing the formation and dividing the cliff would be detected in exposed places; or the deep "breaks" filled with earth, would point out the probable line of the fissure. The "Cliff vein" was found in the face of the cliff, on the property of the Pittsburgh and Boston Mining Company, four miles southwest of the port of Eagle river. In 1846 the mine was a success, although only recently discovered, and its vein became an examplar for the explorer. To its honor, be it said en passant, the Cliff mine was for many years a beacon light that encouraged mining pursuits in other places on the peninsula, and prevented, in tunes of doubt, uncertainty and financial difficulty, and entire abandonment of the country.

But had our early explorer possessed more light—known about belts and lodes of a cupriferous character, stupendous blunders, in following after the *ignis fatuus*—fissure veins—would have been avoided, and millions of dollars saved; and the country would have been a decade ahead of what it now is, in progress and population.

Owing to the dense underbrush, and the deep drift—from 4 to 20 feet—covering the country, the finding of underlying beds of rock, with metalliferous lodes, was a costly and difficult and doubtful operation, necessitating expensive trenching, heavy pit work and handling of water. Skillful engineering is also in demand; and the only guide or clue that the explorer often has, is a piece of float rock or stone picked up on the surface, showing traces of copper, to the lode he is searching for.

“Float copper” is found all along the range for one hundred and fifty miles, in size from a pigeon's egg up to a "mass" of 18 tons. Old gold hunters have remarked, in view of this phenomenon, that if, instead of copper, this “float" were gold, the whole country would be torn up and washed with the hydraulic apparatus of California. Fortunately for those owning farms on the range, nature is not so prodigal of her chief treasures. Yet the gross value of the float copper, hidden in the drift and under the waters of the great lake, must be very considerable.

The explorer of to day is a man quite accomplished in. wood-craft, has a practical knowledge of the surface of the country and of the underlying rocks, of the working mines and the veins and the beds in which mining is being carried on. He can use a theodolite and make a map, and unless controlled by some absurd theory, or visions, such as dreams are made of, he is trustworthy—of course the explorer of today has the light of all past experience in the milling region to guide him.

Upon entering a field for discovery, if there are no outcroppings to afford & clue to a vein or belt, the explorer-scours the woods for specimens of "float"

copper with vein rock adhering. The track of the glacial drift in this region is from the east, northeast. This track is plainly to be seen, in favorable situations, by the beautiful grooves scored in the surface of solid rock, and in spots where the course of the heaped up boulders of trap and conglomerate have been arrested. A favorable specimen found—and the more angular and less rounded the specimen is, the better—the explorer turns his steps in the direction whence the drift came; if, as he advances, the float evidences of a, vein accumulate, are less rounded or worn, he is pretty sure that the object of his search is near. He now proceeds with greater care, noting every "sign" like an Indian on a trail, till he comes to a line beyond which there is no "float" of the kind he has been following. He pauses, for this is an indication that he has passed over the lode he is in quest of. Retracing his steps, he, in accordance with his best judgment as to depth of drift, sticks an initial stake, and directs his men to sink a pit there down to the solid rock and drift therefrom towards the vein.

The vein, or lode, found, the next step is to sink pits on the longitudinal course of the vein, at as many points on the property as may be desirable to prove the lode superficially.

Should the several pits encourage the beginning of mining, the next process in that vein is the clearing of the forest and undergrowth: the building a wagon road out to the nearest settlement; the erection of a few log huts or cabins for the workmen, and the sinking of two shafts, say four hundred feet apart on the lode, and one hundred feet deep from the surface, or "grass;" connecting the same, at that depth, by means of a drift, and not neglecting some stoping, in order the more thoroughly to prove the value of the lode before venturing upon more extensive mining, costly surface improvements and mine plant.

Quite recently, the diamond steam drill has been used sucessfully, as an instrument in explorations. The dip needle has never been much used in the discovery of copper lodes. Yet the rocks cause a marked deflection of the magnetic needle, which deflection is greatest near some well-known working mines. The common compass is not trustworthy as a surveying instrument on the trap range. Burt's solar compass and the theodolite are the instruments relied upon in geodetic work. All the land has been subdivided and marked in accordance with the United States system of linear surveys. The section and town lines are of great assistance to the explorer, and those lines, as a rule, form the demarkation or boundary lines of the several mining “locations."

The copper produced by the mines of Lake Superior, is virgin or native copper, almost chemically pure as it lies in the vein. Stamping, washing and smelting are processes only necessary to free the copper from its rocky matrix and put it into a merchantable shape. The copper of commerce is turned out of the smelting works in the form of ingots bars, bolts and cakes.

Experience has pretty well settled the fact that if a lode does not show on the surface or back copper in quantity or percentage large enough to justify regular and profitable mining, it would be a waste of time and means to sink deeper in the vain hope of finding richer ground. Much money has been squandered in on copper districts by mining in lodes that were poor to start with. The error ought to be avoided in future. It is true, instances are known when the surface show, by careful analytical trial and a practical treatment of a quantity of the vein rock, has proved to be all that was desirable; yet it was further shown that after one or two levels had been opened in the mine, and the rock stoped out and sent to the stamp mill in considerable quantities, the percentage of copper was found to be so low as not to cover the cost of mining. Of course, such a result was disastrous; the fair inference is that the trial experiments were faulty.

It sometimes happens—we hope rarely—that mines of no intrinsic value are kept alive for the purpose of speculation in stock, or for the support of impecunious employes. It is pretty well settled that really good veins, lodes and belts, as, for example, the Central, the Cliff, the Calumet & Hecla, the Pewabic, and others that might be mentioned, all rich on the surface, do not fail as depth is attained, but on the contrary are, if anything, richer at the greatest depths. This is a noteworthy feature of our good mines, but there are some exceptions.

It is not to be denied that there is always risk, more or less, in mining ventures; but the gains are often enormous—and the net gain is far in excess of legitimate losses, so far as the copper mines are concerned. Has mining on Lake Superior been more hazardous than others of our great industries? Has it not done much to encourage settlement, and hasten the march of civilization? And is it not as respectable a business as any other, when prudently and honestly followed for legitimate ends? Certainly the production of gold, silver, iron, copper, and other useful metals, is of great benefit to the world at large.

In the preceding pages of this paper allusion has been made to the so-called ancient miner. A brief notice of this man who, no doubt, was respectable in his day and generation, may not be improper in this place. This man who wrought in the copper mines probably belonged to the Stone Age of the race. If born at a later period he was—although very sagacious in the matter of finding copper bearing lodes—a rude miner, using rounded stones or boulders for hammers, and milling by means of fire and water, calcining the vein rock with a fire made of wood, and rending the vein by throwing water upon the heated rock. He managed to mine from 10 to 20 feet in depth, or down to the water line. Further he did not go on account, probably, of the difficulty he had in keeping his pits and trenches clear of water. He had no means of cutting up or removing any considerable masses of copper. There have been found in ancient pits masses of copper from one to three tons in weight, which show evidences of his work. The stone hammer marks can be distinctly seen; the angular pieces of the mass have

been removed; in some cases the mass has been partly raised, and the blocking which shored it up remains; broken, hammers, rude copper tools and plenty of charcoal .are found in the pits. What a grief to the enterprising, yet unskillful miners, to be obliged to abandon so fair a treasure! These ancient pits are found by our explorers by observing on the surface of the ground circular, or trench-like depressions, in line for a distance of several hundred feet. They are filled with sand, debris of rocks and vegetable mould. Large trees have been found growing in these pits. These works are common all along the Trap Range. The most recent discovery, in this line, was made by the Hon. Samuel W. Hill, at the Minong mine, on the north side of Isle Royal, near McCargo's cove. "Here," according to Mr. Jacob Houghton, "for a distance of one and three-fourths of a mile, and for an average width of four hundred feet, the succession of pits indicate the mining out of the belt, (solid rock,) to an average depth of not less than twenty feet. Scattered over this ground are battered stone hammers, numberless, but running into the millions. This work was carried on by vast numbers of people, and extended through centuries of time." The present writer will indulge in no theories as to who these ancient miners were, whence they came, and whither they departed, but content himself with a statement of the fact of their once having occupied the Lake Superior country, together with the few evidences out of many adduced above, in confirmation of that fact; our Indians had no knowledge of the existence of copper in veins or belts; their knowledge was confined to float pieces in the soil

It is a curious fact that all successful working copper mines on the Lake had been previously wrought by the ancient miner. In this instance do we again see how history repeats itself. The modern explorer has been benefited by these ancient workings which, in many instances have been sure indications of valuable lodes beneath, but not always. Proof exists that the ancient miners often sank pits on poor veins, being no wiser, in these instances, than we are to-day.

When the Lake Superior country was first opened to settlement, no titles in fee simple were given to settlers or mining corporations, nor was pre-emption allowed. The public lands were not, as usual, controlled by the Land Office, but by the War Department. As before stated, an agent of the War Department, and a corps of surveyors and draughtsmen, were stationed at the U. S. agency. Permits, as they were called, were issued in Washington; these permits at first covered nine square miles, but afterwards were reduced to one square mile. So great was the demand for permits, it was soon found that the whole south shore of Lake Superior would not (if the issuing of nine mile permits were continued) be big enough to give each one of the numerous and importunate applicants a slice. These permits were authority for taking possession of any lands not otherwise claimed. The holder of a permit was allowed one year for exploration, and three years more to mine, with the privilege of two renewals of three years each, making the whole term of occupancy ten years. The Department required returns to be made to the Mineral Agency giving an account of the work performed and mineral raised, and a payment to the mineral collector, at the rate of twenty per cent, mineral value. The term of the grant, or lease, presumed to be ample to enable the fortunate holder thereof to realize immense gain—such wealth as would enable him to leave his mine, plant and improvements without regret, free to the next comer. Afterwards commissioners were sent out to appraise the mineral lands and fix a money value on them. Five dollars per acre was the valuation. Later, all lands were open to pre-emption except mineral lands. Finally, all lands, without exception, remaining unsold, (save school and canal lands,) were thrown open to pre-emption and sale, and could be purchased for one dollar and a quarter the acre. Lands held under permits required personal occupancy. After so many changes of policy it will be seen the Government settled upon this—the wisest plan of all. The fixing the minimum price of one and a quarter of a dollar per acre gave all an equal chance to obtain land, the poor man as well as the rich; it promoted settlement, and was not so encouraging to mere speculators in lands who, as a rule, are a drawback to the country. The same wise system extends over all the territories wherever the government owns land; gold and silver lands are held at the same price as agricultural lands; aliens as well as citizens may purchase. By the laws of the State of Michigan no corporation could hold more than ten thousand acres of land; but a recent amendment to the law permits mining and manufacturing companies, who use charcoal largely in the reduction of ores, to hold fifty thousand acres.

In the days when permits were issued *they* were much sought for. The holder of one of these pieces of paper considered himself a rich man. So valuable was the whole copper district considered to be that it mattered little where one plastered his permit. People were simply wild—hence, after an examination, many a rich location was found to be entirely worthless, was not on the Trap Range, or was covered fathoms deep under Lake Superior; money was made by sale and transfer of these permits, but the last holder had the grim satisfaction often of knowing *himself "sold."*

The first pre-emption of mineral land was made by Captain Rickard, in February, 1851.

The linear surveys were extended over the Range, and completed in the autumn of 1848. Dr. Douglass Houghton, the state geologist and contractor to make the surveys, perished by drowning October 13, 1845, but the surveys were completed by his able assistant, Mr. Bela Hubbard, of Detroit.

The season of 1848 was, perhaps, the most active of any in the work of exploring lands; it was the culmination of the first grand rush to the copper mines. On the approach of winter all that could do so, departed from the country. The government troops stationed at Fort Wilkins had, about mid-summer, been ordered to Mexico to assist in the war then waged against that country. The government agent also left, never to return

permanently, for in the next year the agency was removed to Sault Ste. Marie. Even the only press on the lake, the *Lake Superior News and Mining Journal*, was removed to the same place.

The first working companies organized for the mining of silver, copper and iron were managed by boards of trustees; were incorporated under the laws of different states, and issued such number of stock certificates as suited the corporators. One company, for example, had 1,200 shares, par value one hundred dollars; another 3,000 shares, the par value of which was ten dollars. It was not until several years later that the State of Michigan enacted the wise and salutary mining laws now on the statute book, fixing the number of shares of each organization at 20,000, with par value fixed at $25 per share. These laws have been amended so as to permit actual working companies to consolidate, and thereby virtually increase the number of shares; a later amendment also authorizes the organization of mining companies upon a basis of $2,500,000, divided into shares of the par value of $25 each.

In the fall of 1848 we find in the copper region only three small villages—namely, Copper Harbor, Eagle Harbor and Eagle River—all lake ports. From that day to this Copper Harbor has made but little progress—the harbor is the best on that stormy, iron-bound coast, and is much esteemed as a port of refuge. Other settlements there were none, except where a mine was being worked. There were no continuous roads from one village to another, or between the mines—an Indian trail, or bridle path winding through the woods, was the only path open. There were few horses or oxen; provisions and mine supplies were packed on men's backs. The old bush rangers found steady employment. Travelers were obliged to go on foot; all pedestrians, in winter, were compelled to use snow-shoes. Dog trains were used in the transportation of the mails, and for other purposes. The dwelling houses and offices in the mine locations were generally few in number, and of the most primitive character, being constructed of logs. The dense forests were cleared a little space, giving just room enough for the little cluster of cabins. The food of the officers and miners was of the simplest kind—pork, bread, beans, coffee, tea and sugar—all imported. The lake and streams furnished a good supply of fish—trout and whitefish. Potatoes were rare, and fresh meats were out of the question with most people during the long winters of that region.

There was a semi-weekly mail; it was hauled three hundred miles, through a wilderness, on a dog train. Travelers "for below" or civilized lands in the south, were obliged to "snow-shoe it" the same distance. To reach the land office at the Sault, the same conveyance was resorted to, and a month was sometimes consumed in accomplishing a journey that now, by rail, would be made in twelve hours. The isolation of our pioneer miners was somewhat oppressive; the deep snows and fierce storms of winter did not tend to soften the feeling. Yet the people were hospitable to a fault, and were always more than glad to receive a visitor.

It is not deemed necessary for the purposes of this paper to give a detailed description of what we term the pioneer mining companies, operating in the year 1847. A brief running notice must suffice.

THE PITTSBURGH AND BOSTON MINING COMPANY

Had worked a vein of black oxide of copper at Copper Harbor, just east of Fort Wilkins. A few tons of this ore had been raised, when not proving profitable, the company transferred its men and supplies to another location, afterwards known as the Cliff mine.

THE ISLE ROYALE MINE

Was in the immediate vicinity of Copper Harbor, but it was soon abandoned. In the next decade a mine of the same name attained prominence on the south side of Portage Lake.

THE LAC LA BELLE AND BOHEMIAN MINES

Were situate on the south side of the range, in the conglomerate and syenitic rocks, on the high lands overlooking that charming inland sheet of water, called Lac La Belle. These mines were in fissure veins, and the copper was in the form of yellow sulphuret and grey ores. Although work in these mines has been discontinued and resumed more than once, thus far they have not reached a paying point. A small smelting furnace was erected there about eleven years ago, and quite a village built, but nothing is doing there at the present time. The government voted 100,000 acres of land to improve the outlet of Lac La Belle, and piers were built and the rim dredged so that large steamers entered the lake. Between Copper Harbor and Eagle Harbor several veins were worked at different points, but they never reached the dignity of mines.

THE NEW YORK AND LAKE SUPERIOR COMPANY

Was operating at Agate Harbor; the mine is not known to-day.

THE NORTH-WEST COMPANY

Was mining in a bluff back of Grand Marais harbor; in an open cut quite a handsome show of copper was to be seen. This mine has been idle for many years.

THE EAGLE HARBOR COMPANY,

At Eagle Harbor, was working quite a large force, and their property bid fair to be one of the great mines of the country. The harbor proper is a good haven, though

small. The village was handsomely situated at the west end of the bay. Mining was being conducted near the lake shore, in a fissure vein, with considerable mass copper showing. But as a mine, this vein was not a success. The Eagle Harbor property covers nine square miles, and is considered valuable. Being favorably situated on the Trap Range, the chances are that good paying mines will yet be developed on this great property. Eagle Harbor is the shipping port for the Central, Copper Falls, Amygdaloid and other mines.

COPPER FALLS MINE

Is situated on the high lands overlooking Lake Superior, a few miles west of Eagle Harbor. This mine has been worked since its organization down to the present time with varied sucess. The works are in a fissure vein and in the ash bed. Ball's steam stamps are used on the mine; at this point they were first introduced on the Lake. Although at times the show of copper in the mine has been rich, yet the company has never been fortunate in receiving many dividends from profits—$100,000.

NORTH-WESTERN COMPANY,

Working a location a few miles southeast of Eagle River; vein or fissure, carrying heavy mass copper. The enterprise did not prove a success, although in the opinion of good mining men it ought to have succeeded. It may in the future, if work upon the vein is ever resumed.

LAKE SUPERIOR COMPANY.

This is the Pioneer company, par-excellence; situate 1½ miles south of Eagle River. There were twenty buildings on the property; seventy men employed; two shafts sunk, 125 and 150 feet respectively; ore raised from the mine was considered very valuable, as follows: Silver $568, Copper $200, per ton of rock. This mine had a small stamp mill and a saw mill, the first of the kind in the region. Mr. C. C. Douglass, one of Dr. Houghton's assistants in the geological survey, was the superintendent. But this mine failed in reaching a permanent position. In later years, farther back in the country, under the greenstone bluff on the same property, a new mine was opened on a handsome fissure vein and called the Phoenix.

THE PITTSBURGH AND BOSTON OR "CLIFF MINE."

This celebrated mine had got fairly started in 1846, and was situated on a nine mile permit tract, four miles southwest of Eagle River village. The mine was upon a true vein, and was just tinder the greenstone bluffs. It has been a very successful mine; its history is well known. The company has divided among its stockholders $2,280,000. The mine has attained great depth, and has been worked oil a limited scale for the last few years.

NORTH AMERICAN COMPANY.

This concern was operating half a mile west of the Cliff, upon a fissure vein carrying mass copper, but it has never reached a paying point and is now idle.

THE ALBION AND MEDORA,

Working a little further west, under the same greenstone cliffs, upon north and south fissures. Quite a large sum of money was expended at these points but without adequate success. These mines are not active now.

FULTON MINING COMPANY,

Occupying a nine mile tract, and working a small fissure vein, southwest of the Albion. Work was discontinued after two or three years trial; the property to day is considered by good judges to be valuable.

OHIO TRAP ROCK COMPANY,

Working upon a seam of serpentine of no value; a mistaken venture; soon abandoned.

NEW YORK & MICHIGAN COMPANY,

Working at the junction of the sandstone and trap four miles northeast of Torch Lake. Some stamp rock was found, but not enough to meet the cost of mining; location abandoned to be revived, like so many other old concerns, at some future day, under a new name. It subsequently took the name of Washington and is now the St. Louis, but these changes have not brought success.

DOUGLASS HOUGHTON COMPANY,

Mining under a branch of Trap Hock river, at the junction of the sandstone and trap formations. Not successful. Theory of the early geologists was, that at the junction of these rocks copper would be found abundantly; but the theory has not been sustained by facts.

PORTAGE LAKE DISTRICT.

In the winter of 1846 and '47 almost unknown; one or two small parties of men wintered there, one of which, lived in a miserable hovel on Wheal Kate mountain.

SILVER MOUNTAIN,

A knob of diorite found some twelve miles west of the head of Keweenaw bay, not on the copper range, was the scene of mining operations. Silver was looked for, but the expectations of the adventurers were evidently not realized, for the location was found abandoned in the autumn of 1847.

IN ONTONAGON COUNTY,

Much exploring had been done on the head waters of Misery, Flint Steel, Fire Steel and Ontonagon rivers, as well as upon Iron river and in the Porcupine mountains further west, down to the close of the season of 1847.

THE ALGONQUIN COMPANY,

On Flint Steel; working quite a force of miners; mine in an epidote lode, with outcrop in a bluff, and producing stamp copper mainly with small masses, termed barrel work.

DOUGLASS HOUGHTON COMPANY

Near the Algonquin. working on a small fissure. This mine belonged to the same corporation as the one before mentioned, of same name, situate on Torch Lake. In passing I would remark that in those days of "permits" mining corporations managed to claim a large amount of land, and a single corporation had lands, at points, from the northeast end of Keweenaw point to the Porcupines; so that if they failed at any given point, they would remove to another and try again. They proposed not to have all their eggs in one nest; or in other words, they chose to have several strings to their bow. As we have seen in the foregoing pages, the Pittsburgh and Boston company abandoned their first work at Copper Harbor and removed to the Cliff mine, where they attained eminence and wealth. But all were not so fortunate in changing base. Upon the

ONTONAGON RIVER

Twelve miles from its mouth, much preliminary mining was going on in the epidotic rocks of that section, but no marked success had as yet attended the efforts of the miners. The discovery of the great Minesota mine, at a date a little later, in that vicinity, brought out that section. strongly upon the canvas, and was the beginning of a new era in the copper mines.

This closes our summary of the history of what may, not improperly, be termed the pioneer enterprises of Lake Superior.

ONTONAGON DISTRICT.

Iii the winter of 1847-8 Mr. Samuel O. Knapp discovered the Minesota lode. Evidences of the existence of a valuable lode were numerous. The works of the ancient miners attracted his attention, and an exploration of the old pits and trenches revealed many curious and suggestive remains; the most interesting, because of practical importance, was the uncovering of a considerable mass of almost pure copper which the ancient miner had worked at but .finally abandoned. In the spring of 1848, as soon as the snow was gone, he explored for the supposed lode, and his labors were rewarded by the discovery of the great Minesota lode, which eventually became one of the greatest copper mines in the world, producing for many years enormous products of mass copper and much native free silver. Hitherto in the copper districts of Lake Superior mass copper had been observed only in fissure veins. But here was presented a new feature—and this copper region has, from first to last, always been full of surprises or novelties in chemical geology—a lode running with the formation, not a true vein, carrying, as its chief burden, masses of copper of great purity and several hundred tons in weight. The lode lies between conglomerate and trap beds, and has the same strike as the range, with a dip to the northwest.

The Minesota mine was eminently prosperous for fifteen years, or more, and during that time it divided among its shareholders the sum of $2.000,000; it was the bonanza mine of its day. The success of this mine encouraged new hopes in the breasts of mining adventurers, and was a great stimulus to new enterprises all along the range. During the succeeding decade many important discoveries were made, and a better knowledge of the country acquired. Great addition was made to the now long list of mining corporations whose papers are filed in the office of the secretary of State, and whose locations are platted upon the large map of Lake Superior copper mines.

After, as has been observed, enjoying a period of almost unexampled prosperity, the fortunes of this great mine began to wane; the annual product of mineral decreased more and more until finally the old management retired, or in the terse language of the country, "got out of it." It is a mooted question whether the mine was really worked out. It is assumed by some that the mineral portion of the lode was lost in the lower levels, and that a thorough system of cross-cutting, or deeper sinking would again lead to the discovery of the lode. At this date the mine is in the hands of tributors. This mine was organized under the mining laws of Mich., June 5th, 1855.

THE NATIONAL AND ROCKLAND MINES

Are on the same lode, the first just west, and the second immediately east of the Minesota, and are in pretty much the same condition as the last mentioned concern. Although at one time prominent as good mines, and producing a large amount of copper, yet they could never compare with the mother mine; organized under laws of Michigan in 1854

During the active existence of these mines, a large number of mines, situated both east and west of the Ontonagon river, were worked with varied success, extensive improvements were made, the country opened up and a large amount of money was expended, often without profit. (A full list of these mines is presented elsewhere; space will not permit a seriatim description of all.)

The most prominent of these mines now, is the

RIDGE MINING COMPANY,

Which has been working regularly and unobstrusively, year after year. The mine is producing, of stamp and mass mineral, about two hundred tons annually at a handsome profit. In the judgment of good miners, this mine should be worked more extensivley, in just proportion to its great merits.

On the Evergreen bluff range, and east and west therefrom, we find many good properties—mines that have produced from one to three hundred tons of copper each, namely: the Evergreen Bluff, the Flint Steel, the Mass, the Ogima, the Caledonia, the Bohemian, the Toltec and Knowlton; on the west side of the Ontonagon the Norwich, the Victoria, the Nonesuch, &c.

The one great imperative need of this section is a steam railroad along the range. The mines are situated from 14 to 30 miles from the lake and Keweenaw bay; the streams on the ridge are too small for extensive stamping operations; therefore, for transportation of stamp stuff, supplies, &c, the railroad would be a prime factor to success.

The above mentioned mines are mostly founded upon amygdaloidal-epidote beds, which often present rich shows of stamp copper, together with small masses. No doubt, many of these mines are valuable; but the veinstone, charged, mainly, with stamp copper, requires for its extraction adequate stamping and washing machinery. The stamp mills employed at these mines, it is believed, have been insufficient to build up prosperous concerns. The stamp lodes of the Portage Lake district, many of them, are no richer in mineral than certain belts in Ontonagon district, but the Portage mines have succeeded admirably, soley by reason of their great mills most of which reduce four hundred tons of stamp rock per day for each mill. The example of Portage Lake mines is worthy of imitation, especially as it is believed, that if followed, the result would be beneficial to those most concerned. It is not asserted that *all* of the mines that have a “local habitation and a name” in the Ontonagon district, will ultimately, under improved circumstances, be remunerative but it is candidly beleived that at some future time, perhaps not distant, a fair proportion of them will prove to be profitable undertakings.

It is a melancholy fact that at the present time, in this once renowned district, mining, except on a limited scale, is at a stand still. The low price at which copper has ruled for several years past, *and the want of railroad facilities*, has greatly discouraged mining enterprises therein.

In Ontonagon county there is a large area of mineral land that has been only partially explored, or not at all; and new discoveries of great value are within the range of probability, at any time.

The once flourishing villages of Ontonagon and Rockland are suffering from the general stoppage of mining; their population has dwindled, and business is almost extinct.

Aside from its mineral resources, Ontonagon county is a good agricultural section, and the people of the county have turned their attention to farming—a pursuit not commonly popular in mining regions. The plow seems to be bringing to them that measure of content and modest prosperity which the miners' pick and hammer have failed to insure. Wheat, oats, grass, potatoes, garden vegetables, small fruits, apples and flowers all do well, and some of them remarkably well.

PORTAGE LAKE DISTRICT.

This district is of more recent origin than either Keweenaw or Ontonagon. When the Cliff and Minesota mines and their cotemporaries were flourishing, the Portage Lake mines were nearly unknown. To day this district is the busiest centre of mining, as well as the most wealthy and populous. It occupies a happy geographical position, about midway between the extremity of Keweenaw point and the Porcupine mountains. Portage Lake, an inland sheet of water from which the district takes its name, is one of the most spacious, deep and accessible harbors on the lakes. Its basin cuts across the trap rang at Hough-ton and Hancock, and at the head of Torch Lake, 16 miles distant from Houghton, in a northeasterly direction, the waters come very near to the range. Thus is a deep waterway formed in close connection with the mines, a natural advantage which has been of inestimable value in the development of the country. At the south end of the lake, by means of artificial canals, Portage river has been made navigable; at the north end, twenty-four miles from the south end, the old Grand Portage has been changed to a ship canal over two miles in length, one hundred feet wide,, and 15 feet deep, with heavy breakwaters projecting from the shore into Lake Superior 800 feet. The river connecting Portage and Torch lakes, has also been dredged and enlarged. So that with these extensive and costly internal improvements, Portage Lake is accessible at the two extremes, and the largest sail vessels and steamers navigating, the great lakes pass through it and touch at the mine docks., warehouses and smelting works, to discharge mine supplies and take on copper. These advantages have rendered Portage Lake a commercial centre, and the trade of the other districts is gradually converging thither.

The villages of Houghton and Hancock, the first named situated on the south side of the lake, and the last named on the north side, less than one mile apart, and connected by a draw-bridge sixteen hundred feet long, are flourishing, well built mining towns, containing (both places and including the mills and furnaces, foundries, machine shops, saw mills, rolling mills and other manufactories located in the suburbs,) about 8,000 inhabitants. The shore of the lake, on the south side, is abrupt and rocky, and at a point one mile back attains an elevation of four hundred feet; on the north side the slope is steeper, and at a distance of one-half mile the

brow of the hill is nearly six hundred feet above the level of the lake. The lake at this point, scarcely one-half mile wide, resembles a river, and the steep declivities, rough in outline, by shortening the view, tend to confirm the impression; the whole scenery is picturesque. The steepness of these declivities are rendered subservient to mine economies. Those mines which lie back of the lake on the plains above, send their stamp rock to their stamp mills, which are located on the immediate shore of the lake, by means of inclined tram-roads; the gravity of the loaded descending cars drawing the empty ones up. At the head of the incline planes, the cars are moved to the mines either by horses, or small locomotives. A large quantity of water, from 1,500 to 3,000 gallons per minute, is used in the stamp mills; hence these establishments are always placed within reach of water. Mines that are situated from four to eight miles from an adequate stream or lake, are compelled to build railroads to connect mine and mill.

Nearly all of the copper mineral produced in the district, about 20,000 tons per annum, is smelted at the Detroit and Portage Lake smelting works, situated on the lake, opposite Houghton. These works are quite extensive and complete, and maintain an enviable reputation both in home and foreign markets—a branch of these works is located at Detroit.

On the south side of the lake there is a good copper rolling mill. There are five large, first-class stamp mills located near Houghton and Hancock, which stamp and wash daily at least 1,500 tons of rock. A stamp mill costs from $100,000 to $200,000. The foundry and machine shops are able to supply the mines with a large proportion of the machinery required; the saw mills also supply the mines with pine and hard wood lumber and timber sufficient, for their need. There is a fleet of small steam tugs and scows which, bring from a distance to the mills wood for fuel, and timber and lagging for the mines.

At the head of Torch Lake there are two large stamp mills with 800 tons daily capacity, and quite a village called Lake Linden has grown up around them; they belong to the celebrated Calumet and Hecla consolidated mining company. Across the lake, near these mills, Mr. Gregory has erected a large steam saw mill, a planing mill, and door and sash factory. Bituminous coal, imported from Cleveland, Ohio, or Erie, Pa., is largely used at the stamp mills, and is laid down on the mill docks and at the smelting works at a cost of from three to four dollars per ton. Good building stone—sandstone and trap rock—are easily procured; a good quality of red brick is made at L'Anse, distant by water thirty miles, and at the same point the best kind of slate for roofing and marbling can be had in unlimited quantity. The forests of maple covering the range furnish excellent fuel, while the pine, hemlock and cedar, growing alike on the trap range and the low lands of the Silurian rocks, have yielded thus far an ample supply of timber and lumber.

Thus it will be seen that all these necessary adjuncts to successful mining are possessed in pretty full measure by the people of Portage Lake. Ingot copper is transported via the lakes, to Buffalo at cost of $4.00 per ton.

Between the years 1852 and 1857 considerable exploring was done in the vicinity of Portage Lake, and mining was inaugurated on rather a limited, parsimonious scale. Perhaps it was advisable to proceed slowly. At first mining was most active on the south side of the lake, and was confined to the Isle Royale lode. This lode is an amygdaloidal epidote; its strike is north 32° east; it dips to the northwest at an angle of 55° from the horizon. Its width varies from 4 to 40 feet; the copper found in it is in the form of rather coarse stamp work, barrel work, (mineral not sent to the stamps, but dressed with a hammer and, when the product was shipped to distant smelting houses, was packed in barrels,) and irregular masses often three to four tons in weight. The vein rock is composed of a variety of minerals, such as quartz, calc-spar, prehnite, green earth, epidote, etc. Much native silver occurs in the lode; the copper deposits have a tendency to make in bunches from 50 to 200 feet in length; at such points the lode widens enormously, and the yield of copper is very fine. But the objection to the lode is that these bunches are not more persistent in length, and that there is too much poor, unproductive ground between them. The cost of passing through these poor "bars" in regular mine work, and hoisting such a quantity of rock to the surface, which has to be thrown into the waste piles, militates against the success of the mine, eating up the profits accruing from the mineral raised from the rich bunches. It is believed that by a consolidation of two or more of the present mining companies whose separate mining territory is rather limited, and by confining the work underground to the rich shutes, or bunches, the mines could be made to pay a good profit. The situation of these mines in a settled country, with good roads, and in close proximity to navigable waters, smelting works, &c., is very advantageous. The following mines are located on the Isle Royale lode, namely: The SHELDON AND COLUMBIAN, CONSOLIDATED, (formerly the Shelden and Albion,) the GRAND PORTAGE, (formerly the Portage,) the ISLE ROYALE and the HOUGHTON, (formerly the Huron,) the DODGE and FRUE.

Oil the Shelden and Columbian, near the shore of the lake, there is a fissure vein; course N. 12° W., and dipping to the northeast. This vein is four to eight feet wide; veinstone, quartz carrying native copper, whitneyite and domeykite. The vein is a strong one, but has not been worked sufficiently to test its value. There is another small fissure, crossing the Isle Royale lode in a northeasterly direction, but of no apparent value.

On the north, or opposite side of the lake, on the supposed extension of the Isle Royale lode, in the year 1863-4 several mining companies were organized, and began work in a small way. These are the HIGHLAND, (formerly the Ripley,) the DOUGLASS, the CONCORD, the

ARCADIAN and the EDWARDS. The characteristics of the lode are similar to the Isle Royale. Rich bunches, or shutes, of copper were found, but owing to many causes, of these mines only the Concord is at work, and that in a small way. These mines have not been thoroughly proved up, but the indications are sufficient, in the matter of copper, to justify a larger expenditure of money in testing them. At the Arcadian the ancient miner has left extensive remains of workings. The vein, or lode, carries much heavy copper and first-rate stamp rock. There is a small fissure crossing the lode on the Douglass, out of which a mass weighing one ton was taken. On the Concord, in the soft brown amygdaloid, very numerous deep and perfect glacial grooves were observed. The rock was polished, and the grooves were as perfect as if they had been cut with a chisel. The score marks were from one inch to four inches deep, and from a line, or scratch, to six inches wide.

In the year 1853 on the north side of Portage Lake regular mining had been begun, and in the year 1857 on the great Pewabic lode were found several mining organizations namely, the QUINCY, PEWABIC and FRANKLIN. The Pewabic lode has the same strike and dip, nearly, as the Isle Royale lode, and lies a little more than one mile to the west of the Isle Royale. For a mile or so in length, on the territory owned by the Quincy, Pewabic and Franklin, the lode-has been and is very rich in metallic copper; the yield since 1860 has been, large, and the profits handsome. The lowest levels in the Quincy and Pewabic are 2,000 feet in depth on the dip of the lode; the lode is from ten to forty feet in width, and the veinstone is chocolate colored, quite soft, and is associated with calcite or tabular spar, and many other minerals; some of the crystallizations are very perfect and beautiful. The copper has often taken the place of crystals, and retains the form of the extinct mineral. Much silver is found associated with the copper, sufficiently so to make it an object to be looked after by the silver pickers in the stamp mills. The copper mined occurs in the forms of mass, barrel and stamp work. Masses and barrel work constitute perhaps 33 per cent, of the mineral raised. That part of the lode worked, or the veinstone manipulated, yields about 2 per cent, ingot copper. There is considerable waste rock taken from these mines, as from all amygdaloid belts of this character, and the stamp rock must be assorted before sending to the stamps.

In the year 1860 these mines had reached an assured position, and within a year or two thereafter they began to pay dividends to the shareholders. Each of the above mentioned mines have a first class stamp mill, situated or the lake shore, tram-roads leading thereto, excellent mine plant, extensive ranges of offices, shops, good macadamized roads, comfortable dwellings and tenement houses, supply stores, hospitals, dispensaries, and are, in brief, model industries.

The example and success of these mines gave character to, and confidence in, the Portage Lake District. In the early days of mining in this country this district was not much esteemed by the copper magnates of Keweenaw and Ontonagon counties, and, for a time, there was but one man in the country to do it reverence, and that was Mr. Ransom Shelden. He was laughed at as an enthusiast, and little heed was given to his word as he expatiated on the riches of his beloved district.

The Quincy is the leading mine on the Pewabic lode, and it is still maintaining its high character for regular products and handsome dividends. It was never a great burden to its stockholders, the amount of money called in being comparatively small—$200,000—the mine from the first yielding much copper, which was used in developing the mine, in lieu of assessments. This company, thus far, from legitimate profits of mining, has divided with its stockholders $2,200,000. The Quincy company has been working under an old special charter, but this year, 1878, has organized under the General Mining Laws of Michigan; capital stock, 40,000 shares—$1,000,000. The Pewabic has divided $400,000; assessments, $240,000; the Franklin, $240,000; assessments, $380,000. The copper ground in the Pewabic mine is short, and is now worked out on the company's property, but the shute of copper, always so rich, extends to other property on the west.

The following interesting figures are taken from Quincy Mining Company's report for the year 1877, copied from the *Mining Gazette*. The Quincy is a *characteristic* mine, working on amygdaloid lodes of Portage Lake District; therefore these figures afford a fair exhibit of the cost of mining these lodes:

GENERAL SUMMARY OF RECEIPTS AND EXPENDITURES OF THE QUINCY MINING COMPANY, FROM ITS ORGANIZATION TO DECEMBER 31, 1877:

EXPENDITURES.

For expenditures on location previous to 1856.....	$ 42,097.98
For expenditures on Quincy vein in 1858, not now worked.....	55,000.00
For openings and explorations on 3,800 feet "east" or Pewabic vein, extending to Portage Lake, preparatory to future work.....	11,500.00
For real estate and permanent improvements on same, including dwelling houses, stamp mill, machinery, steam engines, tram-road, dock, warehouses and other buildings, and roads.....	670,641.63
For mining and surface labor, expense of smelting and marketing copper, and all incidental expenses.....	7,953,183.66
Balance carried down.....	2,594,685.85
	$11,327,109.12

DIVIDENDS DECLARED.

No. 1 payable July 31, 1862.....	$ 60,000
No. 2 payable February 2, 1863.....	80,000
No. 3 payable August 5, 1863.....	120,000
No. 4 payable February 5, 1864.....	120,000

No. 5 payable August 15, 1864	160,000	
No. 6 payable February 27, 1865	160,000	
No. 7 payable February 7, 1868	60,000	
No. 8 payable March 20, 1869	40,000	
No. 9 payable March 10, 1870	120,000	
No. 10 payable February 6, 1871	80,000	
No. 11 payable August 1, 1871	60,000	
No. 12 payable February 15, 1872	200,000	
No. 13 payable August 1, 1872	150,000	
No. 14 payable February 24, 1873	100,000	
No. 15 payable February 20, 1874	160,000	
No. 16 payable February 15, 1875	160,000	
No. 17 payable August 1, 1875	60,000	
No. 18 payable February 15, 1876	100,000	
No. 19 payable August 28, 1876	60,000	
No. 20 payable February 15, 1877	80,000	—$2,130,000.00
Balance		464,685.85
		$2,594,685.85

RECEIPTS.

From capital stock, full paid	$ 200,000.00
From proceeds copper and silver (43,126,038 lbs. copper	11,022,517.12
From interest received (less amount charged off on government bonds)	50,953.66
From sales of real estate, Hancock, Mich	46,508.34
From profit on sale P. L. & R. Improvement Co. stock	7,130.00
	$11,327,109.12

Balance brought down, being receipts over expenditures.....$2,594,685.85

Balance brought down, being amount undivided, as per statement of assets and liabilities.....$464,685.85

Amount of contracts brought down	$147,912 38	
Mining captains and timbermen	6,948 44	
Miners on company account	14,230 41	
Laboring hands, including landers	21,750 89	
Engineers and firemen at hoisting engines	4,512 47	
Carpenters' work	1,576 87	
Blacksmiths work	4,416 07	
Attending change house, watchman and teaming	1,779 75	
Machinist and mason work	3,729 29	
Surveying and engineering	720 00	
Supplies and materials used in mine	21,596 07	
		$229,172 55

RETURN OF MINING COST FOR THE YEAR ENDING DECEMBER, 1877.

1877.	Number of Men on Contract.	Number of Fathoms Stoped.	Average Price per Fathom for Stoping.	No. of Feet Sunk.—Winzes.	Average Price per Foot for Sinking Winzes.	No. of Feet Drifted.	Average Price per Foot for Drifting.	Amount Paid for Stoping.	Amount paid for Sinking Winzes.	Amount Paid for Drifting.	Amount Paid for Extra Work aside from Contract.	Mining Cost, Powder, Fuse, Candles, etc.	Amount.
January	228	403,201	$ 18.51	47.4	$13 54	402.7	$12 00	$ 7,463 32	$ 641 60	$ 4,829 50	$ 440 51	$ 3,016 98	$ 13,374 83
February	210	317,963	18.87	144.0	13 54	373.4	12 14	5,999 24	1,950 00	4,535 40	442 77	2,623 44	12,927 41
March	216	246,281	18.25	120.4	13 55	424.4	12 60	4,495 09	1,712 90	5,348 20	421 17	2,436 74	11,978 26
April	187	215,275	17.53	124.3	13 48	449.3	11 00	3,773 70	1,675 55	4,941 90	368 77	2,235 88	10,751 92
May	218	219,473	16.97	104.9	13 19	414.4	11 07	5,421 71	1,384 00	4,587 40	367 85	2,583 77	11,'01 96
June	228	373,657	16.73	131.3	13 35	357.8	11 25	6,241 16	1,780 50	4,024 05	515 80	2,742 24	12,561 51
July	222	454,486	16.08	47.0	13 89	351.9	10 99	7,309 35	653 50	3,867 00	479 95	2,739 49	12,309 80
August	232	381,449	17.04	83.7	13 68	384.6	10 75	6,501 16	1,145 00	4,131 65	641 90	2,762 72	12,421 71
September	222	445,782	18.65	86.4	12 63	288.8	9 95	8,315 31	1,090 80	2,873 30	299 95	2,742 23	12,579 36
October	226	504,307	17.50	76.2	12 27	227.6	10 11	8,826 88	934 60	2,301 90	401 36	3,134 94	12,400 74
November	226	644,378	15.39	66.5	14 17	129.8	10 61	9,917 81	942 50	1,377 60	368 68	2,909 12	12,606 50
December	212	423,056	17.75	96.0	14 20	252.2	10 67	7,508 79	1,363 70	2'695 90	396 90	2,886 91	12,165 29
	219	4,729,368	17.29	1,136.1	$ 13 44	4,056.9	$11 22	$81,774 42	$15,274 65	$45,515 70	$5,347 61	$32,874 41	$147,912 38

SUMMARY FOR THE YEAR.

Average force employed	474 men.	Total rock hoisted	81,587 tons.
Average number of miners	249 men.	Total stamp rock treated at rock house	73,251 tons.
Average wages of miners on contract per month	$43 79	Total poor rock rejected	8,336 tons.
Yield of mineral per fathom of ground broken	568 lbs.	Product mineral	3,304,580 lbs.
Yield of refined copper per fathom of ground broken	467 lbs.	Product refined copper	2,720,558 lbs.
Total rock mined	98,916 tons.		

February 15, 1878, a dividend of $100,000 declared from profits made in 1877.

The Franklin mine for several years was in the hands of tributers, but the company has taken hold of it again with good prospects of success; it is yeilding over 100 tons per month.

The Pewabic lode has been traced many miles, and it has been opened and mined at several points. Just north of the Franklin, the

QUINCY STAMP MILL—BATTERY STAMPS—WAYNE PATTERN.

RESULTS.

1877.	No. of Days Mill in Operation.	Average No. of Heads run per day.	Tons of Rock Stamped Per Month.	Tons of Rock Stamped per Cord of Wood.	Pounds of Copper Produced.	Percentage of Copper per Ton of Rock.
January	25½	71	6,977	13.50	260,490	1.87
February	24	70¼	6,234	13.00	260,360	2.09
March	13½	69¾	3,373	14.30	202,180	3.00
April						
May	22	70¼	5,651	11 77	229,140	2 03
June	26	70	6,959	15.00	313,950	2.26
July	25	70	7,130	16.58	264,900	1.86
August	27	67½	8,318	16.74	269,020	1.62
September	24¾	68	7,655	15.75	295,295	1.94
October	27	67½	8,730	17.15	284,165	1.63
November	26	67	7,446	13.76	497,635	3.34
December	25	65¾	6,828	11.38	294,455	2.16
	266	69	75,307	14.16	3,171,630	2.11

Running expense.....$49,237 77
Or 65 4-10 cents per ton of rock.
Cost of repairs..... 22,204 17
Or 29½ cents per ton of rock.
Total expense..... 71,441 94
Or 94 9-10 cents per ton of rock.

MESNARD MINING COMPANY,

Organized in 1859, sank several shafts two levels deep on it; removed some barrel and stamp copper, but thus far the success of the company has not been satisfactory. It was upon this company's property that the famous 18 ton mass, almost pure copper, and showing marks of the ancient miner's hammer, was found. The discovery of this mass led to the finding of the so-called epidote vein, the source of the mass. Several shafts were sunk on this epidote vein; some mass copper was removed and then work was suspended on the whole property.

THE PONTIAC MINE

Was organized in 1860 to work on the Pewabic lode, but after a brief career and the finding of a little copper, work was discontinued. This was next on the north of Mesnard. These mines were worked during the speculative period of the war. At the Albany and Boston mines, four miles northeast from the lake, the Pewabic lode has been opened, but shows only a little stamp copper. At some other point, or points in its course, it may or may not again become worthy of attention. So little is really known of the lodes and belts of the country, where they have not been opened, that it is not safe to pronounce upon them dogmatically.

Between the Pontiac and the Albany and Boston the ST. MARY'S, the DORCHESTER and the DUDLEY were worked in 1862-4 upon a conglomerate and the epidote belts; a little copper was found, but no thorough mining was prosecuted and the mines were closed.

THE ALBANY AND BOSTON

Was organized in 1860 to work the so-called Albany and Boston amygdaloid lode and the Albany and Boston conglomerate. A large amount of work was done on this property, and at one time the success of the venture seemed well assured. The amygdaloid lode carries a good deal of copper but whether it would pay as a mine is problematical. Work on this lode was interrupted by

the discovery of the supposed much more valuable conglomerate, and the company's attention was turned to that attractive belt. The surface show on the conglomerate was really very fine, and as the shafts were sunk three levels deep, and the drifts opened therefrom, the same encouraging indications of a valuable mine continued. By analysis, and by treatment under the stamps, the rock taken from the mine yielded four per cent. This was good enough. The management thereupon put up machinery, including a 24 head stamp mill, Gates' pattern, and worked with vigor. After a time, and after several thousand tons of rock had been stamped as it came from the mine, it was ascertained that the copper contained in the veinstone did not yield one per cent. This result was so unexpected and disappointing that the mine was shut up. It has been idle about ten years.

THE RHODE ISLAND COMPANY,

For a brief period, contemporaneously with the ALBANY AND BOSTON, operated on the same belt, just northeast of the Albany and Boston company's lands, but without satisfactory results. These two companies own property extending across the range, and it is quite probable that some-where on this large territory valuable discoveries will be made in the future.

The Albany and Boston conglomerate is a wide belt, 30 to 40 feet, with very coarse boulders and much carbonate of lime in the cement, which is not very firm. This belt is not identical with the Calumet conglomerate.

On the north side of Portage Lake, opposite the village of Hancock, with their northern boundaries in the water, lie the MONTEZUMA, DACOTAH and SOUTH SIDE MINES. Little more than exploratory work was done on these properties, but much money was expended in the deep drift overlying the rocks of that section. The object, mainly, of all this work was to find the Pewabic lode. But that lode has not yet been found on the south side of the lake, though the writer believes it may be.

Three miles back from the lake, on the supposed course of the Pewabic lode, in the year 1861-5, a promising belt was discovered, carrying very handsome copper throughout the mass of veinstone, 15 feet wide and for several hundred feet long. The veinstone is a purple-brown soft rock very like that; found in the Pewabic lode. The mine organized under the name of the SOUTH PEWABIC MINING COMPANY. But this was not the Pewabic lode, but the ash bed of Copper Falls; it contained no mass copper and very little barrel work. The copper existed in shape and size of rifle balls, duck shot and very finely comminuted grains very difficult to save in the washers. This lode has nearly the same course and dip as the Pewabic lode.

THE ADAMS MINE,

Under the same auspices, was organized on the same lode, and was conducted by the same management. These mines, more particularly the South Pewabic, was regularly opened, sufficient mine plant provided, and four heads of Ball's stamps with Collum's washers were set up on the lake shore.

Crossing the lode, near the dividing line of the Adams and South Pewabic, a true fissure vein was found, about four feet wide, filled with quartz or dolomite, carrying small, pure masses of copper. This vein, it was found, had been mined for several hundred feet on its course and to a depth of ten or fifteen feet. Nothing on the surface pointed out these ancient works. Maple forests had covered the even ground with a thick mat of leaves. It is curious to note how this discovery, like so many others in the districts, was the result of accident. Mr. Chas. H. Palmer, a gentleman of observing mind, while leisurley sauntering in the usual way through the woods, noticed that the hoofs of some stray cattle made deep impressions in the ground. He cut a sapling and probed the foot marks, and to his surprise found no bottom. An excavation was ordered, and an old mine was uncovered; the fallen timber and leaves, the accumulation of centuries, bad completely bridged over the chasm. The workings were very interesting and undoubted. Stone hammers were found, and the vein rock, after the reparation of the masses had taken place, was piled up across the vein in a regular wall. At one point, on a projection or shelf of rock, reposed a handsome specimen of copper, which the miner had placed there and forgotten.

The South Pewabic Mining Company, after an active but brief career, and the expenditure of more than its capital stock of $500,000, shut down. The bondholders absorbed the concern, and the honest shareholders are still whistling for their money, for it should be remarked, assessments in the sum of $500,000 had been levied and collected.

A few years ago, in 1872, the company was re-organized, consolidating with the Adams, and named the ATLANTIC, with 40,000 shares. The Atlantic is now working at a profit, and producing over 100 tons of mineral per month. There is little, if any, waste rock in this mine; all the veinstone is sent to the stamps; the percentage of copper is about 1. The company, with locomotive and cars on its own railroad, 3½ miles long, transports its rock to the mill. This mine,(as the South Pewabic,) was the first to use Frue's automatic railway between its shafts and rock-breaking house.

THE HANCOCK MINE,

Now SUMNER, located just west of the village of Hancock, is one of the older mines of the district, organized in 1859. The belt upon which the mine is based is a mixed-up conglomerate; it carries stamp copper and small masses. It has never reached a high position, except in the hands of stock speculators, and is idle to-day.

Commencing at a point on the trap range five miles southwest of Portage Lake, and traveling thence a

distance of some twenty miles, and embracing the entire width of the range, there is a large area of mineral land, but little known. On the head waters of the Salmon Trout, Misery and other streams, some exploring and mining was done in early days.

As a rule, the rocks are covered very deeply with sand drift, with few outcrops, which renders the work of exploration difficult and costly. There is no reason why this great territory is not as rich in mineral resources as any other portion of the range, with the same mileage. Good float copper, with rock attached, has been observed in this section and some fine, promising veins uncovered. This is a legitimate and encouraging field for the coming miner. A railroad along the range, through this unsettled tract, is a desideratum.

In the year 1866 a discovery was made out in the woods, near the old Eagle river trail, ten miles from Hancock, out of which has grown the greatest copper mine in the world. The locality was as obscure as the tract we have just been describing. There was no road leading to it—the surface was heavily wooded and the drift deep. Reference is here made to the Calumet lode. And just here, if the legend be true, is another curious fact of discovery. On this Eagle river trail, so often wearily threaded by pioneer explorers, in a rude cabin called the half-way house, where a "drop of whisky" was procurable, resided a solitary individual, whose only constant companions were some barnyard fowls and two pigs kept in a pen. Now these pigs disliked confinement, and preferred to roam. Being knowing animals, they nosed out of their pen and wandered into the woods. The master's efforts to capture them were in vain. Indignant at the vagrant habits of his pets, so obstinately persisted in, one day, after a hot, ineffectual chase, he came in swearing like a woods pirate and begged a French gentleman resting at his inn to shoot them. The gentleman did as he desired, fired at and wounded one of them with his revolver. The injured porcine ran squealing away, followed by the master. The pig, tracked by blood on the leaves, was found hidden in a nest on the side of a knoll. With the quick eye of an explorer, the man noticed green carbonate of copper plentifully mixed with the earth which the pigs had worked up. He dug into the mound and found further evidences of copper. He reported the circumstances to Mr. John Hulbert, who was exploring there at the time, who in turn communicated the fact to his principal, Mr. Ed. J. Hulbert. Without delay the mound was examined, a pit sunk some fifteen feet through the sand down to the firm rock, when lo and behold, there lay the great Calumet conglomerate. This mound was the veritable work of the "ancient miner." The cackling of a goose saved Rome, so an obstinate pig discovered the Calumet. Of course this legend does not detract from the merits of such skilled explorers and engineers as the Messrs. Hulbert. To them the honor of the discovery belongs.

It is said that the celebrated Cliff mine was discovered by a miner who had been out rabbit hunting on the bluffs, and coming down the steep declivity his foot tripped on a wet moss-covered rock, and down he came on his a *post parte*. Looking around to see what had hurt him, he saw a shining mass of copper, "a smiling at him." This might be termed a *donkey* discovery.

THE CALUMET AND HECLA CONSOLIDATED MINING COMPANY,

80,000 shares, capital stock $2.000,000, is working on the Calumet conglomerate. This belt is of an average width of ten feet; it dips to the northwest 39¼ degrees and has the same strike, or trend, as the formation of which it is a constituent part. The average percentage of the copper of the whole lode mined is now five per centum. Mineral yields 88 per cent, ingot; all of the stamp rock is sent to the mill, without assorting or rejection. The workings vary from 900 to 1,700 feet down on the dip—1,300 feet is the average depth for a whole mile. Length of workings three-fourths of a mile. The conglomerate of the belt is mostly made up of pebbles firmly cemented together; the mass has a lively flesh-colored appearance occasioned by the presence of feldspar; minute black specks of mineral are seen in it, and the whole is of porphyritic texture. The cementing material is very hard and is the same as the pebbles in a finely comminuted form; it is in this cement that the metallic copper is found, and often copper alone is the cementing substance. This veinstone, or matrix, is so hard and jaspery, and contains such a large amount of copper, that the work of boring it with hand drills is excessively slow and expensive. The best steel is soon-dulled, and the expense of mining the rock, as compared with that in amygdaloid belts, is double, if not more.

Mining is done here on a grand scale; two thousand men are employed, and the industry indirectly supports twice that number of people. The machinery used in mining, hoisting, pumping and stamping, is all of the most improved pattern and very powerful and effective. What with the engine houses, shaft houses, rock breaking houses, offices, dwellings for officers and men, supply stores, hospital, school house, hotel and churches, a large and populous village is built over the mine. The Red Jacket village, situate just off the mine limits, is a large, flourishing mining town. The population of the two villages is more than 5,000, for many of the miners have brought their families from the old country. The number of children that attend the schools is something incredible. The Calumet school is graded, and is one of the largest and best conducted in, the state of Michigan. Being absolutely free to the poorest child, it is an inestimable boon to miners' children. On the Calumet belt we find next south

THE OSCEOLA CONSOLIDATED MINING COMPANY,

A comparately new mine organized in 1873, working a large force, and producing about 150 tons of copper per month. It possesses a Ball's stamp mill of two heads,

located on Portage Lake, near Hancock, whence the stamp rock has to be transported a distance of nine miles, on the Mineral Range Railroad, which passes through the property. The Osceola company is also working on an amygdaloid of promise. Mining profits for the year 1877—$140,000.

On the north side of the Calumet and Hecla mine, on the same belt, the

SCHOOLCRAFT MINING COMPANY,

Organized in 1865-6 has made quite extensive openings, and erected a stamp mill and other machinery, with the customary surface improvements for the accommodation of mine employes.

At points, this mine has yielded a fair amount of copper, but the metal is not equally distributed, and there is much barren ground. The conglomerate is fine grained, but of brighter color than that found in the Calumet, showing more spar and epidote. Owing to financial difficulty the mine is closed.

Still further north, on the KEARSARGE, the Calumet conglomerate has been opened, but it is found, on the surface, almost destitute of copper. The Kearsarge Mining Co. also opened on their property a fine looking amygdaloid lode carrying small mass and stamp copper, but no regular mining has been done on the location.

There are several other mining associations that own lands, or have done business in the Portage Lake district, namely, the St. Louis, the Dover, the Hungarian, the Portage Lake, the Florida, and the Ossipee. All that can now be said of them is that their lands are well situated on the trap range in the vicinity of good mines, and are well chosen estates.

It is believed by many good explorers that there is a conglomerate belt lying somewhere to the eastward of the Calumet, that is very rich. A large amount of time and money has been expended in the fruitless effort to unearth it. If it exist, the deep drift and cedar swamps hide it from mortal eye; yet it will be found. A large quantity of float copper in the conglomerate, of exceeding richness, has been to mid on the surface and it suggests strongly the existence of the mother vein, *in situ*, somewhere to the eastward, whence the drift came.

The writer now proposes to take some one mine as characteristic of all stamp lodes in the district, and describe the *modus operandi* of mining, the hoisting machinery, stamp mills, &c. He will choose the Calumet and Hecla mine, for example.

In this new country, as before stated, preliminary to mining, the forests have to be cleared and the surface, if wet, drained. Houses to shelter the mine employes have to be made as well as roads and other absolutely necessary conveniences.

The lode having been satisfactorily tested by surface examination, shafts are started at well chosen points, at convenient distances apart, say four or six hundred feet. These shafts vary in dimensions, but 10 by 14 feet is a good working shaft. In the Lake Superior copper mines, more particularly on stamp lodes, the shafts are always sunk on the dip of the lode, whatever angle it may be. Hence these shafts are inclined planes, and generally they keep to the foot wall. These shafts are sunk to a depth of 75 or 100 feet, at which point the first level is started and is run from shaft to shaft until the whole number of shafts are connected by a continuous gallery, or drift. These drifts are 6 feet by 4, or wider if necessary to accommodate rail tracks. The shafts, while the drifts are opening, are sunk away to the second level; the second level, in due time is opened like the first, and so on down. Between the shafts, for the purpose of ventilation and convenience in stoping, minor shafts are sunk, called winzes. The mine thus opened is like the rectangular blocks on a city map tilted up; the shafts and drifts are main streets crossing each other, and the winzes are alleys. The solid blocks of veinstone bounded by the streets are, if the whole lode is workable, taken out excepting pillars of rock left to support the hanging wall and keep the mine from coming together. This work is technically called stoping. The shafts are cribbed from the surface down to solid rock with square timber and plank, and is divided into two or more compartments, in one of which is laid the rail track, in another the pumps, and in the third a ladder-way. But in large mines, like the Calumet, one shaft is used as a pump shaft, while another shaft, or intermediate opening, is fitted for the man-engine, the duty of which machine is to take the men in and out of the mine. The top of the shaft is carried from 20 to 30 feet above the ground for convenience in the handling of rock. The iron, cars or skips, holding several tons, are held by large wire ropes, which pass over pulleys to the drum of the engine. The movement of these skips is regulated with great precision by bell signals, from under ground; and to the brakeman at the drum the position of the skip, at any depth, is told by an ingenious little indicator. The skip comes up out of the mine, dumps itself, and returns whence it came. At the Calumet the skip dumps its load into a car resting on a horizontal tram-road, which car, moved by an endless rope, apparently without human agency, moves off at a considerable speed to the rock-breaking house, perhaps a thousand feet away, where it dumps itself and immediately returns to its proper position. This economical railroad, set on trestles, more or less elevated above the ground, is called Frue's automatic road. The rock from each shaft has the same common destination, the great receiving rock house. Here the large blocks of copper-tied conglomerate are first crushed under a ponderous steam hammer, which resembles a section of the main shaft of an engine; it operates vertically in slides, and has the lower end beveled off. To compare great things with small, it is like the stub of the pencil which the writer is using. The motive power is a steam cylinder on top. Broken by this great hammer, the pieces of rock fall into a number of large and small Blake rock-breakers, whose corrugated iron jaws crunch them up remorselessly. From these breakers the comminuted conglomerate falls into shutes,

and from thence it is, at will, drawn into cars. A train of cars, each holding four to eight tons, drawn by a locomotive engine, moves off to the stamp mill, five miles distant, where the copper rock is dumped into large bins placed at the top of the mill. The stamps now begin their work of further redaction; the rock is thrown into the hoppers of the great steam stamp, which strikes a blow of many tons eighty times a minute, smashing the rock into minute pebbles, fine sand and slime, which is washed from under the head by a stream of water, and carried by the same agent to the washers set on an inclined floor, when by a process of jigging, in fresh supplies of water, the gravel and sand are separated from the freed copper, which, owing to its greater specific gravity, settles at the bottom on the sieves, while the sand is carried over the apron to the waste launder and is washed out into the lake, or spoil bank. There is a large number of washers in this stamp mill, and the copper rock is subjected to repeated washings, and even the fine slimes are carefully treated upon slime tables. Yet quite a percentage of fine copper goes to waste in spite of the most ingenious contrivances used to save it. The mineral, or washed copper, having been graded, is packed into barrels and sent to the smelting works, where, passing through fire, it is purified from all rock remaining and cast into ingots, bolts, bars and cakes. All of this work,—processes which we have not pretended to describe in detail—is accomplished by that potent agent steam. These stamp mills are an interesting study for any one interested in such works.

Returning to the mine, we go underground, and fathoms deep, where no ray of sunlight ever pierces, we find a populous community of busy workers; the atmosphere of the place is damp and murky, with a strong odor of sulphur, the remains of exploded powder. The only light is that of tallow candles stuck on the hats of the men with clay, .or upon the walls, or as head-lights on the rock cars. Each level is provided with tram roads; the cars are pushed along by men to and from the shafts, where the loaded rock is dumped into the skips. The visitor will not fail to observe, all along the drifts, immense round timbers, set near together and reaching diagonally from one wall 10 the other. These timbers are called stalls or stalls, and serve the purpose of keeping the walls from coining together and closing the mine. With lagging thrown upon them, a platform is made for the rock falling from the stopes above, which platform also protects the workmen in the level and on the tram-ways. Most of the mining is done with the hand drill; one man holds the drill while two strike. Black, very coarse powder is used as an explosive. Steam drills and air compressors are used to some extent. The mine, as a rule, is not very wet; the ventilation is good, as there is no foul air or poisonous gasses liberated in mining. The miners are a healthy, robust class of men. The work of mining proceeds night and day, summer and winter, with great regularity. The men work ten hours, and are divided into day shifts and night shifts, and change from day to night once in seven days. But it frequently happens, in different places, or when greater expedition is required, certain of the miners are divided into three gangs, each gang working eight hours, and all fully occupying the twenty-four hours. Much of the mining is done upon contract, and the average wages are from $45 to $50 per month, out of which the man has to pay his board and other necessary expenses. Every mine has one physician and surgeon, or more, and a good hospital. The men are charged for the support of the surgeon and for medicines; a married man, including family, $1 per month; a single man, fifty cents,

The Calumet and Heel a mining company has been very successful. It is making with great regularity, and pays quarterly, dividends of $5 per share on its capital stock of 80,000 shares. To date, February 15th, 1878, it has divided, twelve millions, four hundred thousand dollars, and the mine shows no abatement in the yield of copper or in productive ground. $800,000 in assessments were paid to open and equip the mine. The mine is always kept well opened in advance of the stoping parties.

Yet this great mine had its period of doubt and uncertainty, and at one time, owing to bad management and financial trouble, it came near failing.

Successful mining upon conglomerates was an anomaly, many had no faith in the permanent value of conglomerate belts; but the Calumet and Hecla has dispelled all doubts on that subject.

First in the history of the copper country of Lake Superior, fissure veins, charged with enormous masses of metallic copper, had to gain favor; next, stamp lodes had to fight their way into popular estimation, and lastly, the conglomerate belts astonished the scientific world. What next?

KEWEENAW DISTRICT.

THE ALLOUEZ MINING COMPANY,

Whose property lies just north of the northern line of Houghton county, is working on a conglomerate belt which is supposed to be the Albany and Boston conglomerate. This belt is 50 (?) feet wide, and the boulders of the conglomerate are coarse; some portions of the cementing material are well charged with copper, but the deposits of that metal are very irregular and uncertain. The belt being so wide, the cost of stoping so much barren veinstone, lessens the profits of mining. Were the copper, which is unequally distributed in the lode, concentrated upon the foot wall, for example, in a zone from ten to fifteen feet wide the length of the mine, the mine could be worked much more economically, and doubtless with very satisfactory results. Not even the Calumet can produce car loads of rock richer than those we see sent to the Allouez stamps, but there is so much low grade rock intermixed, say in 1,000 tons, that the average percentage of copper is greatly reduced. This company was organized prior to 1860, and some exploring, by shallow shafts, was done, but active work was begun only about five years ago; 188 tons of copper

was sent to the smelting works in 1875. This mine has an extensive mine plant; a stamp mill with two heads of Ball's stamps, and a railroad connecting the mine and mill; the trains are hauled by a locomotive engine. The mine has shipped a good deal of copper, but at present, owing to financial difficulties, it is in the hands of tributers. Although the directors have expended more than the capital stock—$500,000—raised by assessments, yet the mine has not readied a paying point.

THE SENECA MINE

Is a new concern, though the organization of the company was effected some twelve years ago; the lands belonging to the company were set off from the old Fulton, which occupied under a nine mile permit. Two shafts have been sunk to the first levels, on what is known as the Kearsarge conglomerate, which lies 1,600 feet east of the Calumet conglomerate. The site of the mine is some five miles northeast of the Calumet mine, or one mile in the same direction from the Allouez. The Kearsarge conglomerate, as opened here, very much resembles the Calumet rock, the pebbles being fine and firmly cemented, but the color of the veinstone is a shade darker. The belt is, however, 50 feet wide, but is not rich in copper the whole thickness. Under the hanging wall there is a longitudinal section from four to six feet wide, which carries from one to three percentum of stamp copper. The dip and course of this belt correspond with that of the formation. All that can now be said of this mine is, that it is an undeveloped concern of much promise. The company is working only a few men, and proceeding cautiously. The lands owned by this organization embrace several thousand acres, and are most favorably situated on the Trap Range.

THE "CLIFF,"

Next in order of working mines, has been described.

A few years ago this company changed hands—the mine was sold. It was left to fill with water. At great cost and labor, agent Farwell removed the water and resumed mining operations. He is working a moderate force of miners. As the mine is very deep, the cost of mining is great. Besides working from the perpendicular hoisting shaft, and being under the necessity of drifting back from the shaft to the vein, at every level, the loss of time and cost are very serious draw-backs to successful working. It is not admitted that the mine is worked out, but doubtless it has seen its best days. Unlike agriculture, when the soil, by proper cultivation can be forever renewed, a mine, however good, will in time become impoverished to such a degree as not to pay, or become too deep to be mined profitably.

THE PHOENIX MINING COMPANY,

Working in a true fissure vein, is one of the prominent mines of this district, and is producing much mass copper; of late the annual product of mineral has averaged 700 tons. The Bay State Mine, absorbed by the Phoenix, adds greatly to its productive territory. The mine is well situated, about two miles from Lake Superior, on Eagle River, just south of the Greenstone. It has a small stamp mill, good machinery, and comfortable habitations for its people. The surrounding country is cleared and cultivated, and the roads are excellent.

THE CENTRAL MINING COMPANY,

Is operating upon a splendid fissure vein. The mine is under the greenstone, the cuprifirous deposits on the north being limited by the slide; it is situated about midway between Eagle River and Eagle Harbor. The mine was organized in 1854, made its first shipments of copper two years thereafter, and has always been distinguished as an eminently, trust-worthy and successful concern;—the annual dividends coming with great regularity and paying good profits. The capital stock is 20,000 shares—$500,000. The assessments levied and collected with which to open the mine were comparatively light, $100,000, the money derived from the sale of copper going far towards equipping the mine. The mine, is well fitted with machinery, offices and dwellings and the underground department is ably managed. The mine is worked through a great main shaft which enters the mine under the greenstone slide and rung parallel thereto,—a heavy car, running upon T rail laid in the shaft is used in the mine traffic. The vein, which has nearly a north and south course, dips to the east. The principal product is mass copper of 65 per cent, purity; the deposits of this metal are found in calcspar, sugar spar, laumontite, chlorite and other minerals, often occuring in form of beautiful crystals. The masses are often enormous, irregular slabs—isolated bodies of copper—and weigh in gross from four to eight hundred tons. They are mined by working on each side and removing the vein rock, and are blasted down so as to expose one face, by sand blasts in which several kegs of powder are used. They are cut, by means of chisels, into convenient blocks for handling, of from four to eight tons each. Some of these blocks are of great purity; when hoisted from the mine they are sent to the smelting works without further dressing. At first, smelting furnaces had to be constructed on purpose to receive and smelt these great solid masses. They were a novelty not only to miners, but to smelters. But all difficulties in treatment have been overcome by American genius.

But a small percentage of the vein rock is stamp stuff, therefore the Central company operates only a small stamp mill of the Gate's pattern.

It is estimated that the total dividends made by this mine, at date, 1878, amount to $1,320,000—assessments paid in $100,000.

To all appearances the mine will not be exhausted for many years to come.

THE COPPER FALLS MINING COMPANY,

Already described, is not at present operating in the mine proper, but is engaged in bringing up a deep adit to tap the mine at a low level. When this work shall be finished, it is hoped, with, ample drainage, that the company will be able to resume active mining in the lower sections of the mine when it is expected good paying ground will be opened in the fissure vein.

THE DELAWARE MINING COMPANY

Is working on a fissure vein, on their location, which lies a few miles southeast of Eagle Harbor. The vein is rather small, but carries a fair percentage of copper; a small force is at present employed in opening the mine.

The Amygdaloid Mine, situate near the Delaware, is on a fissure vein and is working in a small way.

The Clark Mine, an old organization, is situated near Copper Harbor. It is owned by Monsieur Estevant, who resides in Paris, France. The vein carries small mass and stamp copper, but the production thus far has not been satisfactory. Only a few men are at work in the mine.

This completes the record of the working mines of today in the Keweenaw county district.

The entire ground from the Houghton county line to the extreme eastern end of point Keweenaw is occupied by mining companies, but a large majority of these Companies have been idle, from ten to twenty-five years. Some of them will doubtless again resume work and upon veins or belts partially mined, or upon new beds, meet with that success which thus far they have failed to reach.

The conglomerate belts, especially, offer a fine field for exploratory observation.

The reader, who has had the patience to follow these sketches thus far, has doubtless been surprised at the number of mining associations in the copper mines, as a whole, that have suspended operations, and may pertinently inquire why this is so? In this respect it is presumed that our mines do not present an exceptionable case. The same causes that have produced these effects exist in other mining regions on this continent; and the same stagnation and dilapidation of mining settlements, is apparent; especially is this so, in all the new territories.

It does not come within the scope of this paper to present a full statement of all the facts as they are found in our copper mines.

We repeat what has been already said that many so-called mines have merit which, in the course of time, will become manifest; while on the other hand many of these concerns have no value at all and never had any. They were the offspring of speculation and did not deserve to succeed. Others were blunders, the only excuse for which was a pardonable want of knowledge of the vein phenomena of the district. Still others failed from lack of sufficient capital and perseverance in the face of obstacles and discouragements, such as a general financial crisis, a fall in the price of copper, high price and scarcity of labor and a want of sound judgment as to the necessary outlay requisite, under the most favorable circumstances, to open and equip a mine. The remoteness of residence of the majority owners of these mines, (the board of directors generally having their offices in sea-board cities,) and a want on their part, of familiarity with mining, or its general business details, have often operated detrimentally to the best interests of the mines.

Then, it must not be forgotten that the copper region of Lake Superior was, and is, to a great extent, a wilderness, that the native forests had to be cleared—all supplies brought from long distances at great cost; that the only means of communication with the settled portions of the union, was by the lakes which, for one-half of the year, were fast bound in ice; and that the climate of winter in this high latitude was dreary and remorseless, and the deep snows overwhelming.

Many of these depressing draw-backs have ceased to exist. The copper mine settlements are no longer entirely dependent upon the natural water ways for intercommunication, but find an outlet by several railroads. Good turnpike and macadamized roads have been built from Copper Harbor to Ontonagon, and good lateral roads are found where there is a necessity for them. The population of the country has become more stable, and the cost of living has materially decreased, while more comfortable habitations, and all those appliances of civilization which man knows how to invent and use, have robbed winter of much of its terror.

Hereafter it is not likely that gross blunders will be repeated. The managers, with the acquired experience of years should make no grave mistakes in opening and equipping a mine. Examples of machinery, stamp mills, tram roads, &c. are numerous, and should serve as guides in the future.

As a rule the local managers of our copper mines, from first to last, have been men of character and ability. Instances are rare, if any exist, where the chief officers intrusted with so much power and responsibility have proven defaulters, or have been willfully unfaithful to their high trusts. They have, doubtless, from want of experience in a new field, committed mistakes, but they have been governed by an honest purpose. A large majority of the copper mines are controlled by boards of directors, resident in Boston or New York. The board chooses a president, treasurer and secretary, who reside in those cities. The local affairs of the mine are managed by a corps of officers, the chief of whom is the agent, or superintendent; his associates are the mine captains, surface captains, engineers, civil and mechanical, chemist or assayer, clerks and surgeon. There is also quite a staff of sub-officers to direct the multitudinous details of a great mine. A good working mine expends from $20,000 to $100,000 per month.

From 500 to 2,000 men, of all classes, are employed regularly, by each mine. Reference is here had to mines working full capacity.

ISLE ROYALE DISTRICT.

Mines were opened in a small way on the island twenty five years ago, at Rock Harbor, where a small stamp mill and a small smelting furnace were erected. The enterprises were short lived. About 1872-3, mining was resumed on the island by the ISLAND MINING COMPANY, on a tract of land lying two miles north of the head of Siscowit bay, south side of the island. The basis of the mine was an immensely thick bed of conglomerate. The course of this belt is about 35° northeast; the dip is very flat, so that the shaft forms an easy inclined plane. This dip is the reverse of that of the belts observed on the south shore, being southeasterly. This belt resembles the Albany and Boston conglomerate where it is mined at the Allouez. The veinstone is often highly charged with metallic copper, but the copper is unevenly distributed, and there is much poor ground intermixed with the richer parts. Our remark made upon the mining operations at the Allouez are applicable to the mine under consideration.

At one time great hopes were entertained by the management that the Island mine would make a brilliant success. The mine was opened vigorously—money was freely expended, and two shafts were sunk to the third level, some drifting was done, but very little stoping attempted. Land about the mine was cleared; comfortable buildings for the miners' erected; a road was cut out and graded to the bay, and a substantial dock and warehouse were built on the shore. A space was also cleared for a large stamp mill which, however, was not erected. But for reasons not known to the writer mine work was suddenly suspended by the company, in 1875-6.

Tributers, who have erected a small stamp mill, on the creek near the mine, are treating the rock hoisted from the mine during active operations by the company; they are also doing some stoping. What success they are meeting with is not known.

In 1876-7 the SAGINAW MINING COMPANY began work in some old shafts, in an epidote vein, found near the west end of Rock Harbor. Only a small force of miners have been employed there; however, the company's agent is very much encouraged by the show of copper found in two veins crossing each other on the property. One of the veins, at least, is said to be a true vein, carrying copper in small thin masses.

On the north side of the island, at McCargo's cove, the MINONG MINING COMPANY has been mining for about three years. The company was organized Dec. 16th, 1874, but did not get down to regular work until the next season. The mine is based upon a thick metalliferous, or cupriferous bed, and upon transverse veins. Attention was directed to this spot by surface evidences of most extensive ancient workings.

The cove is a perfectly land-locked harbor, two and one-half miles long, one thousand feet wide, and deep enough for large draught vessels to navigate. The mine is one hundred and fifty feet above the lake, and well situated for drainage, milling, &c. The bad upon which shafts are being sunk dips to the southeast, and is quite flat; as first exposed in the ancient mine, it was supposed to be several hundred feet thick, but recent mining disproves this theory and fixes the thickness of the belt at from 15 to 20 feet. Much small mass copper has been uncovered; from June to November of the first seasons work, thirty tons of 88 per cent, were shipped. The largest mass uncovered weighed 5,720 pounds, bearing marks of ancient stone hammers. The bed, or lode, has the same strike as the formation, is amygdaloidal-epidote, and carries a handsome percentage of stamp copper. The fissure veins are promising, but not enough is yet known of the vein phenomena of this section to enable us to decide conclusively upon their merits. The display is truly wonderful, and everything points towards a profitable outcome of copper for the Minong. The company owns 1,455 acres of land traversed by these belts and veins.

Isle Royale is isolated. The storms of the great lake rage around it during the winter solstice, and when the season is severe and the lake filled with ice, communication; with the main shores is entirely cut off. During the season of navigation, communication with Portage Lake is kept up by means of small daily steamers; large steamers also visit the island.

The estimated population of the copper mines of Lake Superior is 25,000. There is a large foreign element, chiefly found among the mining classes, namely, Cornishmen, Germans, Irish, Italians, Scandinavians and Canadian French. They are good workmen, and, as a general thing, they are an orderly, law-abiding people. Society at the mines and in the towns is cultivated and refined. Many of the leading people have immigrated from the larger eastern cities of the Union, and have brought with them all the tastes and refinements of an older civilization. Schools, churches and benevolent institutions abound. There are many beautiful homes to be seen, and a considerable display of wealth. The climate is salubrious, and the inhabitants enjoy a large immunity from disease. In fact, the Lake Superior country is visited in the summer season by a large number of invalids. The region is also a very inviting and favorite resort for those intent upon pleasure, or who wish to escape from the oppressive heat of more southern climes.

Agricultural pursuits have been followed only to a limited extent in the copper districts. The soil may be called second rate farming lands. The Trap Range is covered chiefly with hard maple, with a mixture of white cedar, white pine, birch, hemlock, spruce and balsam fir. The low lands support more trees of the evergreen class, and extensive pine forests are among the most valuable resources. The manufacture of lumber for the use of the mines, and for exportation, is largely increasing every

year. Heavy pine, hemlock and cedar timber is consumed by the mines in immense quantities, but the supply is ample for years to come. The maple and birch, cut up into cord wood, find ready sale at the stamp mills where there is a large yearly consumption of fuel.

The chief products of the soil are grass, bay, oats, potatoes, rutabagas and garden vegetables and small fruits. The raising of Indian com is attempted only in gardens. That wheat can be grown has been satisfactorily proven in Ontonagon county, and elsewhere. Owing to the deep snows of winter, stock raising has received but little attention. But that the country is peculiarly well adapted to the raising of cattle, the writer knows by seeing how rapidly imported animals take on flesh grazing upon the native grasses of the country, which spring up as soon as the forests are cleared, and are fully equal, in every respect, to the celebrated Kentucky blue grass. This grass remains green, if it does not grow all winter, under the deep snows of that latitude; the ground does not freeze, and as soon as the snow disappears in spring the pasturage is good. Cattle raising, also sheep, could be made a profitable industry in the mining regions, we have no doubt; the period for foddering cattle, after all, would be no greater than that which rules in the vicinity of the State Capital. Butter, with the mines for a market, would be a most profitable product, also milk. All domestic cattle and beef, as well as oxen and horses, to supply the towns and mines, are drawn from Illinois, Wisconsin and Minnesota. Flour, mill feed, maize, pork, ham, poultry, &c., &c., are derived from those states mainly. It is estimated that at least $2,000,000 are annually expended for supplies for the whole mining region—iron and copper—and that but a small proportion of the outlay goes to southern Michigan.

In favorable situations, in the vicinity of mines, upon the lake shores and river banks of the interior, many farms have been opened out. The forests are cleared and sold in the shape of cord wood and timber to the mines and towns, so that the cost of making a farm in the woods, helped by the sale of timber, is comparatively light. The Canadian French are the chief agriculturists on Portage Lake. Elsewhere, American and German citizens are putting their hands to the plow in earnest.

The native forests are not the home of many kinds of wild animals good for food. The fur-bearing animals, once plenty, are being thinned out rapidly. Occasionally a deer, a black bear, or a wolf may be seen, but they are not permanent denizens; they are only summer visitors. The rabbit, porcupine and ruffled grouse are to the "manor born," and are still found in abundance.

The waters abound in fish. The yearly catch of whitefish and Mackinac trout amounts to many thousands of dollars. Americans, Norwegians, French and Indians engage in this profitable business. Thus a cheap and abundant supply of fish food is furnished to the people of the mines. The small streams and bays are full of brook trout, some of which grow to a great size—from one to seven pounds. Taken from the ice cold waters, they are very delicate food.

OTHER SOURCES OF COPPER SUPPLY.

In Canada, in the New England and several of the southern states are found mines which are, or have been, producing ores of the sulphuret of copper in limited quantity. In New Mexico, Arizona and in the Pacific slope states and territories have been discovered veins carrying ores and native copper. Many of these discoveries are reported to be rich, but the geographical situation of these mines is, for the most part, remote and in desert countries, without railroad facilities, or water communications. In such a country where mines of precious metal, of ordinary grade, do not meet with success, owing to the enormous cost of mining, and transportation, it is not likely that mining for copper there will very soon become so prominent as to seriously affect, by competition, the prosperity of the Lake Superior mines. And it remains to be proven whether those western veins are of such value and permanence as to be trustworthy. It will be remembered that about the year 1863 discoveries of exceedingly rich and productive mines of yellow sulphuret of copper were made at Copperopolis, near Stockton, California. These mines were very favorably situated in a settled country, near a point of ocean shipment, and were very wide deposits, which could be easily and cheaply worked. It was thought that they would speedily become dangerous rivals of the Lake Superior mines. But after having been worked for a period of a few years the deposits of ore were found to be superficial, and were soon mined out. In the year 1868, at which time the writer visited that section, these mining companies had suspended operations, and those millionaires who had reveled in a little brief prosperity, had failed and, with accustomed California courage, had once more taken up the hammer of the modest explorer and wended their way to the mountains in quest of treasures new.

The mines of Cornwall are so nearly exhausted as to have lost a preponderating influence in the copper market. The ore mines of Chili are still producing a good deal of copper, but there has been a marked falling off in production of late years. The new copper mines of Australia are producing some copper—how much we do not know. The mines of Continental Europe can, by no means, supply the home demand.

From this statement it would appear that at the present time the Lake Superior copper mines are without a rival. From the well known purity of the metallic copper of this region, and the high estimation put upon it by leading manufacturing and commercial nations of the earth, it is not probable that it will very soon lose favor, or cease to be in demand.

As to the origin of the metallic copper found in such abundance in the amygdaloidal rocks of the Trappean Range, different opinions are held. Prof. Winchell, late state geologist, thinks that these rocks are of igneous

origin, while others are of the opinion that these rocks, like the conglomerate belts, intercalating, are sedimentary and metamorophosed, and that the copper, which exists in solution in all of the rocks, including the sandstones, is deposited through the agency of electricity in the pre-existing cavities of the lodes and belts, and in the more recent fissures, which are true veins, carrying mass copper. The latter seems to be the general opinion among practical men at the mines.

GENERAL REMARKS.

It will be seen from the perusal of the foregoing pages that the copper districts have made great progress in settlement, improvement and production, during the last quarter of a century. All doubt and uncertainty as to the intrinsic value of the copper mines of Lake Superior have been dissipated. They are favorably known throughout the civilized world. The refined copper sent out from these mines is In high favor, and commands, for many uses, a premium above all other copper whatever.

Still, mining in the copper rocks of Lake Superior, must be regarded as in its infancy. Not one thousandth part of the Trappean, or Copper Range, is known, or has been minutely explored. The people of that country only stand upon the shore of the great ocean of discovery which lies before them. The mines of Cornwall have been worked for a thousand years, new discoveries having been made as old ones were exhausted. No one who has paid any attention to developments in this region can doubt for a moment that a great profitable future lies open, and that centuries hence the copper mines will be worked by a populous, intelligent and prosperous community, educated in our common schools, and mine colleges, and made happy by the perpetuated blessings of civil and religious liberty.

At this date—1878—in common with other great industries of the United States, copper mining is sharing in the general distress. The low price at which copper has ruled for the last four years has made necessary the closest economy and the use of the best skill to prevent the mines from losing money. In this respect the depression has been salutary.

The general dullness has also had the effect to stop the tide of reckless speculation in mining stocks, or shares, and mine owners are now more than ever anxious to obtain profit from honest, legitimate mining.

Another effect of hard times is a lack of enterprise in exploring. At such periods men do not readily invest their money in undertakings that in their mature are uncertain and expensive; they wait for more prosperous times. Yet this is really the best time to engage in exploring and looking up abandoned properties, because labor and material are plenty and cheap.

But the present outlook is anything but discouraging. It is believed that the copper mining industry was never in a more healthy state. To-day there are more mines that are doing well than there ever was at any period in the history of the country. The future is full of hope, full of encouragement, and the people of the Upper Peninsula only ask of their brothers in the southern part of the state, fair and just recognition in the halls of the Legislature, in order that they may keep pace in progress and improvement, and in all high behests, with the rest of our great and advancing commonwealth—the Michigan of the two Peninsulas.

JOHN H. FORSTER.

List of mining companies that have reported copper product at Auditor General's office:

1 Adventure.....Organized February, 1854
Capital stock, 20,000 shares, $500,000
2 Ætna..... .....Organized January, 1864
Capital stock, 20,000 shares, $500,000
3 Albany & Boston..... Organized June, 1860
Capital stock, 20,000 shares, $500,000
2 Allouez ....Organized September, 1859
Capital stock, 20,000 shares, $500,000
2 Amygdaloid..... .....Organized July, 1860
Capital stock, 20,000 shares, $500,000

3 Arcadian ..... Organized July, 1864
Capital stock, 20,000 shares, $500,000
3 Atlantic..... .....Organized July, 1872
Capital stock, 40,000 shares, $1,000,000
1 Aztec..... .....Organized August, 1863
Capital stock, 20,000 shares, $500,000
2 Bay state .....Organized Bay, 1853
Capital stock, 20,000 shares, $500,000
1 Bohemian..... Organized October, 1864
1 Caledonia (old Nebraska)..... .....Organized March, 1863
Capital stock, 20,000 shares, $500,000
3 Calumet & Hecla Consolidated.....Organized December, 1864
Capital stock, 80,000 shares, $2,000,000
1 Carp Lake.....Organized June, 1878
Capital stock, 20,000 shares $500,000
2 Central..... .....Organized November, 1854
Capital stock, 20,000 shares, $300,000
2 "Cliff" (Pittsburgh & Boston Co.) Chartered at first, Organized April, 1873.
Capital stock, 20,000 shares, $500,000
3 Concord ..... Organized May, 1864
Capital stock, 20,000 shares, $500,000
2 Copper Falls ....Organized November, 1855
Capital Stock, 20,000 shares, $500,000
2 Dana..... Organized April, 1853
Capital stock, 20,000 shares, $500,000
2 Delaware..... Organized January, 1873
Capital stock, 200,000 shares, $500,000
1 Devon ..... Organized November, 1863
Capital stock, 20,000 shares, $500,000
3 Douglass..... Organized January, 1863
Capital stock, 20,000 shares, $500,000
2 Eagle River..... .....Organized February, 1853
Capital stock, 20,000 shares, $500,000
1 Evergreen Bluff..... .....Organized September, 1853
Capital stock, 20,000 shares, $500,000
1 Flint Steel .....
Capital stock, 20,000 shares, $500,000
1 Forest, (Victoria)..... .....Organized April, 1855
Capital stock, 20,000 shares, $500,000
3 Franklin..... ....Organized April, 1857
Capital stock, 20,000 shares, $500,000
2 Garden City..... ..Organized October, 1855
Capital stock, 20,000 shares, $500,000
1 Gogebic..... .....Organized February, 1853
Capital stock, 20,000 shares, $500,000
3 Grand Portage, (old Portage)..... .....Organized May, 1860
Capital stock, 20,000 shares, $500,000
1 Great Western.....Organized March, 1863
Capital stock, 20,000 shares, $500,000

3 Hancock, (now Sumner).....Organized April, 1859
1 Hazard.....Organized December, 1853
Capital stock, 20,000 shares, $500,000
1 Hilton.....Organized May, 1863
Capital stock, 20,000 shares, $500,000
3 Huron (now Houghton).....Organized December, 1853
1 Indiana.....Organized March, 1854
Capital stock, 20,000 shares, $500,000
1 International (old Bohemian).....
Capital stock, 20,000 shares, $500,000
3 Isle Royal.....Organized June, 1857
Capital stock, 20,000 shares, $500,000
1 Knowlton.....
Capital stock, 20,000 shares, $500,000
1 Lake Superior.....Organized July, 1853
Capital stock, 20,000 shares, $500,000
2 Madison.....Organized August, 1859
Capital stock, 20,000 shares, $500,000
1 Magnetic.....
Capital stock, 20,000 shares, $500,000
2 Manhattan (Old Albion).....Organized January, 1863
Capital stock, 20,000 shares, $500,000
1 Mass.....Organized May, 1856
Capital stock, 20,000 shares, $500,000
3 Mesnard.....Organized May, 1859
Capital stock 20,000 shares, $500,000
1 Minesota (charter).....(Organized laws of Mich.) 1855
Capital stock, 20,000 shares, $500,000
4 Minong.....Organized December, 1874
Capital stock, 40,000 shares, $1,000,000
1 National (chartered).....Organized 1848
Capital stock, 20,000 shares, $500,000
1 Native (chartered).....Organized 1848
Capital stock, 20,000 shares, $500,000
1 Nonesuch.....Organized June, 1867
Capital stock, 20,000 shares, $500,000
2 North American.....
Capital stock, 20,000 shares, $500,000
2 North Cliff.....
2 Northwestern.....
2 Northwest (changed to Pennsylvania).....
1 Norwich.....Organized March, 1855
Capital stock, 20,000 shares, $500,000
1 Ogima.....Organized December, 1860
Capital stock, 20,000 shares, $500,000
3 Osceola, consolidated.....Organized 1873
Capital stock, 40,000 shares, $1,000,000
2 Pennsylvania.....Organized June, 1860
Capital stock, 20,000 shares, $500,000

2 Petherick.....Organized April, 1861
Capital stock, 20,000 shares, $500,000
3 Pewabic.....Organized April, 1853
Capital stock, 20,000 shares, $500,000
2 Phœnix.....Organized November, 1865
Capital stock, 20,000 shares, $500,000
3 Pontiac.....Organized April, 1859
Capital stock, 20,000 shares, $500,000
3 Quincy (chartered).....
Capital stock, 20,000 shares, $500,000; now 40,000, $1,000,000
Organized under mining laws, 1878
2 Resolute.....Organized March, 1864
1 Ridge.....Organized October, 1863
Capital stock, 20,000 shares, $500,000
1 Rockland.....Organized October, 1853
Capital stock, 20,000 shares, $500,000
3 Shelden & Columbian.....Organized June, 1864
Capital stock, 20,000 shares, $500,000
3 South Pewabic (now Atlantic).....Organized November, 1864
Capital stock, 20,000 shares, $1,000,000
5 Star.....Organized July, 1853
Capital stock, 20,000 shares, $500,000
2 St Clair.....Organized March, 1864
Capital stock, 20,000 shares, $500,000
3 St Mary's.....Organized March, 1863
Capital stock, 20,000 shares, $500,000
2 Summit.....Organized November, 1862
Capital stock, 20,000 shares, $500,000
3 Sumner (Old Hancock).....Organized November, 1867
Capital stock, 20,000 shares, $500,000
1 Superior.....Organized October, 1855
Capital stock, 20,000 shares, $500,000
1 Toltec (consolidated).....Organized May, 1853
1 Union.....Organized October, 1864
Capital stock, 20,000 shares, $500,000
1 Victoria.....Organized April, 1858
Capital stock, 20,000 shares, $500,000
2 Vulcan.....Organized March, 1864
Capital stock, 20,000 shares, $500,000
1 Windsor.....Organized March, 1855
Capital stock, 20,000 shares, $500,000

1 Mine in Ontonagon county.
2 Mine in Keweenaw county.
3 Mine in Houghton county.
4 Mine in Isle Royale county.
5 Mine in Houghton and Kewenaw counties.
NOTE.—Some of the foregoing companies at first worked under a charter; afterwards they organized under the general laws (mining) of Michigan.

LAKE SUPERIOR BROWN STONES.

Skirting the south shores of Lake Superior, at intervals, may be seen beds of sandstone resting nonconformably against the archæn rocks. At some points, as at Grand island—where the "capping strata" are more highly indurated—the sandstone forms high bold cliffs, as those of Pictured rocks at Grand island, discolored from the decomposition of thin seams of pyrites.

These sandstones are supposed to belong to the Potsdam period, and therefore form the base of the lower Silurian. The sandstone is usually of a brownish color, and many of the shades are very rich and warm. At Marquette and L'Anse have been opened brownstone quarries which are now furnishing a very excellent building material that is rapidly gaining favor among architects.

The quantity of stone at these quarries, so far as developed, is apparentely inexhaustible, and the quality fully equal to the best eastern grades. This interest, however, is only in its infancy; and there can be no question but that it will grow and eventually become one of the prominent industries of our state.

The Marquette Brownstone company was organized in Sept., 1872, with S. P. Ely, president; Peter White, secretary and treasurer; Sidney Adams, general agent, and J. H. Jacobs, superintendent. This property was previously known as the Wolf quarry. It is located in the southern portion of the city of Marquette, and is only a short distance from the lake shore.

The first shipment of brownstone was made by Wolf & Co., in 1869. The present (1877) officers of the company are F. P. Wetmore, president; S. Brownell, secretary, treasurer and general manager, and J. H. Jacobs superintendent.

The brownstone is one of the layers of the Potsdam sandstone which at one time covered the greater portion of the lower horizons of the Lake Superior country, but now only limited fields or small patches remain. About Marquette are narrow ridges of greenstone and quartzite of the Huronian period, having nearly an east and west trend, and which rapidly terminate as we approach the lake. In these sheltered bays bounded by the termini or spurs of the ridges, are often small fields of sandstone. The above quarry is one of these isolated patches, protected as it is on its north side by a high greenstone ridge.

In the quarry there is now (March, 1878,) a working face at the west side 250 feet long, having a thickness of four

feet on the south end and varrying from six to nine feet on the north end. The stone has a rich, warm, brown color, and is of a medium grained, very uniform texture. Some portions of the bed are variegated, and when first quarried works “very free" under the hammer or chisel, and from it have been sculptured some very fine and elaborate pieces of art. This latter fact is given to show its homogeneity and freeness from treacherous seams which are often so discouraging to the stone cutter. It weathers well, and when seasoned, becomes hard and is not then affected by the frost.

Wishing to present the opinion of those who have made building material a special study, I addressed the leading architects of Detroit, Chicago and Cleveland, with the following pleasing results:

DETROIT MICH., Nov. 28, 1877.

CHAS. E WRIGHT, M. E., Commissioner Mineral Statistics, Marquette, Mich.—*Dear Sir*: In reply to your favor of the 22inst., we have used, the Marquette Brownstone, and consider it to be of the very best quality for building purposes, fine grained, easily cut, and keeping color, while the stone hardens with age and exposure to the atmosphere. We consider it fully equal in quality to the Portland Brownstone. Respectfully yours,

WILLIAM SCOTT & Co.,
Architects & Civil Engineers.

CHICAGO, ILL., Dec. 17th 1877.

CHAS. E. WRIGHT, M. E., Commissioner, &c., Marquette, Mich.—*Dear Sir*: In reply to yours asking for information regarding the Marquette Brownstone, we would state that having used it to a considerable extent, we consider it an excellent building stone, especially adapted to elegant residences and structures, where its beautiful color appears to an advantage. This latter feature must ever secure it favor with the true artist, being rich and warm, and suggestive of vitality. As a working material, it is all that the artist can desire, being very soft and tenacious, thus enabling the stone cutter to cut and carve the most elaborate and intricate designs of the architect. Durability being one of the essential qualities, we would add that having carefully observed buildings constructed from this stone which have stood for a number of years, that in our opinion it possesses this property in a high degree. During a short visit to the quarry last summer, we were highly pleased with what we saw, and the inexhaustible quantity of brownstone. Yours, &c.,

CUDELL & BLUMENTHAL, Architects.

CLEVELAND, OHIO, Dec. 14, 1877.

CHAS. E. WRIGHT, Marquette, Mich.—*Dear Sir*: In reply to yours of the 22nd Nov., would say, I have used but little of the Marquette Brownstone; but so far as I can judge from my limited knowledge of it, I regard it as being a very superior material as to color, soundness, and working qualities. In this vicinity its use will doubtless be limited to surface decoration upon white sandstone buildings, and for this purpose it is far preferable to the Connecticut stone, particularly as to its durability; nor would I hesitate to recommend it for entire facing of walls, should any of my clients approve of a "brownstone front," and not object to the cost of it.

Yours truly,
JOSEPH IRELAND, Architect.

The above are but a few of the letters from equally reputable parties which I have received in answer to my inquiries, and coining from such unbiased sources, and from those, too, whose opinions must be authority in matters of this sort, they seem to settle the question as to the value of our Lake Superior brownstone.

The quarry has good drainage, and possesses many other natural advantages, one of which is a large living spring of water running close by the openings. The water has been utilized by constructing a dam some distance above the workings, and conducting it through a 26-inch pipe to the stone saw mill of the company. This affords a sixty-foot head of water, quite sufficient to drive the two gangs of saws.

Explorations made 800 feet to the west have discovered a layer of brownstone similar in quality to that in the quarry, and it is highly probable that it is of the same bed. It is the intention of the company to thoroughly explore, with the diamond drill, their lands in the immediate vicinity of the quarry.

The product of the quarry since its opening has been as follows:

YEAR.	CUBIC FEET.
1869	26,300
1870	37,640
1871	56,000
1872	53,000
1873	53,000
1874	48,000
1875	37,300
1876	55,000
1877	59,000
1878	34,290
Total	459,530

Adjoining the Marquette Brownstone quarry is the Burt Freestone quarry, from which has been produced about 6,500 cubic feet of commercial brownstone; but the quarry is now idle.

THE L'ANSE BROWNSTONE QUARRY.

This quarry is situated about one and three fourths miles northeasterly from L'Anse, on the east shore of L'Anse bay and possesses many natural advantages that could hardly be more desirable. The first work was done on this location in September, 1875, by T. T. Hurley, Esq., of Marquette, and a little later in the season the above company was organized, with T. T. Hurley, president and general manager. John J. Graham, secretary, and Hon. Ed. Breitung, treasurer. Mr. Hurley continued the development of the property, and in the spring of 1876 constructed substantial crib docks, ballasted with rubble or waste rock. The docks are conveniently located abreast of the quarry, a tram road is laid along them, and everything is so arranged that by means of derricks the large blocks of sandstone are swung directly from their beds and loaded on the tram cars, or, when desired, are stored away to one side ready for future shipment. At the end of the dock other derricks are erected to transfer the stone from the cars to the vessels.

The first shipment of stone, consisting of ten tons, was made to Chicago by rail in march of 1876, while the entire product of the quarry for that year amounted to 8,500 cubic feet; in 1877 the product was 10,000 cubic feet. The present (May, 1878.) working face of the quarry is about one hundred feet from the water's edge. The thickness of the bed varies from four to fourteen feet, and is seven hundred feet in length. The stone has a rich brown color, and is very even in texture. The upper portion of the bed is, frequently, slightly banded with light grayish layers, alternated with brownish ones. Some portions of the bed are somewhat mottled with pale greenish-gray spots of from one-eighth to three-fourths of an inch across; no difference, however, can be detected in the hardness of these spots and the material which encloses them.

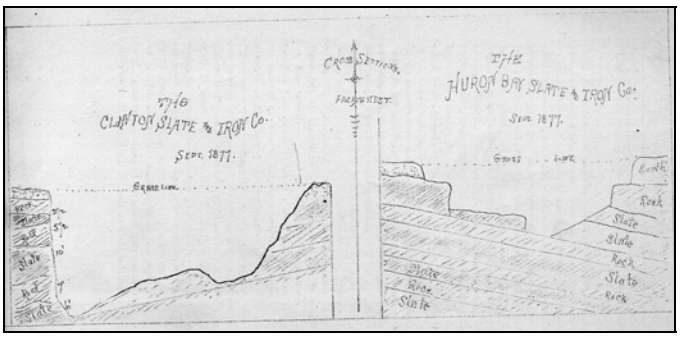
It appears that the only difference consists in the color, which, in all probability, is due to .the unequal oxidation of the protoxide of iron; that is, it is possible that the entire bed was at one period of a much lighter shade than it is now. I am inclined to believe that the contrast in color between the spots and the ground mass will gradually lessen on exposure.

The formation in which this brownstone occurs belongs as before stated, to the Potsdam period, and the stone being horizontally bedded, enables nearly perfect blocks of almost any desired size to be obtained; as for instance, a block was taken from the main bed and practically perfect in every respect, of which the dimensions were 34 feet in length 12 feet in width and 10 feet in thickness.

It is the intention of this company to increase their facilities and endeavor to do a much larger business in the future than they have heretofore done. The shipments are:

YEAR.	CUBIC FEET.
1876	8,500
1877	10,000
1878	10,300
Total	28,800

As the matter of building materials is one of large public interest, it is a subject of much congratulation that we have within the borders of our own state an article of such surpassing beauty and excellence as our brownstone is shown to possess. It has been spoken of every where, by those competent to judge and whose business it is to know the quality of building material, in terms of the highest commendation, and in no particular has it met with adverse criticism. Mr. Hurley, of the L'Anse quarry, has in his hands a large number of letters from leading architects and builders in Chicago, Detroit, and elsewhere—all of whom, unqualifiedly, pronounce it to be one of the best brownstones in the market, as being nearly if not wholly exempt from defects—as having a uniform color, a close fine grained texture—easily cut, carved or sawn,—and as capable of being procured in as large size and as perfect form as any which the country affords.



SLATE.

In the general sense of the word, slate occurs in several horizons of the Huronian series, as has been already noted in the chapter on the geology of the iron bearing rocks. In the Marquette district it is chiefly confined to formations V. and IV. and constitutes formation XV. The latter approches nearest in quality to a roofing slate, but as far as my own observation goes, within this district, it contains too much of iron pyrites, even if the cleavage were perfect, to fulfill the requirements of merchantable slate. In the Huron Bay district, however, slate fully equal, if not superior to, the best eastern slate, has been found, and is now produced at two quarries which are described in detail further on. The slate formation in these quarries forms a wide belt, and extends over a portion of the Huron Mountains. It consists of several strata, or narrow beds, of good slate and slate rock. The cleavage, or splitting planes of the slate, dips very uniformly to the south; but the natural bedding is in broad anticlinal and synclinal waves, which have a trend of nearly east and west, and a consequent dip to the south or north as the case may be. The building planes are very plain, still, an expensive error was made, at one of the quarries at their opening, in mistaking the cleavage for the bedding. Our present state geologist. Dr. C. Rominger, who made in his official capacity a personal examination of this mine, also failed to distinguish between the bedding and cleavage planes, as appears in his state report for 1876, page 163. This structure may be readily understood by reference to the diagram on the opposite page, and its importance from a scientific as well as an economic stand point can be easily appreciated. It will be noticed that the formation in the Huron Bay quarry dips about 15 degrees to the north, while the cleavage pitches about 30 degrees to the south. In the Clinton quarry the cleavage is the same, but the bedding is about 12 degrees to the south, or very nearly conforms to the cleavage. If the strike of the Huron Bay were extended westward it would pass about 450 feet north of the Clinton quarry. This gives us an anticlinal wave between these quarries. It is hardly possible, however, with our present data, to correlate the beds of the two quarries. The above named companies are the only ones which have thus far shipped any slate, though several others have been formed and considerable exploring has been done.

THE HURON BAY SLATE AND IRON COMPANY,

This property is located in T. 51, R. 31, and embraces altogether some 1,100 acres of land which includes that of the quarry now worked. It is situated on the S. W. ¼ of the S. E. ¼ of Sec. 28.

The company was organized Nov. 2nd, 1872, with W. L. Wetmore, president; M. H. Maynard, secretary and treasurer; John J. Williams, agent, and John Thomas, sup't. During the fall of 1872 preparatory work was begun, and in the following spring actual mining commenced. A three foot tram road of four and one-half miles was constructed down to Huron bay, and a dock was built at this point extending 600 feet into the bay. Along the outer-end of the dock is some 14 feet of water, sufficient to enable the lake steamers to load directly from the dock. At the quarry location (July, 1877,) are several substantial buildings, and everything is in very fair "shape" to do a large and profitable business; what appears lacking is want of sufficient ready capital to make this one of the leading interests of the state.

The slate formation, as developed here, as before stated, (see diagram) dips 15 degrees to the north, and the strike is N. 85° W.; but on the other hand the cleavage planes of the slate dip 25 degrees to the south. The upper slate bed is about 13 feet thick; then comes a layer of poor slate 4 feet thick, and under this is another bed of slate 7 feet thick, then a poor bed of three feet, and underlying this again is still another bed of slate 4½ feet thick; this is as far down as they have explored the quarry.

The quality of the slate, as has been already remarked, is of the very best; it comes out in large jointed blocks, and is easily cloven into as thin slates as are required. One slab 36 by 18 inches and 4 inches thick split into 29 perfect slates, which presented a very even face, free from any corrugations or scales. At the company's office in L'Anse they have on exhibition a much larger slab than this one, split into equally as thin and perfect slates. They have also some very handsome tiles which have been planed down to show the adaptibility of the slate to mantles, table tops, &c. The color of the slate is a rich unfading bluish black. It is very tough and gives forth a metallic ring when struck.

The company shipped previous to 1878, 5,100 squares and during 1878, 1,535 squares.

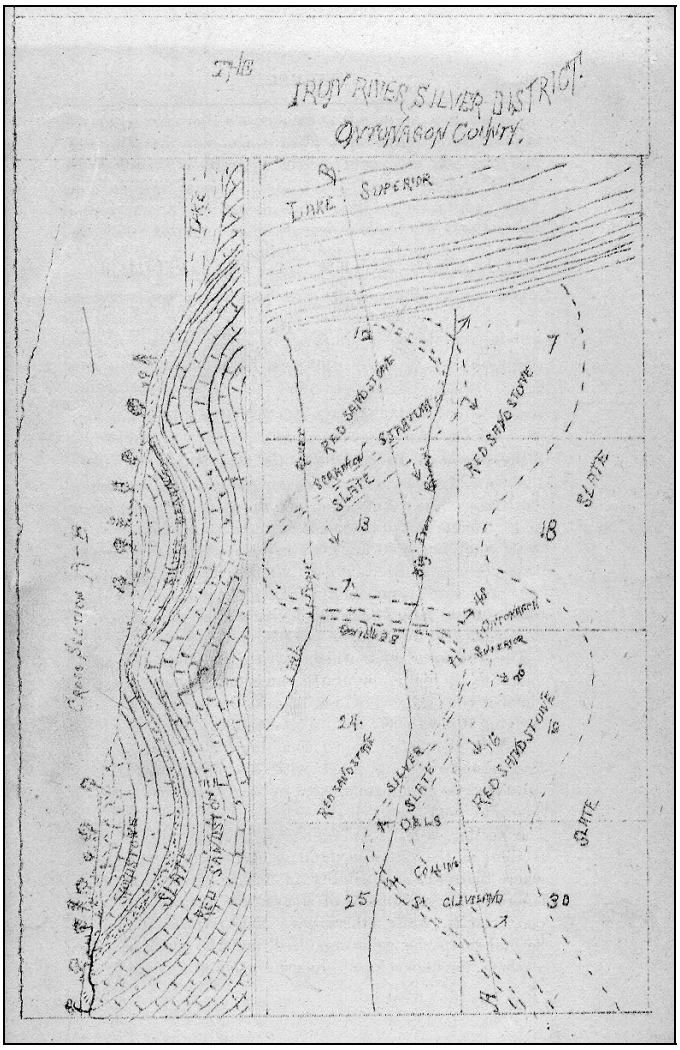
CLINTON SLATE AND IRON CO.

This quarry is situated 1,600 feet west and 300 feet south of the Huron bay quarry, and is on the N. W. ¼ of sec. 33, close to the section line.

The officers of this company are .Dewitt C. Wheeler, president; Jas. H. Seager, secretary and treasurer, and E. E. Williams, superintendent. The first work was done at this location in August, 1874, but no shipments were made that year. The slate is very similar to that in the Huron bay quarry. The formation, as already noted, dips about 12 degrees to the south, and the cleavage a few degrees more in the same direction; (see diagram). The manufacture of slates is a very interesting operation, and the various manipulations though apparently simple, require considerable skill and good judgment to reduce the waste to a minimum. The quality of this slate is essentially the same as that of the Huron bay quarry.

The shipments from the quarry have been as follows:

YEAR.	SQUARES.
1875	405
1876	1,045
1877	1,034
1878	600
Total	3,084



THE IRON RIVER SILVER DISTRICT.

Is situated on the south shore of Lake Superior, about ten miles west of Ontonagon. The rocks, as exposed along the Little and Big Iron rivers, are sedimentary, and consist chiefly of alternate beds of brown sandstone, argillaceous and arenaceous slates. The structure is very simple and easily made out. It appears that these once horizontal strata have been buckled up or rendered

wavy by lateral pressure along a north and south line, and that the subsequent uplift of the Porcupine mountains has tilted them, thereby giving the formation in addition to its northerly or southerly dip as the case maybe, a general pitch to the east, while later erosion from glacial action and other abrading forces have worn away the upturned edges of the strata, affording, as we can readily imagine, the serpentine like course of the various beds as they appear upon a sketch of this district on the opposite page.

The stratum of rock which carries the silver is a gray quartzite, or highly indurated sandstone. Overlying this member is a dark colored argillo-arenaceous slate, and underlying it is a heavy bed of brown sandstone. The silver occurs in the native form; sometimes it is deposited in thin seams or joints filled with a chloro-plumbaginous substance, or it is disseminated in the ground mass of the quartzite, and again it is seen in the overlying slate. During the season of 1874, great activity prevailed in this section; all the vacant government lands near this locality, where there was a possibility of finding silver, were soon entered. Large numbers of assays were made; many with poor results, while others gave rich returns in silver. Several companies were organized, and the stock of some of them, for undeveloped properties, sold at a high figure. A small stamp mill was erected at the mines, and three or four mill tests were made with, apparently, good results. At the mouth of Big Iron river a town site was laid out and the lots were held at fancy prices. Some harbor improvements were begun, and everything for a time promised well. Silvery visions seemed to cloud the intellect of some of the more sanguine, thereby seriously affecting their better judgment. Stress of hard times, however, soon brought them face to face with stern reality; then came the reaction which is always sure to follow a period of great excitement. To day, the timid deer browses undisturbed among the small clearings made by the different companies.

GANISTER OR QUARTZITE.

This material is used for the lining of Bessemer steel converters, and similar purposes. Formerly it was imported from England, but now our Lake Superior quartzite* has been found fully equal to the best English article.

During the past two years several thousand tons have been quarried. Eventually, however, when the requirements of the consumer are fully understood, there can be no question but what we shall see established in this new industry a large and profitable business.

The shipment of quartz in gross tons, by different parties, are respectively as follows:

Years.	Lake Fairbank Co.	Carp River Iron Co.	R. P. Travorse.	Totals.
1873	718	.....	.....	718
1874	954	.....	.....	954
1875	2,320	.....	.....	2,320
1876	1,048	664	.....	1,712
1877	379	1,051	1,281	2,711
1878	2,443	3,101	.....	5,544
Totals	7,862	4,816	1,281	14,959

*See page 12.

MARBLE.

Northeast of Ishpeming, about three and one-half miles, is a series of sharp ridges composed of serpentine, marble, magnesian schists, greenstones and quartzite, which have nearly an east and west trend. The ridges of serpentine and marble have been traced for three or four miles, and the former is, no doubt, the equivalent of that at Presque Isle, some fifteen miles to the easterly. The idea of applying these marbles and serpentines to economic purposes is largely due to J. Ropes, Esq., who, with his characteristic energy, has collected and polished several specimens of these rocks to illustrate their many excellent qualities.

This fall (Nov., 1878,) in company with Mr. Ropes, I made a hasty examination of the locality. The points we visited were within the south half of the northwest quarter of section 29, T. 48, R. 27. Proceeding at once to the west side of the section we found there a sharp ridge, presenting on its north side an abrupt face forty feet or more in height, of massive serpentine. The ledge is strongly jointed and apparently free from minor checks or sub-joints, and I should judge that perfect blocks of any desired size could be obtained. On close examination the veining on the smooth, weathered face of the bluff is plainly visible; but to "bring it out" fully the surface requires to be polished. It presents then all the imaginary shades of green, varying from a deep greenish black to a pale pea green or greenish white. The darker green, often semi-translucent, forms the rich back ground of the polished surface, which is beautifully mottled and enriched by delicate moss-like tracery of the lighter shades, and the entire surface is then rendered mosaic by irregular veins of greenish white marble traversing the rock in every direction, and even then, as if nature were not satisfied, to enhance the pleasing effect still more, are minute veinlets "shooting out" from the larger ones, which, in their branchings, finally disappear, blending imperceptibly with the dark back ground.

Farther to the east the ridge becomes broader, and there rises up on its north side a ledge of very handsome variegated marble breccia. The outcrop is a large one and promises well. The colors of the breccia appearing on the polished surface are white, yellow, brown, purple, drab and blue, with numerous shades of these producing indescribable combinations. The polished specimen in hand is traversed by a large vein of coarsely crystallized

marble, and in the vein are strewn angular fragments of the colored base of the rock. The rock resembles in many respects the famous *Breche Herculaneum* from Belgium. A little farther east is another large outcrop of serpentine marble, which is very similar to the celebrated *Vert Maurin* from Grenoble, France. It is slightly mottled, and is thickly veined with white and pale green marble. There is a certain parallelism to the veins which is very apparent when viewed at a distance.

Continuing east we pass another ledge producing a variety of marbles. One, particularly noticeable, has a sort of a wavy appearance from fringy-like colored rows of shades of green and yellow. It is an odd looking specimen. The most easterly ledge we examined was a large outcrop of dolomitic marble. It is massive and apparently very free from seams. The polished specimen is beautifully clouded and mottled with the various shades of grayish white and light drab; it is also traversed by white veins of coarsely crystallized marble, which often contain small concretions resembling fossil remains.

Another specimen, taken from a low ledge just east of here, is very attractive. It has a very rich dark green color, sprinkled with fleecy clouds of a little lighter shade; it is also veined with branching veins of pale green, and others of bright glistening seams of copper colored penninite, which latter sometimes has a soft silken lustre. The specimen takes a high polish. These are only a few of a very large number of different specimens which Mr. Ropes has collected and polished from this locality, and it would seem that his cabinet represents nearly all the possible varieties of serpentine marble, and the quantity appears to me to be "practically" inexhaustible. It is one of our infantile industries, and like our slate, sandstone and other partially developed interests, will sooner or later win its way into public favor.

Since writing the above, I learn that Mr. Robert Nelson, of Ishpeming, so well known as the pioneer of many successful enterprises, has taken an interest in this marble, and no doubt in our next annual report we shall have something more definite to chronicle.

GYPSUM.

The determination of the origin, qualities and extent of the plaster deposits of Michigan is a scientific problem which possesses much geological interest and great economic value. The utility of ground plaster in promoting the growth of important agricultural products has become so well understood and accepted by American farmers, that it is no longer a subject for argument. It is consistently believed that by its free and general use the original fertility of our soils may be maintained and even increased and rendered, constantly, more and more productive, a result which within our present experience would not be possible, without it. Agriculture, the chief industry of our state and, hence the prosperity of the entire commonwealth, is so greatly promoted by the application of this fertilizer, that it becomes a matter oil general importance that its value be everywhere understood, and its ready distribution be provided for; and well may we congratulate ourselves that we have within our own state inexhaustible deposits of this important material, accessibly located, and possessing, as experience has proven, the requisite fertilizing qualities, and also the properties which have brougth it very largely into use for the purposes which the finer grades of gypsum are used, especially as stucco. At Grand Rapids, the gypsum occurs in horizontal deposits from forty to seventy feet below the surface, and extends, in the vicinity of Grand river, over an area of ten or twelve square miles.

No person visiting Grand Rapids can fail of being pleased with the substantial character of the improvements found at the plaster quarries of the older and larger companies; the convenience of the arrangements for carrying on the work with facility and economy, and the general care and system which evidently prevails in the conduct of the business.

The two oldest of the present companies are the Grand Rapids Plaster Co., and the firm of Godfrey & Bro. At the works of the former the quarry is all underground, and is entered through a gently inclining shaft, up through which the product is drawn in cars into the building where it is crushed and ground, and thence carried in conductors to the department for calcining or into the loom for storing land plaster. On being brought into the building and before going into the crusher, the material is carefully assorted and all flinty or otherwise impure product is rejected; the grayish colored rock is selected for calcining, and the lighter colored for grinding into land plaster.

There is no practical difference in the fertilizing value of these different kinds of plaster; the choice being determined by the hardness and grit, properties essential to suitable stucco plaster. There would seem to be very little necessity or inducement for using worthless material in the manufacture of either land plaster or of calcined plaster; for the product, as it comes from the quarry, is remarkably free from extraneous rock, and the deposits are of such unlimited extent, and so easily mined, that there could be but little gain in using the impure rock; besides the difficulty of grinding the flinty or slaty material as compared to the soft gypsum, would occasion a degree of injury or increased wear of the mill stones, that it alone necessitates care in assorting.

The quarry of the Grand Rapids Co. is quite dry; the only water in the underground workings that finds entrance is down the incline shaft at times of rain, or from the melting of snow; but this is drawn off into a sump, and thence is pumped out of the mine as occasion demands. The roof is supported by pillars of gypsum, which are left at about seventy feet apart, and intermediate timber supports are put in so as to realize perfect safety.

Tram-way tracks extend in all directions as required, and the cars which run over them to convey the material to

the surface, are drawn by mules; light is furnished by gas, which is manufactured in the quarry from gasoline and conveyed to points required in rubber tubing. About eighteen barrels per year of gasoline are used in this quarry for the purpose of lighting and they are kept, for safety, in tanks filled with water. The depth of the workings is ten or twelve feet, the whole thickness of the deposit not being worked out, leaving the roof and floor of the same material.

In other quarries in this vicinity the deposit is stripped, the large amount of superincumbent drift being first removed, and the gypsum openly quarried.

The quarries are provided with railway side tracks and docks for conveying away the products by cars or boats.

At Alabaster, in Iosco county, on the east side of the state, the gypsum deposit is exposed in a bluff contiguous to the waters of Lake Huron, and the plaster rock is readily transferred into vessels for transportation to distant points to be ground and prepared for use.

That these deposits are extensive is well known, and their economic value can scarcely be overestimated; but their origin is a matter which has not yet been determined; as they are associated with the salt, it is generally supposed, as is the case with the gypsum deposits in England and elsewhere, that they were originally great salt basins, subsequently changed into their present character; but they are facts which lead one to conjecture that they may have been deposits of carbonate of lime, that have been altered, through chemical action, into sulphate of lime. Possibly a thorough geological examination of the localities, with the aid of borings carried down to a sufficient depth at suitable points, would lead to a satisfactory determination of this interesting subject; as elsewhere stated, it is hoped that proper attention may be given to it at some future period.

It is difficult to ascertain, with absolute certainty, the annual product of the quarries for past years, as some who have been engaged in the work have kept but meagre record of the results of their operations. Considerable pains have been taken to render these statistics as accurate as possible, and they are doubtless as reliable as can be obtained under the circumstances. The business of calcining plaster was of small importance prior to 1870; but, a few years subsequent to the Chicago fire, it assumed large dimensions, ending in 1873-74, 100,000 barrels for each year; the Grand Rapids Co., and Godfrey & Bro., each making nearly 40,000 barrels—since then, however, the business has fallen off, so that these parties now make but about 10,000 barrels each.

The total number of tons of land plaster for the State, since 1860, a period of eighteen year, is probably 500,000. Of calcined plaster, 700,000 barrels of 300 pounds each. These estimates are based upon the actual production of a few of the oldest companies, taken from their books particularly those of Messrs. Godfrey & Bro. and Win. Horey, agent of the Grand Rapids Co., the two oldest of the companies, the latter having been organized in 1860—previous to this time the annual out-put was very light. The total product of the Grand Rapids Plaster Co. since 1860 has been 200,140, tons of which 132,900 tons were land plaster, and the remainder calcined plaster. The firm of Godfrey & Bro., organized in 1863, has done the next largest business, amounting to nearly the same as the Atlas Company. The present plaster companies in the state are as follows:

Grand Rapids Plaster Co., Win. Harvey, Agent, Grand Rapids, Kent County, Mich. Godfrey & Bro., Grand Rapids, Kent County, Mich. Geo. H. White & Co., Grand Rapids, Kent County, Mich. Taylor & McRengolds, Grand Rapids, Mich. Day & Taylor, Grandville, Kent County Mich. Union Plaster Mills, Grandville, Mich. Smith, Bullard & Co., Alabaster, Iosco County, Mich.

The total product for the past two years are as follows: 1877, land plaster 40,000 tons, calcined plaster 50,000 barrels. 1878, land plaster 75,000 tons, calcined plaster 50,000 barrels.

MICHIGAN SALT.

S.S.GARRIGUES, Ph. D., STATE SALT INSPECTOR.

HISTORICAL.

It is not proposed to enter upon an exhaustive history of this, one of the great Michigan staples, but as salt forms one of the leading factors in our commercial relations and interests as a state, a brief historical compendium will be in keeping with our subject. The first discovery of the great salt deposit of Michigan is hidden in obscurity, but it is a well established fact that its presence was well known to the Aborigines of the country long prior to the earliest settlement by the whites. Salt springs abounded upon the Lower Peninsula from which the Indians obtained their supplies of salt, which fully established the existence of a great, natural salt deposit, principally located in what was known as the Saginaw Valley, but whether in the form of rock salt or reservoirs of brine, was a mooted question with those whose attention had been early turned to the subject. Still, in view of the presumed value of the undeveloped salt springs, the general government made numerous reservations of lands, embracing within their area the supposed salt deposits, which even at that early day had created such interest in their development that it is a matter of record that successful attempts to manufacture salt in Michigan had been made many years before Michigan had been organized into a state government. This wise action on the part of the government was perpetuated by the provision in the act of admission of Michigan into the Union in 1837, by which the state authorities were permitted to select from the various salt reservations seventy-two sections of lands which embraced within them the best portions of the then known saline springs in the then territory.

The wisdom of this action was more fully understood and appreciated when the late, lamented state geologist, Dr. Douglass Houghton, was appointed by the first Michigan legislature in 1838, and who in his report at a subsequent session of the legislature recommended strenuously the immediate selection of the spring lands by the state, and following his instructions he at once proceeded to thoroughly survey the salt indications as observed on the Grand and Tittibawassee Rivers, in Kent and Saginaw counties, and also continued his researches and surveys in .the counties of St. Clair, Macomb, Wayne and Jackson. In this Dr. Houghton met with a measure of gratifying success.

Still, though public attention had thus been called to the mine of saline wealth possessed, and while practical experiment and investigation looking to the rapid development of this important commercial interest had received a forward. Impetus from the report of Dr. Houghton, these experiments failed of perfect success in the subsequent death of the learned geologist who had given so much of his time and scientific attention to the salt interests of Michigan, thus depriving the state of one in whom implicit reliance had been placed to give intelligent direction to these experiments and enterprises—a loss which for a time discouraged further action in their development.

But where Dr. Houghton laid down his burden of investigation and research in this particular, other investigators took it up and became so fully satisfied of the existence of abundant reservoirs of saline waters in our state that they at once determined to extend their experimental re searches still further, resulting in fully demonstrating in the most satisfactory manner the entire truth of the theories advanced by Dr. Houghton and others.

Especially was this the case in the Saginaw Valley, then becoming prominent as a good objective point for the capitalist and laborer. Encouraged by the favorable report of the state geologist, borings for brine were begun in various localities, and the most gratifying results obtained in the superior strength and purity of the brine produced; the borings have been continued, or rather extended in the later wells, to the geological formation embracing other groups of rocks much older and lower than any previously reached, viz: The "Onondago salt group," or rather the group in this state, so represented in the state of New York, and while, up to this writing, the results obtained may not have sufficiently established its productiveness, still sufficient encouragement has been had to fully establish the fact that this "group" may yet yield such an inexhaustible supply of salt as to render them a source of profit to the enterprising operators, and an augmented addition to the wealth of the state.

The field of abstruse speculation might tempt the curious in striving to elucidate the problem of the actual configuration of the salt reservoirs underlying the Lower Peninsula of Michigan. Whether these vast subterranean saline lakes are intimately connected with each other by arteries and veins, causing depression or increase in the located bulk of each, or whether the salt rock is the source of supply moistened in the secret laboratory of nature by the percolation of surface drainage, or otherwise, are points which must remain, for the present, sealed from the gaze of the interested scientist. We but know that the great depositories for brine thus far discovered in Michigan are located in the Michigan salt group, with the associated sandstones, particularly in what is known as the "Waverly Group." Also, is it undetermined to what extent these depositories extend in which brine may be found in quantity and quality sufficient to repay the cost of manufacture. With this fact in view, it is to be sincerely regretted that the wise provisions made by the state legislature some years ago to fully ascertain this much desired point, has not been made available in the collecting of the records of the various borings throughout the salt bearing portions of the state. It is to be sincerely hoped that this grave omission may yet be rectified, so all the *data* possible may be preserved for future calculation and reference.

In regard to the full extent of the salt territory of Michigan, speculation need not greatly err. Arguing from simple analogy, we are led to the conclusion that those portions of the group of rocks showing the greatest depression below the level of the lakes are found to possess the superlative in the character of the brine produced. Actual experiment has proven this to be the case, and the regions over which the Saginaw valley extends are found to be the territory where the greatest depression is had. In the work of boring, a depth of over 1,000 feet, below the level of the lakes has been attained before reaching or passing through what is known as the Michigan salt group from which our brines are obtained. In accordance with this theory we find that the salt wells of the Saginaw valley are found to produce a brine of greater specific gravity than any other portion of the state.

When we state that the supply of brine thus produced is illimitable, where these depressions are found, we speak from actual knowledge. With each new well is found a full supply, and while some slight fluctuation in quantity and strength is discoverable, still this is but temporary in character. The same rule will apply not only to quantity but to quality, and no better illustration of the fact can be had than in the report of the committee of the New York legislature, which, as a commission to investigate the salt interests of Michigan, visited the Saginaw valley in 1868. The commission, on pages 21 and 22 of their report, truthfully says, "it is only by chemical analysis that the value of brine can be determined. All the brines used in the manufacture of salt this side of the Mississippi river, with one exception, are more or less loaded with impurities which must be removed or the salt is valueless."

Further reference will be found in this report, to the higher value of Saginaw brine; and experience has taught that the best quality of salt can be made from

Michigan brines; and, further, that a large proportion of Saginaw salt sold in the market, is as pure, as efficient, and as antiseptic as any mined or manufactured, either in our own, or in foreign countries.

This leads us to note more at length the process of

SALT MANUFACTURE.

There are two modes of salt making: one is the evaporation of the brine by artificial heat, the other by solar evaporation,

SOLAR SALT.

Solar salt at Saginaw, as at Syracuse, is made by evaporating the brine in shallow wooden vats, which affords a salt much purer and cleaner than that made in vats dug in the ground. A salt cover is 1.8 feet square and 6 to 8 inches deep, and gives an annual product of fifty bushels. The solar process is a very simple one. Late in the month of March the brine, which has remained in the vats during the winter, is withdrawn and everything cleaned and put in order. The vats are kept partly full of brine during the winter to preserve them from the action of the frost, while the drippings prevent the ground from freezing so hard as to force the supporting posts out of position. As soon as the sun begins to have sufficient power, the brine is run into the innumerable wooden vats from the reservoirs. Each vat is provided with a roof, which may be moved backward or forward on a moveable stage, so as to protect or expose the water as the weather may render desirable.

The brine is required to remain in the vats from six weeks to two months to evaporate according to the number of sunny days. The salt covers produce three crops of solar salt during the year, the middle crop being the largest and most valuable. The first crop is gathered about the middle of July, the second in September, and the third, the last of October. Solar salt, is of exceeding coarseness in its granulation and this coarseness gives it increased value. The pork and beef packers prize solar salt highly, as, in consequence of its coarseness, it prevents the meat from packing too closely and permits a free circulation of the pickle.

For manufacturing salt by artificial heat, three processes are used, known as the kettle, pan and steam process.

KETTLE SALT.

A kettle salt block, properly speaking, consists of fifty or sixty kettles, and the stone or brick work in which they are set. The kettles are set in two rows, over two arches, reaching from the mouth of the furnace to the chimney. These arches are close together, merely a dividing-wall separating them, and the kettles are set close together in each row. Each block is housed under a building from 75 to 100 feet long, and about twenty feet high in the center, with sheds on each side containing bins for depositing the salt as made. The salt after remaining in these bins fourteen days, for complete drainage, is packed in barrels for market. When the works are in operation, an engine is kept running for the purpose of pumping and forcing it in pump logs to the cistern near by. From these vats another set of pump logs carries the purified brine into the block house and along the top of the brick work between the two rows of kettles, and from which a spout extends over each, kettle. After a kettle of brine is boiled a short time, the crystals of salt commence forming on the surface and fall to the bottom. When the quantity of brine is boiled down to about one-third, the salt is dipped out with a long handled shovel and thrown into a basket which, is placed over one side of the kettle where it remains for drainage. The bitter water is thus drained off, carrying with it all other impurities. A thorough drainage is considered one of the most important points in this mode of the manufacture of salt.

STEAM SALT.

In the steam process, the brine is pumped into the outside cisterns where it is settled as in the kettle process. From here it is drawn into the inside settlers, which are wooden cisterns from 100 to 120 feet long by 8 feet wide and 6 feet deep and strongly keyed together.

The brine in the settlers is heated by three or four steam pipes, and, after being brought to saturation, it is allowed to rest for a few hours so as to insure a perfect settlement of the impurities. At the proper time this purified brine is drawn into the grainers, they being filled to about two-thirds their capacity. The length of these grainers is from 100 to 120 feet, ten to twelve feet wide, and twelve or fifteen inches deep. These are heated in the same way as the settlers, the steam being carried through by galvanized iron pipes, all being controlled by steam gates. As the purified brine comes into these grainers quite warm and fully saturated, it soon commences to make salt, which forms on the surface and falls to the bottom, when a new lot of crystals are formed to fall in the same way. Thus the evaporation continues until enough of the brine is evaporated. During this time the brine is occasionally stirred so as to make the crystals fine. As soon as the brine is sufficiently evaporated, the bailers commence the lifting of salt. This is done by first washing the salt thoroughly in the brine that is left in the grainers, and taking it out with shovels and throwing it upon the draining boards, where it remains for a number of hours for drainage, a large drain completely filling the boards. From the drain boards it is taken to the bins in the packinghouse where it remains for fourteen days for complete drainage. It is then packed in barrels, weighed and branded if of prime quality, and by the inspectors branded as "fine salt."

PAN SALT.

A pan block is a building of a size to properly cover the settler, pan and packing rooms. The brine is either settled cold or hot, it being a great advantage to have the brine in a saturated condition before it is drawn into the pans. These pans are either set in double flues,

running to smoke stack, or are made wider when the flues are built to return—the heat in this way being greatly economized. The fire being applied directly to the bottom of the pan, the evaporation of the brine is very rapid, and the salt makes continually and requires to be drawn out upon the draining boards constantly. This process has great economy and, where there is no exhaust steam from a mill, is the most practical process. The grain of salt made by this method is very fine.

Since the discovery of salt in the Saginaw valley, and the organization of the first company in 1859, wonderful, changes have taken place, not only in the mode of manufacture, but in the general conduct of the business. The discovery of salt gave an impetus to trade; and the growth of the valley cities, during the few years following, was more rapid than during any previous or subsequent years. Immense capital was invested in salt manufacturing operations, and the business of the first few years was more of a speculative character than of a substantial nature. The more systematic methods of manufacture in vogue at Syracuse and other salt manufacturing points, the lack of uniformity of the grades of Saginaw salt, and other causes began to tell against us. Even at the price of salt ruling previous to 1870, many found the business unprofitable and block after block was abandoned.

Our manufacturers, however, profited well by the experience of the first ten years and turned it to a good account in several ways. The process of manufacture was materially cheapened by dispensing with the item of fuel and utilizing the exhaust or surplus steam from the saw mills. Kettle blocks have fallen into disuse, and steam and pan blocks have taken their place. The law for the uniform inspection of salt went into effect in 1869, and has been rigidly enforced. From $1.50, which was originally estimated as the cost of making a barrel of salt on the Saginaw river, the cost has been reduced to 50 or 60 cents—some manufacturers asserting that they can place their salt on the dock for shipment at 40 cents. This, however, will not include the cost of repairs, insurance or interest on the investment.

MODE OF MANUFACTURE.

The following table shows the method of manufacture and the amount manufactured during the past nine years, by each method. It will be observed that there is a large decrease in the amount manufactured by the kettle or boiling process, and a large increase in steam. Solar evaporation about holds its own, the quantity, in a measure, being regulated by the favorableness of the season.

	Kettle.	Pan.	Steam.	Solar.
1869	333,093	42,000	126,701	15,294
1870	301,901	56,430	225,142	15,307
1871	290,559	68,080	330,102	37,645
1872	322,700	65,800	425,920	21,461
1873	192,250	127,700	471,198	32,257
1874	181,200	130,500	695,888	21,391
1875	117,000	199,100	741,629	24,336
1876	177,400	341,000	910,182	24,418
1877	182,500	373,642	1,080,646	22,946

STATISTICS,

Salt operations in. the Saginaw valley were first commenced in the year 1859. Through the influence of Geo. A. Lathrop, M. D., the East Saginaw Salt manufacturing-company was organized in April of that year, and commenced operations in May following; first well, completed in March, 1860. First salt made in July, 1860. The following table shows the strength of brine obtained from this well, at various depths:

At 90 feet	1 degree.
At 102 feet	2 degrees.
At 211 feet	10 degrees.
At 212 feet	14 degrees.
At 487 feet	26 degrees.
At 516 feet	40 degrees.
At 531 feet	44 degrees.
At 559 feet	60 degrees.
At 569 feet	64 degrees.
At 606 feet	86 degrees.
At 636 feet	90 degrees.

The following tables show the amount of salt made in Michigan for 1877, and preceding years:

	BARRELS.
1860	4,000
1861	125,000
1862	243,000
1863	466,356
1864	529,073
1865	477,200
1867	407,077
1868	474,721

Amount and quality of salt made in the state since 1869, when the inspection law went into effect:

	Fine.	Packers'.	Solar.	2nd Quality.	Total.
1869	553,189	12,919	15,246	10,117	591,988
1870	568,326	17,369	15,307	19,659	621,361
1871	655,125	14,677	37,645	19,930	726,176
1872	672,934	11,110	21,461	19,856	725,481
1873	740,702	23,671	32,257	20,706	825,346
1874	969,257	20,000	21,391	16,742	1,026,970
1875	1,027,886	10,253	24,336	19,410	1,081,905
1876	1,402,410	14,253	24,418	21,668	1,462,729
1877	1,520,841	20,858	22,946	26,249	1,660,897
Total for nine years					8,891,831
Previously manufactured					3,278,117
Aggregate to Dec. 1, 1877					11,969,938

The State inspector's report for 1877, also shows the following statistics in reference to the salt manufacturing business of the State:

	No. Companies.	No. Kettle Blocks.	Steam Blocks.	Pan Blocks.	Salt Covers.	Capacity.	Manufactured.
District No. 1	14	9	10	32	500	250,000	185,467
District No. 2	10	32	8	32	.....	250,000	138,555
District No. 3	9	32	8	32	.....	250,000	238,400
District No. 4	6	1	4	32	2,800	250,000	114,524
District No. 5	10	..	13	32	.....	300,000	247,954
District No. 6	10	32	8	1	500	250,000	328,300
District No. 7	9	32	8	32	.....	200,000	130,144
District No. 8	5	..	10	4	.....	150,000	145,895
District No. 9	2	..	..	32	.....	100,000	88,804
District No. 10	4	..	4	1	.....	100,000	44,796
	79	20	71	32	3,800	2,100,000	1,660,897

The districts are divided as follows: No. 1, East Saginaw, George W. Hill, inspector; No. 2, Saginaw City, V. W Paine, inspector; No. 3, Carrollton, James Hill, inspector; No, 4, Zilwaukie, John Haight, inspector; No. 5, Portsmouth and part of Bay City, W. R. McCormick,

inspector; No, 6, part of Bay City and Essexville, Castle Baker, inspector; No. 7, Salzburg, Wenona and Banks, W. R. Wands, Inspector; No. 8, Caseville, Port Austin, New River and Fort Hope, Huron County, J. Dwight Hill, inspector; No. 9, Sand Beach, White Hock, and balance of Huron County, J. M, Muldrock, inspector; No. 10, Iosco County, C. W. Gabrielle, inspector.

GRADES OF SALT.

The grades of salt established by the state inspector are as follows:

NO. 1 SALT.

Fine—In bbls. of 280 lbs. for general use and for all family purposes.

Packers'—In bbls. of 280 lbs. suitable for packing and bulking meat and fish, one of the finest and best brands of salt for such purposes In the market.

Solar—In bbls. of 280 lbs. when screened, branded C solar—C for coarse, and F solar—F for fine grades. The solar salt is equal in all respects to New York solar salt.

NO. 2 SALT.

Second Quality—All salt intended for No. 1 of any of the above grades, when condemned for any cause by the Inspector, is branded second quality, and sold as such. This salt is good for salting stock, hay, hides, etc.

WHO MAKE THE SALT.

Below is a full list of manufacturers, together with a statement of the amount of salt made by each during the years named. From this list it appears that a large proportion of the number are also engaged in the manufacture of lumber:

THE SHORE.

	1877.	1876.
Ayers & Co., Port Austin	37,419	35,427
Frank Crawford, Caseville	45,479	41,575
New River Salt Co., New River	19,976	14,279
Port Hope Salt Co., Port Hope	40,720	34,123
Jenks & Co., Sand Beach	47,083	7,067
Thompson Bro's, White Rock	41,276	40,465
J. L. Wicks Bro's, East Tawas	22,024	24,136
Oscoda Lumber & Salt Co., Oscoda	14,483	5,456
Emery Bro's, East Tawas	7,260	....
Pigeon River Salt Co., Pigeon River.	.....	11,948
Smith, Gratwick & Co., Oscoda	3,835	....
Total	279,555	214,476

BAY COUNTY.

Ayrault, Smith & Co.,	12,837	6,095
N. B Bradley & Co.,	37,047	31,329
Eddy, Avery & Co.,	53,574	49,103
H. M. Bradley & Co.,	18,885	18,415
Pitts & Crannage	23,376	31,746
Folsom & Arnold	22,918	19,358
Chapin & Barber	45,881	38,380
Dolson, Chapin Bro's	39,688	45,624
John McEwen	17,508	13,927
J. R. Hall	36,422	17,254
Carrier & Co.,	5,388	14,447
Atlantic Salt Co.,	3,536	3,234
Laderick Bro's	13,243	10,157
H. W. Sage & Co	65,609	65,480
W. H. Malone	22,522	16,702
Moulthrop & Lewis	12,491	18,396
Moore, Smith & Co.,	7,543	5,086
L. L. Hotchkiss & Co.,	34,278	24,832
Key Stone Lumber and Salt Co.,	11,047	6,719
Jno. McGraw & Co.,	51,133	45,217
Bousfield & Co.,	2,698	.....
A. Miller	35,536	65,967
S. McLean & Son	39,189	33,199
B. H. Webster	26,290	23,532
A. Rust & Co.,	29,008	30,681
Hay, Putman & Co.,	19,121	4,576
Wm Peter	18,933	15,786
North Western, G. & W. P. Co.,	.....	1,899
Long & Bradfield	.....	107
Total, Bay County	706,701	657,288

SAGINAW COUNTY.

W. R. Burt & Co.,	64,412	77,945
Jno. F. Driggs	17,648	15,140
E. F. Gould	21,449	19,042
Sanborn & Bliss	11,448	.....
H. B. Allen	10,493	7,898
Shaw & Williams	23,576	16,620
A. T. Bliss & Bro	57,467	55,175
H. P. Lyon & Co.,	17,542	7,647
T. Jerome & Co.,	18,780	20,848
William B. Mershon	3,722	911
Rust, Eaton & Co.,	25,639	22,272
Wylie Bro's	11,924	.....
Booth & Hickey	7,054	18,488
Sturtevant & Green	33,114	30,433
Conrad Kull	14,595	14,932
Barnard & Binder	21,958	17,479
George F. Williams Bro's	27,004	28,033
D. Hardin & Co., (new)	691	.....
Pearson & Son	8,951	.....
Swift & Lockwood	28,310	24,990
C. T. Brenner	3,088	3,813
Pearson, Wright & Co.,	34,338	25,570
Shimons Bro's	2,962	.....
Stephens Bro's	11,087	.....
Cook & Davis	3,263	1,311
George Rust & Co.,	20,157	26,220
C. & E. Ten Eyck	17,212	16,547
Remington & Co	14,787	.....
Burnham & Still	6,150	5,613
Eaton & Potter	5,754	7,483
Thompson & Camp	9,698	15,912
Warner & Eastman	20,056	11,164
Sears & Holland	27,169	31,060
A. P. Brewer	18,203	17,901
East Saginaw Salt Manufacturing Co.	39,318	27,727
H. Bischkie	3,381	2,585
Bundy & Yousman	4,994	14,721
Titterington & Co.,	5,187	6,254
Robert Conner	5,060	4,043
Champion Brown	.....	1,045
Oneida Salt & Lumber Co.,	.....	538
Rochester Salt & Lumber Co, (burned)	.....	586
Total for Saginaw county	674,641	590,976
Total for the State, barrels	1,660,897	1,462,729

BRINE ANALYSES.

Analysis of brines taken from salt wells on the Saginaw river and analyzed by C. A. Goesmann, Ph. D., the investigation being directed to ascertain their commercial value.

Gillmore well, Bay City. Depth of well 505 feet, brine 65° by salinometer.

Sulphate of Lime (Gypsum)	0.3961
Chloride of Calcium	0.5302
Chloride of Magnesium	0.4115
Chloride of Sodium (Salt)	15.2674
Water	83.3948
	100.0000

The above brine comes from the upper salt bearing sand rock.

Swift & Lockwood well, Saginaw City. Depth of well 860 feet, brine 86° salinometer

Sulphate of Lime	0.0983
Chloride of Calcium	2.6430
Chloride of Magnesium	1.0685
Chloride of Sodium (Salt)	17.5102
Water	78.6799
	100.0000

Long & Bradford's well, Banks Bay. Depth of well 774 feet, brine 95° salinometer.

Sulphate of Lime	0.0722
Chloride of Calcium	2.9611
Chloride of Magnesium	1.2612
Chloride of Sodium (Salt)	19.8595
Water	75.8460
	100.0000

These two brines, as the depth of the wells indicate, are from the lower salt bearing sand rock and are supposed to belong to the Waverly group. They are the representative brines of the Saginaw valley and are those that are most worked.

Analysis of brines taken from wells outside of the Saginaw valley. Ayres & Co.'s salt well, Fort Austin, Huron county, Mich. Depth of well 1198 feet, brine 88° salinometer.

Sulphate of Lime	0.0109
Chloride of Calcium	3.1274
Chloride of Magnesium	1.5675
Chloride of Sodium (Salt)	17.6161
Water	77.6761
	100.0000

This well, with those at Caseville, Oscoda and East Tawas, shows a marked increase in the earthy chlorides and come from the lowest portions of the Waverly group.

Analysis of brine taken from the Thomson & Bro. salt well, at White Rock, Huron county, comes from another saliferous horizon. Depth of well 556 feet, brine 98.5° salinometer.

Sulphate of Lime	0.2622
Chloride of Calcium	0.5373
Chloride of Magnesium	0.4106
Chloride of Sodium (Salt)	18.9134
Water	79.8764
	100.0000

ANALYSES OF SALT.

Kettle salt made by the East Saginaw Salt Co. Analyzed by Dr. C. A. Goesmann.

Sulphate of Lime	0.3165
Chloride of Calcium	0.3564
Chloride of Magnesium	0.1408
Moisture	3.3441
Chloride of Sodium (Salt)	95.8422
	100.0000

Pan salt made by the Bay City Salt Co., Bay City. Analyzed by S. S. Garrigues, Ph. D.

Sulphate of Lime	0.697
Chloride of Calcium	0.329
Chloride of Magnesium	0.340
Moisture	1.346
Chloride of Sodium (Salt)	97.288
	100.000

Steam salt made by the New York and Michigan Salt Col, at Zilwaukie. Analyzed by Dr. H. C. Hahn.

Sulphate of Lime	0.363
Chloride of Calcium	0.699
Chloride of Magnesium	0.313
Moisture	3.303
Chloride of Sodium (Salt)	95.327
	100.000

Solar salt made by New York and Michigan Co., Zilwaukie. Analyzed by Dr. H. C. Hahn.

Sulphate of Lime	0.173
Chloride of Calcium	0.743
Chloride of Magnesium	0.417
Moisture	2.19.
Chloride of Sodium (Salt)	96.470
	100.000

DAIRY SALT.

There has been a great want of a good quality of this kind of salt, so as to complete the list of Michigan salts now in the market. Several attempts have been made to start its manufacture, but none has been successful, owing in a great part to the want of care in making an article of sufficient purity.

I have now the pleasure of stating that during the past summer the Michigan Dairy Salt company, located at East Saginaw, was organized for washing, purifying and grinding the salt, with a capacity of two hundred barrels, daily, and is now in successful operation, turning out a superior quality of dairy salt, as the following analysis will show. We can hardly realize the importance of the manufacture of this grade of salt, putting, as it does, the farmer in possession, at a cheap rate, of a quality of salt for dairy purposes that cannot be excelled.

Sulphate of Lime	0.57
Chloride of Calcium	0.08
Chloride of Magnesium	0.09
Chloride of Sodium	99.03
Moisture	.23

ERRATA,

Page 10, 10th line from bottom, for separated read separated.

Page 11, 14th line from bottom, for 1876 read 1877.

Page 14, 1st line from top, for silicous read silicious.

Page 39, 21st line from top. for 500 feet read 515 feet.

Page 41, 9th line from top, for lower read iron.

Page 42, 2nd line from top, for 66 miles read 08 miles.

Page 45, 17th line from top, for afford road afforded.

Page 48, 3rd line from bottom, for indicate read indicated.

Page 49, 13th line from top, for fitful read gifted.

Page 59, 15th line from top, for 1873 read 1853.

Page 76, 16th line from top, for 38,332 read 37,882.

Page 82, 7th line from bottom, for 25 read 225.

Page 107, 3rd line from bottom, for 1877 read 1878.

Page 112, in table of analyses, for 0.47 phosphorus read .047.

Page 114, in table of analyses, for 0.44 phosphorus read .044.

Page 118, in table of analyses, for 0.27 phosphorus read .027.

Page 118, in table of analyses, for 0.22 phosphorus read .022.

Page 115, 26th line from top, for undelying read underlying.

Page 116, 27th line from top, for lead read led.

Page 125, 17th line from top, expunge the word most.

Page 129, 4th line from top, for Huron read Hudson.

Page 132, 12th line from bottom, for 47° W. read 47 N.

Page 134, 14th line from top, for noticable read noticeable.

Page 137, 5th line from bottom, for and read an.

Page 139, 1st line from top, for mor- read more.

Page 193, 16th line from bottom, for apparentely read apparently.

Page 194, 14th line from top, for varrying read varying.

Page 199, 5th line from top, for approches read approaches.

Page 199, 21st line from top, for building read bedding.

Page 208, 8th line from bottom, for they read there.

Page 209, 9th line from top, for ending read amounting.

Page 209, 2nd line from bottom, for 75,000 read 45,000.